7ο ΠΑΝΕΛΛΗΝΙΟ ΣΥΝΕΔΡΙΟ ΒΙΟΪΑΤΡΙΚΗΣ ΤΕΧΝΟΛΟΓΙΑΣ

7 Απριλίου 2017 | Αθήνα | Ελλάδα

Πρόγραμμα Συνεδρίου & Βιβλίο Περιλήψεων

ΕΛΕΒΙΤ

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Το Συνέδριο τελεί υπό την αιγίδα των:

IFMBE — International Federation for Medical and Biological Engineering

European Alliance for EAMBES Medical and Biological Engineering & Science — European Alliance of Medical and Biological Engineering

ΕΛΛΗΝΙΚΗ ΦΑΡΜΑΚΕΥΤΙΚΗ ΕΤΑΙΡΕΙΑ — Ελληνική Φαρμακευτική Εταιρεία

Παναγιώτης Μπαμίδης, Βασίλειος Γκέργκης (Συντ.)

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Conference Program & Book of Abstracts

Panagiotis Bamidis, Vasileios Gkergkis (Eds)

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7th Panhellenic Conference on Biomedical Engineering, 7 April, 2017, Athens, Greece

ΕΛΛΗΝΙΚΗ ΕΤΑΙΡΕΙΑ ΒΙΟΪΑΤΡΙΚΗΣ ΤΕΧΝΟΛΟΓΙΑΣ (ΕΛΕΒΙΤ)

Μέλος της

International Federation for Medical and Biological Engineering

European Alliance for Medical & Biological Engineering & Science

υπό την αιγίδα του Υπουργείου Υγείας

και των

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Τεχνική Επιμέλεια: Σωτηρία Γυλού, Βίκυ Ζηλίδου

Αγαπητοί Σύνεδροι,

Η Ελληνική Εταιρεία Βιοϊατρικής Τεχνολογίας (ΕΛΕΒΙΤ) είναι ένα επιστημονικό σωματείο, το οποίο αποσκοπεί στην εν γένει προαγωγή των τεχνολογικών εφαρμογών στις βιοϊατρικές επιστήμες. Πιο συγκεκριμένα, έχει ως στόχο την ενίσχυση της έρευνας, την προώθηση της εκπαίδευσης στον τομέα της Βιοϊατρικής Τεχνολογίας αλλά και την αξιολόγηση και διαχείριση της τεχνολογίας υγείας. Ο στόχος αυτός επιτυγχάνεται κυρίως μέσω της ενίσχυσης της ερευνητικής δραστηριότητας με την οργάνωση και υποστήριξη επιστημονικών εκδηλώσεων (συνεδρίων, ημερίδων, εκπαιδευτικών σεμιναρίων), καθώς και τη σύνδεση και συνεργασία με άλλες παρεμφερείς οργανώσεις της Ελλάδας και του εξωτερικού. Η ΕΛΕΒΙΤ σήμερα είναι μέλος της European Alliance for Medical and Biological Engineering & Science (EAMBES) και της International Federation of Medical and Biological Engineering (IFMBE) με ενεργό εμπλοκή στα Clinical Engineering και Healthcare Technology Assessment Τμήματά της. Μετά την επαναδραστηριοποίηση της ΕΛΕΒΙΤ το 2010, καταφέραμε και διατηρούμε μια σταθερή και διαρκώς βελτιούμενη σε ενδιαφέρον και συμμετοχή σειρά εκδηλώσεων, όπως η διοργάνωση των Πανελληνίων συνεδρίων Βιοϊατρικής Τεχνολογίας (του 3ου το 2010 στο Πόρτο Καράς στη Χαλκιδική, του 4ου το 2012 στο ΕΜΠ στην Πολυτεχνειούπολη της Αθήνας, του 5ου και 6ου το 2013 και 2015 αντίστοιχα στο Ξενοδοχείο President στην Αθήνα), όπως και μιας σειρά άλλων θεματικών ημερίδων και εκδηλώσεων. Για όλα αυτά μπορεί κανείς να ενημερωθεί από την ιστοσελίδα του σωματείου (www.elevit.org.gr).

Σας καλωσορίζουμε λοιπόν και φέτος στο 7ο Πανελλήνιο Συνέδριο Βιοϊατρικής Τεχνολογίας. Ένας από τους κύριους στόχους του συνεδρίου είναι να δώσει την ευκαιρία στις σχετικές ερευνητικές και επαγγελματικές ομάδες της χώρας μας, να συνάψουν συνεργασίες διεθνούς βεληνεκούς σε τομείς ακαδημαϊκού και κλινικού ενδιαφέροντος, συζητώντας παράλληλα καυτά θέματα εφαρμογής της βιοϊατρικής τεχνολογίας στη σύγχρονη πραγματικότητα του Ελληνικού Συστήματος Υγείας. Παράλληλα, πιστεύουμε ότι το συνέδριο θα δώσει τη δυνατότητα καταγραφής νέων επιστημονικών εξελίξεων στον τομέα της Βιοϊατρικής Τεχνολογίας και της Κλινικής Μηχανικής. Καλούμε όλους τους σχετικούς επιστήμονες και επαγγελματίες να έρθουν κοντά στην ΕΛΕΒΙΤ και να γίνουν μέλη της, καλώντας με τη σειρά τους και άλλους που πιθανόν να ενδιαφέρονται. Προφανώς, μια τέτοια συσπείρωση θα ενδυναμώσει τον κλάδο μας, τόσο ερευνητικά όσο και επαγγελματικά.

Κλείνοντας το εισαγωγικό αυτό σημείωμα, θα θέλαμε να ευχαριστήσουμε όλους τους συμμετέχοντες για την παρουσία και συμμετοχή τους, καθώς και όλους τους χορηγούς, τους εκθέτες και υποστηρικτές για την οικονομική τους συμπαράσταση στους δύσκολους αυτούς καιρούς που διανύουμε. Δεσμευόμαστε, η ενδιαφέρουσα συζήτηση που θα ανοίξει στο 7ο Πανελλήνιο Συνέδριο να συνεχιστεί από το φθινόπωρο και με άλλες θεματικές ημερίδες.

Εκ μέρους της οργανωτικής επιτροπής του συνεδρίου και του ΔΣ της ΕΛΕΒΙΤ,

Παναγιώτης Μπαμίδης
Βασίλειος Γκέργκης

ΧΟΡΗΓΟΙ ΣΥΝΕΔΡΙΟΥ

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Α.Ε. ΙΑΤΡΙΚΩΝ ΕΦΑΡΜΟΓΩΝ

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ΠΑΡΑΣΚΕΥΗ 7 ΑΠΡΙΛΙΟΥ 2017
7ο Πανελλήνιο Συνέδριο Βιοϊατρικής Τεχνολογίας
7 Απριλίου 2017
Ξενοδοχείο PRESIDENT, Αθήνα

ΕΛΕΒΙΤ
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2. ΗΛΙΑΣ ΜΑΓΚΛΟΓΙΑΝΝΗΣ (ΑΝΤΙΠΡΟΕΔΡΟΣ)
3. ΒΑΣΙΛΕΙΟΣ ΓΚΕΡΓΚΗΣ (ΓΡΑΜΜΑΤΕΑΣ)
4. ΓΕΩΡΓΙΟΣ ΚΑΡΑΓΙΑΝΝΗΣ (ΤΑΜΙΑΣ)
5. ΜΙΧΑΗΛ ΖΕΡΒΑΚΗΣ
6. ΖΑΧΑΡΙΑΣ ΚΑΜΑΡΙΑΝΑΚΗΣ
7. ΔΗΜΗΤΡΗΣ ΚΟΥΤΣΟΥΡΗΣ
8. ΠΑΝΑΓΙΩΤΗΣ ΜΑΛΑΤΑΡΑΣ
9. ΛΕΟΝΤΙΟΣ ΧΑΤΖΗΛΕΟΝΤΙΑΔΗΣ

Οργανωτική Επιτροπή

Παναγιώτης ΜΠΑΜΙΔΗΣ (ΠΡΟΕΔΡΟΣ)
Βασίλειος ΓΚΕΡΓΚΗΣ(ΠΡΟΕΔΡΟΣ)

Κώστας ΓΚΙΟΚΑΣ
Μιχάλης ΖΕΡΒΑΚΗΣ
Βασιλική ΖΗΛΙΔΟΥ
Ζαχαρίας ΚΑΜΑΡΙΑΝΑΚΗΣ
Γεώργιος ΚΑΡΑΓΙΑΝΝΗΣ
Ηλίας ΜΑΓΚΛΟΓΙΑΝΝΗΣ
Παναγιώτης ΜΑΛΑΤΑΡΑΣ
Αναστασία ΡΟΝΤΙΝΑ-ΘΕΟΧΑΡΑΚΗ
Πέτρος ΤΟΥΜΠΑΝΙΑΡΗΣ
Λεόντιος ΧΑΤΖΗΛΕΟΝΤΙΑΔΗΣ

Επιστημονική Επιτροπή

Παντελής ΑΓΓΕΛΙΔΗΣ
Αντώνης ΑΛΕΤΡΑΣ
Παναγιώτης ΑΝΤΩΝΙΟΥ
Αλέξανδρος ΑΣΤΑΡΑΣ
Διδώ ΓΙΟΒΑ
Βασίλειος ΓΚΕΡΓΚΗΣ
Δέσποινα ΔΕΛΗΓΙΑΝΝΗ
Ευάγγελος ΔΕΡΜΑΤΑΣ
Μιχάλης ΖΕΡΒΑΚΗΣ
Δήμητρα ΗΛΙΟΠΟΥΛΟΥ
Εμμανουήλ ΚΑΚΛΙΔΑΚΗΣ
Ζαχαρίας ΚΑΜΑΡΙΑΝΑΚΗΣ
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Δημήτρης ΚΟΥΤΣΟΥΡΗΣ
Ευδόκιμος ΚΩΝΣΤΑΝΤΙΝΙΔΗΣ
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Ηλίας ΜΑΓΚΛΟΓΙΑΝΝΗΣ
Σταυρούλα ΜΑΚΡΗ
Παναγιώτης ΜΑΛΑΤΑΡΑΣ
Χρήστος ΜΑΝΟΠΟΥΛΟΣ

Γιώργος ΜΑΤΣΟΠΟΥΛΟΣ
Βασίλης ΜΕΓΑΛΟΟΙΚΟΝΟΜΟΥ
Χρήστος ΜΙΧΑΗΛ
Κωνσταντίνος ΜΟΥΣΤΑΚΑΣ
Παναγιώτης ΜΠΑΜΙΔΗΣ
Βηθλεέμ ΜΩΥΣΙΔΟΥ
Ηλίας ΝΑΣΟΣ
Κωνσταντίνα ΝΙΚΗΤΑ
Νίκος ΠΑΛΛΗΚΑΡΑΚΗΣ
Γεώργιος ΠΑΠΠΟΥΣ
Σωτήρης ΠΑΥΛΟΠΟΥΛΟΣ
Νικόλαος ΠΙΤΣΙΑΝΗΣ
Ανδριάνα ΠΡΕΝΤΖΑ
Χριστόφορος ΠΡΟΒΑΤΙΔΗΣ
Γιώργος ΣΑΑΤΣΑΚΗΣ
Θεόδωρος ΣΑΜΑΡΑΣ
Γεώργιος ΣΕΡΓΙΑΔΗΣ
Αναστάσιος ΣΙΟΥΝΤΑΣ
Αθανάσιος ΣΚΟΔΡΑΣ
Ιωάννης ΣΤΑΘΟΥΛΗΣ
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Αντώνιος ΤΖΕΣ
Σωκράτης ΤΣΑΓΓΑΡΗΣ
Δημήτρης ΦΩΤΙΑΔΗΣ
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Μαρία ΧΑΡΙΤΟΥ
Λεόντιος ΧΑΤΖΗΛΕΟΝΤΙΑΔΗΣ

Πρόγραμμα Συνεδρίου

ΠΑΡΑΣΚΕΥΗ 7 ΑΠΡΙΛΙΟΥ 2017

08.30 – 09.00 **ΠΡΟΣΕΛΕΥΣΗ - ΕΓΓΡΑΦΕΣ** / REGISTRATION

09.00 – 09.15 **ΕΝΑΡΞΗ - ΧΑΙΡΕΤΙΣΜΟΙ** / CONFERENCE OPENING - WELCOME SPEECH

09.15 – 10.45 1η Θεματική Ενότητα: Τεχνολογία - Ασφάλεια - Κόστος Ι

Συντονιστής: Π. Μαλαταράς, Παν. Πατρών

Εισήγηση 1: «Τεχνική Ασφάλεια στο χώρο του Νοσοκομείου για ασθενείς & προσωπικό»
Ιωάννης Ρέτσιος, Ειδικός εκπαίδευσης και εφαρμογών.

Εισήγηση 2: «Η σημασία των ΣΕΑ (Σχέδια Εκτάκτου Ανάγκης)»
Νικόλαος Διαμαντής, Υποστράτηγος Π.Σ. ε.α. , Νομικός - Σύμβουλος Πυρασφάλειας & Πολιτικής Προστασίας.

Εισήγηση 3: «Ανάλυση Κόστους Παραγωγής Οξυγόνου 93% Συστημάτων PSA & VPSA»
Κωνσταντίνος Καραπιπέρης, Χημικός Μηχανικός του ΕΜΠ, Ειδικός Ιατρικών Αερίων και των Εφαρμογών τους.

Εισήγηση 4: «Κατάλληλη επιλογή κλινών νοσηλείας»
Βασιλική Καλαντζή, Προϊσταμένη Καρδιολογικού τμήματος, Γενικό Νοσοκομείο Αθηνών η Ελπίς.

10.45 - 11.15 ΔΙΑΛΕΙΜΜΑ ΚΑΦΕ - ΑΝΑΡΤΗΜΕΝΕΣ ΑΝΑΚΟΙΝΩΣΕΙΣ,

COFFEE BREAK - POSTER SESSION

11.15 – 13.15 2η Θεματική Ενότητα: Τεχνολογία - Ασφάλεια - Κόστος ΙΙ

Συντονιστής: Α. Χαλαζωνίτης, Δ/ντής Ακτινοδιαγνωστικού Τμ. Γ.Ν. ''Αλεξάνδρα''

Εισήγηση 1: «Πώς μπορούν τα ειδικά προγράμματα συλλογής δόσης ασθενών να βοηθήσουν ένα απεικονιστικό τμήμα»
Βιργινία Τσαπάκη, Ακτινοφυσικός Ιατρικής Κωσταντοπούλειο Γεν.Νοσοκομείο Νέας Ιωνίας, Πρόεδρος Ένωσης Φυσικών Ιατρικής Ελλάδος

Εισήγηση 2: «Operating room building and planning: New technologies & innovations»
Andreas Kirschner, Specialist Surgical Workflows - Hybrid Operating Rooms
Η ομιλία θα πραγματοποιηθεί στην αγγλική γλώσσα

Εισήγηση 3: «Ηλεκτρονικοί εξαερωτές και αναδραστικά συστήματα αναισθησίας: Τεχνολογία στην ασφάλεια του ασθενούς»
Δρ. Δημήτρης Βαλσαμίδης, Δ/ντης Αναισθησιολογικού Γ.Ν. ''Αλεξάνδρα''.

Εισήγηση 4: «Healthcare Information Security»
Κώστας Παπαδάτος, Πρόεδρος (ISC)^2, Hellenic Chapter

Εισήγηση 5: «Ανακαλύπτοντας τη βέλτιστη απόδοση του Διαγνωστικού εργαστηρίου»
Konstantinos Varlas PhD, Professional Service Developer Emerging Market

13.15 – 14.30 3η Θεματική Ενότητα: Κλινική Μηχανική

Συντονιστής: Ν. Παλληκαράκης, Ομότ. Καθηγητής, Παν. Πατρών

Εισήγηση 1: «Εγκατάσταση και Συντήρηση Ιατροτεχνολογικού Εξοπλισμού: Από την σκοπιά της Επιθεώρησης EN ISO 13485»
Γεώργιος Μελαχρινός, Χημικός Μηχανικός, Επικεφαλής Επιθεωρητής Συστημάτων Διαχείρισης Ποιότητας.

Εισήγηση 2: «Αξιοπιστία και συντήρηση, οι δυο όψεις του ίδιου νομίσματος»
Χαρίλαος Αποστολίδης, MSc Διπλ. Ηλεκτρ. Μηχανικός, Πρνος Υποδιεύθυνσης Τεχνικού, Γ.Ν.Λάρισας.

Εισήγηση 3: «Ο ρόλος του κτηματολογίου ιατροτεχνολογικού εξοπλισμού στην ασφάλεια ασθενούς και τον έλεγχο κόστους διαθεσιμότητας»,
Παναγιώτης Μαλαταράς, INBIT

Εισήγηση 4: «Ο Νόμος 4412/16 και η δυνατότητα εργασιών επισκευής και συντήρησης»
Κωνσταντίνος Σαμαρτζής, Δικηγόρος παρ' Αρείω Πάγω.

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14.30 – 15.00 Ελαφρύ γεύμα-Αναρτημένες Ανακοινώσεις

15.00 – 16.15 4η Θεματική Ενότητα: Σύγχρονες ερευνητικές εξελίξεις στη Βιοϊατρική Μηχανική

Συντονιστής: Δ.Δ. Κουτσούρης, Καθηγητής, ΕΜΠ

Εισήγηση 1: «Ανάπτυξη έξυπνων & φορητών συστημάτων παρακολούθησης υγείας»
Κώστας Γκιόκας, ΕΜΠ.

Εισήγηση 2: «An ultrasonic and spectroscopic mapping microscopy lab performing non invasive evaluation of epidermic structures»
Γεώργιος Καραγιάννης, Ίδρυμα Ορμύλια

Εισήγηση 3: «Τεχνολογίες αισθητήρων και Internet of Things στην Ιατρική»
Ηλίας Μαγκλογιάννης, Αναπλ. Καθηγητής Πανεπ. Πειραιά

Εισήγηση 4: «Αξιολόγηση και προτυποποίηση τεχνολογιών φροντίδας ευπαθών ομάδων»
Παναγιώτης Μπαμίδης, Αναπλ. Καθηγητής ΑΠΘ, Πρόεδρος ΕΛΕΒΙΤ

Εισήγηση 5: «Συστήματα ολοκληρωμένης φροντίδας: σχέση ηλεκτρονικών φακέλων ασθενών και βιοϊατροτεχνολογικού εξοπλισμού»
Δήμητρα Ηλιοπούλου, Ερευνήτρια, Εθνικό Μετσόβιο Πολυτεχνείο

16.15 – 17.15 5η Θεματική Ενότητα – Στρογγυλή Τράπεζα: Αξιολόγηση Βιοϊατρικής Τεχνολογίας από τη σκοπιά της Διοίκησης

Συντονιστές: Άγγελος Παπαδόπουλος, Διοικητής, 1η ΥΠΕ ΑΤΤΙΚΗΣ,

Δημήτρης Νιάκας, Πρόεδρος, Ωνάσειο Καρδιοχειρουργικό Κέντρο

Συμμετέχοντες Πάνελ:

Ευαγγελία Παππά, Υποδιοικήτρια, Γ.Ν. «Αλεξάνδρα»

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Νίκος Κοντοδημόπουλος, Ν. Διοικητής, Γ.Ν. ΚΑΤ

Γεώργιος Χαλούτσος, Πρνος Βιοϊατρικής Τεχνολογίας, Ωνάσειο Καρδιοχειρουργικό Κέντρο

Μαρία Ράικου, Επίκ. Καθηγήτρια, Παν. Πειραιά

17.15 – 17.45 Γενικά Συμπεράσματα και Λήξη Συνεδρίου

17.45 – 18.00 Διάλειμμα καφέ / Coffee Break

18.00 – 20.30 Γενική Συνέλευση ΕΛΕΒΙΤ και Εκλογές Δ.Σ

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ΑΝΑΡΤΗΜΕΝΕΣ ΑΝΑΚΟΙΝΩΣΕΙΣ / POSTER SESSION

1. **ΓΕΩΓΡΑΦΙΚΗ ΑΠΟΤΥΠΩΣΗ ΚΑΙ ΟΙΚΟΝΟΜΙΚΗ ΔΙΑΧΕΙΡΙΣΗ ΤΟΥ ΙΑΤΡΟΤΕΧΝΟΛΟΓΙΚΟΥ ΕΞΟΠΛΙΣΜΟΥ ΜΕ ΧΡΗΣΗ GIS: ΠΙΛΟΤΙΚΗ ΕΦΑΡΜΟΓΗ ΣΕ ΑΝΑΠΝΕΥΣΤΗΡΕΣ ΜΕΘ**
   Δ. Τσορομώκος, Δ. Ζαρακοβίτης και Α. Λαζακίδου

2. **ΑΞΙΟΠΟΙΗΣΗ ΤΩΝ GIS ΣΤΗ ΓΕΩΓΡΑΦΙΚΗ ΑΠΟΤΥΠΩΣΗ ΚΑΙ ΟΙΚΟΝΟΜΙΚΗ ΔΙΑΧΕΙΡΙΣΗ ΤΩΝ ΣΥΣΤΗΜΑΤΩΝ ΥΠΕΡΗΧΟΤΟΜΟΓΡΑΦΙΑΣ ΤΩΝ ΔΗΜΟΣΙΩΝ ΑΚΤΙΝΟΛΟΓΙΚΩΝ ΕΡΓΑΣΤΗΡΙΩΝ ΤΗΣ ΠΕΛΟΠΟΝΝΗΣΟΥ**
   Δ. Ζαρακοβίτης, Δ. Τσορομώκος και Α. Λαζακίδου

3. **A DECISION MAKING SUPPORT SYSTEM IN NUCLEAR MEDICINE USING FUZZY COGNITIVE MAPS**
   J.D. Apostolopoulos and P.P. Groumpos

4. **AN OPTIMIZATION STUDY FOR PRECLINICAL X-RAY IMAGING OF GOLD NANOPARTICLES USING GATE SIMULATIONS**
   M. Rouchota, G. Loudos, P. Papadimitroulas and G. Kagadis

5. **COMPUTED TOMOGRAPHY DOSIMETRY AND OPTIMIZATION FOR PAEDIATRIC PATIENTS**
   T. Kostou, P. Papadimitroulas, G. Loudos and G.C. Kagadis

6. **EXPERIMENTAL DETERMINATION OF THE MECHANICAL PROPERTIES FOR THE PROPAGATION OF THE HUMAN AORTIC DISSECTION**
   C. Manopoulos, I. Karathanasis, I. Kouerinis, M. Dimosthenous, A. Lazaris, G. Geroulakos, D.P. Sokolis and S. Tsangaris

7. **CARDIOVASCULAR MONITORING FROM ARTERIAL WALL MOTION BASED ON ELECTROMAGNETIC INDUCTION**
   G. Karageorgos, C. Manopoulos, A. Karagiannis, S. Tsangaris and K. S. Nikita

8. **WAVELET ECG ANALYSIS IN TIME-FREQUENCY DOMAIN OF THE QRS-COMPLEX IN NORMAL INDIVIDUALS AND HEART FAILURE PATIENTS WITH LEFT BUNDLE BRANCH BLOCK**
   K. Papathoma, S. Chatzimiltiadis, N. Maglaveras, I. Chouvarda, E. Theofilogiannakos, D. Konstantinou and V. Vassilikos

9. **A REWORKED SECOND ORDER BLIND IDENTIFICATION ALGORITHM IN EEG PROCESSING TECHNIQUE FOR FAST RECOGNITION OF MOTOR IMAGERY MOVEMENTS**
   G. Kalogiannis and G. Hassapis

10. **CARBON NANOTUBES IMMUNOBIOSENSOR FOR GLIAL FIBRILLARY ACIDIC PROTEIN (GFAP) DETECTION IN NEUROCLINICAL DIAGNOSIS**
    G. Katsipis, L. Tzounis, A.S. Paipetis, G. Litsardakis and A.A. Pantazaki

11. **WHEAMO: A WIRELESS HEALTH PLATFORM FOR MONITORING PANCREAS-RELATED DISEASES**
    T. Chrysikos, I. Zisi , G. Raptis, C. Katsini and S. Kotsopoulos

12. **MERCURY 2.0: NON-INVASIVE BCI-CONTROLLED ROBOTIC ARMS**
    G. Arfaras, P. Kartsidis, A. Athanasiou, A. Astaras and P.D. Bamidis

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13. **DERMASENSE: A NOVEL, NON-INVASIVE DERMATOLOGICAL SCANNER BASED ON ELECTRICAL IMPEDANCE SPECTROSCOPY**
S. Gilou, A. Zogkas, C. Korfitis, C. Kemanetzi, E. Lazaridou, P.D. Bamidis and A. Astaras

14. **DECIPHERING SIGNALING MECHANISMS OF CARTILAGE TISSUE ENGINEERED ALGINATE SCAFFOLDS**
A. Korcari, M. Kallo and L. Alexopoulos

15. **ΣΥΝΔΥΑΣΤΙΚΗ ΧΡΗΣΗ ΨΗΦΙΑΚΗΣ ΑΠΟΤΥΠΩΣΗΣ ΚΑΙ ΜΗΧΑΝΙΚΟΥ ΑΙΣΘΗΤΗΡΑ ΕΠΑΦΗΣ ΓΙΑ ΤΗ ΜΕΤΡΗΣΗ ΑΠΟΚΛΙΣΕΩΝ ΘΕΣΗΣ ΟΔΟΝΤΙΑΤΡΙΚΩΝ ΕΜΦΥΤΕΥΜΑΤΩΝ ΣΕ ΠΕΡΙΒΑΛΛΟΝ 3D-CAD/ CMM**
Γ. Καϊσαρλής, Ε. Παπάζογλου και Χ. Προβατίδης

16. **A DEVICE FOR REAL-TIME MONITORING DEGRADATION IN MULTIPLE CARTILAGE SAMPLES**
I. Panagiotopoulos, D.S. Tzeranis, S. Gkouma, G.P. Kanakaris, G. Vasileiou, V. Spitas and L.G. Alexopoulos

17. **PRIMARY HUMAN HEPATOCYTE MODELS FOR NAFLD/NASH BASED ON PHOSPHOPROTEOMICS**
D.S. Zareifi, D.E. Messinis, A. Minia, V. Pliaka, J. Rožanc, M.M. Konstadoulakis, K.J. Bramis, E. A. Antoniou and L.G. Alexopoulos

18. **SUBPATHWAY APPROACHES ON THE ROAD TO NETWORK MEDICINE**
A.G. Vrahatis, A. Dragomir and A. Bezerianos

19. **NEUROFEEDBACK INTERVENTION FOR CERVICAL DYSTONIA**
N. Pandria, A. Athanasiou and P.D. Bamidis

20. **CLINICAL DECISION MAKING TOWARDS EARLY DETECTION OF NEUROPATHOLOGICAL PATTERNS AND TRAINING PROMOTING ACTIVE AGEING**
C. A. Frantzidis, V. Zilidou, S. Gilou, E. Romanopoulou, S. Douka and P.D. Bamidis

21. **NEW FIGURE OF MERIT FOR DUAL ENERGY X-RAY IMAGE QUALITY ASSESSMENT BASED ON LINE PROFILES ANALYSIS: INITIAL RESULTS**
A. Dermitzakis and N. Pallikarakis

22. **NEW PERSPECTIVES AND CHALLENGES IN BIOMEDICAL ENGINEERING EDUCATION**
N. Pallikarakis and A. Dermitzakis

23. **HOME TELE-MONITORING OF PATIENTS WITH IDIOPATHIC PULMONARY FIBROSIS**
A. Georgountzou, L.Sheikha, E.P. Smyrli, F. Malli, A. Menychtas, C. Panagopoulos, Z. Daniil, K. Gourgoulianis, P. Tsanakas and I. Maglogiannis

24. **WIRELESS SYSTEM FOR DYNAMIC BODY STABILITY ASSESSMENT**
E. Valchinov, A. Antoniou, K. Rotas, G. Kaimakas and N. Pallikarakis

25. **AN ULTRASONIC AND SPECTROSCOPIC MICROSCOPY LAB PERFORMING HIGH RESOLUTION QUANTITATIVE AND QUALITATIVE EVALUATION OF EPIDERMIC STRUCTURES (USE CASES ON SKIN, BRAIN AND NAIL)**
G. Karagiannis

26. **ΠΑΡΑΜΕΤΡΙΚΕΣ ΜΕΛΕΤΕΣ ΓΙΑ ΤΗ ΔΙΑΔΙΚΑΣΙΑ ΜΑΓΝΗΤΙΚΗΣ ΟΔΗΓΗΣΗΣ ΣΦΑΙΡΙΚΩΝ ΣΩΜΑΤΙΔΙΩΝ ΣΤΟ ΠΛΑΙΣΙΟ ΤΗΣ ΣΤΟΧΕΥΜΕΝΗΣ ΜΕΤΑΦΟΡΑΣ ΦΑΡΜΑΚΟΥ**
Ε.Γ. Καρβέλας, Ν.Κ. Λαμπρόπουλος , Τ.Ε. Καρακασίδης και Ι.Ε. Σαρρής

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27. **SLEEP MACRO-ARCHITECTURE DISTURBANCES DURING 60 DAYS 6° HEAD DOWN TILT BED-REST AND THE EFFECT OF SLEDGE JUMPING SYSTEM (SJS) AS A COUNTERMEASURE TO PREVENT THOSE CHANGES**
P. T. Gkivogkli, C. A. Frantzidis, M. Karagianni, A.Lada, P.D. Bamidis and C.Kourtidou-Papadeli

28. **3D "SPECTRACOUSTIC" SYSTEM: A MODULAR, TOMOGRAPHIC, SPECTROSCOPIC MAPPING IMAGING, NON-INVASIVE, DIAGNOSTIC SYSTEM FOR DETECTION OF SMALL STARTING DEVELOPING TUMOURS LIKE MELANOMA**
G. Karagiannis

29. **Η ΤΕΧΝΙΚΗ ΔΙΠΛΗΣ ΚΑΤΗΓΟΡΙΟΠΟΙΗΣΗΣ ΣΤΗΝ ΑΝΑΛΥΣΗ ΓΟΝΙΔΙΩΝ**
Δ. Ανδρουλάκη, Α. Σ. Μπέη και Μ. Ζερβάκης

30. **ΣΥΓΚΛΙΣΗ ΤΟΥ ΤΟΜΕΑ ΑΠΕΙΚΟΝΙΣΗΣ ΤΟΥ Γ.Ν. ΧΑΝΙΩΝ 'Ο ΑΓΙΟΣ ΓΕΩΡΓΙΟΣ' ΣΤΙΣ ΣΥΓΧΡΟΝΕΣ ΑΠΕΙΚΟΝΙΣΤΙΚΕΣ ΜΕΘΟΔΟΥΣ**
Γ.Μακρής-Τσαλίκης, Σ. Σεφερλής, Γ. Ζαρίφης, Ι. Πολογιώργη και Μ. Ζερβάκης

31. **NEUROPROTECTIVE EFFECTS OF PHYSICAL ACTIVITY IN PARKINSON'S DISEASE: A RESTING STATE EEG STUDY ON THE webFitForAll EFFICACY**
P. Kartsidis, C. Styliadis, M. Karagianni, V. Zilidou, E. Konstantinidis, Z. Katsarou, S. Bostantjopoulou, L.J. Hadjileontiadis and P.D. Bamidis

32. **SLEEP STAGE CLASSIFICATION USING NETWORK CHARACTERISTICS CALCULATED FROM ELECTROENCEPHALOGRAPHIC RECORDINGS**
P. Chriskos, D.S. Kaitalidou, G. Karakasis, C. Frantzidis, P.T. Gkivogkli, P.D. Bamidis and C. Kourtidou-Papadeli

33. **DECIPHERING THE MOLECULAR MECHANISMS OF ORAL CANCER PROGRESSION**
K. Kourou, C. Papaloukas and D.I. Fotiadis

34. **ANALYSIS OF CORONARY COMPUTED TOMOGRAPHY ANGIOGRAPHY FOR 3D RECONSTRUCTION OF ARTERIAL TREES AND PLAQUE DETECTION**
P.K. Siogkas, V. Kigka, G. Rigas, A.I. Sakellarios, T.P. Exarchos and D.I. Fotiadis

35. **ULTRASONIC EVALUATION OF CORTICAL POROSITY**
V.T. Potsika, K.N. Grivas, T.V. Gortsas, V.C. Protopappas, D.K. Polyzos and D.I. Fotiadis

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ABSTRACTS
Περιλήψεις

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ORAL PRESENTATIONS

Προφορικές ανακοινώσεις

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«Τεχνική Ασφάλεια στο χώρο του Νοσοκομείου για ασθενείς & προσωπικό»

Ιωάννης Ρέτσιος
Υπεύθυνος Εκπαίδευσης & Εφαρμογών

Γιατί χρειαζόμαστε τεχνική ασφάλεια στα Νοσοκομεία ;
Ποιοι πρέπει να προστατευθούν εντός των Νοσοκομείων, και οι παράγοντές που επηρεάζουν τους χώρους και την υποδομή.
Μέσα προστασίας της αναπνοής για τους εργαζόμενους αλλά και τους επισκέπτες στα νοσοκομεία σε περίπτωση εκτάκτου ανάγκης.
Η κείμενη νομοθεσία σύμφωνα με το ΦΕΚ 2434/2014 περί αναπνευστικών συσκευών.
Προσωπίδες ολόκληρου προσώπου και φίλτρα προστασίας, πότε χρειάζονται και πώς επιλέγονται.
Πυροσβεστικοί σταθμοί και εξοπλισμός πυρασφάλειας, περιλαμβάνει τα σωστά υλικά που θα με βοηθήσουν σε περίπτωση εκτάκτου ανάγκης.
Επιπλέον εξοπλισμός προστασίας, κουκούλες διαφυγής & αυτόνομες συσκευές παροχής φιλτραρισμένου αέρα στα νοσοκομεία.
Η ασφάλεια των φιαλών υπό πίεση & η ορθή μεταφορά & αποθήκευση τους.
Κίνδυνοι ατυχημάτων στα νοσοκομεία και οι μέθοδοι μείωσης τους μέσω της εκπαίδευσης, της τεχνογνωσίας και των ασκήσεων.

«Η σημασία των ΣΕΑ (Σχέδια Εκτάκτου Ανάγκης)»

Νικόλαος Γ Διαμαντής
Υποστράτηγος Π.Σ. ε.α.
Νομικός - Σύμβουλος Πυρασφάλειας & Πολιτικής Προστασίας

Ο Επιχειρησιακός Σχεδιασμός Περιλαμβάνει: Τον **Γενικό Σχεδιασμό** που είναι το σύνολο των δράσεων που αναλαμβάνονται για την προσαρμογή των πόρων και των κανονικών συστημάτων διοίκησης, λειτουργίας και ασφάλειας του Οργανισμού, στις ανάγκες και τους στόχους πολιτικής προστασίας (ειδικούς, έκτακτους ή και προσωρινής διάρκειας).
Τον Επιχειρησιακό **Σχεδιασμό** που είναι η μετατροπή των έργων (που ομαδοποιούνται σε προγράμματα) σε σχέδια. Πρόκειται για ένα σύνολο τεχνικών και διαδικαστικών κανόνων για την διάθεση πόρων που έχουν κριθεί απαραίτητοι και διατίθενται σε σχέση με τις προβλεπόμενες ανάγκες.
Τα **Σχέδια Εκτάκτων Αναγκών** που αποτελούν ένα σύνολο τεχνικών και διαδικαστικών κανόνων για την επαναδιάθεση πόρων σε σχέση με κάποια έκτακτη ανάγκη Πολιτικής Προστασίας.
Το Σ.Ε.Α είναι ένα βασικό εργαλείο μέγιστης προτεραιότητας, για την εξασφάλιση της επιχειρησιάκης και επιχειρηματικής συνέχειας της εγκατάστασης και εξασφαλίζει στο μέτρο του δυνατού:

- την ασφάλεια των ασθενών, των υπαλλήλων και των επισκεπτών της εγκατάστασης και του Οργανισμού,
- την ασφάλεια των υποδομών της εγκατάστασης και της περιοχής γενικότερα,
- την εγκαιρή και συντονισμένη συνεργασία με τις αρμόδιες κρατικές υπηρεσίες πυροπροστασίας και πολιτικής προστασίας (ΕΛ.ΑΣ, Π.Σ., ΕΚΑΒ, Τ.Ο.,Γ.Γ.Π.Π κλπ.),
- την άμεση υποστήριξη των ειδικών συνεργαζόμενων συνεργείων,
- την προετοιμασία για τον χειρισμό των απαιτήσεων για πληροφορίες από τους πελάτες, το γενικό κοίνο και τα Μ.Μ.Ε.

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«Ανάλυση Κόστους Παραγωγής Οξυγόνου 93% Συστημάτων PSA & VPSA»

Κωνσταντίνος Καραπιπέρης
Χημικός Μηχανικός του ΕΜΠ
Ειδικός Ιατρικών Αερίων και των Εφαρμογών τους.

Το οξυγόνο από φυσικό διαχωρισμό είναι το προιόν που παράγεται από γεννήτριες οξυγόνου μέσω μοριακών φίλτρων. Οι γεννήτριες-συστήματα παραγωγής οξυγόνου 93% εφαρμόζουν την τεχνολογία PSA, ήτοι τον στατικό διαχωρισμό των συστατικών του ατμοσφαιρικού αέρα. Η τελευταία εξέλιξη της τεχνολογίας διαχωρισμού είναι τα συστήματα VPSA, με χρήση κενού για τη διαδικασία αναγεννησης και αέριας εκκενωσης. Αναπόφευκτα λοιπόν παρουσιάζει ιδιαίτερο ενδιαφέρον η προσεγγιστική ανάλυση του κόστους παραγωγής οξυγόνου 93% για νοσοκομειακή χρήση, από συγκροτήματα PSA και VPSA, συμπεριλαμβάνοντας το κόστος κτήσης, λειτουργίας (ηλεκτρική ενέργεια) και συντήρησης.

«Κατάλληλη επιλογή κλινών νοσηλείας»

Βασιλική Καλαντζή
Προϊσταμένη Καρδιολογικού τμήματος, Γενικό Νοσοκομείο Αθηνών η Ελπίς

Το θέμα παρουσιάζει όλα τα σημεία που πρέπει να συμπεριληφθούν κατά την επιλογή και προμήθεια οποιασδήποτε κλίνης νοσηλείας σε οποιοδήποτε τμήμα.

Συγκεκριμένα, γίνεται αναφορά:

- Στατιστικά στοιχεία τα οποία αποτυπώνουν το πρόβλημα που δημιουργείται όταν δεν υπάρχει η σωστή κλίνη και ποια είναι τα αποτελέσματα.
- Ποιους εξυπηρετεί η σωστή επιλογή κλίνης.
- Συγκριτικά τεχνικά στοιχεία και πως πλεονεκτεί η προμήθεια ηλεκτροκίνητης έναντι μηχανοκίνητης κλίνης.
- Στους τρεις (3) τομείς (Νοσηλευτικό προσωπικό, ασθενή, Διαχείριση νοσοκομείου) που επωφελούνται με την χρήση ηλεκτροκίνητων κλινών.

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«Πώς μπορούν τα ειδικά προγράμματα συλλογής δόσης ασθενών να βοηθήσουν ένα απεικονιστικό τμήμα»

Βιργινία Τσαπάκη
Ακτινοφυσικός Ιατρικής Κωσταντοπούλειο Γεν.Νοσοκομείο Νέας Ιωνίας
Πρόεδρος Ένωσης Φυσικών Ιατρικής Ελλάδος

Τα ειδικά προγράμματα συλλογής δόσης ασθενών η αλλιώς dose tracking systems, είναι εξειδικευμένα λογισμικά πακέτα τα οποία έχουν στόχο να συλλέξουν όλες τις κλινικές πληροφορίες αλλά και τις τεχνικές παραμέτρους που καταγράφονται ή καταχωρούνται από το λογισμικό του κάθε απεικονιστικού ιατρικού μηχανήματος ή των ιατρικών πληροφοριακών συστημάτων (HIS, RIS, PACS κλπ) και μεταφέρονται μέσω του πρωτοκόλλου Digital Imaging and Communications in Medicine (DICOM).
Τα ειδικά αυτά προγράμματα συλλογής δόσης ασθενών μπορούν να συνδεθούν με τα απεικονιστικά ιατρικά μηχανήματα και τα συστήματα διαχείρισης των ιατρικών δεδομένων διαφορετικών εταιρειών. Η ανάλυση όλων των παραπάνω παραμέτρων παρέχει εξαιρετικά αναλυτικές πληροφορίες όσον αφορά στη δόση ακτινοβολίας των ασθενών αλλά και στον τρόπο χρήσης των πρωτοκόλλων ακτινοβόλησης.
Τα προγράμματα αυτά αποτελούν ένα πολύ σημαντικό εργαλείο και μπορούν να συνεισφέρουν στη μείωση της δόσης ακτινοβολίας των απεικονιστικών ιατρικών εξετάσεων, στην πιστοποίηση των εργαστηρίων από διεθνής οργανισμούς (π.χ JCI), στη συμμόρφωση με την Ευρωπαϊκή Νομοθεσία, στην εκπαίδευση του προσωπικού που χειρίζεται τα μηχανήματα αυτά, αλλά και κυρίως να αναβαθμίσουν τη γενικότερη λειτουργία των απεικονιστικών Τμημάτων.

«Operating room building and planning: New technologies & innovations»

Andreas Kirschner
Specialist Surgical Workflows - Hybrid Operating Rooms

Hybrid Operating Rooms: today and tomorrow. Imaging equipment as angiography systems, CT and MRi enable on-the-spot intraoperative diagnostic in the OR and sophisticated hybrid therapies in cardiac, vascular, orthopedic and neurosurgery. Hybrid Operating Rooms provide perfect conditions and the right space for less traumatic procedures, enabling better outcome for high-risk patients. How to plan and how to equip the perfect Hybrid Operating Room today? Which possibilities will a Hybrid Operating Theatre provide tomorrow?

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«Ηλεκτρονικοί εξαερωτές και αναδραστικά συστήματα αναισθησίας: Τεχνολογία στην ασφάλεια του ασθενούς»

Δρ. Δημήτρης Βαλσαμίδης
Δ/ντης Αναισθησιολογικού Γ.Ν. ‘’Αλεξάνδρα’’

Η δουλειά του αναισθησιολόγου είναι τόσο τέχνη όσο και επιστήμη, με τελικό στόχο τον προσδιορισμό της βέλτιστης αναισθησίας για κάθε ασθενή ξεχωριστά σε συνθήκες κλινικής ασφάλειας.
Οι αναισθησιολόγοι ξοδεύουν πολύτιμο χρόνο για τον έλεγχο και τον επανέλεγχο των τιμών του οξυγόνου και των αναισθητικών παραγόντων (EtO2 και ETAA) με επαναριθμήσεις και εκ νέου προσαρμογή για τις αλλαγές που προκύπτουν στην πρόσληψη και στον μεταβολικό ρυθμό του ασθενούς, ώστε να εξασφαλιστεί η ασφαλής και αποτελεσματική αναισθησία για τον συγκεκριμένο ασθενή. Όλα αυτά γίνονται παράλληλα με ένα πλήθος άλλων χρονοβόρων και πολύπλοκων εργασιών.
Με την εφαρμογή της σύγχρονης ψηφιακής τεχνολογίας στους Ηλεκτρονικούς Εξαερωτές πτητικών αναισθητικών παραγόντων σε συνδυασμό με σύγχρονα αναισθησιολογικά μηχανήματα μπορούμε να μειώσουμε με ασφάλεια πολλές από τις ανωτέρω χρονοβόρες διαδικασίες μειώνοντας παράλληλα δραματικά και το κόστος των χορηγούμενων πτητικών φαρμάκων ανά ασθενή

«Healthcare Information Security»

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Τα τελευταία χρόνια η τεχνολογία της πληροφορικής έχει αναπτυχθεί ραγδαία ενώ, έχει διεισδύσει έντονα σε όλους τους επαγγελματικούς κλάδους προσφέροντας σημαντικά ανταγωνιστικά πλεονεκτήματα.
Τα ιατρικά δεδομένα αποτελούν ίσως τον ευαίσθητο τύπο πληροφοριών καθώς μια πιθανή διαρροή ή τροποποίηση τους, τους μπορεί να επηρεάσει σημαντικά τη προσωπική ζωή αλλά και την εξέλιξη της θεραπείας ενός ατόμου. Μέχρι πρότινος τα ιατρικά δεδομένα αποθηκευόταν μόνο τοπικά (στα ιατρικά γραφεία, εξεταστικά κέντρα, νοσοκομεία κλπ.), χωρίς να υπάρχει δυνατότητα εξ αποστάσεως πρόσβασης. Αυτό είχε ως αποτέλεσμα την περιορισμένη έκθεση τους σε κινδύνους που σχετίζονταν μόνο με τις εσωτερικές απειλές.
Σήμερα όμως, η επανάσταση στον χώρο των νέων τεχνολογιών έχει επιφέρει σημαντικές αλλαγές στον τρόπο με τον οποίο αντιλαμβάνεται το κοινό το εύρος και το περιεχόμενο των υπηρεσιών παροχής φροντίδας υγείας. Αυτή η ανάγκη έχει δημιουργήσει πλέον πληροφορικά συστήματα υγείας που όχι μόνο είναι διασυνδεδεμένα μεταξύ τους αλλά που παρέχουν και δυνατότητα άμεσης επικοινωνίας με τον ασθενή μέσω Internet.
Επομένως, η ασφάλεια και η πιστοποίηση των υποδομών και εφαρμογών υγείας, είναι απαραίτητη όχι μόνο για την αποτροπή των νέων αυξημένων απειλών αλλά και γιατί το επιβάλει το επικείμενο νομικό/κανονιστικό πλαίσιο. Δεδομένα σχετικά με το ιστορικό υγείας κάποιου ατόμου, όπως οι ασθένειες, τα συμπτώματα και η περίθαλψη που έχει λάβει είναι από τις πλέον ευαίσθητες και εμπιστευτικές ενώ η διαχείρισή τους θα πρέπει να συμμορφώνεται με διεθνώς αναγνωρισμένα πρότυπα ασφάλειας.

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«Ανακαλύπτοντας τη βέλτιστη απόδοση του Διαγνωστικού εργαστηρίου»

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Professional Service Developer Emerging Market

Σκοπός της παρουσίασης «Ανακαλύπτοντας τη βέλτιστη απόδοση του Διαγνωστικού Εργαστηρίου» είναι να επισημάνει τις τάσεις της αγοράς τόσο σε παγκόσμιο επίπεδο, όσο και σε τοπικό, λαμβάνοντας υπ' όψιν και την οικονομική συγκυρία της ελληνικής πραγματικότητας.
Ο ρόλος του εργαστηρίου αναδεικνύεται σε πρωταρχικής σημασίας, με την προϋπόθεση την μεταμόρφωσή του από απλό παρατηρητή των τεκταινόμενων σε ενεργό παράγοντα που συμμετέχει καθοριστικά στην διαμόρφωση και παροχή προστιθέμενης αξίας στο σύστημα με βάση τους πυλώνες «Ποιότητα», «Αποδοτικότητα» και «Μείωση του Κόστους». Σύμφωνα με αυτά, καθοριστικό ρόλο παίζουν και τα πληροφοριακά συστήματα που καλούνται με τη σειρά τους να βοηθήσουν στη διαχείριση του τεράστιου όγκου δεδομένων αλλά και των πληροφοριών που μπορεί να αναχθούν από την σωστή επεξεργασία τους. Έτσι λοιπόν, γίνεται ανάλυση της κατανομής του κόστους στο εργαστήριο ώστε να εξακριβωθούν οι τομείς που περιλαμβάνουν «κρυφό κόστος», πέρα από το άμεσο κόστος που αφορά αυτή καθεαυτή τη διενέργεια των εξετάσεων. Η ανάλυση αυτή αναδεικνύει την έννοια της αξίας ως το λόγο οφέλους/κόστους στο σύστημα της υγείας με το οποίο είναι άρρηκτα συνδεδεμένο το εργαστήριο. Στα πλαίσια αυτά, καθίσταται πολύ σημαντικός ο τρόπος επιλογής κάθε προμηθευτή του εργαστηρίου, αλλά και ο τρόπος λειτουργίας του εργαστηρίου, ώστε να «ξεκλειδωθεί» η κρυμμένη αξία του εργαστηρίου στις σύγχρονες νοσηλευτικές μονάδες με σκοπό την συνεχόμενη βελτίωση των παρεχομένων υπηρεσιών υγείας, προσφέροντας περισσότερα με λιγότερους πόρους.

«APPLICATION OF EN ISO 13485 – ELECTROMEDICAL EQUIPMENT»

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INTRODUCTION
An analysis of the requirements of the latest version of EN ISO 13485 is presented, for organizations involved in processes related to life-cycle of Electro-medical equipment (manufacturers, distributors, service/maintenance providers).

DISCUSSION
The new version of ISO 13485, as adopted by CEN on March 2016 (EN ISO 13485:2016), has been reviewed in light of particular requirements related to electro-medical equipment.
The points discussed are mainly related to the documentation, the competency and authorization of personnel involved, the infrastructure and resources needed, for the Service/Maintenance of electro-medical equipment, and in particular the ones considered as more critical (life supporting /sustaining).
It is not the intention of this presentation to discuss the actual status of this topic in the Greek Healthcare System (this would require a detailed study), but to present the minimum requirements for SAFE and PERFORMING devices available to the users and patients, mainly POST MARKET (suppose they are evaluated and placed on the market under the applicable regulatory requirements). But it is expected to (maybe) initiate a discussion of this actual status.

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EN ISO 13485:2016 "Medical Devices-Quality Management Systems-Requirements for Regulatory Purposes"
COUNCIL DIRECTIVE 93/42/EEC of 14 June 1993 concerning medical devices (OJ L 169, 12.7.1993, p. 1)
Medical Device Regulation (draft, 27 February 2017)

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«Αξιοπιστία και συντήρηση, οι δυο όψεις του ίδιου νομίσματος»

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Η Βιοϊατρική Τεχνολογία ως παραγωγικός κλάδος αριθμεί σήμερα περισσότερους από 10.000 κατασκευαστές, με διεθνή δραστηριότητα, που παράγουν περισσότερα από 500.000 είδη προϊόντων. Ο κλάδος χαρακτηρίζεται από πολύ υψηλούς ρυθμούς ανανέωσης σαν αποτέλεσμα της συνεχούς παραγωγής νέας γνώσης, μεθόδων και τεχνικών που προκύπτουν από μεγάλο αριθμό προγραμμάτων έρευνας και ανάπτυξης σε όλες τις ανεπτυγμένες χώρες.
Ο κλινικός μηχανικός διαχειρίζεται το σύνολο του ιατροτεχνολογικού εξοπλισμού του νοσοκομείου και μπορεί ως εκ τούτου να προτείνει εργονομικές και οργανωτικές αλλαγές, ώστε να αυξηθεί η αποτελεσματικότητα της χρήσης και η αξιοπιστία του εξοπλισμού. Η συντήρηση αποτελεί τομέα της διαχείρισης εξοπλισμού. Ο προγραμματισμός της συντήρησης πρέπει να γίνεται σε λειτουργική και οικονομική βάση, έτσι ώστε να ελαχιστοποιείται το κόστος, διατηρώντας την αξιοπιστία των συστημάτων που συντηρούμε.
Απαραίτητη προϋπόθεση για να προχωρήσουμε σ' έναν προγραμματισμό και οριοθέτηση συστήματος συντήρησης, είναι η ιεράρχηση προτεραιοτήτων, ο καθορισμός στόχων δηλαδή σε τι αποβλέπουμε σχεδιάζοντας ένα πρόγραμμα, πως θα μετράμε τα αποτελέσματα και με ποιούς τρόπους θα βελτιώνουμε και θα αναπροσαρμόζουμε το σύστημα συντήρησης.
Ένα άρτια δομημένο σύστημα συντήρησης αυξάνει την αξιοπιστία του εξοπλισμού βελτιώνοντας την ορθολογική χρήση των διαθέσιμων πόρων που διαθέτει το νοσοκομείο. Η κατάλληλη επιλογή των εργαλείων συντήρησης βοηθά το νοσοκομείο στον περιορισμό του συνολικού κόστους λειτουργίας και την ικανοποίηση των χρηστών υπηρεσιών υγείας.

«Ο ρόλος του κτηματολογίου ιατροτεχνολογικού εξοπλισμού στην ασφάλεια ασθενούς και τον έλεγχο κόστους διαθεσιμότητας»

Παναγιώτης Μαλαταράς
INBIT

Είναι γνωστό από τις αρχές της δεκαετίας του 70 ότι η δημιουργία και συντήρηση κτηματολογίου ιατροτεχνολογικού εξοπλισμού αποτελεί την πρωταρχική ενέργεια στην κατεύθυνση της ορθολογικής διαχείρισης του εξοπλισμού για ένα τοπικό, περιφερειακό ή εθνικό σύστημα παροχής υπηρεσιών υγείας (Νοσοκομείο, Υγειονομική Περιφέρεια, Υπουργείο Υγείας).
Επιπρόσθετα τα τελευταία δεκαπέντε χρόνια, το κτηματολόγιο έρχεται να διαδραματίσει σημαντικό ρόλο ως ένα εργαλείο το οποίο σε συνδυασμό με άλλα μέσα, ενισχύει τις δράσεις για την παροχή ασφαλών υπηρεσιών υγείας (ασφάλεια ασθενούς) αλλά και τον έλεγχο και διαχείριση του κόστους των υπηρεσιών αυτών.

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«Ο Νόμος 4412/16 και η δυνατότητα εργασιών επισκευής και συντήρησης»

Κωνσταντίνος Σαμαρτζής
Δικηγόρος παρ' Αρείω Πάγω

ΣΥΜΒΑΣΕΙΣ ΣΥΝΤΗΡΗΣΗΣ & ΕΠΙΣΚΕΥΗΣ ΙΑΤΡΟΤΕΧΝΟΛΟΓΙΚΩΝ ΠΡΟΪΟΝΤΩΝ
Βασικές καινοτομίες του νέου Ν. 4412/2014 περί δημοσίων συμβάσεων
Μικτές συμβάσεις (άρθρο 4)
«Κατώφλια» - Αξία σύμβασης- Όχι κατάτμηση (άρθρα 5-6)
Διαχωρισμός σε τμήματα (άρθρο 59)
Γενικοί κανόνες (άρθρο 18)
Εχεμύθεια (άρθρο 21)
Διαδικασίες ανάθεσης (άρθρο 26)
Τεχνικές Προδιαγραφές, Σήματα, Πιστοποιήσεις (άρθρα 54-56, Παράρτημα VII)
Υπεργολαβία (άρθρα 58, 131) – Δάνεια εμπειρία (άρθρο 78)
Κριτήρια επιλογής (άρθρο 75)
Πρότυπα διασφάλισης ποιότητας (άρθρο 82)
Κριτήρια ανάθεσης (άρθρο 86)
Πρόχειροι διαγωνισμοί & απ' ευθείας αναθέσεις (άρθρα 117-118)
Τροποποίηση συμβάσεων – Συμπληρωματικά έργα (άρθρο 132)
Εκτέλεση της σύμβασης παροχής υπηρεσιών, Επόπτης, Ημερολόγιο (άρθρο 216)
Παράταση (άρθρο 217)
Καθυστερήσεις παροχής υπηρεσιών & ποινικές ρήτρες (άρθρο 218)
Επιτροπή παραλαβής- Απόρριψη (άρθρα 219-220)

«Ανάπτυξη έξυπνων & φορητών συστημάτων παρακολούθησης υγείας»

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Over the past decade, smartphones have radically changed many aspects of our everyday lives. With innovative digital technologies, cloud computing and machine learning, the medicalized smartphone is going to upend every aspect of health care. With the smartphone revolution, an increasingly powerful new set of tools such as attachments that can diagnose an ear infection or track heart rhythms or an app that can monitor mental health or by using wearable wireless sensors generating our own medical data, including measuring our blood-oxygen and glucose levels, blood pressure and heart rhythm, these can cut costs, speed up the pace of care and give more power to patients. Many medical applications for smartphones have been developed and widely used by health professionals and patients. The use of smartphones is getting more attention in healthcare day by day. Medical applications make smartphones useful tools in the practice of evidence-based medicine at the point of care, in addition to their use in mobile clinical communication.

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Also, smartphones can play a very important role in patient education, disease self-management, and remote monitoring of patients. Mobile applications can help people manage their own health and wellness, promote healthy living, and gain access to useful information when and where they need it. These tools are being adopted almost as quickly as they can be developed. According to industry estimates, 500 million smartphone users worldwide will be using a health care application by 2016, and by 2018, 50 percent of the more than 3.4 billion smartphone and tablet users will have downloaded mobile health applications. The widespread adoption and use of mobile technologies is opening new and innovative ways to improve health and health care delivery.

«An ultrasonic and spectroscopic microscopy lab performing high resolution quantitative and qualitative evaluation of epidermic structures (use cases on skin, brain and nail)»

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In this talk, the study of the stratigraphy of epidermic structures and not only, i.e. skin, nail and brain, is presented. The techniques used consists of acoustic microscopy and infrared (IR) mapping imaging. The former technique provides tomographic images in a region of interest (ROI) of the structure, whereas, the latter reveals the distribution of physiochemical properties in the same ROI.

Specifically, acoustic microscopy is a conventional sequential ultrasonic scanning but using piezoelectric transducers which have very high frequency content (>10MHz) and insonify areas with very small diameter (~20μm). Thus this technique provides high spatial resolution tomographic images, as well as 3D cube images, which allow the examination of micro structures (>10μm) in the under investigation ROI.

On the other hand, the IR spectra acquired after a raster scanning on the same ROI can be clustered to similar physiochemical property groups so as to result spectroscopic mapping images which reveal spatial patterns of the physiochemical properties possibly identifying suspicious cases. The clusters are consisted of spectra that have similar characteristics and thus are indicating the existence of similar materials; hence, similar physiochemical composition. The spatial distribution of such clusters can be illustrated in pseudocolour images, in which each pixel of image is colored according to its cluster membership. The Fourier transform infrared (FTIR) spectroscope (Bruker ALPHA) with special adapted reflectance illumination area (0.5mm) was used in order to acquire the array of spectra. The spectral area in wavenumbers covered by ALPHA is 7500- 375cm-1. This spectral area (SWIR/MWIR/LWIR) used ensures the penetration of the radiation in deeper layers. Moreover, the mapping images can be produced by clustering the acquired spectra in specific spectral bands in order to provide stratigraphic information, i.e., images that convey information of the distribution of physiochemical properties from deeper, as well. To cluster the spectra, unsupervised machine learning algorithms are applied, e.g., hierarchical clustering.

Finally, both the results of both modalities can be fused in order to enhance the identification capability of the user. The fusion is achieved properly registering both imaging results and visualizing them together providing a high fidelity 3D information of both stratigraphy and physiochemical distribution. To achieve an accurate registration an optical microscopy camera is attached to a computerized numerical control (CNC) system which is driven by a software that is specially developed for the scanning of both modalities (acoustic microscopy, IR reflectance spectroscopy).

Both techniques as well as their fusion have been tested on melanoma tumors and nails revealing the high fidelity and resolution of the acquired information which can be extremely useful for the investigation of the skin and nail condition.

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«Cloud Computing and IoT Enables new Services in Electronic Healthcare»

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Pervasive healthcare systems have been extensively used recently in order to support the independent living of elderly people and the need for constant medical supervision of chronic patients or habitants at remote isolated or underserved locations. In this context, advanced electronic healthcare services are required to be made available through a network anytime, anyplace and to anyone. A medical assistive environment on the other hand concerns the utilization of biosensors for delivering the above services. Wireless technologies enable the real time transmission of vital data about a patient's condition to caregivers. Numerous wireless and wearable devices are available that can detect certain medical conditions—pulse rate, oxygen saturation, blood pressure, glucose and breath alcohol level, and so on—from a user's touch.

The realization, however, of health information management through mobile devices introduces several challenges, like data storage and management (e.g., physical storage issues, availability and maintenance), interoperability and availability of heterogeneous resources, security and privacy (e.g., permission control, data anonymity, etc.), unified and ubiquitous access. One potential solution for addressing all aforementioned issues is the introduction of Cloud Computing and Internet of Things

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(IoT) concepts. Cloud Computing provides the facility to access shared resources and common infrastructure in a ubiquitous and transparent way, offering services on-demand, over the network, and performing operations that meet changing needs. Internet of Things paradigm enables the direct interaction of healthcare sensors with the Internet and by extension with Cloud Computing platforms. IoT utilizes specific protocols for inter-device and Internet communication provides real time access to device information and allows the remote management of the devices. It also features web applications that are scalable, accessible globally and provide communication interfaces to external applications.
In this talk we will present the IoT and Cloud Computing paradigms that can be used for developing mobile healthcare applications. In this context, we will describe wearable – textile sensors that collect biosignals from the user (like heart rate, ECG, oxygen saturation and temperature), motion data sensors and environmental contextual data (like location, ambient temperature, activity status, fall detection etc.). Computational modules in terms of HW and SW that can be used as gateways for collecting and aggregating data and pushing them to the Cloud will also be presented.

« Αξιολόγηση και προτυποποίηση τεχνολογιών φροντίδας ευπαθών ομάδων »

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Πρόεδρος ΕΛΕΒΙΤ

Το θέμα της αξιολόγησης της Βιοϊατρικής Τεχνολογίας (ΒΙΤ) έχει αρκετά μακριά ιστορία όπως και η καθιέρωση προτύπων και προφίλ ηλεκτρονικής υγείας (eHealth Standards and Profiles). Έχουν μελετηθεί στο παρελθόν και ξαναμελετώνται στο σύγχρονο παρόν και οι κοινωνικο-οικονομικές πτυχές των προδιαγραφών με γνώμονα τη διαλειτουργικότητα της ηλεκτρονικής υγείας και έχουν αξιολογηθεί ενίοτε υπό το πρίσμα του κόστους σε συνάφεια με την αποτελεσματικότητα των προδιαγραφών και της διαλειτουργικότητας της ηλεκτρονικής υγείας. Τέτοια π.χ. είναι τα πρότυπα της σειράς ISO/IEEE 11073 (Health Informatics - Medical / Health Device Communication Standards, eHealth and Wireless Monitoring).
Πρόσφατα στο τραπέζι των συζητήσεων της τεχνολογίας της υγείας προστέθηκαν και θέματα αξιολόγησης εξωνοσοκομειακών συσκευών, όπως αυτές που χρησιμοποιούνται στον ευρύτερο χώρο της «υγείας εν κινήσει» (mobile health, mhealth), όπως και της τεχνολογίας των πραγμάτων του διαδικτύου (Internet of Things, IoT). Οι τελευταίες όμως υποστηρίζουν και ενέργειες που εντάσσονται είτε στο χώρο της ενεργούς και υγιούς γήρανσης (active and healthy ageing) είτε στο χώρο της φροντίδας έτερων ευπαθών ομάδων όπως τα άτομα με ειδικές ανάγκες. Στην παρουσίαση λοιπόν αυτή θα ξαναεπισκεφτούμε τα πρότυπα από το χώρο των Body Area Network (BANs) δίνοντας τελικά έμφαση σε πρότυπα (κανονικά ή εναρμονισμένα) που υποστηρίζουν τέτοιου είδους εφαρμογές (π.χ. το Harmonised Standards and The Radio Equipment Directive, RED), καταλήγοντας στην ανάγκη να προσδιοριστούν και πρότυπα στο χώρο των ζωντανών εργαστηρίων (Living Labs) που αξιοποιούνται ευρέως πλέον για τις προαναφερθείσες εφαρμογές και χώρους.

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«Συστήματα ολοκληρωμένης φροντίδας: σχέση ηλεκτρονικών φακέλων ασθενών και βιοϊατροτεχνολογικού εξοπλισμού»

Δήμητρα Ηλιοπούλου
Ερευνήτρια
Εθνικό Μετσόβιο Πολυτεχνείο

Τα πληροφοριακά συστήματα βρίσκουν όλο και περισσότερο σημαντικές εφαρμογές στο χώρο της υγείας. Εκτός των παραδοσιακών συστημάτων υποστήριξης της διοικητικής και οικονομικής λειτουργίας των νοσοκομείων, ένας από τους τομείς εφαρμογής των τεχνολογιών πληροφορικής στην υγεία είναι και ο Ηλεκτρονικός Φάκελος Υγείας (ΗΦΥ) ασθενούς. Ένα από τα βασικότερα προβλήματα εφαρμογής συστημάτων ΗΦΥ είναι το γεγονός ότι η πληροφορία, ή αλλιώς τα δεδομένα που τον απαρτίζουν είναι κατακερματισμένη και αποθηκευμένη σε διαφορετικά πληροφοριακά συστήματα διαφορετικών τεχνολογιών και αρχιτεκτονικών. Είναι λοιπόν εξαιρετικά χρήσιμη αλλά ταυτόχρονα επιστημονικά και ερευνητικά ενδιαφέρουσα η σχεδίαση και υλοποίηση μηχανογραφικών συστημάτων που να είναι σε θέση να παρουσιάζουν με τρόπο ενιαίο αλλά και διαφανή για το χρήστη, το σύνολο της διαθέσιμης πληροφορίας για κάθε ασθενή.
Επιπλέον η ολοκληρωμένη παροχή φροντίδας απαιτεί επιπλέον πληροφορία όσον αφορά στον βιοϊατροτεχνολογικό εξοπλισμό. Η κατάστασή του, το ιστορικό του (αστοχίες, χρόνος σωστής λειτουργίας, προγραμματισμένο και μη, service) είναι η απόλυτα ελάχιστη πληροφορία που θα πρέπει να είναι διαθέσιμη στο ιατρικό και παραϊατρικό προσωπικό. Επίσης νέες τεχνολογίες μπορούν πλέον να μας βοηθήσουν να γνωρίζουμε την ακριβή θέση αλλά και το ιστορικό χρήσης (ποιος, που και πότε) του εξοπλισμού, έτσι ώστε να μπορούμε να προγραμματίσουμε τη διαχείρισή του με βέλτιστο τρόπο.

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Θεματική Ενότητα -Στρογγυλή Τράπεζα:
Αξιολόγηση Βιοϊατρικής Τεχνολογίας από τη σκοπιά της Διοίκησης
Συντονιστές: Α. Παπαδόπουλος – Διοικητής, Α' ΥΠΕ ΑΤΤΙΚΗΣ,
Δημήτρης Νιάκας, Πρόεδρος, Ωνάσειο Καρδιοχειρουργικό Κέντρο

Συμμετέχοντες Πάνελ:
Παππά Ε. - Υποδιοικήτρια, Γ.Ν. «Αλεξάνδρα»
Κοντοδημόπουλος Ν. - Διοικητής, Γ.Ν. ΚΑΤ
Χαλούτσος Γ. - Πρνος Βιοϊατρικής Τεχνολογίας, Ωνάσειο Καρδιοχειρουργικό Κέντρο
Ράικου Μ. - Επίκ. Καθηγήτρια, Παν. Πειραιά

Στην τράπεζα αυτή έμφαση θα δοθεί στο σύγχρονο ρόλο της Διοίκησης, τη σημασία της εκπαίδευσης και της Βιοϊατρικής Τεχνολογίας (ΒΙΤ), επικεντρώνοντας στο πώς συσχετίζονται η τεχνολογία και οι υπηρεσίες υγείας. Πόση τεχνολογία άραγε υπάρχει στις υπηρεσίες υγείας στην Ελλάδα; Ποιες είναι οι εμπειρίες από τις Υγειονομικές Περιφέρειες;

Είναι γνωστό πως η ραγδαία εξέλιξη της ΒΙΤ έχει συμβάλει σημαντικά στην εξέλιξη του σύγχρονου νοσοκομείου και έχει επιδρά με διττό τρόπο: i) στο επίπεδο του ασθενή, όπου επηρεάζει τη βελτίωση του επιπέδου υγείας και στην ποιότητα ζωής του ασθενή και ii) στο επίπεδο του νοσοκομείου, όπου δεσμεύει ένα μεγάλο μέρος των διαθέσιμων οικονομικών πόρων λόγω του υψηλού κόστους και επηρεάζει την ποιότητα των παρεχόμενων υπηρεσιών υγείας. Το ενδιαφέρον της Διοίκησης από τη χρήση της ΒΙΤ εστιάζεται στην εξασφάλιση των πολιτικών για την μεγιστοποίηση του οφέλους, της αποτελεσματικότητας και της αποδοτικότητας για όλη τη διάρκεια ζωής της.

Έτσι, θα γίνει μια σύντομη παρουσίαση ορισμένων θετικών επιδράσεων και επιπτώσεων της (υψηλής κυρίως) βιοϊατρικής τεχνολογίας (ΒΙΤ) σε μεγάλο δημόσιο νοσοκομείο, δίνοντας ωστόσο έμφαση στην έννοια της αποδοτικότητας και τη σημασία της για την οικονομική διαχείριση του νοσοκομείου και θίγοντας τη σύνδεση της προκλητής ζήτησης (ΠΖ) με το έλλειμμα αποδοτικότητας στα περισσότερα δημόσια νοσοκομεία. Θα γίνει επίσης αναφορά στη συχνή έως και υπερβολική χρήση της ΒΙΤ (λόγω και ΠΖ) και τις μεγάλες ανάγκες προληπτικής και επιδιορθωτικής συντήρησης που δημιουργεί, αλλά και στις δυσκολίες για τη Διοίκηση του Νοσοκομείου που έχει να διαχειριστεί και τη στενότητα του προϋπολογισμού, την έλλειψη πιστώσεων, την αδυναμία των εσωτερικών τμημάτων ΒΙΤ (π.χ. λόγοι εκπαίδευσης ή ελλιπούς στελέχωσης). Συνέπεια των παραπάνω είναι η συνεχής εξάρτηση από συμβόλαια συντήρησης με τις προμηθεύτριες εταιρείες και ότι αυτό συνεπάγεται.

Προκύπτει έτσι το θέμα της αξιολόγησης των τεχνολογιών υγείας (Health Technology Assessment) και ιδιαίτερα των ιατρικών συσκευών (medical devices). Στη τράπεζα θα συζητηθούν λοιπόν και οι διάφορες εξελίξεις από το μέτωπο του Executive Board του Joint Action 3 της EUnetHTA (European network of Health Technology Assessment), με πληροφόρηση περί του:
- τι είναι η Αξιολόγηση Τεχνολογιών Υγείας και γιατί πρέπει αυτή να εδιαφέρει τη Διοίκηση;
- τι συμβαίνει σήμερα στο εξωτερικό και (τι δεν συμβαίνει) στην Ελλάδα και ακόμη
- τι προβλέπεται να γίνει στην Ευρώπη μετά το έτος 2020.

Η τράπεζα θα κλείσει με το ρόλο της αξιολόγησης της τεχνολογίας υγείας στη ρύθμιση του υγειονομικού τομέα μέσα από το παράδειγμα του NICE (National Institute for Health and Care Excellence) στη Βρετανία. Παρόλο που υπάρχουν μεγάλες διαφορές μεταξύ των συστημάτων υγείας στην Ευρώπη και ταυτόχρονα παρατηρούνται διάφορες προσεγγίσεις στην αξιολόγηση, τιμολόγηση και αποζημίωση των υπηρεσιών υγείας, φαίνεται να παρουσιάζονται αυξανόμενες απαιτήσεις για τη διεξαγωγή οικονομικής αξιολόγησης των νέων τεχνολογιών υγείας στις χώρες αυτές. Βασικά θέματα που θα συζητηθούν: τι είναι η αξιολόγηση της τεχνολογίας υγείας, ποιος είναι ο ρόλος της στη λήψη αποφάσεων, το παράδειγμα του Εθνικού Ινστιτούτου Υγείας και Κλινικής Αριστείας στη Βρετανία, NICE.

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POSTERS

Αναρτημένες ανακοινώσεις

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ΓΕΩΓΡΑΦΙΚΗ ΑΠΟΤΥΠΩΣΗ ΚΑΙ ΟΙΚΟΝΟΜΙΚΗ ΔΙΑΧΕΙΡΙΣΗ ΤΟΥ ΙΑΤΡΟΤΕΧΝΟΛΟΓΙΚΟΥ ΕΞΟΠΛΙΣΜΟΥ ΜΕ ΧΡΗΣΗ GIS: ΠΙΛΟΤΙΚΗ ΕΦΑΡΜΟΓΗ ΣΕ ΑΝΑΠΝΕΥΣΤΗΡΕΣ ΜΕΘ

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Εισαγωγή

Παγκοσμίως, όλα τα συστήματα υγείας βρίσκονται αντιμέτωπα με την πρόκληση της σωστής διαχείρισης παροχής υγειονομικής φροντίδας, κάτω από συνθήκες περιορισμού των πόρων [1]. Επιπλέον, οι αποφάσεις που λαμβάνονται στον υγειονομικό τομέα, θα πρέπει να εστιάζονται στην παροχή της πλέον αποτελεσματικής και αποδοτικής φροντίδας υγείας [2]. Το Γεωγραφικό Πληροφοριακό Σύστημα (ΓΠΣ/GIS) αποτελεί μια νέα προσέγγιση, που μπορεί να προσφέρει πολλά οφέλη στην οργάνωση της Δημόσια Υγείας [3].

Σκοπός

Ο σκοπός της εφαρμογής είναι η δημιουργία μιας online πλατφόρμας ως κτηματολόγιο και παρατηρητήριο τιμών για την οικονομική διαχείριση του Ιατροτεχνολογικού Εξοπλισμού των Δημόσιων Νοσηλευτικών Ιδρυμάτων του Εθνικού Συστήματος Υγείας.

Υλικό και Μέθοδος

Η εφαρμογή GIS4BIT χρησιμοποιεί την πλατφόρμα της ArcGIS της ESRI και διαθέτει μια κοινή βάση δεδομένων (GeoDatabase), όπου γίνεται η ταξινόμηση των μηχανημάτων ανά μονάδα υγείας, κατηγορία, μοντέλο, κατασκευαστή και κωδικό GMDN. Εξουσιο-δοτημένοι κλινικοί μηχανικοί του τμήματος ΒΙΤ των Νοσοκομείων θα πραγματοποιούν την εισαγωγή των δεδομένων με χρήση κωδικών ασφαλείας (όνομα χρήστη και κωδικό). Η εισαγωγή των δεδομένων γίνεται μέσω της εφαρμογής Survey 123 for ArcGIS (από υπολογιστή, κινητό ή tablet) ή μέσω της εφαρμογής ArcGIS for Office. Παράλληλα μέσω της εφαρμογής GIS4BIT υπάρχει η δυνατότητα να πραγματοποιείται σύγκριση των συμβάσεων συντήρησης, του κόστους προμήθειας νέων μηχανημάτων, του κόστους αποκατά-στασης βλαβών, των ανταλλακτικών και υπολογισμό δεικτών (δείκτης παλαιότητας εξοπλισμού, δείκτης δα-πανών ανανέωσης εξοπλισμού, δείκτης κόστους συντή-ρησης, κλπ). Η ιδιαιτερότητα της εφαρμογής σε σχέση με ένα άλλο σύστημα διαχείρισης Ιατροτεχνολογικού Εξοπλισμού είναι η γεωγραφική αποτύπωση των ειδών. Μέσω της εφαρμογής, ο χρήσης λαμβάνει πληροφορίες όχι μόνο για το πλήθος και την κατάσταση των μηχανη-μάτων αλλά και για την γεωγραφική κατανομή τους. Παράλληλα με τον χάρτη μπορούν να εξαχθούν και αναφορές (reports) με τα στοιχεία του Ιατροτεχνολο-γικού Εξοπλισμού (π.χ. πλήθος μηχανημάτων / μονάδα υγείας), οι οποίες είναι δυναμικές και ανανεώνονται κά-θε φορά που υπάρχει καινούργια εγγραφή. Οι αναφο-ρές μπορούν να εξαχθούν σε μορφές pdf, html, rdf, rtf, tif, txt, xls και να χρησιμοποιηθούν ανάλογα.

Αποτελέσματα

Μέσω της εφαρμογής GIS4BIT δημιουργήθηκαν δια-δραστικοί χάρτες με διαφορετικές θεματικές ενότητες: α) Χάρτης με το πλήθος των αναπνευστήρων ΜΕΘ ανά Μονάδα Υγείας και συγκεντρωτικός χάρτης, β) Χάρτης με τους αναπνευστήρες ΜΕΘ ανά κατασκευαστή, γ) ανά μοντέλο, δ) ανά λειτουργική κατάσταση, και ε) χάρτης με οικονομικά στοιχεία. Τα προαναφερθέντα στοιχεία αποτελούν και μέσο λογοδοσίας τόσο του τμή-ματος ΒΙΤ όσο και της Διοίκησης. Οι κλινικοί μηχα-νικοί λογοδοτούν για τις ενέργειες που έχουν πραγματο-ποιήσει (IPM & CM) και η Διοίκηση είναι υπεύθυνη για την επιβεβαίωση της ορθής διεκπεραίωσης των διαδι-κασιών. Τα δεδομένα μπορούν να δημοσιοποιηθούν και στους πολίτες, έτσι ώστε να εξασφαλίζεται η διαφάνεια των διαδικασιών.

Συζήτηση

Η εφαρμογή GIS4BIT είναι χρήσιμη για την αποφυγή υπερκοστολόγησης σε υπηρεσίες και προμήθεια νέων ειδών. Η εφαρμογή θα επιφέρει πληρέστερη, καλύτερη και συνεχή ενημέρωση των κλινικών μηχανικών αλλά και της Διοίκησης. Η συλλογή χρήσιμων στατιστικών στοιχείων για περαιτέρω ανάλυση θα βοηθήσουν στη λήψη ορθών αποφάσεων, όχι μόνο σε τοπικό αλλά και σε εθνικό επίπεδο.

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Λέξεις - κλειδιά:
GIS4BIT, Ιατροτεχνολογικός Εξοπλισμός, Γεωγραφικά Συστήματα Πληροφοριών, Οικονομική Διαχείρηση, GIS, Διαδραστικοί Χάρτες

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ΑΞΙΟΠΟΙΗΣΗ ΤΩΝ GIS ΣΤΗ ΓΕΩΓΡΑΦΙΚΗ ΑΠΟΤΥΠΩΣΗ ΚΑΙ ΟΙΚΟΝΟΜΙΚΗ ΔΙΑΧΕΙΡΙΣΗ ΤΩΝ ΣΥΣΤΗΜΑΤΩΝ ΥΠΕΡΗΧΟΤΟΜΟΓΡΑΦΙΑΣ ΤΩΝ ΔΗΜΟΣΙΩΝ ΑΚΤΙΝΟΛΟΓΙΚΩΝ ΕΡΓΑΣΤΗΡΙΩΝ ΤΗΣ ΠΕΛΟΠΟΝΝΗΣΟΥ

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Εισαγωγή
Τα τελευταία χρόνια η πρόοδος της ψηφιακής τεχνολογίας έχει οδηγήσει στην ανάπτυξη νέων εφαρμογών ελέγχου των κρατικών δαπανών για την υγεία. Τα Γεωγραφικά Συστήματα Πληροφοριών (G.I.S.) αποτελούν ένα χρήσιμο εργαλείο χωρικής ανάλυσης [1] και βελτίωσης της αποδοτικότητας των υγειονομικών μονάδων [2].

Σκοπός
Ο σκοπός της εργασίας είναι η καταγραφή των συστημάτων υπερηχοτομογραφίας και η διερεύνηση κόστους - εσόδων των αντίστοιχων εξετάσεων με τη δημιουργία ψηφιακών χαρτών. Τα στοιχεία αφορούν στα Δημόσια Ακτινολογικά Εργαστήρια της Πελοποννήσου την περίοδο 2012-2015, για τα οποία υπάρχουν διαθέσιμα δεδομένα.

Υλικό και Μέθοδος
Χρησιμοποιώντας το λογισμικό ArcGIS,αναπτύσσεται ένα ιδιαίτερο χωρικό περιβάλλον αλληλεπίδρασης του χρήστη με συγκεκριμένες πληροφορίες. Οι πληροφορίες αυτές περιλαμβάνουν τον τύπο, το είδος και το μοντέλο τωνυπερηχοτομογράφων. Τα δεδομένα αυτά συνδυάζονται με τα οικονομικά στοιχεία εσόδων και κόστους των αντίστοιχων εξετάσεων, δημιουργώντας μια βάση δεδομένων. Επιλέγοντας το κατάλληλο θεματικό υπόβαθρο [3], επιτυγχάνεται η οπτικοποίηση των προαναφερθέντων δεδομένων. Δημιουργούνται ψηφιακοί χάρτες, όπου ο χρήστης μπορεί να έχει πρόσβαση σε πραγματικό χρόνο και να αντλεί πληροφορίες. Η χρηστικότητα του συστήματος επιτρέπει την ενσωμάτωση διαγραμμάτων για την εξαγωγή συγκριτικών αποτελεσμάτων.

Αποτελέσματα
Χρησιμοποιώντας τις δυνατότητες των διαδραστικών χαρτών, αναδύονται παράθυρα επισκόπησης των οικονομικών και τεχνικών χαρακτηριστικών των υπερηχοτομογράφων. Η ψηφιοποίηση τους επιτρέπει την ενσωμάτωση και επεξεργασία πινάκων ιδιοτήτων (attribute tables) πάνω στους χάρτες. Σε αυτούς καταγράφεται η συχνότητα βλαβών των μηχανημάτων. Επιπλέον, η online εφαρμογή επιτρέπει τη διασύνδεση των Ακτινολογικών Εργαστηρίων τόσο μεταξύ τους όσο και σε κεντρικό επίπεδο. Η ιδιαιτερότητα του συστήματος είναι η λήψη μεγάλου όγκου πληροφορίας σε πραγματικό χρόνο. Είναι δυνατή επίσης, η αντιγραφή και εξαγωγή των πινάκων ιδιοτήτων, δημιουργώντας ένα ψηφιακό αρχείο κόστους και ζημιογόνων μηχανημάτων. Μέσω της εφαρμογής διαπιστώνεται κυρίως μείωση των εσόδων από τις εξετάσεις υπερήχων σε ποσοστό 5,5%-98% στα δημόσια ακτινολογικά εργαστήρια την περίοδο 2012-2015. Εξαίρεση αποτελεί το Ακτινολογικό Εργαστήριο του Γενικού Νοσοκομείου - Κέντρου Υγείας Μολάων που εμφανίζει αύξηση των εσόδων κατά 110% περίπου. Επιπλέον, παρατηρείται μείωση του κόστους ακτινολογικού υλικού σε ποσοστό 7,5%-40% στα Δημόσια Ακτινολογικά Εργαστήρια. Στην περίπτωση αυτή εξαιρούνται τα ακτινολογικά εργαστήρια του Γενικού Νοσοκομείου Άργους, Καλαμάτας και Κυπαρισσίας που σύμφωνα με την εφραμογή παρατηρείται αύξηση κατά 10%, 102% και 22% αντίστοιχα.

Συζήτηση
Η εφαρμογή που παρουσιάζεται είναι χρήσιμη για τον περιορισμό του κόστους των Ακτινολογικών Εργαστηρίων και αντικατάστασης πεπαλαιωμένου ακτινολογικού εξοπλισμού. Το σύστημα αναμένεται να συνεισφέρει στη βέλτιστη κατανομή των πόρων και τον πληρέστερο έλεγχο σε κεντρικό επίπεδο.

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Λέξεις - κλειδιά:
Συστήματα Υπερηχοτομογραφίας, Γεωγραφικά Πληροφοριακά Συστήματα, Οικονομική Διαχείριση, Δημόσια Ακτινολογικά Εργαστήρια

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A DECISION MAKING SUPPORT SYSTEM IN NUCLEAR MEDICINE USING FUZZY COGNITIVE MAPS

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Introduction

There is a lot discussion nowadays regarding the decision making problem. Making decisions and creating computational models using the tools of Fuzzy Cognitive Maps and Neural Systems is a complicated task. The reason is that the contributing factors are several and complicated themselves. In medicine, factors such as age, symptoms, clinical tests all play their role and have their own importance when it comes to examine a patient, or to decide a medical action. Heart disease is the leading cause of death in developed nations despite known ways to prevent and treat heart problems. One common type of heart disease is called Coronary Heart Disease, sometimes referred to as coronary artery disease (CAD) [1].

Materials and methods

In this work, we illustrate the development of a Medical Decision Support System (MDSS) using Fuzzy Cognitive Maps (FCM). FCM is a soft computing technique capable of dealing with situations including uncertain descriptions using similar procedure such as human reasoning does [2]. FCM was chosen because of the nature of the application problem. The prediction of diseases like CAD is a complex process with sufficient interacting parameters and FCMs have been proved suitable for this kind of problems. Similar MDSS have been suggested for the prediction of diseases like pulmonary infection [3]. Three physicians-experts were pooled to define the number and type of parameters-factors affecting the possibility of been affected by CAD. For this application, concept values take either two, three, four or five possible discrete or fuzzy values. These variables contain information about the patient (ex Age, Gender), the heaviness of the main symptom, some Comorbidities and predisposing factors for CAD, as well as diagnose tests that the patient has been submitted to. The Decision Concept represents the severity of CAD and takes four fuzzy values *(low possibility, medium possibility, high possibility, very high possibility).* The thirty identified concepts keep relations with each other, in order to characterize the process of assessing infectious diseases and to provide a first front-end decision about the prediction of CAD. After the determination of fuzzy sets, each expert was asked to define the degree of influence among the concepts and describe their interrelationship using if-then rules.

Results

After construction of the FCM tool, a number of scenarios have been introduced and the decision making capabilities of the technique will be presented by simulating these scenarios and finding the predicted outcomes according to the available data. The constructed FCM-MDSS model was tested into several real examples. After several simulations we summarize some weaknesses that could be a field of future research, as to how those weaknesses could be overpassed. One main weakness is that all the factors, from the special characteristics of the patients to the test results are been described as similar type values, though they aren't. The test results for example have a completely different nature than the age and the gender of the patient. After the simulation, variable as the age for example and a test result might have similar numerical influence to the output value.

Conclusions

The knowledge-based approach used in this work focuses on the soft computing technique of Fuzzy Cognitive Maps to offer a diagnostic tool. It was demonstrated that FCMs can be a useful tool for capturing the physicians' understanding of the system and their perceptions on the medical requirements of the infectious diseases management. Future work will be directed towards the insertion of other possible input values and bringing the model to a whole new level, perhaps with the use of learning algorithms.

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AN OPTIMIZATION STUDY FOR PRECLINICAL X-RAY IMAGING OF GOLD NANOPARTICLES USING GATE SIMULATIONS

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Introduction

Gold Nanoparticles (GNPs) are used preclinically, either as contrast agents or as drug delivery carriers and their accurate localization is of major importance. In X-ray imaging changes in contrast are due to density alterations in structures where they accumulate. GNPs size does not affect image contrast [1], although it strongly affects biodistribution [2]. Trying new methodologies regarding GNPs and X-ray imaging, many experiments are needed to establish a protocol, increasing the need of animals. Simulations can provide in silico investigation tools to study if an administered NPs solution of given concentration, composition and biodistribution will produce an adequate and detectable image contrast, thus optimizing protocols with a reduced need for animals.

Materials and Methods

Firstly, our X-ray system, consisting of an X-ray tube irradiating at 35kVp and a CMOS detector of 0.2mm pixel and 12 x 12 cm^2 active area size, was simulated in GATE. The imaging results were validated through commercial iodine solutions and compared against experimental data. The computational MOBY mouse phantom was used and both iodine and GNPs were simulated as homogenous solutions. Concentrations ranging between 5-40mgAu/0.2ml were tested. Different administration routes were studied in conjunction with already published biodistributions of GNPs, with respect to the injected concentration of GNPs.

Results

The model was validated with iodine solutions both in phantoms and mice studies. Simulated solutions of concentrations ranging between 25-200mgAu/ml produced detectable image contrast, following already published biodistributions in certain structures, as the liver and the spleen. A series of images and the corresponding CNRs were extracted for a set of different injected concentrations and of different biodistribution models of GNPs.

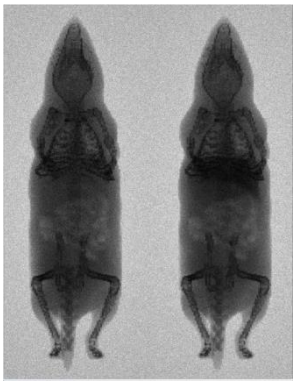

Figure 1. Simulated X-ray images of the MOBY phantom, before and after the administration of 20mg of GNPs, accumulated in the liver.

Conclusions

A simulation platform to study the in vivo imaging properties of GNPs was successfully validated. By importing the NPs solution density, composition and expected biodistribution one can determine the minimum concentration needed for an adequate image contrast. This platform is already being used in designing our experimental GNPs imaging protocols in mice.

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Keywords:
Gold Nanoparticles, X-rays, GATE Simulation

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COMPUTED TOMOGRAPHY DOSIMETRY AND OPTIMIZATION FOR PAEDIATRIC PATIENTS

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Introduction

Patient specific dosimetry is of high interest in pediatric applications where exposure to ionizing radiation is widely debated. This work intends to create an organ dose database for pediatric reference individuals undergoing computed tomography (CT) examinations. The data will permit rapid estimates of organ effective doses for patients of different age, gender and examination type.

Materials and Methods

In the present study, the GATE open-source MC toolkit (v7.2) [1] was used for modeling Aquilion™ PRIME multislice helical CT system.

The energy spectrum was calculated using the software Spektr. The energy photon spectrum was defined in GATE as a gamma-particle point source with certain fan and cone angles. The X-ray source-to-detector distance and the source-to-isocenter distance were also defined and an almost continuous movement of the source was achieved.

In order to validate our results, the absorbed dose in PMMA digital phantom was compared with measured data in corresponding PMMA physical phantom at 1 position. A thin-walled ionization chamber was constructed from manufacturer specifications and a Monte Carlo normalization factor was also described.

An XCAT anthropomorphic phantom [2] was used as reference model for the dosimetric simulations. Helical CT trajectories were modeled by rotating and translating the voxel phantom with respect to a fixed source position in order to simulate a chest protocol.

Results

Normalization factors were derived to convert the dose simulated to absolute absorbed dose for the particular beam collimation. The measured and simulated $CTDI_{100}$ in air at isocenter are presented below.

Table 1: Measured and simulated $CTDI_{100}$ in air

Energy (kVp)	Measured (mGy x mAs^{-1})	Simulated (mGy x $particle^{-1}$)	NF (particle x mAs-1)
120	34.6×10^{-2}	7.52×10^{-11}	4.59×10^{9}

Table 2: Comparison of CTDI in mGy between simulated and published data for the center position

Phantom	Measured	Simulated	Diff. %
32-cm	35.0	31.96	8.69

Results of XCAT dose maps (figure 1) indicate the chest helical movement.

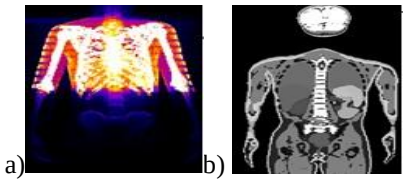

Figure 1. a) Simulated chest scan and b) the corresponding slice of the attenuation phantom

Discussion

The verification of the CT scanner was completed, with high accuracy comparing experimental and simulated results. Initial dosimetric simulations were applied using standard pediatric phantoms.

Conclusions

This is an ongoing study for optimization of pediatric dosimetry. The next step is to irradiate several children phantoms with different clinical scanners in order to extract the absorbed doses in the most critical organs.

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Keywords:

CT-Dosimetry, XCAT phantom, GATE Monte Carlo

Acknowledgement

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EXPERIMENTAL DETERMINATION OF THE MECHANICAL PROPERTIES FOR THE PROPAGATION OF THE HUMAN AORTIC DISSECTION

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Introduction: The acute dissection of an ascending thoracic aortic aneurysm (ATAA) starts with an initial crack in the intima of the aortic wall and propagates creating a "*false lumen*", approximately between media and adventitia of the aortic wall. The propagation is accelerated under the influence of blood pressure and there is a risk of rupture of the aortic wall, thus causing the patient's death. The aim is to study the mechanical properties causing the propagation of the aortic dissection between the layers of the ascending thoracic aorta, comparing the adhesive strength between patients with aortic dissection and controls.

Materials and Methods: Peeling experiments performed as described in ref. [1] on 177 specimens corresponding to 15 controls with normal aorta and on 146 specimens corresponding to 18 patients with type A aortic dissection aneurysm, respectively. The propagation of the dissection in patients had stopped in the ascending aorta around the rupture, forming a separation line as limit. The selected patients' specimens include this limit along their length, beyond which the dissection could not continue.

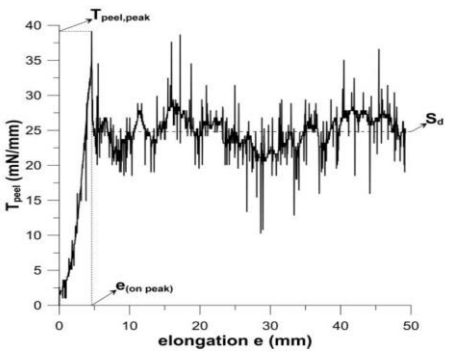

Figure 1. Typical delamination profile

Tests on the specimens were made to demonstrate the stress state that will be able to propagate the dissection beyond these limits. The *maximum peel tension* $T_{peel,peak}$ (force/unit width) and its corresponding *elongation e (displacement)* value were determined, through the peel tension versus elongation diagram (Figure 1). The mean peel tension after the $T_{peel,peak}$ was calculated being the *delamination strength* (S_d) responsible for the propagation of the dissection between the two layers of the specimen.

Results & Discussion: Peel tension, elongation and delamination strength in controls were significantly smaller than those of the patients in both directions (Table 1).

	direction	patients	controls	p
$T_{peel,peak}$	CIRC	50±3.9	35±1.6	<0.001
(mN/mm)	LONG	47±4.2	40±1.6	0.15
$e_{(on\ peak)}$	CIRC	5.3±0.36	3.3±0.13	<0.001
(mm)	LONG	6.5±0.50	5.5±0.24	0.25
S_d	CIRC	40±3.4	30±1.4	0.006
(mN/mm)	LONG	49±3.9	37±1.6	0.05

Table 1: Mechanical properties of the directions CIRC and LONG denote patients vs. controls differences.

It seems that the propagation of the dissection is easier to initiate in the transverse direction, since the peel maximum tension and delamination strength appear lower for the circumferential direction with respect to the longitudinal at the controls' results.

Conclusions: Based on the above difference between patients and controls it can be concluded that the adhesion of the layers around the rupture region is stronger than normal. Possibly, this constitutes a form of patients' adaptation in order for the dissected wall to withstand the developed pressure in this region stopping the propagation. However, despite this adaptation of the wall by increasing its resistance to the dissection, in case of a possible pressure increase, the wall is unable to hold and ultimately fails to result in the propagation of the dissection.

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Keywords:
Acute Ascending Thoracic Aortic Dissections, Peeling, Crack Propagation, Delamination Strength, Peel Tension.

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CARDIOVASCULAR MONITORING FROM ARTERIAL WALL MOTION BASED ON ELECTROMAGNETIC INDUCTION

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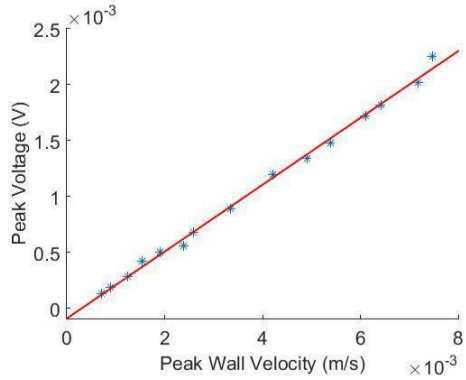
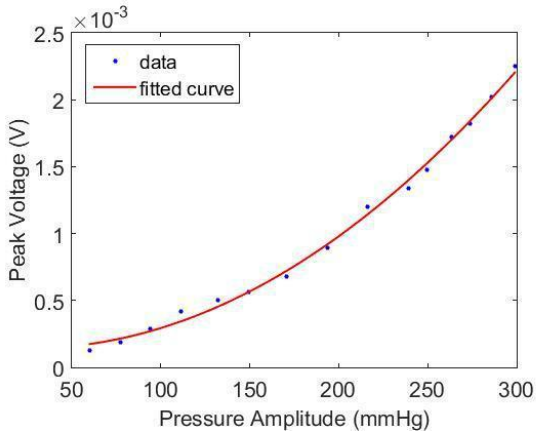
Introduction: A significant issue involving medical implantable devices arises from their battery, because its replacement requires surgical procedure. To increase the functional life of medical implants, several energy harvesting devices have been developed that convert the motions of the cardiovascular system to electrical power. The purpose of this study is to present the potential of a device, originally developed for energy harvesting from arterial wall motion [1], to operate as a sensor for cardiovascular system monitoring. This device is based on electromagnetic induction and consists of two permanent ring magnets that are placed in parallel and a flexible conductive coil that is positioned between them. The artery is inserted through the coil and the holes of the magnets. The coil moves along with the arterial wall inside the magnetic field, and as a result, an alternating voltage is induced across its terminals.

Materials and Methods: An energy harvester based on the above design was fabricated. In order to test the fabricated device in vitro and evaluate its potential operation as a sensor, an experimental setup was developed to simulate arterial motion. An elastic tube was filled with water and a motor-based compression device was used to compress and decompress a segment of the tube periodically, causing a pressure pulse inside the elastic tube with controllable frequency and pressure amplitude.

Results & Discussion: Figure 1-(a) presents the peak voltage with respect to the peak velocity of the tube's wall, along with a linear fit. Our experiments demonstrated an excellent linearity between these two quantities. Figure 1-(b) shows the peak voltage against the pressure amplitude, along with a second-order polynomial fit. The voltage-tube's radius diagram had a similar form as the one of voltage-pressure amplitude. Furthermore, a linear relationship between the frequency of the pressure pulse and the peak voltage was observed. Hence, the obtained results showed that the energy harvester under study, can be used to determine heart rate, blood pressure, artery's radius and wall velocity.



(a)



(b)

Figure 1: (a) Peak voltage versus the peak velocity of the tube's wall, (b) Peak voltage versus pressure amplitude.

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Keywords:
Cardiovascular Monitoring, Arterial Wall Motion, Medical Implantable Devices, Energy Harvesting.

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WAVELET ECG ANALYSIS IN TIME-FREQUENCY DOMAIN OF THE QRS-COMPLEX IN NORMAL INDIVIDUALS AND HEART FAILURE PATIENTS WITH LEFT BUNDLE BRANCH BLOCK

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Objectives

LBBB in heart failure patients is a negative predictor for survival. This pattern is also recorded in individuals without significant structural heart diseases. The purpose of this analysis is to investigate if there are any differences in LBBB morphology between normal individuals and patients with heart failure. The LBBB morphology has not been previously analysed using wavelet analysis in *timefrequency* domain in order to identify markers which distinguish these patients.

Materials and methods

Data of eighty-one (81) patients (mean age 66, 58 male) have been analyzed (Table 1). Group A consisted of sixteen (16) patients with LBBB without heart failure and Group B consisted of sixty-five (65) patients with LBBB and heart failure. ECGs recorded with a 3-channel digital recorder (Galix Biomedical Instrumentation) in 3 axes (X,Y,Z) for 10 minutes at rest. The sampling frequency was 1000Hz, and the duration of each signal was 90 seconds in order to ensure as much as possible artifact free signal of same length for all patients. Manual inspection of all QRS complexes by experts was pre-followed with amplitude normalization, baseline correction and application of a denoising wavelet filter. QRS complex transform was performed using 'cmor' wavelet analysis. QRS complex was divided into 3 equal scales in time domain and 3 frequency bands (low frequency range: 50-100Hz, medium frequency range: 100-150Hz and high frequency range: 150- 200Hz). The mean and maximum energies of the QRS complexes were calculated in each of the 9 time-frequency band. Demographic, clinical and ECG characteristics (QRS morphology and duration) were presented at table 1.

Results

Wavelet parameters in each of three orthogonal leads for both groups are presented in Table 2. Wavelet parameters of the QRS complex in all frequency bands in all leads were *higher* for Group A. No significant differences were noted in the x and y lead. In the z lead, the differences in mean QRS energies are significant between the two groups in the high and medium frequency band (100-200Hz) in all time segment whereas the maximum energy is significant in high frequency band (150-200Hz) in the second time segment. In conclusion wavelet transformation of the QRS complex could differentiate normal individuals from heart failure patients with LBBB.

Table 1: Baseline characteristics of study participants.

	Total n=81	Group A n=16	Group B n=65	p - value
Age (years)	66 (42 - 87)	68 (58 - 87)	66 (42 - 82)	0.282
Male gender	58 (71,6%)	4 (25%)	54 (83.08%)	0.001
QRS_duration (ms)	158 (120 - 192)	152 (120 - 163)	166 (129 - 192)	0.001
Ejection Fraction	31 (14 - 64)	58 (53 - 64)	25 (14 - 44)	0.170

P-values in bold indicate significance at 5% or lower. Values are rounded to the closest integer.

Table 2: Baseline wavelet features

Lead		Group A	Group B	P-value
X	mean (m-t1)	14,4	4,9	0,023
Y	max (m-t3)	31,70	18,60	0,049
	mean (l-t3)	6,80	4,70	0,035
Z	max (h-t2)	106,50	60,90	0,017
	mean (h_t1)	82,4	52,1	0,019
	mean (h-t2)	74,5	38,8	0,008
	mean (h-t3)	42,4	24,8	0,013
	mean (m-t2)	22,6	12,1	0,046
	mean (m-t3)	14,2	8,4	0,013
	mean (l-t3)	8,1	5,1	0,044

Terminology used for wavelet parameters: mean or max {frequen- cy bandtime}, e.g. mean{m-t1} represents the mean energy of the QRS complex recorded in the medium frequency band (100-150Hz) in the first time segment, mean{l-t3} represents the mean energy of the QRS complex recorded in the low frequency band (50-100Hz) in the third time segment and mean{h-t2} represents the mean energy of the QRS complex recorded in the high frequency band (150-200Hz) in the second time segment.

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Keywords: left bundle branch block, signal processing, wavelet transform

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A REWORKED SECOND ORDER BLIND IDENTIFICATION ALGORITHM IN EEG PROCESSING TECHNIQUE FOR FAST RECOGNITION OF MOTOR IMAGERY MOVEMENTS

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Introduction

In this paper we propose an *improvement* in the processing technique which is applied to Electroencephalography (EEG) signals with the purpose to recognize motor imagery movements and use this finding in performing *brain-based control of rehabilitation devices* This technique identifies in the patient signal the occurrence of desynchronization and synchronization (ERD/ERS) events related with motor imagery. However, to do this, the received patient signal is first subjected to the removal of environmental and system noise as well as interference noise which correspond to normal human activities such as eye-blinking and cardiac motion (artifacts). This kind of processing has to take place within time limits imposed by the on-line control requirements of the rehabilitation devices.

Second Order Blind Identification (SOBI) independent component analysis (ICA) algorithm is a widely used algorithm in removing artifacts. This algorithm, however, presents *long processing time* making the overall time for motor imagery movement identification not suitable for brain-based control of rehabilitation devices. A *rework* of this algorithm based on SCHUR decomposition, results to an *accelerated determination* of the imagery movement.

Methods

During imagery motor movements tasks, the so called mu and beta ERD and ERS are taking place, allowing us to determine human patient imagery movement [1]. These imagery tasks, which can be recognized as *power suppression and spikes* (Figure 1), indicate that the ERD/ERS events of imagery motor movements are taking place. However, original recordings of EEG data contain environmental and system noise and interference that corresponds to normal human activity such as eye-blinking and cardiac motion which need to be removed in order to isolate the ERS/ERD events from the rest of the signal.

In order to remove noise that is correlated with eye-movement (EOG) and heart motion (ECG), the Second Order Blind Indedification (SOBI) source separation algorithm [2] can be used. The algorithm works with the use of *joint diagonalisation* on a set of partial covariance matrices. The SOBI modification addressed in this study concerns the way that covariance matrices are diagonalized.

In order to determine the imagery movement, power and energy features of the signal obtained after the removal of artifacts are compared with the same features of classified signals from an available database and the class to which the processed signal belongs, is identified. The database classification is done off-line by using the SVM algorithm.

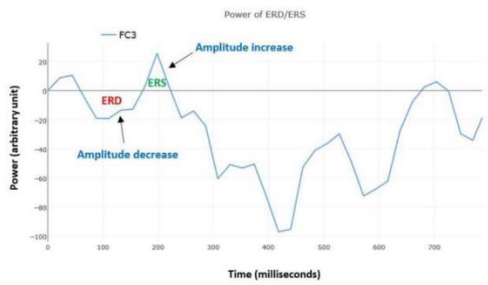

Figure 1. ERD/ERS of motor imagery tasks during EEG recording over premotor cortex signal.

Results

The evaluation of the EEG processing with the purpose of identifying motor imagery movement based on SOBI and modified SOBI algorithms are shown in Table 1. It becomes evident that a reduction of *almost 80%* in the execution time is achieved.

Table 1: EEG process technique execution in seconds

Data set	Execution time of EEG processing algorithms in seconds	
	based on typical SOBI	based on modified SOBI
1	9.845235	1.567458
2	10.379097	1.845277
3	11.514513	1.814460
4	9.800095	1.739605
5	9.799495	1.600469

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Keywords: Rehabilitation, Electroencephalography, Motor Imagery Movements, Second Order Blind Identification, Schur Decomposition.

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CARBON NANOTUBES IMMUNOBIOSENSOR FOR GLIAL FIBRILLARY ACIDIC PROTEIN (GFAP) DETECTION IN NEUROCLINICAL DIAGNOSIS

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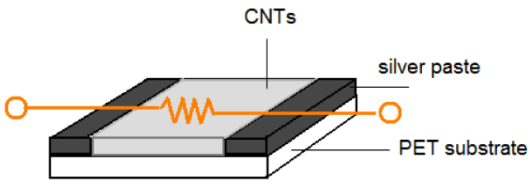

Figure 1. Schematic of the biosensor construction

A biosensor, according to IUPAC, is "a device that uses specific biochemical reactions mediated by isolated enzymes, immunosystems, tissues, organelles or whole cells to detect chemical compounds usually by electrical, thermal or optical signals" [1]. Biosensors are suitable as Point-of-Care Testing devices, that do not require trained staff or additional analytical processes, and provide rapid, quantitative, sensitive and economic biomarker detection.

Carbon nanotubes (CNTs) with attached biological molecules have been largely examined as promising biosensor materials [2]. CNTs are enrolled graphite layer (graphene) sheets in long cylindrical – tube form, produced by robust carbon molecules with the catalytic action of metals at high temperatures. Depending on the number of cylinders, CNTs can be formed in single or multi-wall tubes (SWNTs, MWCNTs). CNTs present extreme strength due to sp_2 bonds, and one-dimensional metallic or semiconducting behavior arising from π-band electrons of the p_z delocalized orbital. Extended research based on their unique properties, in view of applications in the fields of materials, nanotechnology, electronics, energy, medicine etc. has been performed the last decades. algorithm [2] can be used. The algorithm works with the use of *joint diagonalisation* on a set of partial covariance matrices. The SOBI modification addressed in this study concerns the way that covariance matrices are diagonalized.

A carbon nanotube immune-biosensor has been constructed for measurement of Glial fibrillary acidic protein (GFAP) levels (Fig.1). GFAP is the main intermediary filament of astrocytes, the most abundant cell type in the human central nervous system. Following injury or infection in the CNS, GFAP is overexpressed and is considered as a specific astroglial immune-histochemical marker.

This biosensor is based on single-wall carbon nanotubes (SWCNTs), in which an antibody against GFAP has been covalently bound, after oxidation and 1-Ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC)/N-hydroxysuccinimide (*NHS*) chemistry [3].

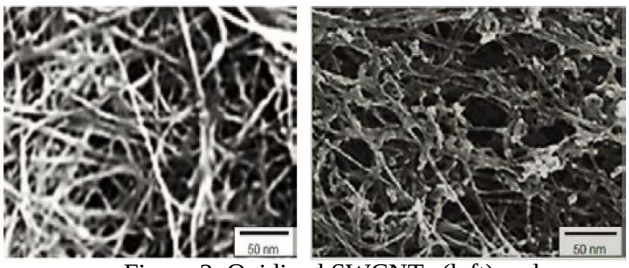

Figure 2. Oxidized SWCNTs (left) and AbGFAP functionalized SWCNTs (right)

Characterization by Raman spectroscopy and SEM (Fig.2) proved the successful bio-functionalization of the nanotubes.

Results showed that standard GFAP solutions lead to increase in the relative percentage of the electrical resistance of the sensor in a linear manner. The sensor had a specificity of up to a few μg/mL, as proved by measuring a 100 μg/mL BSA solution. The sensor platform is currently optimized to be employable in everyday clinical / biotechnology practice, while several other biomarkers and biological fluids combinations are under examination.

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Keywords:
Carbon nanotube, Immune-biosensor, biomarker, GFAP, Alzheimer's Disease

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WHEAMO: A WIRELESS HEALTH PLATFORM FOR MONITORING PANCREAS-RELATED DISEASES

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Introduction

This work presents a wireless e-health platform developed in the context of the Wheamo (Wireless Health Monitoring) project[1], which aspires to provide an end-to-end solution for monitoring the critical parameters whose pathological values are linked to pancreas-related diseases such as pancreatitis and pancreatic cancer.

Materials and methods

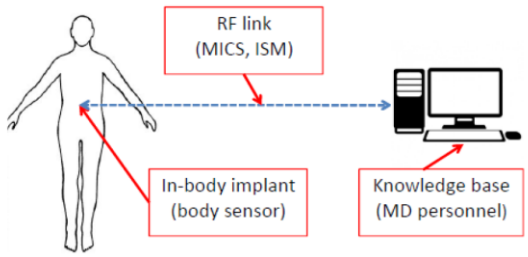

Figure 1. The Wheamo platform

The Wheamo platform employs medical implants (bio-sensors) that function as antennas planted in the pancreas. Via wireless in-body propagation, the signal that monitors and records critical parameters such as glucose, reaches the skin and then is propagated in a 3D indoor environment (i.e., a medical room) over to a terminal equipped with a user-customized, adaptive, and personalized knowledge base operated by medical personnel and other health care workers.

The fundamentals of in-body and on-body wireless propagation and channel characterization have been studied in a series of published works [1]-[3]. Researchers have tested both electric-field (dipole) and magnetic-field (patch, loop) antennas. Another important aspect concerns the frequency band in which the signal propagation will occur. Among the frequencies that have gathered scientific and academic interest are the Medical Implant Communication Service (MICS) band at 402-405 MHz, the 900 MHz channel and the industrial, scientific and medical (ISM) radio band at 2.45 GHz.

[1] www.wheamo.com

Results

Different channel links and different carrier frequencies lead to different behavior of signal attenuation while propagating inside the human body or on the skin surface. Path loss modeling has been mostly based on mathematical fitting of distributions and models on the empirical data acquired via simulations with male and female phantoms built in specific software available to researchers in industry and academia. In order to remove noise that is correlated with eye-movement (EOG) and heart motion (ECG), the Second Order Blind Indedification (SOBI) source separation algorithm [2] can be used. The algorithm works with the use of *joint diagonalisation* on a set of partial covariance matrices. The SOBI modification addressed in this study concerns the way that covariance matrices are diagonalized.

Extensive simulations have been conducted by employing appropriate software that uses human phantoms, both male and female, for both the MICS and the ISM frequency bands, in order to model the propagation of the EM radiation throughout the human body from the pancreas to the skin, with the methodology first established in [4]-[5].

Results confirm the departure of small-scale fading from the Rayleigh distribution in terms of instantaneous signal amplitude, a typical scenario for Non-Line-of- Sight (NLOS) scenarios such as in-body channel propagation. Large-scale fading confirms the Log-normal model, albeit with variations.

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Keywords:
in-body propagation, channel modeling, e-health, pancreas

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MERCURY 2.0: NON-INVASIVE BCI-CONTROLLED ROBOTIC ARMS

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Introduction

Project "Mercury" involved the integration of a lowcost anthropomorphic robotic arm into an experimental research setup, aimed at research in human-robot interaction (HRI) and biomedical engineering and robotics. The robotic arm was developed in-house by the Biomedical Electronics Robotics & Devices (BERD) group of the Lab of Medical Physics, AUTH [1]. Hybrid modality control was a design priority for the HRI platform. The design team has already tested a body-machine interface (BMI) control module comprising of a wearable exoskeletal harness, capable of sensing the position of a human operator's arm [1]. Subsequently, we have evaluated a commercial dry electrode brain-computer interface (BCI) headset as an additional control modality [2]. Moreover we have upgraded the HRI experimental platform, by adding a second arm, hand-like grippers, digitization of all motor controls and by integrating all hardware onto a mounting dock [3]. We also conducted pilot-testing experiments evaluating psychometric perception of the robotic system by healthy-end users [4]. Hereby we present the qualitative assessment results for the current design iteration of the system.

Materials and Methods

The bimanual 8-DoF anthropomorphic robotic arms were operated by healthy end-users using motor imagery BCI control while performing simple motor tasks. Moreover a disabled female patient (spinal cord injury) and a healthy control subject evaluated the system's capabilities for multiple complex motions control, using non-invasive electroencephalographic signals. The primary data acquisition interface was a commercially available Emotiv EPOC headset. User experience was qualitatively assessed using the Godspeed questionnaire [5], translated in the Greek language [4].

Results

The BCI controlled system was successfully tested by healthy end-users and a pilot disabled subject for both simple tasks and complex motion control. BCI training is possible in a single session with short learning curve for most users. While the overall experience was reported to be intuitive and immersive (as evaluated by Godspeed [4,5]), speed and smoothness of movement is still lacking when compared to BMI control [1,4].

Discussion

The completed BCI-controlled robotics system, now "Mercury 2.0" consists of two 8-DoF low-cost, custom built, anthropomorphic robotic arms and a non-invasive commercial dry-electrodes BCI control module. Qualitative experiments were conducted to evaluate the feasibility of this technology being used by both healthy and disabled (spinal cord injury) end users. The current system version has been demonstrated to fulfill its design criteria with regards to speed, accuracy and reliability of operation, intuitive and immersive control, portability and cost minimization, as well as the overall experience. The system is currently being used for neurophysiological study and rehabilitation of spinal cord injured patients in the Brainwave Clinical Trial (NCT02443558) and will be further tested for other biomedical engineering applications.

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Keywords:
Biomedical Engineering, Brain Computer Interface, Dry Electrodes, Emotiv EPOC, Human Robot Interaction, Robotic Arm, Spinal Cord Injury, User Perception.

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DERMASENSE: A NOVEL, NON-INVASIVE DERMATOLOGICAL SCANNER BASED ON ELECTRICAL IMPEDANCE SPECTROSCOPY

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Introduction

As skin cancer incidents increase exponentially in several countries, melanoma is fast becoming a high priority disease. Physical examination and biopsy are the gold standard in melanoma detection and diagnosis, however recent surveys indicate novel non-invasive and radiation-free techniques based on electrical impedance spectroscopy, which can further support diagnostic decisions [1]. Electrical impedance spectroscopy is a relatively novel diagnosis-support tool with a track record of relatively high sensitivity and specificity for the detection of malignant melanocytic lesions [2]. The proposed device, DermaSense, is designed to be a complementary medical decision support tool for early detection of malignant melanoma, providing objective digital sensor data to assist Dermatologists in deciding whether a skin feature should be a candidate for biopsy.

Materials and methods

The DermaSense prototype device is designed to be portable, lightweight and operable without requiring prior experience or specialised instructions. More specifically, the scanner is connects to a PC via a USB cable and the automated measurement proceedure is initiated using customized pre-installed software.

Results & Discussion

Preliminary results presented hereby were derived from our first pilot study. Further improvement of the DermaSense prototype scanner and further medical pilot studies are necessary in order to decide if DermaSense can be used as a complementary tool to detect skin impedance patterns related to melanoma.

In the box plot depicted, scaled impedance samples labeled clear skin 1 and clear skin 2 are shown to have similar median scaled impedance values, which substantially exceed the median obtained from scaled impedance measurements around a skin nevus from a single subject. As we expected, the nevus samples display a larger variability than the clear skin samples, indicating that DermaSense measurements may be able to achieve one of our initial design targets: to consistently distinguish skin nevi from clear skin. Moreovoer, the data point distribution for data sets 'clear skin 1' and 'clear skin 2' are symmetric, while the distribution for 'nevus' is skewed left.

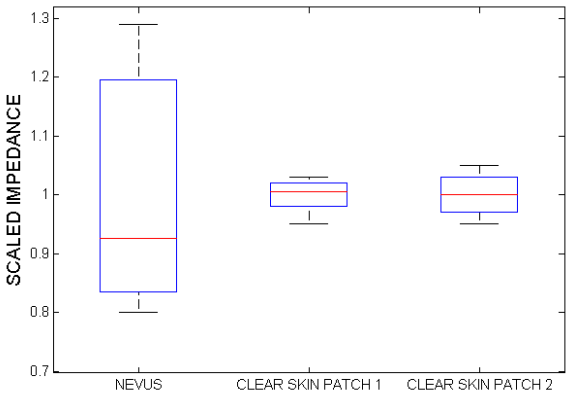

Figure 1. Box plot depicting the range and distribution of scaled impedance in nevus, clear skin patch 1 and clear skin patch 2 of a single subject.

Conclusions

Preliminary results indicate that the device works as expected, differentiating clear patches of skin from a non-malignant nevus when focusing on variability and the shape of the distribution of scaled impedance measurements across all electrodes. Our research team targets to improve the device for more specific results.

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Keywords:
Melanoma, electrical impedance spectroscopy, cancer, dermatology, medical decision support

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DECIPHERING SIGNALING MECHANISMS OF CARTILAGE TISSUE ENGINEERED ALGINATE SCAFFOLDS

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Introduction

Articular cartilage is an avascular connective tissue covering the ends of bones in a joint, responsible for bearing loads with minimum wear and friction. Protein signaling plays a central role to chondrocytes capability to either synthesize cartilage and maintain its homeostasis, or degrade cartilage and promote inflammatory responses. Previous studies have discovered major players such as BMP-2, TGF-b2 and FGF-2 for chondrogenesis of tissue engineered articular cartilage, however, little is known if such stimuli share common pathways related to cartilage growth [1]. In this study, we combine Systems Biology and Tissue Engineering approaches by creating a mechanism for 3D cartilage phenotype evaluation.

Materials and Methods

Cartilage tissue was obtained from the femoral heads of patients undergoing total hip arthroplasty. Chondrocytes were isolated using standard methods. 50,000 chondrocytes were seeded on each alginate scaffold. 9 different categories were produced. The first category was unseeded, the second category was seeded only with chondrocytes and the final 7 categories were seeded with chondrocytes and stimulated with CTGF, IGF-I, FGF-2, BMP-4, EGF, Cadherrin11 and MGP. Cells were cultured for 9 days and stimulated every 2 days. A Luminex 200 system was used to measure the activation of 15 phosphoproteins 9 days after the stimulation. A library of 22 cytokine releases was measured in the supernatant 9 days after stimulation. The sulfated glycosaminoglycans (s-GAG) content was quantified spectrophotometrically using the 1, 9-Dimethylmethylene blue dye (pH=3)

Results

As shown in Fig.1, a large number of stimuli raised a significant response in chondrocytes, activating at least one phosphoprotein signal. Well known players such as BMP-4, CTGF, EGF, FGF-2 and IGF-I responded as expected from previous studies. Apart from the major players, two underreported stimuli, Cadherrin-11 and MGP are found to affect chondrocytes signaling as well as the cartilage phenotype. As shown in Fig. 2, a large number of imposed stimuli promoted significant cytokine release in chondrocytes. The most significant cytokine releases came from MGP and Cadherrin-11. All the stimuli-categories had a higher GAGs concentration. More specifically, BMP-4, EGF and Cadh11 had the highest (175%, 169% and 154% more compared to the untreated with stimuli, respectively).

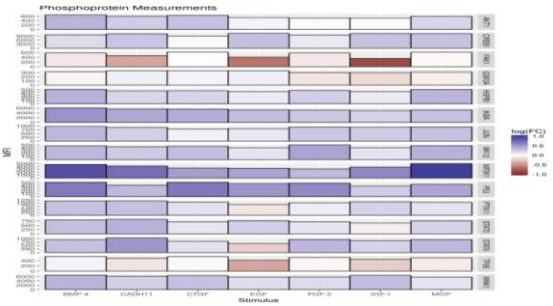

Fig.1: MFI measurements of each pathway/stimuli and comparison with measurement without stimuli (color comparison)

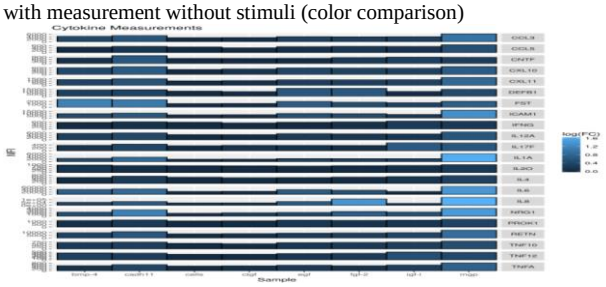

Fig.2: MFI measurements of each pathway/stimuli and comparison with measurement without stimuli (color comparison)

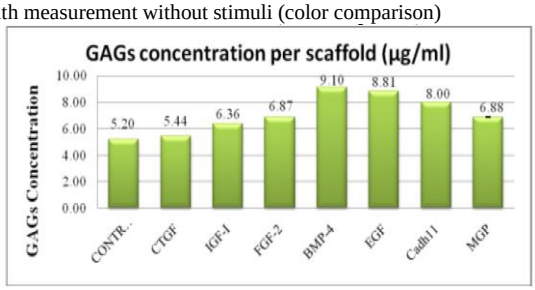

Fig.3: GAGs concentration per category 1. V.Vassilikos et all,

Discussion

BMP-4 and Cadherrin-11 induced the highest responses in both phosphoproteins responsible for cell proliferation, survival and growth and GAGs production. An underreported player, MGP, induced the highest responses in most inflammatory cytokines (showing that it does affect the cell-cell communication regarding inflammation).

Conclusion

IGF-I, FGF-2, CTGF, BMP-4 and EGF share common survival and growth and GAG production. Additionally, we identified new players that share those features. More importantly, we identified that Cadherrin-11 and MGP) have anabolic and catabolic activity.

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Keywords: Tissue engineering, 3D alginate scaffolds Systems Biology

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ΣΥΝΔΥΑΣΤΙΚΗ ΧΡΗΣΗ ΨΗΦΙΑΚΗΣ ΑΠΟΤΥΠΩΣΗΣ ΚΑΙ ΜΗΧΑΝΙΚΟΥ ΑΙΣΘΗΤΗΡΑ ΕΠΑΦΗΣ ΓΙΑ ΤΗ ΜΕΤΡΗΣΗ ΑΠΟΚΛΙΣΕΩΝ ΘΕΣΗΣ ΟΔΟΝΤΙΑΤΡΙΚΩΝ ΕΜΦΥΤΕΥΜΑΤΩΝ ΣΕ ΠΕΡΙΒΑΛΛΟΝ 3D-CAD/ CMM

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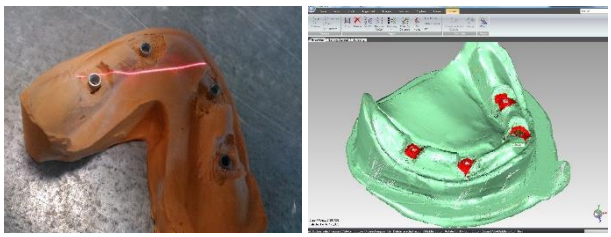
Εισαγωγή

Στον τομέα της σύγχρονης οδοντιατρικής προσθετικής, το στάδιο της αποτύπωσης, ως καταγραφή της πληροφορίας που αφορά στη θέση στο χώρο των αποτυπούμενων μορφολογιών και της όσο το δυνατό πιστότερης μεταφοράς τους στο εργαστήριο, ώστε να κατασκευαστεί το εκμαγείο εργασίας, αποτελεί ίσως το κρισιμότερο για την ποιότητα της παρεχόμενης αποκαταστατικής θεραπείας με ενδοοστικά εμφυτεύματα. Η παρούσα εργασία εστιάζεται στην πειραματική διερεύνηση της συνδυαστικής χρήσης σύγχρονων τεχνολογιών και μέσων ψηφιακής αποτύπωσης *(σαρωτές laser, μηχανές μέτρησης συντεταγμένων)* με στόχο να εξασφαλιστεί η μέγιστη ακρίβεια κατά την μεταφορά της πληροφορίας που θα χρησιμοποιηθεί για την κατασκευή της αποκατάστασης, σε περιβάλλον 3D-CAD *(Computer Aided Design)*.

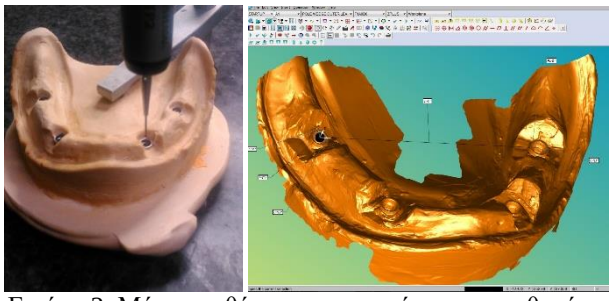
Υλικά και Μεθοδολογία

Για την ψηφιακή σάρωση / αποτύπωση των εκμαγείων χρησιμοποιήθηκε φορητός αρθρωτός μετρητικός βραχίονας τύπου FARO PLATINUM ARM, επτά βαθμών ελευθερίας, με εργόσφαιρα μέτρησης 2.4m και ακρίβεια μέτρησης ± 0.043mm *(ANSI B89.4.22:2004)*, συνεργαζόμενος με σαρωτή laser FARO Laser Line Probe. Η ψηφιακή αποτύπωση και η επεξεργασία του νέφους σημείων έγινε με το λογισμικό Geomagic Studio της 3D Systems, από το οποίο έγινε εξαγωγή αρχείου με μορφή τριγωνικού πλέγματος *(.stl file)*.



Εικόνα 1. Ψηφιακή σάρωση και νέφος σημείων

Για τη μέτρηση των αποκλίσεων θέσης των οδοντιατρικών εμφυτευμάτων χρησιμοποιήθηκε η αυτόματη Μηχανή Μέτρησης Συντεταγμένων (CMM) τύπου γέφυρας Mistral 070705 της DEA–B&S, υποστηριζόμενη από το μετρητικό λογισμικό PC–DMIS 2015 της Wilcox Assoc., που είναι πιστοποιημένο κατά ISO 10360-6 από το PTB. Η αβεβαιότητα μέτρησης για την εν λόγω CMM δίνεται κατά ISO 10360-2 από τη σχέση: U3 (μm) = MPE_E = 3 + L(mm)/250 *(Volumetric length measuring uncertainty)*, όπου L (σε mm) η μετρούμενη διάσταση και U3(σε μm) η αβεβαιότητα στο χώρο μέτρησης. Για την καταγραφή των σημείων χρησιμοποιήθηκε κεφαλή Renishaw PH10M με στέλεχος TP200 και απόληξη *(tip)* μήκους 20 mm και διαμέτρου 1 mm. Το 3D-CAD αρχείο της σάρωσης χρησιμοποιήθηκε για την αυτόματη οδήγηση της μηχανής CMM με αποτέλεσμα τη μείωση της αβεβαιότητας των μετρήσεων θέσης των εμφυτευμάτων στο εκμαγείο *(Εικόνα 2)*.



Εικόνα 2. Μέτρηση θέσης εμφυτευμάτων με αισθητήρα επαφής σε CMM οδηγούμενη από το 3D-CAD μοντέλο της ψηφιακής αποτύπωσης

Συζήτηση - Συμπεράσματα

Η ποσοτική εκτίμηση της αβεβαιότητας των μετρήσεων θέσης των εμφυτευμάτων αποτελεί αντικείμενο ευρύτερης επιστημονική έρευνας-μελέτης, που βρίσκεται σε εξέλιξη και πραγματοποιείται μέσα από τη συνεργασία της Οδοντιατρικής Σχολής του ΕΚΠΑ *(Εργαστήριο Οδοντικής Χειρουργικής)* με τη Σχολή Μηχανολόγων Μηχανικών του ΕΜΠ *(Εργαστήριο Ταχείας Κατασκευής Πρωτοτύπων & Εργαλείων)*. Τα μέχρι τώρα αποτελέσματα της παραπάνω προσέγγισης κρίνονται ενθαρρυντικά.

Λέξεις Κλειδιά:
Οδοντιατρικά Εμφυτεύματα, Εκμαγεία, Ακρίβεια, Μηχανές Μέτρησης Συντεταγμένων, Ψηφιακοί Σαρωτές, 3D-CAD

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A DEVICE FOR REAL-TIME MONITORING DEGRADATION IN MULTIPLE CARTILAGE SAMPLES

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Introduction

Articular cartilage is the connective tissue of diarthrodial joints. Its principal function is to facilitate the transmission of loads and reduce friction between the joints. Due to lack of vasculature, articular cartilage does not regenerate after damage caused by injury or aging. Cartilage degeneration originates from imbalanced anabolic and catabolic activities in chondrocyte [1], and causes movement difficulties and acute pain. Since there are no treatments that can prevent or restore cartilage deterioration, there is need to develop effective treatments that can block cartilage degeneration. This study introduces a new instrument that can help cartilage treatment discovery by monitoring in real time the degradation of 24 cartilage samples, and provides pilot data of cartilage degeneration caused by collagenase treatment.

Materials and Methods

A new instrument was designed and built for quantifying the degradation of 24 cartilage samples. A laser distance sensor was utilized to quantify the displacement of a metal intenders (post) placed above each cartilage sample. The vertical motion of each post was independently guided by a housing that provided minimal friction. A single laser sensor was used to quantify the relative motion of 24 posts by moving the post in the horizontal plane via a XY motion system. Cylindrical porcine cartilage samples (3mm diameter, 1.2 mm tall) were placed in the wells of a 24-well plate in DMEM in the absence or presence of 1 mg/ml collagenase. The degradation of these samples (n=2 per group) was quantified over a time duration of 4 days inside a humidified cell incubator (37ºC, >90% humidity).

Results

Figure 1 shows the vertical deformation in samples treated with just medium (control) or 1 mg/ml collagenase. As expected, cartilage samples in DMEM maintain their height over time. On the other hand, collagenase-treated samples are compressed significantly due to the reduction of their equilibrium modulus caused by collagenase degradation.

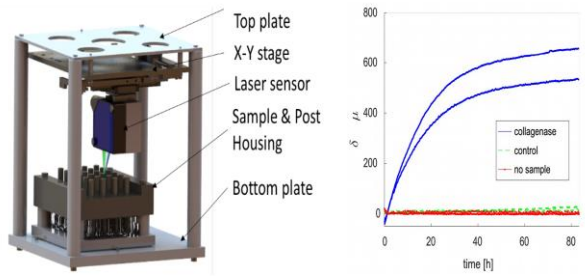

Figure 1. Left: Computer rendering of the instrument highlighting its key components. Right: Representative data from cartilage samples treated with collagenase or with control buffer (DMEM).

Conclusions-Discussion

Compared to the state of the art in instruments that probe the mechanics of multiple cartilage samples [2,3], the proposed instrument is simpler (due to lack of actuators), and provides displacement resolution of 1 μm. The collagenase digestion monitored in the pilot data presented in this abstract can be thought as a simple way to model cartilage degradation that takes places in tissues due to aging or disease. The developed device can monitor 24 cartilage samples over time inside a standard cell culture incubator, enabling to quantify the effects of anabolic and catabolic stimuli on cartilage, and screening the effects of candidate drugs for cartilage degeneration [4].

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Keywords: Articular cartilage, extracellular matrix remodeling, tissue biomechanics

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PRIMARY HUMAN HEPATOCYTE MODELS FOR NAFLD/NASH BASED ON PHOSPHOPROTEOMICS

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Non-alcoholic fatty liver disease (NAFLD) is the most common liver condition in the world, with a prevalence of up to 30% in developed countries[1]. NAFLD is defined by the presence of hepatic steatosis in the absence of excess alcohol consumption and represents a spectrum of disease, from simple steatosis and Non-Alcoholic Steatohepatitis (NASH) to fibrosis, cirrhosis and hepatocellular carcinoma[2]. The cause and disease progression mechanisms of NAFLD are still not completely understood[3,4]. Researchers have tried to understand the disease through multi-omic approaches[5] but there is no study -to our knowledge- exploring the signal transduction level, while phosphoproteomic measurements are becoming very important in drug discovery[6]. In vitro exposure of primary human hepatocytes to increasing concentrations of free fatty acids (FFA) results in increased intracellular accumulation of lipid droplets similar to those observed in patients with NAFLD and NASH[7]. We prepared a mixture of exogenous FFA in ethanol in molar ratio 1:2 Palmitic Acid: Oleic Acid respectively, as it has been done before in a study using Huh7 cells[8]. However, instead of cancer cells, we cultured primary human hepatocyte cells, isolated from healthy resected human liver tissue. The cells were exposed to increasing concentrations of the FFA mixture (100-1000uM). The formation of intracellular lipid droplets was verified using high content screening; lipid droplets were stained with Nile Red fluorescent probe and Hoechst 33342 was used for counterstaining cell nucleus. After a 24h treatment, we lysed the cells, measured the protein content of the lysates and adjusted the samples to the same concentration. After pooling 5 replicates of each FFA concentration, we measured 19 phosphorylated protein targets using Luminex technology (multiplex antibody-based ELISA). We found that the phosphorylation level of heat shock protein beta-1 (HSPB1) was three-fold less than the control. Other scientists have recently shown that HSPB1 is down-regulated in NASH[9]. Moreover, we show irregular phosphorylation patterns in IKBA, AKT1, WNK1, FAK1 and STAT6, most of which play a role in NAFLD/NASH mechanism[10,11,12,13,14]. The present study pinpoints the signaling alterations of FFA-induced NAFLD.

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SUBPATHWAY APPROACHES ON THE ROAD TO NETWORK MEDICINE

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Abstract
In the recent years, network-based approaches have become prevalent in the modeling and analysis of biological systems. This has led to an emerging field, known as network medicine, at the confluence between Systems Medicine and Network Science. Network Medicine approaches improve our understanding of how changes in cellular processes can lead to complex diseases and allow the identification of essential molecules and phenotype-associated modules in biological systems. Nowadays, approaches on cellular subpathways, identified as molecularly and functionally coherent subnetworks, attracted significant interest among the network-based methods. In this context, we present two in-house subpathway-based tools for detecting disease biomarkers.

Introduction
Our biological existence is encompassing a multitude of complex systems where numerous interdependencies among thousands of genes and metabolites occur at various levels and scales. Consequently, a disease is rarely a consequence of an abnormality in a single gene, but reflects the perturbations of the complex intracellular and intercellular network that link tissue and organ systems. This has led the research community to use systems-level and network-level tools to uncover the complexity of biological mechanisms and diseases [1].
A new field of research, known as «Network medicine» follows this direction. It is the combination of «Systems Medicine» and «Network Science» fields and aims to address disease complexity in a holistic, integrated way. The emerging tools of network medicine offer a platform to identify new disease genes, drug targets and biomarkers for complex diseases [1].
In this context, the tools based on cellular subpathways can explore deeper the biological significance of genotype-phenotype associations identified by genome-wide association studies and full-genome sequencing. Subpathways are local areas of cellular networks that can be associated with specific biological processes, the deregulation of which can give rise disease. A number of subpathway-based tools have been published in the recent years, offering new vistas in the field of Network Medicine [2].

Method
We developed DEsubs (*Differentially Expressed SUBpathwayS*), a package that extracts subpathways containing differentially expressed (DE) genes using RNA-seq data and pathway maps [2]. It is a flexible and computationally fast and efficient tool with numerous operation modes providing the user a highly customizable setup, resulting in a wide range of possible analyses. DEsubs enables both the modeler and experimental systems biologist in the systematic exploration of disease-associated changes in gene expression levels identified by RNA-seq studies.
Additionally, the majority of (sub)pathway-based approached fail to deal with the time evolution of the active topologies within a biological pathway network. CHRONOS (*time-vaRying enriCHment integrOmics Subpathway aNalysis tOol*), another recent tool developed by our group, can address this limitation by detecting significantly enriched miRNA-mediated subpathways per time point from paired miRNA/mRNA time series expression profiles [3]. It scans the complete pathway topology to track the time-/context-specific biologically enriched subpathways along with their time-/context-specific miRNA regulators.
Both tools offer a more realistic view of the involved perturbed mechanisms that cause complex diseases.

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Keywords:
Network Medicine, Subpathway tools, Disease Biomarkers

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NEUROFEEDBACK INTERVENTION FOR CERVICAL DYSTONIA

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Introduction

Continuous involuntary neck muscle contractions resulting in pathological posture of the head describe cervical dystonia, one of the most common focal dystonias among adults. While idiopathic cervical dystonia pathophysiology is still under investigation, dysfunction of the communication between basal ganglia and thalamus has been recently shown to play some role [1]. Chronic, often severe pain, emotional and physical limitation and social exclusion are among the key characteristics of this condition. Existing treatment modalities, aiming at symptoms relief and improvement of patient overall functionality, include a variety of approaches, such as physical therapy, antidepressants, intrathecal baclophen, botulinum toxin injections, surgery and deep brain stimulation. These approaches often offer a moderate degree of success, some inducing side effects as well, and dystonia recurrence is common [2]. Biofeedback, based on operant conditioning has been employed with some success in the form of electromyography (EMG) biofeedback [3]. Neurofeedback (NF) is an electroencephalographybased (EEG) biofeedback method to optimize physical and mental training [4] that has been tested with successful results in anxiety, depression, epilepsy and attention-deficit/hyperactivity disorder, among others [5]. Hereby, we present a case study of employing NF as therapeutic modality in a female patient with recurrent refractory idiopathic cervical dystonia.

Materials and Methods

A 37-year old woman, diagnosed 12 years ago with idiopathic cervical dystonia (retrocollis) that showed resistance to standard therapeutic approaches (including physical therapy, anti-depressants and botox) and frequent recurrences was referred for evaluation. She suffered from pain, intermittent involuntary backwards posture of the head, emotional swings and self-reported psychogenic association of the symptoms. Her baseline EEG showed overly increased amplitude of sensorimotor (SMR) rhythm (12-15 Hz) and generally decreased alpha rhythm (8-12 Hz). She attended 15 NF sessions, two per week for eight weeks. A clinical psychologist was also involved, providing counseling once per week. NF sessions lasted 45 minutes and consisted of pre-training EEG recording with eyes-open (EO) and eyes-closed (EC), a 20-30 minutes brainwave training phase and post-training EEG recording. Brainwave training involved first down-training of SMR rhythm and then up-training of alpha rhythm both on Cz location with EO. Feedback was visual (video) for SMR and audio-visual (music and “alpha-zoomer” square) for alpha training. Mean amplitudes of theta (4-8 Hz), alpha, SMR and beta (15-30 Hz) between pre- and posttraining were tested for normality using Shapiro-Wilk Test for both EO and EC conditions. Then, data were analyzed using either paired t-tests or Wilcoxon Signed Ranks Test based on the normality assumption.

Results

All rhythms’ mean amplitudes were decreased post-training during EO, while SMR and theta were increased during EC. Significant difference was found only for SMR during both EO and EC and Beta band on EO condition. The patient reported relative improvement of both dystonia symptoms and her mood.

Discussion

This is the first study, to our best knowledge, that describes NF as therapeutic modality for cervical dystonia. NF may prove useful as alternative or complementary treatment of resistant recurrent idiopathic cervical dystonia, intervening to inhibit or enhance abnormal findings on EEG recording.

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Keywords:
Alpha Training, Cervical Dystonia, EEG Biofeedback, Neurofeedback, Retrocollis, SMR Training.

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CLINICAL DECISION MAKING TOWARDS EARLY DETECTION OF NEUROPATHOLOGICAL PATTERNS AND TRAINING PROMOTING ACTIVE AGEING

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Introduction

Contemporary mathematical models investigate whether non-pharmaceutical intervention may promote neuroplasticity in the mature human brain. Advances in clinical decision making facilitate the fusion of various features and promote the identification of pathological symptomatology. The present study highlights the principles of a generic expert system which aims to identify alterations in brain function even in the case of co-existing disease factors. It employs multiple experimental conditions like resting-state electroencephalography (EEG), event-related potentials and polysomnographic activity during sleep. Feature selection and fusion is then performed and sophisticated algorithms are employed to classify the recordings to average disease models defined through a priori information. These models are dynamically updated and validated by experimental measurements which are semantically described in order to promote data sharing and to prevent study isolation. The proposed system combines the classification result (identification phase) with the suggestion of the optimal nonpharmaceutical training protocol.

Materials and Methods

The recordings were performed through two Nihon-Kohden devices equipped with 64 active and 32 AgCl electrodes. The participants were mainly recruited from the FP7 EU-funded project Long Lasting Memories (LLM), which involved a combination of computerized cognitive training through the Brain HQ neuroplasticity-based program and computerized physical training through the FitForAll platform. This intervention was compared with a project employing traditional Greek dances and a control group performing computerized cognitive stimulation (ACTIVE control group).

Results

Features would be derived from the estimation of functional connectivity and formation of functional brain networks. Then, estimation of global network characteristics (characteristic path length, cluster coefficient) and network performance (small-world property) would provide both global and localized view of the brain activity. The latter would be based on the patient's neurofunctional profile in order to enhance personalized medicine and to achieve better training results. So, the aforementioned holistic approach aims to increase the quality of personalized healthcare in clinical practice.

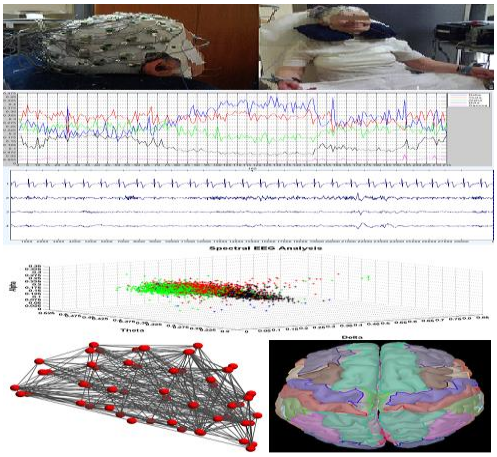

Figure 1 Neurophysiological data acquisition through high density electroencephalography provides a wealth of biosignals quantifying the function of resting state networks and aspects of cognitive functioning and sleep.

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Keywords:
Physical Training, Cognitive Training, Health Care, Active Ageing, Elderly, EEG, Personal Health Services

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NEW FIGURE OF MERIT FOR DUAL ENERGY X-RAY IMAGE QUALITY ASSESSMENT BASED ON LINE PROFILES ANALYSIS: INITIAL RESULTS

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Introduction

Figures of Merit (FoMs) are used in order to evaluate the quality of a produced image. The most broadly used are the Contrast to Noise Ratio (CNR), Signal to Noise Ratio (SNR), Contrast Michelson. Although these FoMs can provide a good mean to evaluate the images, the calculated value when applied to an image does not always come in accordance with visual investigation. For this reason an in-house developed FoM has been defined that is based on analysis of data extracted from line profiles within the image. Regions of Interest (ROIs) are placed along these line profiles and a normalized value is calculated depicting the contrast within the image and evaluates its edge and contrast features. It is referred as Line Contrast (LC).

Materials and Methods

The in-house developed XrayImagingSimulator [1] developed at the Biomedical Technology Unit (BITU), was used to generate projection images in the frame of Brain DECT imaging investigation [2]. The simulated Brain DECT acquisition geometry included rotation of the x-ray source and detector in a full arc of 360^0 around the brain phantom acquiring 181 images at an increment of 2^0.

The following incident photon beams were simulated: ten monochromatic beams from 20 keV to 110 keV and four polychromatic beams 80, 100, 100, 140 kVp.

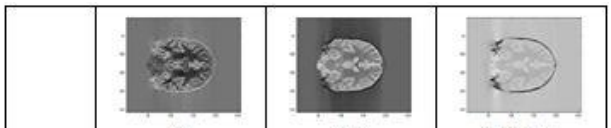
The subtraction algorithm used is based on the theory of Lehmann, Alvarez and Macovski [3]. The process followed is the decomposition of the attenuation coefficients (μ) of each pixel in the projection images of both low and high energy spectra, into a pair of basis materials which in this case are Gray and White matter.

In order to evaluate the performance of the LC FoM it was compared with CNR and Contrast Michelson, in their ability to find images with the better contrast between gray and white matter.

Results

On Fig. 1 a comparison of the images with the highest value according to each FoM are depicted. Below each image the value that the image gets using each FoM is shown. From this figure the accordance of visual and FoM investigation using LC can be seen since the LC values of all images depict the actual contrast seen. While in the case of CNR and Michelson Contrast the two images on the right which have inferior contrast get a higher score.

As it can be seen from visual investigation the contrast on image selected using LC FoM is higher than in the ones selected using CNR or Michelson contrast. Especially in the case of Michelson contrast the image with the higher score has the lower contrast than all images in the figure



	LC	CNR	Michelson
Max LC	0.9199	0.3493	0.2215
CNR	6.2873	9.4786	8.6675
Michelson	-1.5319	0.6184	389.5696

Figure 1. Comparison of the images with higher score using each FoM (columns) and corresponding score using all FoMs (lines)

Conclusions

The proposed FoM which is based on data extracted from line profiles within the image, has proven to be more efficient in finding the images with the higher contrast. It also provides the most consisted results in terms of visual and quantitatively agreement than all other FoMs used. LC comes into full accordance with visual assessment and that it overpass the traditionally used CNR, especially in the ability of detecting the edge enhancement, and contrast of the different tissues within the image.

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Keywords:
Figures of Merit, Dual Energy, Image Evaluation, X-Ray imaging, Simulation

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NEW PERSPECTIVES AND CHALLENGES IN BIOMEDICAL ENGINEERING EDUCATION

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Introduction

Medical technology radically reshaped the way healthcare is delivered today and continues to improve it in an accelerated pace. Biomedical Engineering (BME) is a multidisciplinary field lying in the cross-section of medical/biological sciences and engineering. Healthcare today is technology-driven and delivered by teams rather than individuals. Biomedical Engineers (BMEs) as professionals are playing a vital role in these developments, being behind the recent advances and involved during the whole life cycle of Medical Devices (MDs), from the innovative idea to their final use. More than five hundred thousand MDs models are available in the world market today. As a result, the BME profession is expected to be the first in demand amongst all other engineering subspecialties in the years to come. However, this rapid evolution creates a constant pressure for new knowledge and skills for the BMEs and therefore for continuous curriculum updates in order to meet R&D and market demands, but also harmonisation of studies worldwide that will facilitate staff and students' mobility and collaboration.

Educational programs for graduate and postgraduate studies in BME, should be built upon the basis of evidence-based data from specific studies, surveys and reviews on existing educational programs in BME and the required knowledge, skills and attitudes emerging from recent advances in medical technology, the MDs industry perspectives and the patient safety. The wide acceptance of a consensus-based agreement on a generic core curriculum that would be part of a great number of BME programs, will promote employability, competitiveness as well as staff and student mobility and will facilitate a worldwide opening of the BME job market, through mutual recognition of the competencies acquired.

BME Education in Europe

Education in Biomedical Engineering in Europe has been strongly influenced by the European policy during the last twenty years. The establishment of the European Credit Transfer System (ECTS) increased the flow of students and teaching staff between universities [1]. An extensive review of the BME education in Europe performed in 2012 under the CRH-BME project, identified 40 countries with BME programs [2]. According to the results of this study, by the end of 2012, 150 Universities across Europe were offering in total 350 BME programs, distributed as following: 85 graduate programs offering BSc degree, and 225 Postgraduate programs, from which 160 offered MSc degree and 65 offered PhD degrees.

The Need for Harmonisation of BME Studies Worldwide

The extent of adoption of new and emerging technologies may differ from country to country, and differences in the way the educational programs are implemented present obstacles in mutual recognition of degrees and collaboration amongst the HEIs, in terms of staff and students exchange as well as the access of their alumni to the global job market. This has been recognised as very important for the BME profession, since commonly accepted basic knowledge background, skills and characteristics would greatly facilitate the acceptance that BMEs belong to the same profession. The harmonisation of studies is therefore of prime importance for most universities offering such studies, and has been identified as such by the BME national societies and the international associations (IFMBE, EAMBES and CORAL)

Expected Benefits

Harmonisation will be of interest to *direct users*, such as academics and their institutions (participant and not), as well as to *indirect users* such as students, health institutions, the medical device manufacturer sector, and other institutional stakeholders.

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Keywords:
BME education, Harmonisation, Curriculum, Generic programs

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HOME TELE-MONITORING OF PATIENTS WITH IDIOPATHIC PULMONARY FIBROSIS

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Introduction

As population ages, the need for constant monitoring of health conditions and disease management has become vital. Except for the fact that telemedicine services contribute significantly to the monitoring of patients suffering from chronic diseases, they aim especially towards the early detection of unexpected complications [2]. Research in mobile health has progressed notably and has focused mainly on the management of heavy incidents within the framework of healthcare services [1]. In this context, a fourteen-month pilot program with regard to the home monitoring of patients with idiopathic pulmonary fibrosis (IPF) has been conducted.

Materials and Methods

The participating users-patients were provided with an Android tablet with the "HeartAround" application pre-installed, along with a Bluetooth oximeter and a blood pressure monitor. The daily routine included measuring once a day their hemoglobin saturation, heartbeat and blood pressure. The measurements were stored wirelessly and automatically in their personal EHR and were made available to their practitioners. The users were also offered the opportunity to communicate at real-time via embedded videoconferencing with their personal doctor, family members and a 24/7 helpdesk.

Results

During this fourteen-month period, each of the twenty participants recorded an average of 470 measurements per biosignal with 100% compliance to the program's requirements. Almost 70% of the users utilized the application independently while some others did not hesitate to ask for the helpdesk's support. As a result, our program proved that even participants with no technology literacy are capable of utilizing the "HeartAround" application successfully.

Discussion

The incorporation of a homecare platform in the everyday life of elderly chronic patients, indicates that regardless the participants' age, users are able to use such a system with confidence and remarkable compliance to their monitoring schedules. Furthermore, by incorporating the system in their care process, doctors can have a more accurate and up-to-date overview of their patients' health status. Last but not least, the emergency call service appeared to be indispensable, providing immediate response.

Conclusions

Overall, the pilot program exhibits the benefits offered to patients and their ecosystem of relatives and doctors utilizing the homecare platform. Through this initiative, by offering personalized medical care and monitoring, strengthening the doctor-patient relationship and preventing potentially dangerous situations, the goal of promoting the independent living and improving the quality of life of chronic patients is achieved.
Impact analysis and assessment of user satisfaction will be realized via questionnaires [3].

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Keywords:
Telemonitoring, mhealth, IPF, personalized medicine

Acknowledgement
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WIRELESS SYSTEM FOR DYNAMIC BODY STABILITY ASSESSMENT

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Introduction

Injuries associated with falls strongly affect health and health care expenses, mainly for elderly people. Although thoroughly researched, falls remain an under prevented public health problem. At present, force platforms are the most common device used in balance assessment. However, they are costly and cumbersome, which makes them impractical. The use of Inertial Measurement Units (IMU) in balance assessment even though examined, has not yet turned into a laboratory standard [1]. Furthermore, it was stated that dynamic balance measurement is a superior indicator of functional balance performance than the static one [2]. Hence, new techniques and instrumentation for objective measurement of the dynamic body balance and different aspects of stability are necessary. An effort is made to address these necessities by developing a mobile IMU based measurement system that can track both the subject's and the base surface's sway while the subject is trying to sustain equilibrium on a balance training platform.

Materials and Methods

The system consists of two Bluetooth Low Energy (BLE) enabled sensors featuring a 3D digital accelerometer and a 3D digital gyroscope, a smartphone, as well as Android and iOS Apps. The sensors feature dedicated firmware with dual role: to control the data sampling and transmission to the smartphone, and to support over-the-air updates to allow for future program updates. The IMU values are sampled at 100Hz; these samples are streamed via BLE in real-time and in packets of 20 bytes to a connected smartphone.

Dedicated Android and iOS Apps were developed to establish communication between the sensors and the smartphone allowing the user to receive, store, analyze and display the data through friendly interface. The Android App was written in Java with Android Studio v2.2 using Android SDK 23 and Object Oriented Methodologly. The iOS app was written in Swift 3.0 using XCode 8. It targets iOS 9 & 10 and it is built using Reactive Functional Programming techniques. In order to establish a connection and send/receive data, the iOS App makes a clever use of the CoreBluetooth framework by using a reactive functional programming framework called ReactiveSwift, which facilitates the observation and manipulation of data without having to resort to callbacks. The data is stored locally using another iOS framework called CoreData and can be synced with a cloud for further analysis.

Results

Preliminary measurements were performed with five healthy subjects with the proposed system using Vew-Do Balance Board (Balance Designs Inc.) where the sensors were attached by Velcro strap to ensure optimal sensor fixation. One of the sensors was attached to the subject's sternum and the other to the center of the balance board. The sensors were time-synced and the raw data was transmitted in real time to a paired smartphone. The data was used to plot in real time the projected paths of the trunk acceleration (sway diagram) and that of the balance platform (inclination diagram).

Discussion

The use of multiple IMU based small wireless sensors, and their dedicated placement on both the subject and the balance training platform may evolve in an advanced monitoring system to precisely track the body sway in relation to the platform sway. Typical application of the proposed system may include balance rehabilitation, quantifying the severity of balance disorders, panic/anxiety disorders and balance, postural stability in neurological disorders, effects of alcohol on balance, age and spontaneous sway.

Conclusions

Results from the preliminary tests showed that the proposed system is suitable for further comparative studies in order to evaluate the accuracy of the method as compared to force platforms. Additionally, it may prove to be a potential solution for the assessment of the functional balance performance in elderly and patients with Parkinson's disease. Further optimization of the proposed system in combination with the use of a higher number of sensors may allow for more extensive research in dynamic body balance assessment.

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Keywords:
Dynamic body balance, Accelerometer, Stability, Bluetooth, Smartphone

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AN ULTRASONIC AND SPECTROSCOPIC MICROSCOPY LAB PERFORMING HIGH RESOLUTION QUANTITATIVE AND QUALITATIVE EVALUATION OF EPIDERMIC STRUCTURES (USE CASES ON SKIN, BRAIN AND NAIL)

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Introduction

In this work, the study of the stratigraphy of epidermic structures and not only, i.e. skin, nail and brain, is presented. The techniques used consists of acoustic microscopy and infrared (IR) mapping imaging. The former technique provides tomographic images in a region of interest (ROI) of the structure, whereas, the latter reveals the distribution of physiochemical properties in the same ROI.

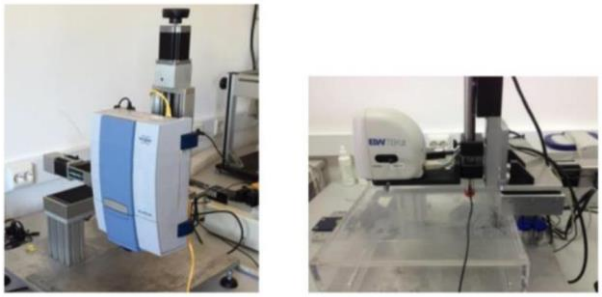
Methods

Specifically, acoustic microscopy is a conventional sequential ultrasonic scanning but using piezoelectric transducers which have very high frequency content (>20MHz) and insonify areas with very small diameter (~20μm). Thus this technique provides high spatial resolution tomographic images, as well as 3D cube images, which allow the examination of micro structures (>10μm) in the under investigation ROI.

On the other hand, the IR spectra acquired after a raster scanning on the same ROI can be clustered to similar physiochemical property groups so as to result spectroscopic mapping images which reveal spatial patterns of the physiochemical properties possibly identifying suspicious cases. The clusters are consisted of spectra that have similar characteristics and thus are indicating the existence of similar materials; hence, similar physiochemical composition. The spatial distribution of such clusters can be illustrated in pseudocolour images, in which each pixel of image is colored according to its cluster membership. The Fourier transform infrared (FTIR) spectroscope (Bruker ALPHA) with special adapted reflectance illumination area (0.5mm) was used in order to acquire the array of spectra. The spectral area in wavenumbers covered by ALPHA is 7500 - 375cm-1. This spectral area (SWIR/MWIR/LWIR) used ensures the penetration of the radiation in deeper layers. Moreover, the mapping images can be produced by clustering the acquired spectra in specific spectral bands in order to provide stratigraphic information, i.e., images that convey information of the distribution of hysiochemical properties from deeper, as well. To cluster the spectra, unsupervised machine learning algorithms are applied, e.g., hierarchical clustering.

Finally, both the results of both modalities can be fused in order to enhance the identification capability of the user. The fusion is achieved properly registering both imaging results and visualizing them together providing a high fidelity 3D information of both stratigraphy and physiochemical distribution. To achieve an accurate registration an optical microscopy camera is attached to a computerized numerical control (CNC) system which is driven by a software that is specially developed for the scanning of both modalities (acoustic microscopy, IR reflectance spectroscopy).

Both techniques as well as their fusion have been tested on melanoma tumors and nails revealing the high fidelity and resolution of the acquired information which can be extremely useful for the investigation of the skin and nail condition.



(a) (b)

Figure 1. Infrared system (a), the acoustic microscopy transducer ucer(b) mounted on the XYZ moving stages (CNC) system.

Results

Images from both the modalities are generated from various cases like melanoma and skin as well as form thicker structures like brain trying to identify melanoma tumors as well as neuro diseases respectively (Figure 1- Figure 6).

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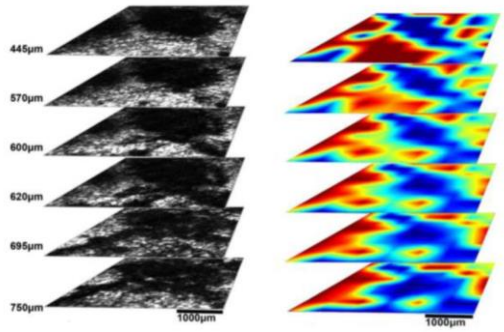

Figure 2. Sagittal sections of ultrasonic 3D images and the corresponding clustering ones that present the development of the tumor in–depth 1, [6].

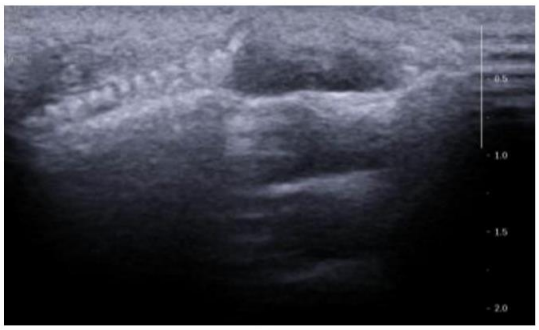

Figure 3. Ultrasonic image of mice brain using the 16MHz phased array probe.

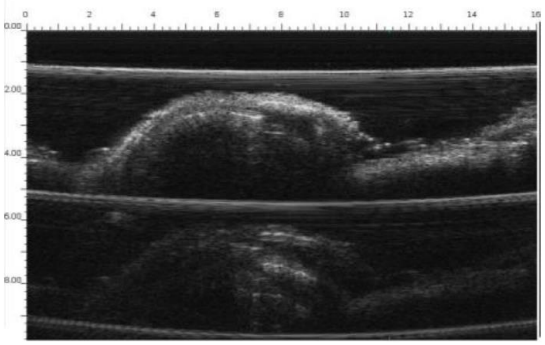

Figure 4. Ultrasonic microscopy image of mice brain using the 32MHz – 50Mhz single element transducer probe [9].

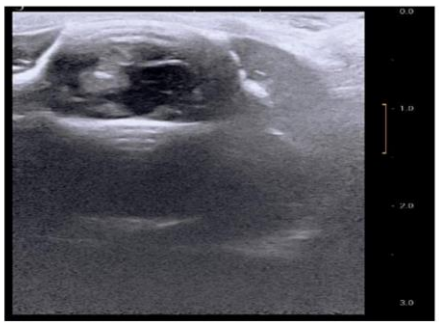

Figure 5. Ultrasonic microscopy image of mice brain using the 32MHz – 50Mhz single element transducer probe [9].

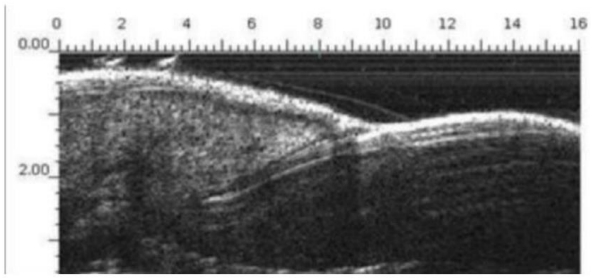

Figure 6. Acoustic microscopy image of nail.

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Keywords:
Acoustic Microscopy, Non Invasive Diagnostics.

ΠΑΡΑΜΕΤΡΙΚΕΣ ΜΕΛΕΤΕΣ ΓΙΑ ΤΗ ΔΙΑΔΙΚΑΣΙΑ ΜΑΓΝΗΤΙΚΗΣ ΟΔΗΓΗΣΗΣ ΣΦΑΙΡΙΚΩΝ ΣΩΜΑΤΙΔΙΩΝ ΣΤΟ ΠΛΑΙΣΙΟ ΤΗΣ ΣΤΟΧΕΥΜΕΝΗΣ ΜΕΤΑΦΟΡΑΣ ΦΑΡΜΑΚΟΥ

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Οι ερευνητές στις αρχές της δεκαετίας του ‘70 χρησιμοποίησαν για πρώτη φορά μαγνητικά σωματίδια με σκοπό να οδηγήσουν τις ουσίες του φαρμάκου στις επιθυμητές περιοχές [1]. Στη μέθοδο μαγνητικής οδήγησης, οι ουσίες των φαρμάκων επικαλύπτουν την επιφάνεια των μίκρο- νανοσωματιδίων, τα οποία στη συνέχεια εισάγονται στον οργανισμό με τη χρήση ενός καθετήρα. Η καθοδήγηση των σωματιδίων στις επιθυμητές περιοχές γίνεται με τη χρήση μεγάλων βαθμωτών μαγνητικών πεδίων. Τα κύρια πλεονεκτήματα της παραπάνω μεθόδου είναι : α) η μείωση της ποσότητας φαρμάκου που εισέρχεται στον οργανισμό και β) η αύξηση της συγκέντρωσης φαρμάκου στις επιθυμητές περιοχές.

Η απόδοση της μεθόδου εξαρτάται από το υλικό από το οποίο είναι κατασκευασμένα τα σωματίδια, τη ροή αίματος μέσα στις αρτηρίες, καθώς επίσης και από δύναμη του μαγνητικού πεδίου. Όσο μικρότερα είναι τα σωματίδια, τόσο μικρότερη είναι και η απόκρισή τους στο μαγνητικό πεδίο. Αυτό έχει σαν αποτέλεσμα την αύξηση της δυσκολίας στην καθοδήγηση των σωματιδίων στις επιθυμητές περιοχές. Για την αντιμετώπιση αυτής της δυσκολίας, προτείνεται η χρήση μαγνητικών σωματιδίων, τα οποία κάτω από την επίδραση σταθερού μαγνητικού πεδίου έλκουν το ένα το άλλο με αποτέλεσμα τη δημιουργία συσσωματωμάτων (Εικόνα 1). Όταν τα συσσωματώματα φθάσουν στην επιθυμητή περιοχή, πρέπει να διαχωριστούν σε απομονωμένα σωματίδια για την εναπόθεση του φαρμάκου. Αυτό μπορεί να επιτευχθεί με τη χρήση παραμαγνητικών σωματιδίων, τα οποία χάνουν τον μαγνητισμό τους, όταν δεν βρεθούν μέσα σε μαγνητικό πεδίο.

Εξαιτίας του γεγονότος ότι είναι αδύνατο να αναπτυχθεί μια αναλυτική μελέτη της διαδικασίας συσσωμάτωσης, προτείνεται ένα αριθμητικό μοντέλο για τη μαγνητική οδήγηση φαρμάκου σε συγκεκριμένες περιοχές. Η υπολογιστική πλατφόρμα περιέχει όλες τις δυνάμεις, οι οποίες δρουν στα σωματίδια και τα κάνουν να κινούνται. Για τον λόγο αυτό τέσσερις δυνάμεις συμπεριλαμβάνονται στο υπολογιστικό μοντέλο: α) οι μαγνητικές δυνάμεις, οι οποίες ασκούνται από στατικό μαγνήτη και οι μεταβλητές μαγνητικές δυνάμεις, οι οποίες ασκούνται από ειδικά βαθμωτά πηνία ,β) η οπισθελκούσα δύναμη για κάθε σφαιρικό σωματίδιο, γ) οι δυνάμεις επαφής μεταξύ σωματιδίων και τοιχωμάτων και δ) οι βαρυτικές δυνάμεις και οι δυνάμεις άνωσης.

Αρχικά, ο υπολογισμός του πεδίου ροής έγινε με τη χρήση των ασυμπίεστων εξισώσεων Navier-Stokes (Εξ. 1,2) και με τη μέθοδο Pressure Implicit with Splitting of Operators (PISO). Στη συνέχεια, η κίνηση των σωματιδίων εξακριβώθηκε με τη χρήση της μεθόδου Lagrangian μέσω της επίλυσης των εξ. (3) και (4) κατά μήκος της τροχιάς του κάθε σωματιδίου. Για την επίλυση των εξισώσεων χρησιμοποιήθηκε η μέθοδος Euler. Το χρονικό βήμα για την εξασφάλιση της σταθερότητας είναι 10^{-6} s. Η απόσταση των κέντρων των κελίων του υπολογιστικού πλέγματος είναι ίση με τη διάμετρο των σωματιδίων.

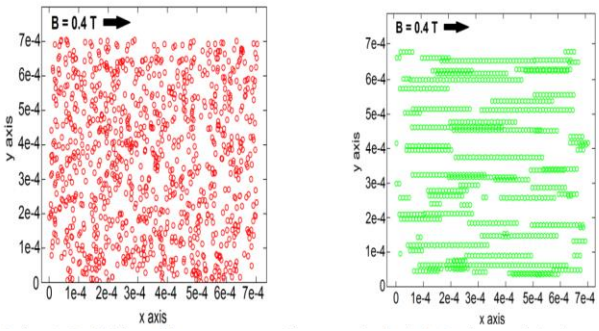
$$\nabla \cdot u = 0 \qquad (1)$$

$$\rho \left(\frac{\partial u}{\partial t} + u \cdot \nabla u\right) = -\nabla p + \mu \nabla^2 u \qquad (2)$$

Η κίνηση των σωματιδίων δίνεται από τις εξισώσεις του Νεύτωνα :

$$m_i \frac{\partial u_i}{\partial t} = F_{mag_i} + F_{nc_i} + F_{tc_i} + F_{hydro_i} + F_{boy_i} + W_i \qquad (3)$$

$$I_i \frac{\partial \omega_i}{\partial t} = M_{drag_i} + M_{con_i} + T_{mag_i} \qquad (4)$$



Εικόνα 1 : Προβολή των θέσεων των σωματιδίων στο επίπεδο (x-y). Οι κόκκινοι κύκλοι (αριστερά) αντιστοιχούν στην αρχική θέση των σωματιδίων για χρόνο *t = 0s* και για συγκέντρωση *2.25 mg/ml*. Οι πράσινοι κύκλοι (δεξιά) αντιστοιχούν στις τελικές θέσεις (ολοκλήρωση διαδικασίας συσσωμάτωσης) των σωματιδίων σε χρόνο *t = 5ms*.

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Η σύγκριση των υπολογιστικών και πειραματικών αποτελεσμάτων έδειξε ότι το μοντέλο που αναπτύχθηκε μπορεί να προσομοιώσει ικανοποιητικά το μέσο μήκος και την ταχύτητα των συσσωματωμάτων [2]. Επίσης, εξακριβώθηκε η απόσταση αλληλεπίδρασης των σωματιδίων υπό σταθερό μαγνητικό πεδίο [3]. Το αριθμητικό μοντέλο χρησιμοποιήθηκε για την εύρεση του μέσου μήκους των συσσωματωμάτων, του συνολικού χρόνου που χρειάζονται αυτά για να σχηματιστούν, καθώς επίσης και της μέσης ταχύτητας των συσσωματωμάτων κάτω από διαφορετικά σταθερά και μεταβλητά μαγνητικά πεδία. Επιπλέον, οι προσομοιώσεις έδειξαν ότι το μέσο μήκος των συσσωματωμάτων είναι ανάλογο με το μέγεθος του μόνιμου μαγνητικού πεδίου και της διαμέτρου των σωματιδίων συμφώνα με την σχέση :

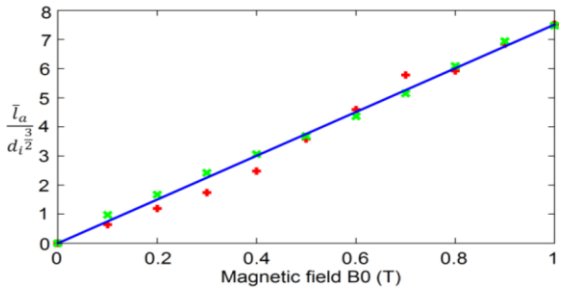
$$\bar{l}_a = 7.5 B_0 d_i^{\frac{3}{2}} \quad \text{(Εικόνα 2α).}$$

Η μέση ταχύτητα των συσσωματωμάτων είναι ανάλογη της κλίσης του μαγνητικού πεδίου, σύμφωνα με τη σχέση:

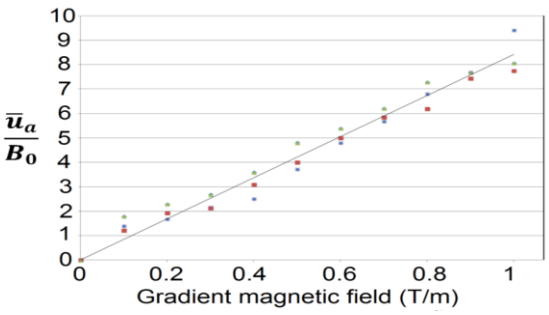
$$\bar{u}_a = 6.63\, \bar{G} B_0 \quad \text{(Εικόνα β)}$$

μετά από ένα ορισμένο χρονικό διάστημα φαίνεται να φθάνει σε μία σταθερή κατάσταση. Ο μέσος χρόνος που απαιτείται από τα σωματίδια για την ολοκλήρωση της διαδικασίας συσσωμάτωσης είναι ανάλογος του μόνιμου μαγνητικού πεδίου και δίνεται από τη σχέση :

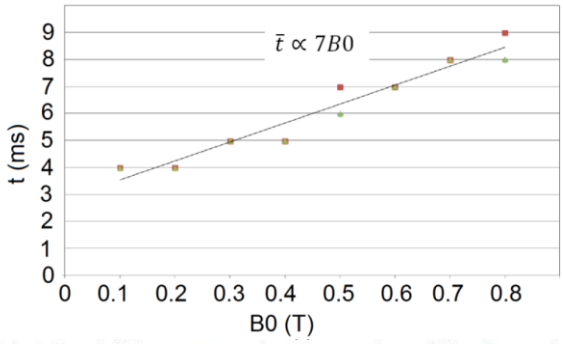
$$\bar{t}_a \propto 7 B_0 \quad \text{(Εικόνα 2γ).}$$



Εικόνα 2α: Μέσο μήκος συσσωματωμάτων, $\bar{l}_a$, για διάφορα B_0 : Τιμές και η σχέση προσαρμογής δεδομένων: $\bar{l}_a = 7.5 B_0 d_i^{\frac{3}{2}}$, $\bar{l}_a$ και d_i σε μm.



Εικόνα 2β: Μέση ταχύτητα συσσωματωμάτων για διάφορα $\bar{G}$ για δύο είδη σωματιδίων και B_0 = 0.5T και 1T: Η γραμμή προσαρμογής δεδομένων $\bar{u}_a = 6.63\, \bar{G} B_0$, $\bar{u}_a$ σε μm /s.



Εικόνα 2γ: Χρονική εξέλιξη για τον σχηματισμό των συσσωματωμάτων για διάφορα B_0 : ο συνολικός χρόνος που απαιτείται για τα συσσωματώματα να σχηματιστούν. Η γραμμή $\bar{t}_a \propto 7B_0$ σχεδιάστηκε μετά την προσαρμογή των δεδομένων με τη μέθοδο ελαχίστων τετραγώνων.

Ένα νέο υπολογιστικό μοντέλο για την πρόβλεψη της κίνησης των μαγνητικών σωματιδίων για ιατρικές εφαρμογές αναπτύχθηκε βασιζόμενο στην πλατφόρμα OpenFOAM. Το μοντέλο μπορεί να προβλέψει με ακρίβεια τον σχηματισμό των συσσωματωμάτων και την κίνησης τους υπό την επίδραση σταθερών και μεταβλητών μαγνητικών πεδίων. Το μέσο μήκος, ταχύτητα και ο χρόνος για την συσσωμάτωση βρέθηκε να ακολουθούν τις σχέσεις

$$\bar{l}_a = 7.5 B_0 d_i^{\frac{3}{2}}, \bar{u}_a = 6.63\, \bar{G} B_0 \quad \text{και}$$

$$\bar{t}_a \propto 7 B_0, \quad \text{αντίστοιχα.}$$

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SLEEP MACRO-ARCHITECTURE DISTURBANCES DURING 60 DAYS 6º HEAD DOWN TILT BED-REST AND THE EFFECT OF SLEDGE JUMPING SYSTEM (SJS) AS A COUNTERMEASURE TO PREVENT THOSE CHANGES

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Introduction

During long-term space flight the sleep physiology is affected [1]. Although sleep in microgravity and extreme environments is feasible, deterioration exists and sleep macro-architecture is affected, leading thus to insomnia and disturbed phase cyclicity [2]. The present bed-rest study with reactive sledge as a potential countermeasure demonstrates preliminary results from the sleep polysomnographic experiment in Long Term Bed Rest (LTBR) simulated microgravity with the collaboration of the Greek Aerospace Medical Association and Space Research (GASMA-SR) and the Laboratory of Medical Physics, Medical School of the Aristotle University of Thessaloniki. The experimental phase of the project took place in the premises (ENVIHAB) of the German Aerospace Agency (DLR) in Cologne, Germany. The RSL study was partly funded by the European Space Agency (ESA) and used head down tilt (6º) 60 days bed-rest to simulate the effects of microgravity in humans, with the reactive sledge jumps as a new countermeasure. The novelty of the sleep polysomnographic (PSG) study analysis was the large number of electrodes (30) used to analyze LTBR effect and the new method of countermeasure used for the first time in those conditions.

Materials and Methods

The data acquisition involved 19 brain electrodes which were placed according to the 10-20 International System, two (2) electrocardiographic (ECG), two (2) chin electromyographic (EMG) and four (4) electrooculographic channels for recording both vertical and horizontal eye movements. The study enrolled 23 healthy young men aged between 20 and 45 years old. It included a two week baseline period followed by eight weeks period of 6° head down tilt bed rest. During that phase the participants should remain in their bed with at least one shoulder attached at the mattress every time even when having meals or shower. That phase was followed by a two week recovery period. The participants were randomly assigned either to the training (12) or to the control (11) group. The training group was subjected to the reactive sledge jump training which took place 3-4 times per week.

To analyze collected data during the experimental period a preprocessing is needed. During preprocessing the data were divided in five segments. For each segment Independent Component Analysis (ICA) and data filtering were performed. Sleep staging is based on electroencephalographic (EEG) and peripheral (EOG, EMG, ECG) recordings. During sleep stages alternation of brain rhythms are present since every sleep stage demonstrates different dominant rhythms. Visual sleep staging was performed by adopting the criteria of American Academy of Sleep Medicine (AASM society). According to these criteria sleep data are divided into epochs of 30 seconds duration and each epoch is scored separately through visual inspection.

Results

The present study will demonstrated results from the baseline (BDC-14), 21 days after the bed-rest initiation, head down tilt (HDT-21/ HDT-50) period and the recovery phase (R7). A 3 x3 4 x 2 mixed ANOVA was conducted to analyze the results, with Time (Baseline, HDT21, Recovery) and Sleep Phase (N1,N2, N3, REM) as the within-subjects factors and Group (Control, Training) as the between-subjects factor. According to the analysis, there was a main effect of Sleep Phase [$F(3,51)= 17.963$, $p< .00001$, $\eta^2= .514$]. Pairwise comparisons with the Bonferroni correction indicated that while in the 1st Sleep Phase, N1, participants had a significantly lower mean (M= 34.41, SD= 18.99) compared to all other phase, namely compared to N2 (M= 704.83, SD= 361.36), to N3 (M= 536.64, SD= 351.92) and to REM (M= 438.53, SD= 267.80), all *p*s < .00001. No other main effects or interaction reached significance. We then submitted mean Number of Arousal for each Sleep Phase condition (number of Arousal for Baseline, for HDT21 and for Recovery) in a one-way MANOVA with Group assessed between-subjects. No significant results were revealed.

Discussion

In conclusion, the results may not support the hypothesis that Reactive Jumping with a sledge may be a robust countermeasure in terms of sleep quality. This will be supported by its ineffectiveness to prevent the decrease in total sleep time (TST) and the number of arousal in training group compared with the control group. Given that our sample was small (i.e. 8 controls and 11 trained participants), further analysis of all participants are expected to lead us to safer conclusions regarding the efficacy of Reactive Jumping on a sledge as a potential countermeasure to prevent sleep disturbances during long-term spaceflights.

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Keywords:
Aerospace Medicine, Sleep Stages,
Polysomnography, extreme environments, Sleep Disorders

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3D "SPECTRACOUSTIC" SYSTEM: A MODULAR, TOMOGRAPHIC, SPECTROSCOPIC MAPPING IMAGING, NON-INVASIVE, DIAGNOSTIC SYSTEM FOR DETECTION OF SMALL STARTING DEVELOPING TUMOURS LIKE MELANOMA

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The method

Acoustic microscopy, infrared reflectance spectroscopy and imaging have been combined in order to study the structure of a variety of objects from various types of small tumor lesions, like melanoma in skin. The tomographic images from a scanned region of interest (ROI) of the object are acquired using acoustic microscopy while the distribution of the materials in the ROI is acquired using infrared reflectance spectroscopy. Using the acquired spectra, the 3D segmentation – clustering of the spectra dataset can be derived in order to result in high resolution rendering of the internal structure of the under investigation object. The clusters consist of spectra that have similar characteristics, i.e., similar chemical composition. The spatial distribution of such clusters can be illustrated in pseudocolor images, in which each pixel of image is colored according to its cluster membership. Such mapping images convey information about the spatial distribution of the chemical substances in an object. A modular infrared spectroscope (Bruker ALPHA) in reflectance mode with a specially designed illumination area was used, after various trials, in order to acquire the array of spectra as well as a custom acoustic microscope for the acquisition of the tomographic data (Figure 3). The spectral area covered by spectroscope is 7500-375cm-1 (1.3-26μm). The wavelengths that are used ensure the penetration of the radiation in deeper layers. Furthermore, a control (CNC) system which is driven by a software that is specially developed for the scanning of the object with the probes of all the modalities (Acoustic Microscopy, Infrared reflectance spectroscopy) (Figure 2). Thus, the mapping images that are produced by clustering the acquired spectra in specific wavelength bands of infrared spectra can provide stratigraphic information in the mapping images, i.e., images that convey information of the distribution of substances or biochemical changes from deeper, as well.

Development of the devices

Based on the ultrasonic of high frequency wave propagation simulation [1] in melanoma simulating structure using Finite Difference Time Domain technique The various transducers were designed (Figure 1). Based on simulation of EM waves propagation in melanoma simulated structure using Finite Integration Technique the system optical adaptation for the illumination area was designed [1] and the estimation of the depth, from witch the reflection is acquired, is performed Figure 2.

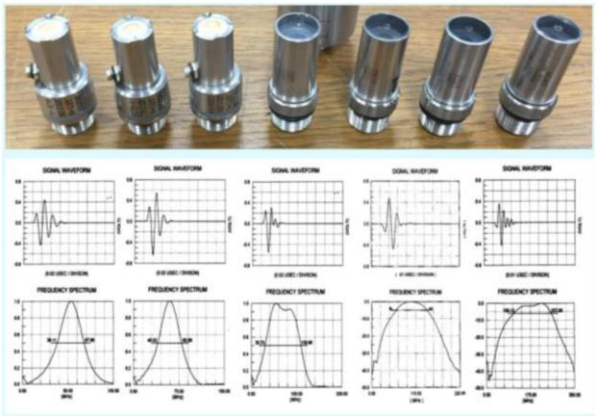

Figure 1. Transducers produced for the acoustic micro tomography system, resolution : From ~70μm to 7μm in tissue, Penetration depth μm->mms.

Figure 2. The acoustic microscopy transducer and the infrared systems mounted on the XYZ moving stages (CNC) system.

Algorithm and processing of the acquired data

Unsupervised machine learning algorithms are applied for hierarchical clustering in the various wavelength areas chosen ((Figure 3(c)) resulting to multispectral mapping images (Figure 3(b)). The clustering images derived by infrared modality are registered on the tomographic images (Figure 3(a)) providing to the user a high fidelity information of the distribution of the materials in the 3D structure resulting to spectroscopic mapping spectroscopy.

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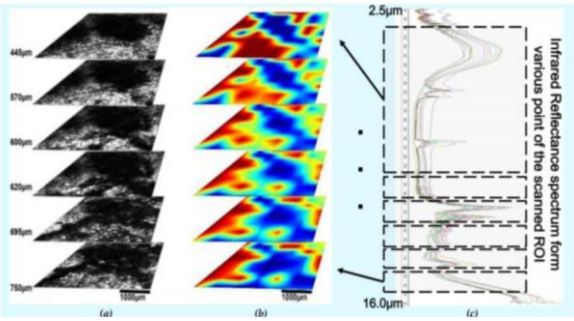

Figure 3. Sagittal sections of (a) ultrasonic 3D acoustic micro tomographic images and (b) the corresponding clustering ones from (c) the various wavelength areas that present the development of the tumor in–depth of a melanoma.

Results

This work led to a new method named 3D spectracoustic tomographic mapping imaging. The current and the future work is related to the fabrication of a combined acoustic microscopy transducer and infrared illumination probe permitting the simultaneous acquisition of the spectroscopic and the tomographic information. This probe provides with the capability of high fidelity and precision registered information from the combined modalities named spectracoustic information Figure 4, Figure 5. modalities (Acoustic Microscopy, Infrared reflectance spectroscopy) (Figure 2). Thus, the mapping images that are produced by clustering the acquired spectra in specific wavelength bands of infrared spectra can provide stratigraphic information in the mapping images, i.e., images that convey information of the distribution of substances or biochemical changes from deeper, as well.

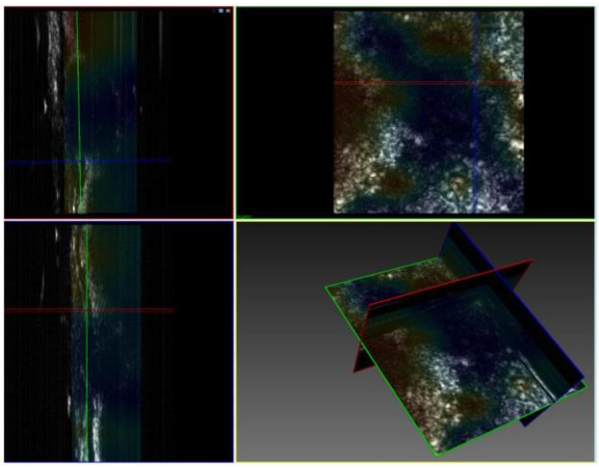

Figure 4. 3D tomographic view of the fused information.

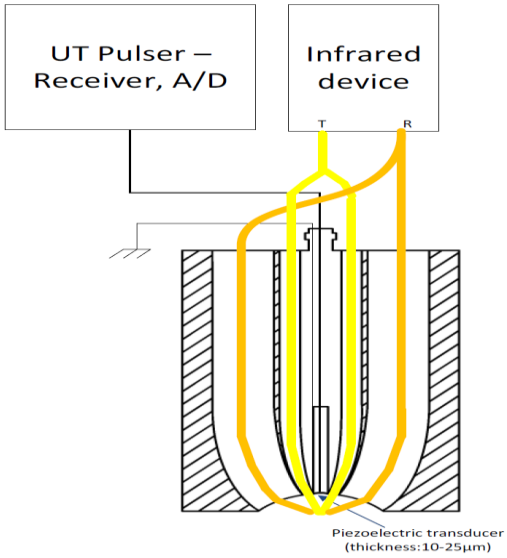

Figure 5. Spectracoustic probe schematic diagram

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Keywords:
Acoustic Microscopy, Non Invasive Diagnostics.

Η ΤΕΧΝΙΚΗ ΔΙΠΛΗΣ ΚΑΤΗΓΟΡΙΟΠΟΙΗΣΗΣ ΣΤΗΝ ΑΝΑΛΥΣΗ ΓΟΝΙΔΙΩΝ

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Περίληψη

Ο προσδιορισμός γονιδίων που συν-εκφράζονται σε συγκεκριμένες συνθήκες (π.χ. ασθένεια) αποτελεί κρίσιμο θέμα για τη γονιδιακή λειτουργική και ρυθμιστική ανάλυση [1]. Στην παρούσα εργασία πραγματοποιείται η εφαρμογή της μεθόδου διπλής κατηγοριοποίησης (biclustering) δεδομένων γονιδιακής έκφρασης που προέρχονται από δείγματα παθολογίας του καρκίνου του μαστού, των ωοθηκών, του ενδομητρίου και του τραχήλου της μήτρας, συγκεντρωμένα σε ένα πίνακα δεδομένων με στόχο την τελική επιλογή γονιδιακών δεικτών από κυτταρικές σειρές [2]. Η μεθοδολογία που προτείνεται περιλαμβάνει την εφαρμογή του αλγορίθμου διπλής κατηγοριοποίησης Cheng και Church (2000) [3], εφαρμόζοντας σε αυτόν μια σειρά βελτιώσεων έτσι ώστε να πετύχουμε την καλύτερη ομαδοποίηση των γονιδίων ή καταστάσεων με βάση την πλειοψηφία των περιπτώσεων παθολογίας.

Μεθοδολογία

Ο αλγόριθμος Cheng και Church (2000) επιλέχτηκε διότι αποτελεί μία μέθοδο ικανή να αντιμετωπίσει μεγάλο αριθμό γονιδίων, παρέχει την δυνατότητα μη-επικάλυψης και τα Biclusters που εξάγει έχουν συνεκτικές τιμές, γεγονός που μας επιτρέπει να μελετήσουμε τη συμπεριφορά τωνγονιδίων κατά μήκος των σειρών χωρίς οι τιμές απαραίτητα να είναι σταθερές. Στα εξαγόμενα αποτελέσματα του αλγορίθμου παρατηρήθηκε ανομοιομορφία μεταξύ των ομαδοποιημένων γονιδίων, τόσο στην τάση, όσο και στις τιμές τους. Για να αποφύγουμε τις δύο αυτές «αποκλίσεις», ο αλγόριθμος εφαρμόστηκε τρεις φορές για κάθε τύπο καρκίνου για συγκεκριμένες τιμές των δ (delta=0.07) και α (alpha=1.1) και με τροποποιήσεις στον υπολογισμό του di (mean squared της γραμμής i) και dj (mean squared της στήλης j). Επομένως, έχουμε :

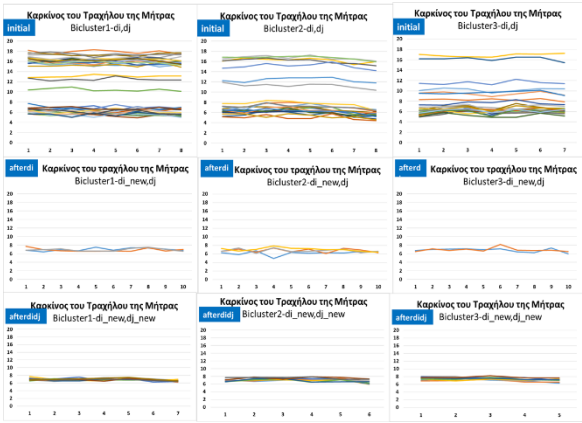
1. $$\mathbf{d(i)} = \frac{1}{|J|}\sum_{j\in J}\left(|aij - aiJ|^2 + |aij - aIj|^2\right) \text{ και}$$

2. $$\mathbf{d(j)} = \frac{1}{|I|}\sum_{i\in I}\left(|aij - aiJ|^2 + |aij - aIj|^2\right)$$

Το d(i) αναφέρεται στην τάση των γονιδίων. Με αυτόν τον όρο ο αλγόριθμος "κρατάει" γονίδια που έχουν ίδια ή παρόμοια τάση. Το d(j) αναφέρεται στην τιμή των γονιδίων. Με τον όρο αυτό, ο αλγόριθμος "κρατάει" καταστάσεις στις οποίες τα γονίδια έχουν όμοια συμπεριφορά γύρω από ένα γενικό μέσο όρο.

Αποτελέσματα-Συμπεράσματα

Στην Εικόνα 1, απεικονίζεται η συμπεριφορά των γονιδίων, που ομαδοποιούνται στα τρία πρώτα εξαγόμενα biclusters, για τα 1000 πρώτα γονίδια του καρκίνου του τραχήλου της μήτρας. Οι ομάδες που δημιουργήθηκαν, εμφανίζουν γονίδια με όμοια συμπεριφορά κατά μήκος των κυτταρικών σειρών και παράλληλα το εύρος των τιμών τους είναι μικρό, κάνοντας έτσι τις ομάδες πιο συνεκτικές και ικανές να εξάγουν σημαντικές βιολογικές πληροφορίες, γενικές αλλά και πιο εξειδικευμένες.



Εικόνα 1. Παρουσίαση των τριών εκτελέσεων του αλγορίθμου Cheng & Church (1000 γονίδια)

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Λέξεις-Κλειδιά:

Γονιδιακή Έκφραση, Καρκίνος του Μαστού, Αλγόριθμος Cheng & Church, Διπλή Κατηγοριοποίηση

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ΣΥΓΚΛΙΣΗ ΤΟΥ ΤΟΜΕΑ ΑΠΕΙΚΟΝΙΣΗΣ ΤΟΥ Γ.Ν. ΧΑΝΙΩΝ 'Ο ΆΓΙΟΣ ΓΕΩΡΓΙΟΣ΄ ΣΤΙΣ ΣΥΓΧΡΟΝΕΣ ΑΠΕΙΚΟΝΙΣΤΙΚΕΣ ΜΕΘΟΔΟΥΣ

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(4) Σχολή Ηλεκτρολόγων Μηχανικών και Μηχανικών Υπολογιστών Πολυτεχνείου Κρήτης

Καινοτόμες πρακτικές στον τομέα της Απεικονιστικής Ιατρικής βρίσκουν πλέον καθημερινή εφαρμογή αναβαθμίζοντας έτσι τις παρεχόμενες υπηρεσίες προς τον πληθυσμό δίνοντας απάντηση σε κλινικά ερωτήματα που στο παρελθόν ήταν αδύνατο. Το Νοσοκομείο Χανίων έχει προχωρήσει σε σημαντική αναβάθμιση του τομέα αυτού και σε συνεργασία με το Πολυτεχνείο Κρήτης προχωρά σε αξιοποίηση τέτοιων τεχνικών. Στόχος του άρθρου αυτού είναι να παρουσιάσει μερικές από αυτές.

Περιγραφή Τομέα Απεικόνισης Γ.Ν. Χανίων

- Μαγνητικός Τομογράφος GE Signa HDxT 1.5 Tesla 16 channels (με δυνατότητα αναβάθμισης έως 32 channels), εγκατασταθείς 8ος/2014
- Αξονικός τομογράφος τελευταίας τεχνολογίας 64 τομών GE Optima 660 (με δυνατότητα αναβάθμισης), εγκατασταθείς 12ος/2014
- Ψηφιακός Αγγειογράφος Phillips INTERGIRIS HM 2000, εγκατασταθείς το 2004. Στον ίδιο χώρο βρίσκεται υπό δημιουργία το Αιμοδυναμικό εργαστήριο
- Κάμερα δύο κεφαλών της GE INFINIA II για εξετάσεις Πυρηνικής Ιατρικής υποστηριζόμενη από GE Healthcare (το τμήμα βρίσκεται υπό ενεργοποίηση)
- Οστεοπυκνόμετρο GE Lunar Prodigy με δυνατότητα διενέργειας εξετάσεων σε όλες τις ομάδες πληθυσμού με πρωτόκολλα ενηλίκων (γυναικών & ανδρών) και παίδων
- Μαστογράφος Italray mammograph plus πλήρως ψηφιοποιημένος με σύστημα Agfa CR 85X
- Ορθοπαντομογράφος Orthopantomograph OP 100

Επίσης λειτουργούν πλήρως ψηφιοποιημένοι δύο (2) θάλαμοι κλασσικής ακτινολογίας, δύο (2) θάλαμοι ακτινοσκόπησης και δύο (2) αίθουσες υπερηχοτομογραφίας στις οποίες διενεργείται πλήρες φάσμα εξετάσεων.

Στον Μαγνητικό Τομογράφο

Δυναμικές Μελέτες: Αγγειογραφικές μελέτες μπορούν να γίνουν πλέον σε δυναμική φάση δίνοντας έτσι πολύτιμες πληροφορίες για την αγγείωση μιας περιοχής. Δυναμικές μελέτες μπορούν να γίνουν πλέον και σε όργανα στόχους, παρέχοντας μας την δυνατότητα για εξαγωγή καμπύλων πρόσληψης της υπό έλεγχο περιοχής υποβοηθώντας έτσι την διαφοροδιάγνωση. Τέτοιες μελέτες αποτελούν πλέον αναπόσπαστο κομμάτι της διαγνωστικής προσέγγισης οργάνων όπως εγκέφαλος, ήπαρ, νεφροί, σπλήν, ωοθήκες, προστάτης, μαστός κλπ.

Propeller Sequence: Ειδικός αλγόριθμος αποκοπής κίνησης, ενσωματωμένος σε μεγάλο φάσμα ακολουθιών παλμών T1 Flair, T2 & T2 Flair, Proton Density. Μέσω του εξειδικευμένου αυτού αλγόριθμου καθίσταται πλέον εφικτή η εξέταση ασθενών με σπαστικότητα ή ασθενών με αδυναμία συνεργασίας (παιδιατρικοί ασθενείς, ασθενείς με εγκεφαλικές βλάβες κλπ.). Η τεχνική αυτή μπορεί να ενσωματώσει αναπνευστικό σκανδαλισμό καθιστώντας έτσι εφικτή την μελέτη ανατομικών δομών με αναπνευστική κίνηση σε ασθενείς με ακανόνιστο αναπνευστικό ρυθμό.

Perfusion: Διενέργεια μελέτης αιμάτωσης εγκεφάλου τόσο με χορήγηση παραμαγνητικής σκιαγραφικής ουσίας όσο και χωρίς σκιαγραφική ουσία μέσω τεχνικής Arterial Spin Label βασιζόμενη σε παλμούς EPI.

DWI: Διενέργεια Diffusion Weighted Imaging σε ολοσωματική βάση βοηθώντας έτσι στον χαρακτηρισμό ιστών με βάση τον συντελεστή διάχυσης των μορίων του ύδατος (Τεχνική Μοριακής Διάχυσης).

DTI: Μελέτη τανυστών μοριακής διάχυσης μεσώ της οποίας απεικονίζονται διαταραχές στις συνάψεις των νευρικών ινών στην λευκή ουσία του εγκεφάλου.

MRS: Μελέτες φασματοσκοπίας σε ιστούς μας δίνουν πολύτιμες πληροφορίες για μεταβολίτες εντός των ιστών οδηγώντας μας σε ασφαλέστερα συμπεράσματα ως προς την ταυτότητά τούς.

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Στον Αξονικό Τομογράφο

KV & mAS modulation: Νέες τεχνικές διαμόρφωσης των παραμέτρων έκθεσης με βάση τα σωματομετρικά στοιχεία του εκάστοτε ασθενή οδηγούν σε ακόμα χαμηλότερες δόσεις.

CT Angiography: Μελέτες αγγειογραφίας πραγματοποιούνται πλέον αναίμακτα σε ελάχιστο χρόνο απαντώντας σε κρίσιμα ερωτήματα όταν ο χρόνος είναι πραγματικά πολύτιμος.

CT Στεφανιογραφία: Αξιόπιστη λύση που σιγά-σιγά περνάει στην πρώτη γραμμή ελέγχου για τα νοσήματα των στεφανιαίων αφού βασικά πλεονεκτήματά της αποτελούν η μικρή ακτινική επιβάρυνση, η ολιγόλεπτη διάρκεια και η ελάχιστες επιπλοκές αφού δεν απαιτεί καθετηριασμό.

Calsium Score: Το σκορ ασβεστίου αποτελεί ακόμα ένα δείκτη πρόγνωσης στεφανιαίας νόσου.

CT Colonoscopy: Μια νέα τεχνική που υποβοήθα την κλασσική μέθοδο της ενδοσκόπησης αφού είναι λιγότερο επεμβατική (εισάγεται ένα ρύγχος λίγων μόνο εκατοστών) και μπορεί να δώσει λύσεις σε στενώσεις σημαντικού βαθμού που δεν επιτρέπουν την ολοκλήρωση της κλασσικής μεθόδου ή σε ασθενείς με καρδιολογικά νοσήματα που δεν μπορούν να λάβουν μέθη ή νάρκωση.

CT Ουρογραφία: Η πλέον αναλυτική τεχνική για τον έλεγχο νοσημάτων σχετιζόμενα με τους νεφρούς καθώς και το αποχετευτικό σύστημα τους.

Trauma Whole Body Scan: Εξελιγμένα πρωτόκολλα τραύματος καθιστούν δυνατό τον ολόσωμο έλεγχο σε πολυτραυματίες σε μερικά μόλις δευτερόλεπτα.

CT Fluoroscopy: Οι επεμβατικές πράξεις που διενεργούνται υπό την καθοδήγηση του αξονικού τομογράφου ολοκληρώνονται ακόμα πιο γρήγορα και με άμεσο έλεγχο του ασθενή και της πράξης αφού μέσω του συστήματος ο ιατρός ελέγχει την διαδικασία με ειδικά χειριστήρια εντός του θαλάμου.

Ψηφιακός Αγγειογράφος / Αιμοδυναμικό Τμήμα

Η διενέργεια ψηφιακής αφαιρετικής αγγειογραφίας (digital subtractive angiography, DSA) χρησιμοποιείται για τη μελέτη στενωμένων, αποφραγμένων, διευρυμένων ή ανώμαλων αρτηριών ή φλεβών σε διάφορες περιοχές του σώματος, όπως στο θώρακα, στην καρδιά, στην κοιλιά, στα άνω και στα κάτω μέλη.

Πυρηνική Ιατρική

Οι διαγνωστικές εξετάσεις Πυρηνικής Ιατρικής πραγματοποιούνται με τη χρήση ραδιοφαρμάκων, τα οποία δρουν στοχευμένα σε συγκεκριμένα όργανα, αναδεικνύοντας όχι μόνο τη μορφολογία αλλά επιπλέον και τη λειτουργικότητά τους και αφορά ευρύ φάσμα ασθενών (ογκολογικοί, ενδοκρινολογικοί, νεφρολογικοί, καρδιολογικοί).

Ψηφιακή Επεξεργασία Ιατρικών Εικόνων – Τμηματοποίηση (Segmentation)

Πέραν του λογισμικού που ήδη διατίθεται και συνοδεύει τον εξοπλισμό, το Πολυτεχνείο Κρήτης έχει ήδη μελετήσει απεικονιστικές τεχνικές, όπως MRI ασθενών με όγκο στον εγκέφαλο και CT αγγειογραφία. Στην πρώτη κατεύθυνση ο στόχος είναι η τμηματοποίηση περιοχών του εγκεφάλου στις κατηγορίες: φυσιολογικός ιστός, οίδημα και νεκρωτική περιοχή του όγκου. Στην δεύτερη κατεύθυνση στόχος είναι η από-οστεοποίηση της εικόνας για καθαρή εποπτεία των αρτηριών καθώς και η τρισδιάστατη μοντελοποίηση αρτηριών.

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NEUROPROTECTIVE EFFECTS OF PHYSICAL ACTIVITY IN PARKINSON'S DISEASE: A RESTING STATE EEG STUDY ON THE webFitForAll EFFICACY

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Introduction

Parkinson's disease (PD) is the second most prevalent neurodegenerative disorder, with an estimated overall prevalence of 0.3 %, and an estimated 1 % prevalence in individuals over 60 years of age. Incidence of PD increases with age, but an estimated 4% of individuals with PD are diagnosed before the age of 50 [1]. Considering the growing elderly population, the prevalence will increase sharply in the next decades

The epidemiology of PD is composite with an adverse effect on the patients' health. PD is characterized by neuromotor symptoms such as tremor, postural instability, bradykinesia, and rigidity. In addition to these symptoms, a wide variety of non-motor symptoms involve cognitive and neuropsychiatric changes, with PD patients presenting an increased risk of developing dementia or depression, amongst other behavioral, mood and speech disturbances [2].

PD has a progressive course and despite the several pharmaceuticals available for its management, no cure is yet available. Therefore, PD imposes a heavy burden on PD patients, their families, caregivers and on health and social support systems [3], [4].

Therapy via physical activity, is the most effective non-pharmacological aid to PD patients. Living a lifestyle of regular physical activity promotes health [5]. The neuroprotective attributes of physical activity were hypothesized [6], and soon after determined [7] to be beneficial for cognition even for clinical populations of older adults nearly a decade ago. A very recent review has provided the up-to-date evidence-based basis for prescribing exercise as medicine in the treatment of 26 different diseases. The benefits for PD motor symptoms include improvements in balance, mobility, walking economy, and quality of life [8]. Quite recently as well, a review confirmed that physical activity can positively impact depression, apathy, fatigue, day time sleepiness, sleep, and cognition [9].

Nevertheless, the effects of exercise have been poorly explored with functional neuroimaging or electrophysiological techniques in patients with PD. There is a knowledge gap regarding the neural correlates of the effects of physical activity, and their relationship with motor and non-motor symptoms in PD. Physical activity facilitates neuroplasticity, which induces changes in sensorimotor, executive, cognitive, and behavioural functioning [10], [11]. In line with this, a recent review highlighted the potential role of exercise in overall brain health that may influence structural and physiological mechanisms of brain function, and repair and/or formation of the neuronal circuitry in PD [12].

Aim and scope

Our study aims to address large gaps in knowledge regarding the relative contribution of physical activity and their effect on brain function, and motor and non-motor behaviour. To this aim and in order to quantify the effect of training, we have used WebFitForAll, which is an easy to use exergaming platform for improving physical fitness and life quality of senior citizens. This platform was originally implemented and is under continuous development by the Assistive Technologies and Silver Science group of the Medical Physics Laboratory. A previous study of our group that explored its efficacy on seniors' physical capacity, demonstrated improvement in body strength, balance and aerobic capacity, shoulder flexibility, gait and fall prevention capacity, as well as in quality of life, mood and processing speed [13].

Material and methods

The intervention took place at the Thessaloniki Active and Healthy Ageing Living Lab (Thess-AHALL) [14]. 16 PD patients in stages 2-3 (5 females, mean age 66.91±4.82, mean years of education 13±3), performed exercise via the use of webFitForAll [15], [16]. 4

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participants dropped-out during the course of the intervention. The remaining participants accomplished an average of 17±3 sessions
(aerobic, resistance exercises, flexibility, and balance exercises), at a frequency of 2 times per week, for 50 minutes, for a total period of 10 weeks.
12 participants (2 females, mean age 65.85±5.3, mean years of education at 13±2) underwent a task independent (resting state, eyes closed) electroencephalographic (EEG) measurement, performed with a Nihon-Kohden 128 channel EEG recording system and an active electrodes cap (actiCAP128, Brain Products), inside the electromagnetically shielded and sound attenuated room of the Medical Physics Laboratory, before and after the webFitForAll intervention. In addition, the participants' cognitive, neuropsychological and mobility capacity was assessed via a battery of appropriate tests. Specifically, the battery comprised Mini Mental State of Examination (MMSE) [17], Montreal Cognitive Assessment (MOCA) [18], the Trail Making Test [19], Geriatric Depression Scale (GDS) [20], and the Parkinson's Disease Questionnaire (PDQ-8) [21]. The physical assessment was based on the 10 Meter Walk Test, the Community Balance & Mobility Scale, the Short Physical Performance Battery, the Fullerton Senior Fitness Test [22], the Berg Balance Scale [23], and the Tinetti Test [24]. 1 female participant was excluded from the EEG analysis due to heavy artifacts related to resting tremor.
The methodology employed for analysing the EEG recordings is described in detail in Styliadis et al., where it was originally applied [25]. The resulting eLORETA images of the pre and post resting states of the participants were compared for spectral current density differences within subjects with the SnPM software included in the LORETA software [26]. The statistic comparison revealed that the physical training induced an increase of cortical activations in theta band, localized at the medial frontal gyrus (Brodmann area 8, coordinates: 0, 40, 45) ($F=4.811$, $p=0.045$).

Results and discussion

Our preliminary results report here only the statistically pre-post intervention difference in terms of cortical source imaging. The medial frontal gyrus is associated to executive functioning and theta band activity of that area is an indicator of default mode network (DMN) activity [27]. DMN is disrupted in PD patients with cognitive deficits [28], [29]. It has been suggested that malfunctioning of the DMN may contribute to the executive function deficits in PD [30]. We demonstrate that after a ten-week long intervention of physical activity in PD patients, a resting state change of brain activity as measured via EEG emerges showing towards a re-organization of executive functioning and thus a potential positive neuroplastic effect on brain health.
It is within our immediate plans to correlate this change with indices of the neurophysiological, and somatometric evaluation as well as the game metrics of the WebFitForAll platform [31]. In addition, we will explore the combined use of cognitive training, as well as, the functional network connectivity changes due to the intervention. Understanding the induced, by physical (and/or cognitive) activity, elements of neuroplasticity is an enormous step towards identifying its contribution to disease modification and synthesizing novel therapeutic targets including pharmacological medication in supplement to the exercise effect.

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Keywords:
Parkinson's disease (PD), eLORETA, Resting State, Electroencephalography (EEG), Physical Activity

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SLEEP STAGE CLASSIFICATION USING NETWORK CHARACTERISTICS CALCULATED FROM ELECTROENCEPHALOGRAPHIC RECORDINGS

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Introduction

Sleep is a vital biological process for physical and mental health [1] and the normal sleep cycle is usually divided in four stages, three being part of Non-Rapid Eye Movement Sleep (NREM), namely NREM1, NREM2, NREM3 and REM sleep. Determining in which sleep stage an individual is in at any given time is usually done by experts who base their annotation of each sleep portion through the alteration of brain rhythms observed in electroencephalographic (EEG) recordings. However this task is time consuming and tedious and at times prone to errors. In order to provide fast and accurate sleep stage classification we study the effectiveness of using synchronization values and network metrics derived from electroencephalographic data to provide robust sleep stage classification. However before we can calculate the above vales and metrics it is necessary to pre-process the available data so that they are appropriate for further analysis.

Materials and Methods

The data used in this study were recorded using 19 electrodes placed according to the International 10–20 system from 23 healthy young men aged between 20 and 45 years old during normal sleeping conditions [2].

The preprocessing pipeline included six steps each with a specific target in mind. In more detail the first step including the segmentation of the initial EEG recordings in five segments to enable easier and more efficient data management. The next step was to subtract the mean value of each signal so that the newly calculated signal would have a mean value equal to zero. The third step involved the filtering of the EEG data to remove unwanted spectral components and noise from various sources. Afterwards Independent Component Analysis (ICA) was applied on the data to decompose the initial signal in simpler components, some of which were manually rejected as a next step, in order to remove further unwanted signal components. From the remaining components a new signal is calculated. In the final step of pre-processing the newly computed EEG signal is partitioned in 30s epochs to enable synchronization likelihood value calculation.

Synchronization likelihood as defined in [3] provides an estimate of the degree of synchronization between two or more time series, based on the concept of generalized synchronization between two dynamic systems. Applying this method results in a symmetric 19 x 19 matrix containing the synchronization likelihood values between each pair of electrodes. This matrix can be considered as the adjacency matrix of a non-directional weighted graph each node representing the electrodes, and as such, various graph metrics are calculated on said graph. Seven different metrics where calculated for the graph of each EEG epoch namely: mean node degree, mean clustering coefficient, characteristic path efficiency and length, connection density, centrality and small world metric. All distinct values of the adjacency matrix along with the seven graph metrics where incorporated in a feature vector of 178 dimensions and subsequently used for sleep stage classification purposes.

Results

Classification experiments were run using three different classifiers the *k* Nearest Neighbor Classifier (k-NN), Support Vector Machines (SVM) and Neural Networks (NN). These were trained on a training dataset containing 845 samples and tested on a test set containing 366 samples. All features were normalized in the interval [0,1]. The highest test classification accuracy attained was using an SVM with a Gaussian kernel equal to 89.07%.

Discussion

From the experimental results it can be concluded that synchronization likelihood values and graph metrics are suitable for sleep stage classification purposes. These features are able to provide an accurate system-wide description of an inherently complex system, in this case the human brain. Further work in this area will be targeted in achieving higher classification accuracies through finer feature extraction and selection.

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Keywords:
Electroencephalography, Synchronization Likelihood, Graph Theory, Artificial Intelligence

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DECIPHERING THE MOLECULAR MECHANISMS OF ORAL CANCER PROGRESSION

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Introduction

Oral cancer is the most commonly diagnosed type of Head and Neck Squamous Cell Carcinoma (HNSCC) [1]. In order to better handle the disease monitoring and further improve diagnosis, the biological and molecular mechanisms underlying the development of cancerous tumor are currently under study. Several studies in the literature have proposed gene expression profiling of a complex disease, such as OSCC, in order to elucidate the molecular mechanisms during the development of oral cancer malignant tumors.

Materials and methods

The microarray data were collected from circulating blood cell samples from 23 patients. The data were extracted during the follow-up period of the study in two consecutive time points and after complete disease remission [2]. In order to further analyze the microarray gene expression data and pinpoint gene expression changes at the follow-up phase and among the two groups of patients, the R Bioconductor limma *package* was employed. We also considered the interpretation of the identified differentially expressed genes (DEGs) in terms of GO annotation by employing the ClueGO Cytoscape plug-in. This tool deciphers biological networks and extracts biological information from large gene sets. In order to discover molecular pathways that may be altered in human OSCC progression we used the Gene Set Enrichment Analysis (GSEA) computation method in accordance with the DEGs identified.

Results & Discussion

After the differential expression analysis, the final set for further investigation was the total of 212 genes at a False Discovery Rate (FDR) of 5%. We also annotated the identified significant gene list to the KEGG database of molecular pathways. KEGG analysis showed that the two most enriched pathways, according to the submitted DEGs, with an adjusted p-value lower than 0.05 are: (i) the Ribosome pathway, and (ii) the Tyrosine metabolism pathway. In order to describe the identified DEGs in terms of their associated biological processes (BP), cellular components (CC) and molecular functions (MF), Gene Ontology (GO) analysis was performed. The output is a functionally grouped annotation network which illustrates the connections between the GO terms found enriched (Fig. 1). The terms are connected with edges according to the similarity of their associated genes, thus forming a group.

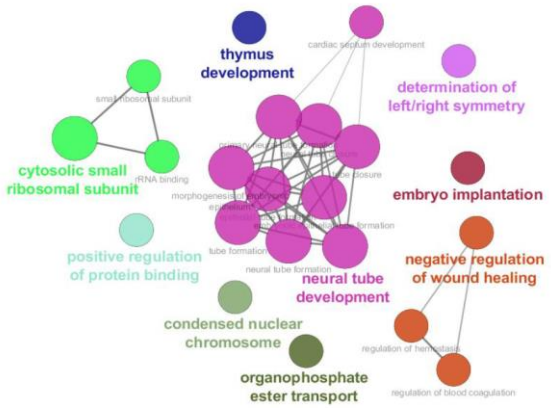

Figure 1. The annotation network of functionally grouped GO terms.

Conclusions

Our analysis results indicate that significant genes are involved in specific gene ontology terms. Moreover, the enriched molecular pathways found, should be further considered in order to unravel the complex molecular processes of the disease. Knowledge of the biological processes and the molecular pathways could enhance our understanding relative to the complex nature of the disease.

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Keywords:
Oral cancer prediction; molecular mechanisms; differentially expressed genes; pathway annotation

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ANALYSIS OF CORONARY COMPUTED TOMOGRAPHY ANGIOGRAPHY FOR 3D RECONSTRUCTION OF ARTERIAL TREES AND PLAQUE DETECTION

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Introduction

Coronary Computed Tomography Angiography (CCTA) has gained substantial ground during the past two decades in clinical practice due to its non-invasive nature and has evolved tremendously in terms of image quality. It is able to visualize the coronary vasculature and assess the presence, extent and type of atherosclerotic plaques and has therefore led to the development of various 3D reconstruction algorithms [1].

Materials and methods

A. 3D Reconstruction Process

Our algorithm is based on an eight-step approach: a) the CCTA images are pre-processed using the Frangi Vesselness filter, which limits the region of interest (ROI) to possible vessel regions. b) The blooming effect [2] caused by intensely calcified plaques is removed. c) Using a minimum cost path approach, the 3D centerline of the vessels is extracted. d) Using a membership function of Hounsfield Units (HU) values and the distance from the centerline, an estimation of the weight function for lumen, outer wall and calcified plaque is made.

An extension of active contour models [3] for e) lumen and f) outer wall segmentation are implemented. The main improvement is an additional term forcing the level set to include a prior shape. Regarding the lumen, the prior shape is a tabular mask across centerline with a small radius. g) A level set method is applied regarding plaque segmentation, taking into account calcified objects of significant size. h) Finally, the 3D surfaces for the lumen, outer wall and calcified plaques are created (Fig. 1).

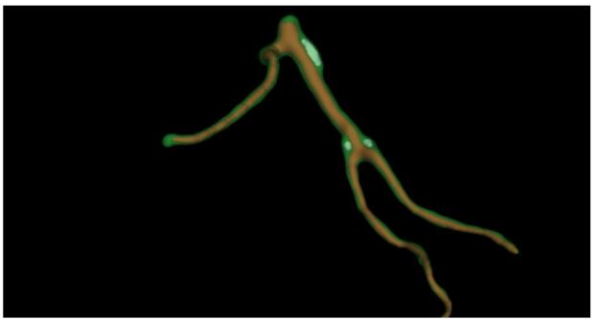

Fig. 1: Final 3D model (transparent green: outer wall, brown: lumen and white: calcified plaque) of an LAD-LCx-1st diagonal branch.

B. Validation

An experienced cardiac radiologist performed the annotation on 12 arterial segments (lumen, outer wall, calcified plaque, mixed plaque). The 3D reconstructed models by the medical expert were then compared to the algorithm-generated models in order to validate it regarding the lumen (Fig. 2). The DICE coefficient and the Hausdorff Distance were used as validation metrics in this study (Fig. 2). The mean DICE coefficient was 0.75 (SD=0.075) and the mean Hausdorff distance was 1.75 (SD=0.55).

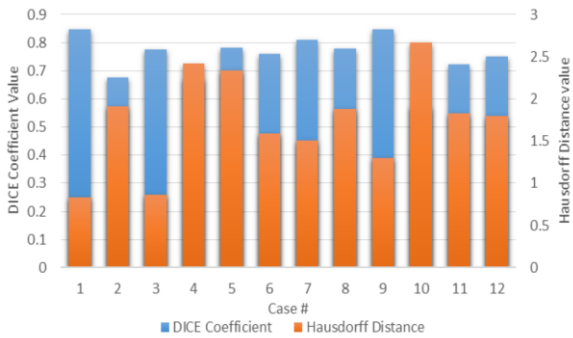

Fig. 2: DICE Coefficient (blue) and Hausdorff Distances (orange) for all 12 cases.

Conclusions

We have presented an algorithm for the 3D reconstruction of coronary arterial trees from CCTA images. Despite the modest size of the validation dataset, the obtained results were very promising, thus indicating the overall accuracy of the proposed reconstruction algorithm. We are currently optimizing our algorithm to improve the vessel classification along with the computational speed.

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Keywords:
Computed; Tomography; Angiography

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ULTRASONIC EVALUATION OF CORTICAL POROSITY

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Introduction

Quantitative ultrasound is a promising method for the assessment of bone. Although several research groups have used ultrasonic backscattering to evaluate cancellous bone, the assessment of the cortical microstructure using this method has been addressed in the literature to a limited extent [1–2]. The research interest has been focused on the discrimination of large basic multicellular units (BMUs) from Haversian canals. In this study, boundary element simulations of wave propagation are conducted to investigate complex scattering effects induced in the backward direction by the interaction of an ultrasonic wave with the porous nature of cortical bone.

Materials and methods

The following porosity scenarios are examined: (a) the ideal case of healthy homogeneous bone (P0), (b) healthy bone with porosity 5% (P5), and (c) normal ageing with porosity 10% (P10). The cortical bone was simulated as a 2D plate (length 40 mm, width 4 mm) immersed in blood to account for the soft tissues surrounding the osseous tissues.The cortical bone was modeled as a linear elastic isotropic plate with Young's modulus E_{bone} = 22.9 GPa, Poisson's ratio ν_{bone} = 0.27 and ρ_{bone} = 1850 kg/m3. The material properties of blood are Young's modulus E_{blood} = 3 MPa, density ρ_{blood} = 1055 kg/m3 and Poisson's ratio ν_{blood} =0.49979. A plane wave at 0.5 MHz was applied as the excitation signal. The magnitude of the scattering amplitude was calculated in the backward direction. The Boundary Element Method was used to simulate the propagation of a plane wave in 2D cortical bone models with different porosities.

Results & Discussion

Fig. 1 presents the scattering amplitude values for the different porosities. It was observed that the three curves differ significantly, while a specific evolution pattern can be observed in the backward (180 degrees) and forward direction (0 degree), as well. Specifically, for 180 degrees the scattering amplitude decreases with increasing porosity from 0.637 for P0 to 0.394 for P5 and 0.262 for P10, respectively. On the other hand, a different trend is observed for the direction of 0 degrees showing a scattering amplitude increase with increasing porosity from 0.066 for P0 to 0.269 for P5 and 0.371 for P10.

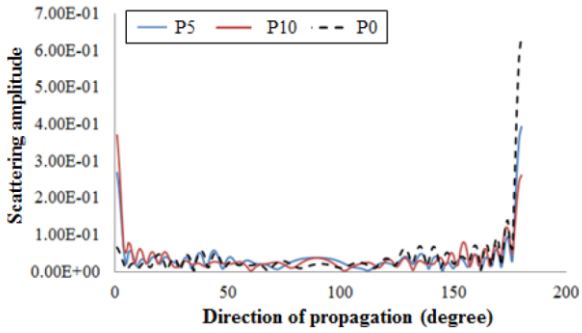

Figure 1. Scattering amplitude evolution (in arbitrary units) for different propagation angles and excitation frequency 0.5 MHz.

Conclusions

In this work, the Boundary Element Method was used to investigate the impact of cortical porosity on ultrasonic scattering. The monitoring potential of the scattering amplitude was shown, while our ongoing study considers the role of different frequencies and the occurrence of BMUs.

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Keywords:
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