הפקולטה להנדסה ביורפואית בטכניון

פרויקט גמר תשע"ה

בשיתוף:

שלום רב,

אנו שמחים להציג בפניכם את תקצירי הפרויקטים של הסטודנטים המסיימים לימודיהם בשנה זו, שנת תשע"ה.

הפרויקט, המבוצע ע"י סטודנטים בשנת הלימודים האחרונה, מהווה את גולת הכותרת של לימודיהם לתואר בהנדסה ביורפואית.

במסגרת הפרויקטים מביאים הסטודנטים לידי ביטוי את הידע והכלים שרכשו במהלך השנים בתחומי ההנדסה, המדע והרפואה.

מטרת הפרויקטים, הינה לתת מענה לצרכי הפיתוח והמחקר של חברות העוסקות בתחום ההנדסה הביורפואית, תוך עמידה בסטנדרטים המקובלים ובמקביל, לתת ניסיון ואתגר מקצועי לסטודנטים המסיימים ולעודד השתלבותם בתעשייה הביורפואית.

לפרויקטים חלק חשוב בעידוד היזמות בקרב הסטודנטים, וחלקם אף מובילים להקמת חברות הזנק ורישום פטנטים.

פרויקטים אלו מהווים נדבך מרכזי בחזון הפקולטה, לחתור לבניית גשר למצוינות ובמה לקשרים ושיתופי פעולה ארוכי טווח בין האקדמיה והחברות המובילות בתעשייה.

הפקולטה מאחלת הצלחה לסטודנטים המסיימים, ומקווה לראותם בעתיד נוטלים חלק פעיל בפרויקטים חשובים אלו כמנחים מהתעשייה.

בברכה,

ד"ר אלכס וילנסקי , אחראי קורס פרויקטים

פרופ"ח אמיר לנדסברג , דיקן הפקולטה

Electrophysiological Phantom For EEG

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Introduction -Electroencephalography (EEG) is a method of recording electrical brain activity noninvasively. EEG may be applied for developing brain–computer interfaces and for medical monitoring. Both EEG manufacturers and operators seek an accurate and repeatable testing methodology that would enable evaluating proper system operation without requiring live subject recordings. To facilitate this an EEG phantom would be required to generate EEG like signals, which can be used instead of live subjects for EEG machine testing.

Methods -Herein, a dipole antenna based EEG phantom is presented. Human EEG signals were processed in Matlab® and uploaded into an arbitrary wave generator. The wave generator was connected to the phantom and played back the EEG recordings. An Alpha Omega EEG machine was used for recoding the phantom signals, using clinical electrodes and a saline solution. The testing system was placed in Faraday cage to reduce electrical noises.

Results and Conclusion- Preliminary results, demonstrated signal playback and recording with satisfactory signal to noise ratios. This preliminary phantom, may be enhanced by introducing multiple channels and proper geometrical placement to replace live subject recordings.

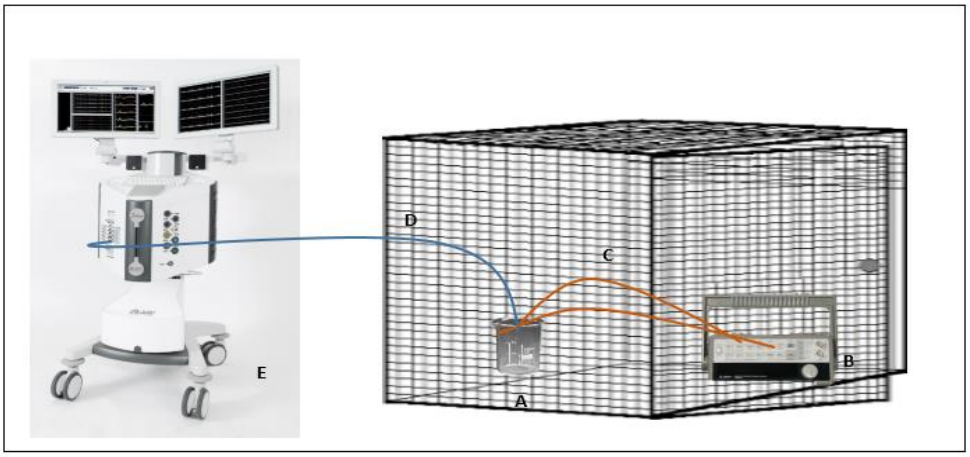

Figure 1- Phantom system description. A: Faraday cage, B: waveform generator, C: BNC cable, D: electrodes, E: Alpha Omega EEG machine

JET Glaucoma Shunt Flow Study

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Introduction: In this study we analyze the flow through a novel polymeric drainage device designed by Hanita Lenses, using Micro PIV. The implant was designed to treat Primary Open Angle Glaucoma – a disease characterized by the accumulation of aqueous fluid in the eye's anterior chamber, causing damage to the optic nerve.

Methods: The device was implanted into a custom-designed PDMS flow chamber. Medium, seeded with 3µm fluorescent beads, was perfused through the flow chamber at physiological flow rate. Data analysis was performed using DaVis PIV (LaVision).

Results: The analysis revealed a region of stagnation and areas prone to protein accumulation. The measured velocities were approximately $150\frac{\mu m}{s}$ near the inlet and $10\frac{\mu m}{s}$ at outlet and stagnation area, in agreement with the proposed analytical model.

Conclusions: The study provided Hanita Lenses with insight regarding the flow through the implant, previously unavailable through in-silico or in-vivo studies, that will potentially lead to changes in design. The experimental system developed for this project can be applied to characterize future designs over longer time periods.

Figure 1: Fluorescent beads flowing through implant, capture using fluorescent microscopy.

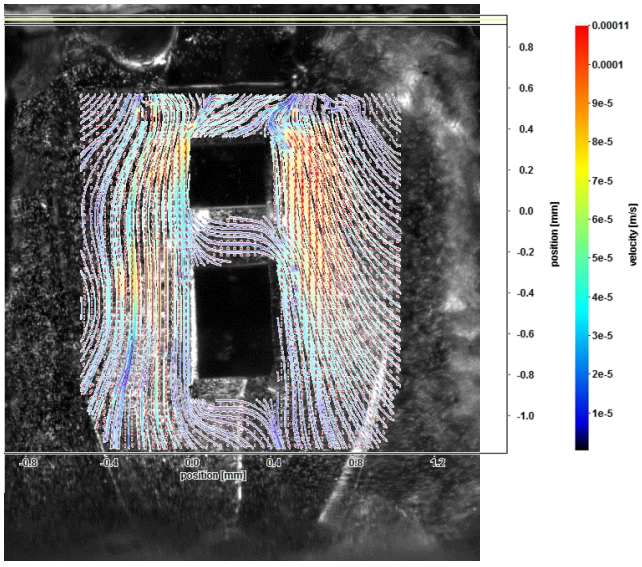

Figure 2: Velocity field and streamlines of flow through part of implant, overlayed on fig. 1.

Development of Applicative Methods for Colon Entrance Identification

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Introduction: 'Check-Cap' offers a friendly solution for colon cancer detection by using low energy x-ray imaging capsule. However, its' energy supply is limited, therefore, we want the capsule to work specifically in the colon. Our research goal was to develop methods for identification of the entrance to the colon, which will trigger the imaging mechanism.

Methods: Some of the unique criteria to distinguish the colon from the rest of the digestive system are: Bacteria types and amounts, enzymatic activity, gas presence, pressure levels, pH and intestine diameter. Our research established the most efficient and precise criteria and methods for sensor implementation.

Results: The research revealed the 2 most efficient and accurate methods: 1. Specific enzymes released from the flora in the colon, which degrade starch and additional substrates. 2. Hydrogen and Methane gases are detected by increased internal capsule pressure and gas specific sensors. (Fig.1)

Conclusions: Combining these 2 main indicators, gives us very high probability that the capsule has arrived to the colon and can start imaging exactly on time, without wasting energy. PH levels criteria proved to be inaccurate, and the diameter scan is energy consuming. For future developments we recommend the use of carbon nano-tubes for specific gas identification.

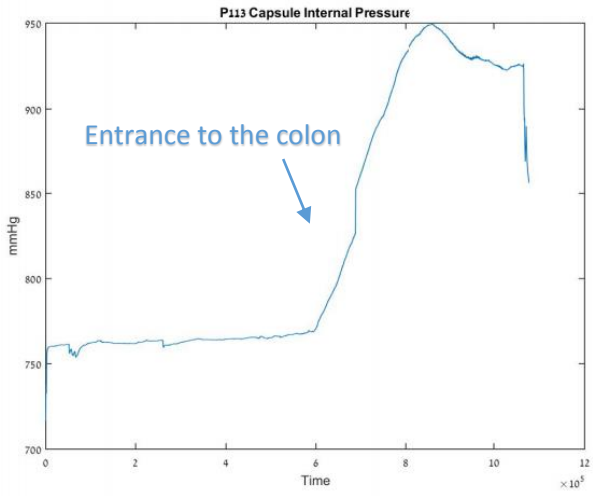

Figure 1: Rise in internal capsule pressure during entrance to the colon as a result of gas presence, proving our concept.

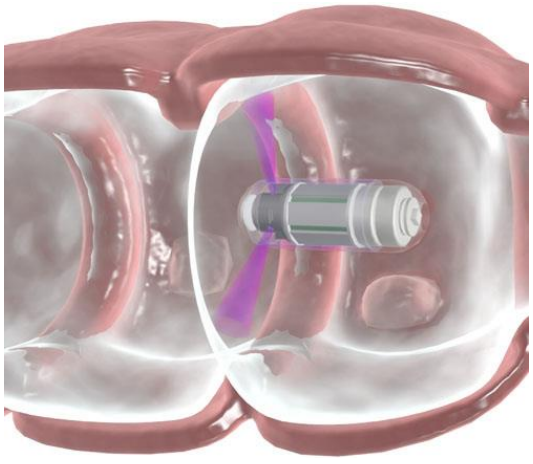

Figure 2: Check-Cap capsule scan in the colon.

Temperature Measurement During Aesthetic Procedures

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Introduction: This project took place at Lumenis corporation facility in Yokneam. The purpose of this project was to develop a non-contact IR temperature measurement apparatus. Temperature measurements were performed during RF energy skin treatment. Our goal was to be able to maintain a safe range of temperatures (up to 45°C) in order to minimize pain and avoid side effects.

Methods: We used an IR temperature sensor to measure temperature of blackbody plate and tissue (pieces of chicken breasts) and compared the readings with a thermal camera, a thermocouple, and an IR temperature gun.

Results:

- Sensor readings were 2°C higher than thermocouple readings at 35-40°C
- Temperature difference between the two devices was roughly ±8°C throughout the experiment
- Readings were affected by false compensation

Conclusions: Many systematic factors affect the accuracy of the temperature measurement and need to be taken into account. The factors I considered and studied were position and direction. In addition I performed a statistical analysis of the experimental results.

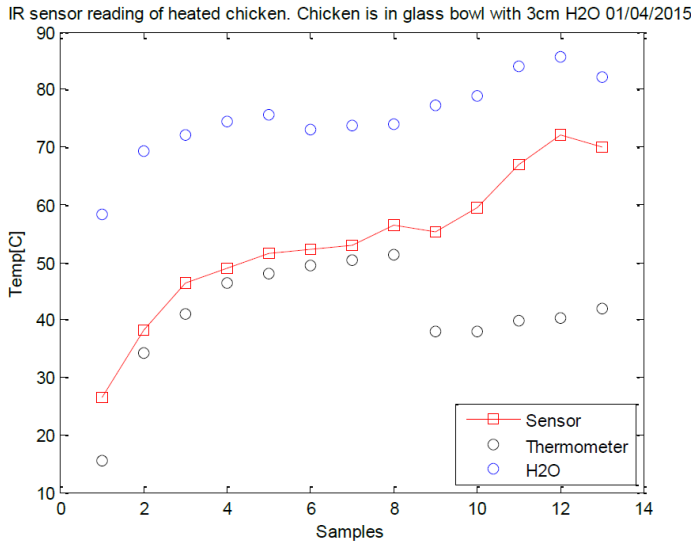

Figure 1: IR sensor and thermocouple readings

Semi-Automatic Image Processing for the Detection of Anatomical Structures in MR Images of Breast Cancer Treatments Using MRgFUS

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Introduction: Magnetic Resonance-guided Focused Ultrasound (MRgFUS) is an innovative noninvasive method for treating breast cancer in its early stages. To help predict which anatomical factors are related to treatment success, image processing methods were utilized on the treatment-planning MR images to calculate the tumor size (TS), tumor to skin distance (TSD) and fat to gland ratio (FGR).

Methods: Modified Expectation-Maximization (EM) and Fuzzy C-Means (FCM) clustering algorithms were used for tumor segmentation to evaluate TS. The same algorithms were used to evaluate the gland volume in tumor vicinity to calculate the FGR. A novel algorithm based on intensity image derivatives was applied for edge detection to determine the TSD.

Results: The three methods required a single manual initiation point per patient for optimal results. A total of 63 patient images were analyzed. Tuning of the image processing parameters was done on five cases, compared with visual inspection performed by an MR specialist. Validation was done on 10 cases, showing accuracy of up to 80% compared to visual inspection of the three anatomical factors.

Conclusions: Semi-automatic segmentation of breast MR planning images results in successful identification of important anatomical factors. Such factors may influence treatment success and can be used in a multi variable analysis of clinical results to help determine optimal patient suitability for the technology.

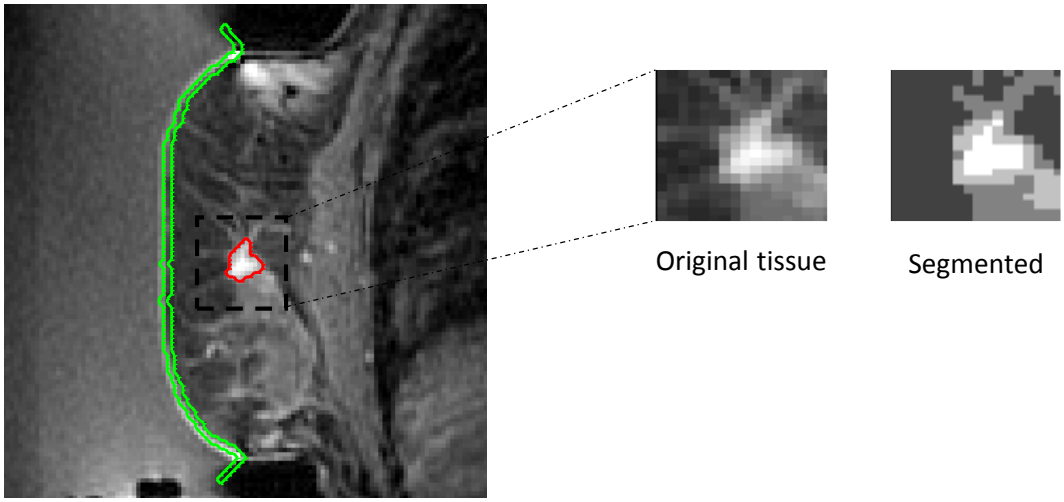

Figure .1 Sagittal MRI view of the breast. In red: Tumor segmentation. In green: skin line detection.

Spectral Imaging Using Spectrally Encoded Endoscopy

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Introduction: Endoscopy is a diagnostic and treatment procedure used in many fields of medicine. The common recent endoscopes have a 4-6 mm diameter size and are based on video camera to acquire the images. By replacing rapid mechanical scanning with spatial wavelength encoding, spectrally encoded endoscopy (SEE) promises miniature, small diameter endoscopic probes that allow easy access to hard-to-reach locations within the body.

Methods: This project is based on images acquired using 1 mm diameter SEE probe with a circumferential scanning. The processing of the data is performed using MATLAB. The goals of this project are divided into two subcategories: 1. Processing black and white images: design an algorithm for conversion of the acquired polar images to Cartesian coordinates, create a video, and implement all of these functions into graphical user interface (GUI). 2. Processing color images: estimating the spectrum and the color of different colored objects in the image.

Results: In practice, we created a Cartesian image by wrapping the polar image on a conic surface. The GUI was designed to be user friendly and allow the user to browse through different images and examine the results.

Conclusions: To summarize, we achieved the initial image processing and created an interface that facilitates the examination of data.

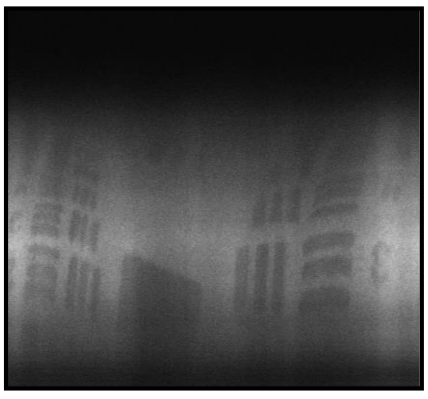

Figure 1. Acquired image

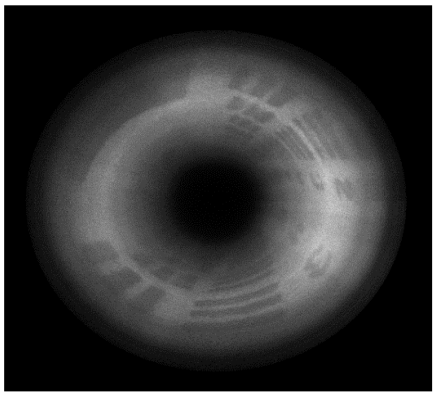

Figure 2. Image after conversion to Cartesian coordinates

Designing and Manufacturing of a Solid Phantom Mimicking Fat Tissue Acoustically and Thermally

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Introduction:

As part of the optimization process for a high intensity ultrasound (HIU) based body shaping device, manufactured by Lumenis Ltd., many experiments are conducted on porcine tissues. In order to procure reliable and replicable results, and avoid animal cruelty, finding a proper synthetic alternative is a necessity. For this purpose, we propose an agar-based phantom, which is composed of agar, milk, Glycerol, an acoustic attenuation agent, Silicon Carbide/ Titanium Oxide and the anti-bacterial/fungi agent Benzalkonium Chloride.

Methods:

To affirm that this phantom is an appropriate substitute to animal fat tissue, we used different experimental set-ups to measure the physical parameters of the phantom and compared them to those of fat tissue. By passing an acoustic wave through the phantom we assessed the speed of acoustic propagation and acoustic attenuation coefficient (figure 1). We also measured the density and used a calorimeter to evaluate the phantom's specific heat capacity. The final test was using the same heating protocol of the HIU-device on the phantom and on porcine tissue, and comparing the temperature rise at the focal heating point.

Results & Conclusions:

Our results show that while we have managed to manufacture a phantom that displays tissue-like properties, the temperature elevation obtained due to ultrasound absorption in the phantom is much dependent on external stress forces.

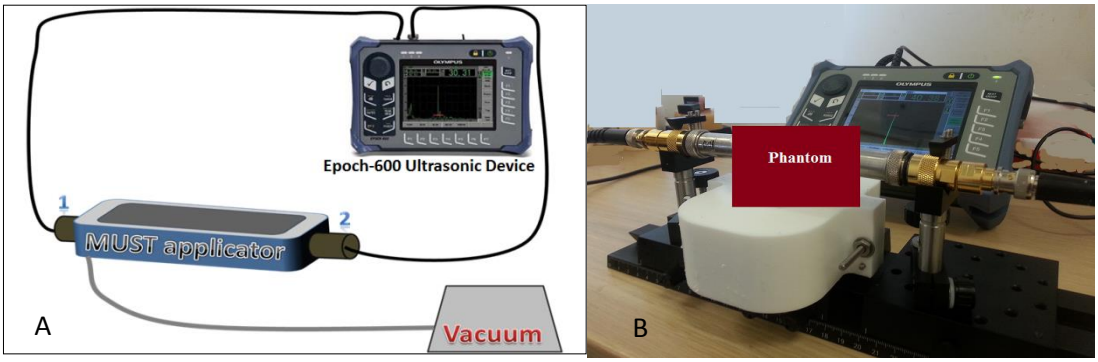

Figure 1: (A) a qualitative scheme of an experimental measuring of the speed of acoustic propagation and acoustic attenuation coefficient. An ultrasonic transmitter (1) and a receiver (2) are placed on opposite sides of device's applicator enabling the measurement of how fast the acoustic wave crosses the phantom, and how much of the energy is attenuated in this process. The vacuum pump ensures the direct transfer of the signal from the transducers into the phantom. (B) Photo of the system in the lab.

FORCE ENHANCEMENT DURING STRETCH-SHORTENING CYCLE; development and testing of a setup for quantifying age, activity and profession (misused) dependent changes in muscle dynamics. A feasibility project.

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Introduction: Stretch-shortening cycle (SSC) is a natural function of the skeletal muscle providing enhancement in the shortening phase force if preceded by a stretching phase. Noninvasive quantification of the muscle response to mechanical deformation is necessary to investigate the SCC phenomenon but also provides a more general tool to test changes in the dynamics of the skeletal muscle in aging and neuromuscular pathologies.

Methods: We developed a setup that allows noninvasive measurement of the index finger flexor muscles response to SCC deformations. The setup consists of lever arm system with built in force sensor (Aurora 309B) and simultaneous EMG recording (Biopac ECG100C), under real time control with custom made Labview program.

Results: 20 young and healthy subjects have been tested. Muscle length, force and EMG response were acquired at 3 different types of mechanical deformations: SCC with varying stretch velocity or amplitude and shortening at varying amplitudes.

Conclusions: The developed system can quantify noninvasively the dynamic force responses of a skeletal muscle to mechanical deformation and identify the various phases that result from the intrinsic properties of the muscle molecular motors, monosynaptic reflex arc, and voluntary activity. The developed setup can determine the time responses of the nervous system used for testing changes in muscle dynamics with aging and/or muscular pathologies. Future studies can lead to optimization of muscular activity, for sport medicine.

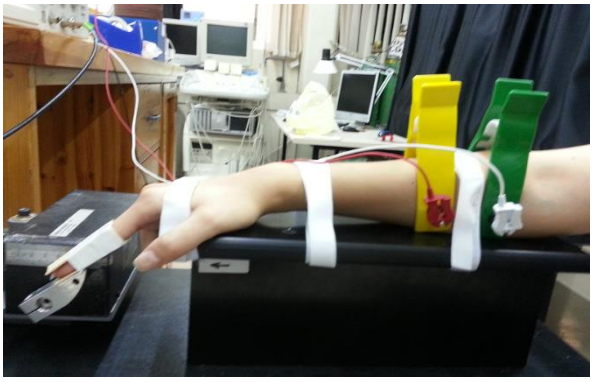

Figure 1: The experimental setup

Biomechanically Improved VERSO Humeral Component Design, for Better Fixation at Reverse Shoulder Arthroplasty - a FEA Comparison

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Introduction: The Glenohumeral (GH) shoulder joint has a ball and socket configuration. During total reverse shoulder arthroplasty (tRSA), a socket-shaped implant is inserted to the humeral bone, replacing the original anatomic ball component. Assuring that this *humeral shell component* (HSC) is anchored firmly inside its intended location poses both design and surgical challenges.

Purpose: By investigating simulated stress effects on both the proximal Humerus bone and the implant, the study compared between three HSC variants, and enabled to screen them according to resultant stresses' amplitude and distribution.

Methods: Two variants, designed to have same length as the original Verso (Innovative Design Orthopedics, UK) model [**fig. 1**, 1a] and different stem configuration, included a rounded-stem [1b] and a rectangular-stem [1c] models. Using SolidWorks (SW) software, a finite element analysis (FEA) approach was taken in order to locate stress concentration regions. Several loads, reflecting standard GH contact forces, were applied upon the concave edge of the HSC's.

Materials: All models were made of a Ti-6Al-4V alloy. Their effects were tested using a *cylindrical bone analog* (CBA) model made of rigid polyurethane, an ASTM advised bone substitute.

Results: In comparison to the original Verso model, both suggested models were found to cause smaller Von Mises (VM) stress. Through all the force range applied, both implant's [**fig. 2**, solid lines] and CBA's [dashed lines] maximal stresses were reduced. Model 1b presented the greatest reduction, with an average of 14.6% and 13.2%, respectively. Moreover, Stress differences are expected to increase as higher loads are applied.

Conclusion: Over time, major loosening effects resulting from bone wear at highly stressed foci are less likely to occur using the suggested model 1b, and therefore it is recommended to adopt it. Further research may include mechanical lab testing and clinical evaluation, for model verification.

Fig. 1: The three SW-simulated HSC's:

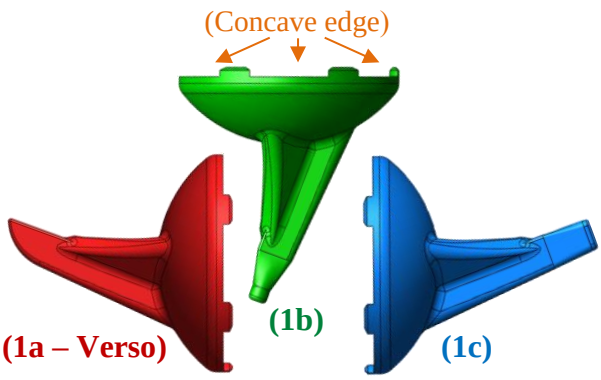
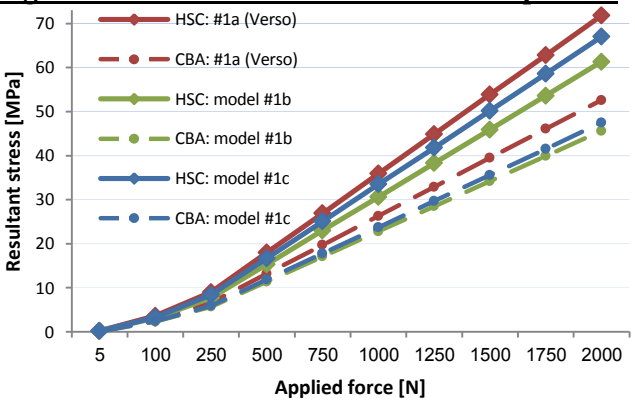


Fig. 2: Maximal VM Stress vs. Force Comparison



For supplementary materials and final study results, correspond with the author by email: shaharrawski@hotmail.com

Polymeric Sticker Design For Measuring Oxygen In The Skin

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Introduction: Measurements of tissue oxygen level are an essential method for many clinical diagnostics. For more accessible and accurate estimation of transcutaneous oximetry (measurement of oxygenation of the skin) a system based on Electron Spin Resonance (ESR) is developed by the magnetic resonance laboratory in the Technion. Our goal was to build a biocompatible polymeric sticker which bridges between the skin and the system and contains a paramagnetic material (LiNu-BuO) which is sensitive to the presence of oxygen.

Methods: The external structure of the sticker was made of oxygen impermeable polymer (polypropylene) using compression molding, and a microporous membrane was pasted over it to allow oxygen diffusion. In addition, toxicity testing was conducted on human foreskin fibroblast cells (hff) to ensure biocompatibility, and microwave attenuation was measured.

Results: The toxicity test showed no negative effect on the cells, and a negligible attenuation of the microwaves through the polymer was measured in microwave attenuation tests. Assembling the sticker parts maintained the flexible surface structure which also fits to the system geometry (Figure1).

Conclusions: The sticker suggested in this project meets all requirements for an effective measurement using the ESR system. Future work will include in-vivo testing of the system together with the sticker developed.

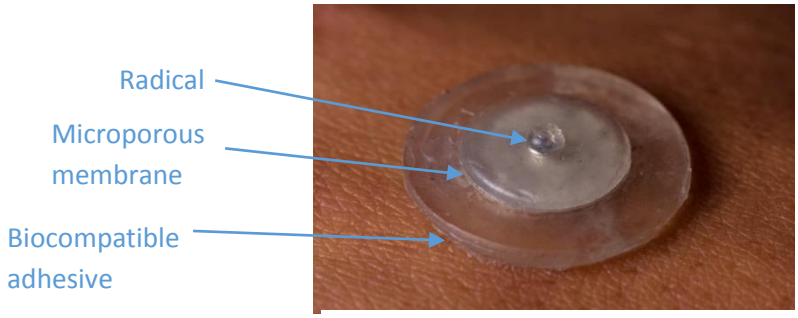

Figure1: Polypropylene sticker pasted on hand

A Miniature Electron Spin Resonance Probe for Subcutaneous Oxygen Monitoring

Anastasia Flores[1], Noy Fridman[1], Helen Wolfson[2], Ygal Twig[2] and Aharon Blank[2]

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Introduction: In cancerous tissues, Oxygen deficiency causes increased function in terms of enhanced growth, increased tendency to metastasize and resistance to treatments. Electron spin resonance (ESR) probe can be a valuable tool in monitoring tissue Oxygen concentration.

Methods: This project focused on design and simulation of a miniature ESR based probe with a typical dimension of 2 mm. The probe main components are 2 Samarium Cobalt magnets and a resonator. Both magnets and resonator were designed using finite element software: *Maxwell*, *CST*. The resulting magnetic field (B_0) and the orthogonal field produced by the resonator (B_1) were used to simulate the resulting ESR signal in Matlab® by solving the Bloch equations.

Results: The probe complex was miniaturized for use in minimally invasive procedures while maintaining a homogenous magnetic field for signal optimization.

Conclusions: This project, although still in its primary stages, shows great promise in the area of real-time detection of Oxygen levels in cancerous tissue. The oximetry probe data is expected to aid the oncologist in determining a personalized treatment plan for each patient.

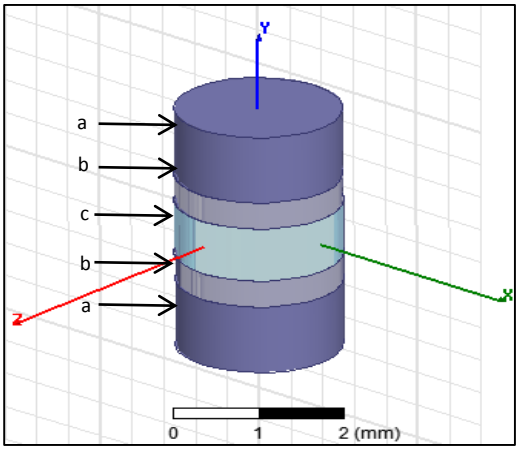

Fig. 1a: The magnetic complex of the probe. a-SmCo magnets, b-steel plates, c-resonator.

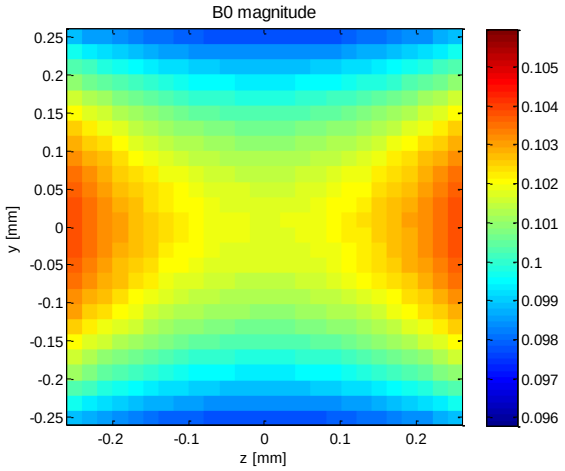

Fig. 1b: A simulation of the B_0 field created by the magnets in the YZ plane.

Development of an Infant Cradle for use in CT and MRI Scans

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[2]Philips Medical Systems, Haifa, Israel

Introduction: Philips Medical Systems is developing CT and MRI scanners and equipment using for diagnostics. In the case of infants, there is a motion risk that can cause rescanning or wrong diagnosis of the patient. Our goal is to create a cradle that can match the both CT and MRI scanners and allow easy switching between them with the minimal need of using drugs to prevent the infant movement.

Methods: Research of the current solutions for every scanner and creating a new model that contained all the necessary requests. Finding the optimal parameters of the structure by calculating the absorption of the cradle in every direction and power analysis by using SolidWorks finite elements simulations.

Results: The designed cradle absorbs only 6% of the radiation for photon energy of 80 KeV, weights 2 kilos and is durable for the required mechanical pressures.

Conclusions: Carbon Fiber was chosen as the preferable material for creating the cradle, allowing minimal weight and strong nonmagnetic structure. The final sketch answers all the project goals.

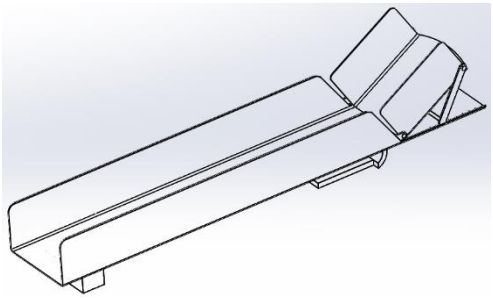

Figure 1: The final sketch of the infant cradle

Automatic View Classification of Echocardiograms Using a Discriminative Learning Dictionary

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Introduction:

2D echocardiographic exam is composed basically of three longitudinal cardiac views: 2 chambers, 4 chambers and 3 chambers (Aplax). Automatic classification of these sequences is essential as a pre-processing stage in cardiac functional assessment. The similarity among longitudinal scans and their noise levels make the classification a challenge.

Methods:

Two automatic algorithms; feature extraction based algorithm and morphology-based algorithm; are presented separately as a prior stage to learning dictionary algorithm for classification. The recognition accuracies are then compared.

Results:

309 clinical clips (103 for each class), were labeled by 2 experts. 70 clips of each class were used as training set and the rest as test set. The recognition accuracies are: 91%, 94% and 97% of 2CH, 4CH and Aplax. The average accuracy rate is 94%.

Conclusions:

It was found that the anatomical morphology and pre-processing based technique provided better accuracy than using the RAW sequences or feature extraction based algorithm. We believe this method could also be used for wider types of sequences and can be improved by using automatic mitral valve detection.

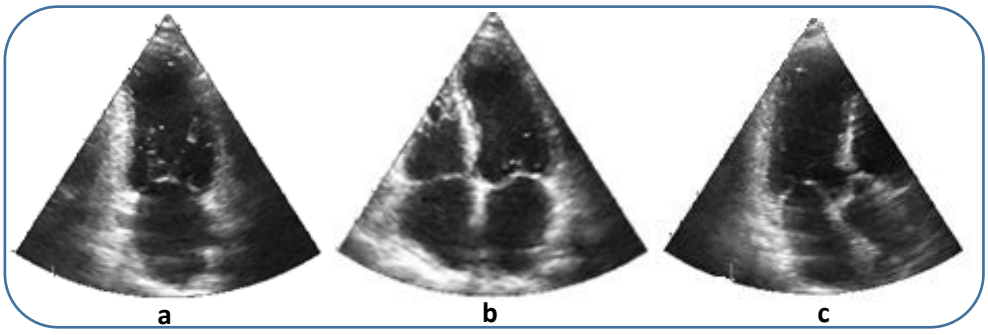

Figure 1: The three longitudinal views: **(a)** 2CH **(b)** 4CH **(c)** APLAX.

Simulation of Optogenetic Excitation of Cortical Neurons

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[b]Technion – Israel Institute of Technology, Faculty of Medicine, Haifa, Israel

Introduction: Optogenetics is a new neuro-stimulation method, which uses light to excite neurons that were genetically treated to express light sensitive channels, most commonly Channelrhodopsin-2 (ChR2). The two most important factors governing excitation, ChR2 expression and local illumination levels, vary significantly between different cellular compartments. The question of the compartments' relative contributions to the overall excitation remains largely unanswered.

Methods: In this project we introduce for the first time a simulation of optogenetic neuronal excitation under realistic illumination conditions, implementing the Beam Spread Function (BSF) analytical model for light scattering (in MATLAB), a cortical neuron morphology and ChR2 model (in NEURON), and a recently developed interface ("NeuroLab") between these two common simulation environments.

Results: Simulations of a layer V neuron illuminated superficially, show that ChR2 channels expressed in apical dendrites contribute predominantly to the initiation of action potentials, which are almost absent when ChR2 is expressed in the soma alone.

Conclusions: A new simulation tool was developed and used to examine the cellular compartments' contributions during optical excitation. This tool will be able to predict optogenetic experimental results, and aid in designing the experimental setups.

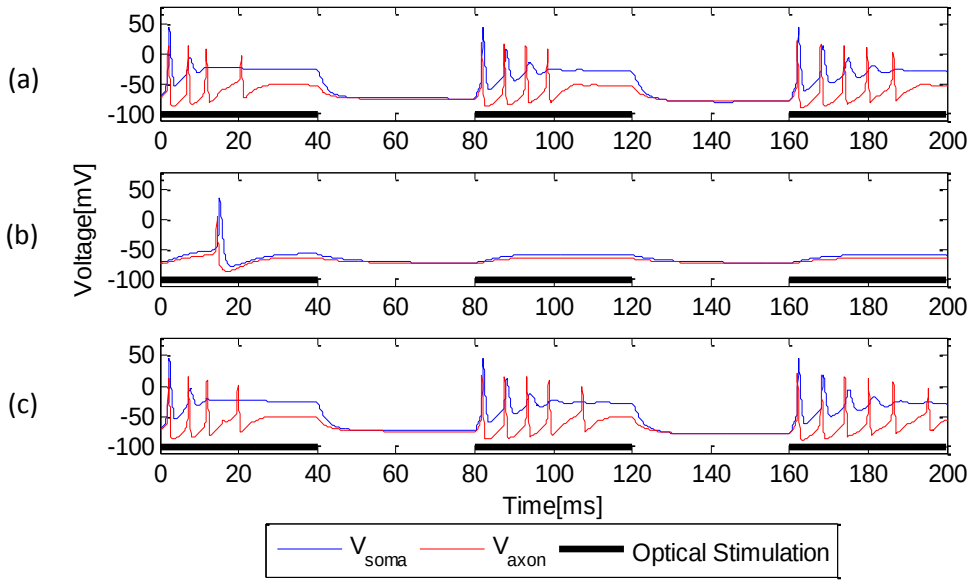

Figure 1: Simulation results of layer V cortical neuron excitation by superficial illumination of light pulses. Action potentials were initiated by illuminating ChR2 expressed in (a) the soma, (b) the apical dendrites (c) all compartments.

Image Processing Based Characterization of Neural Engineered 3D Tissue

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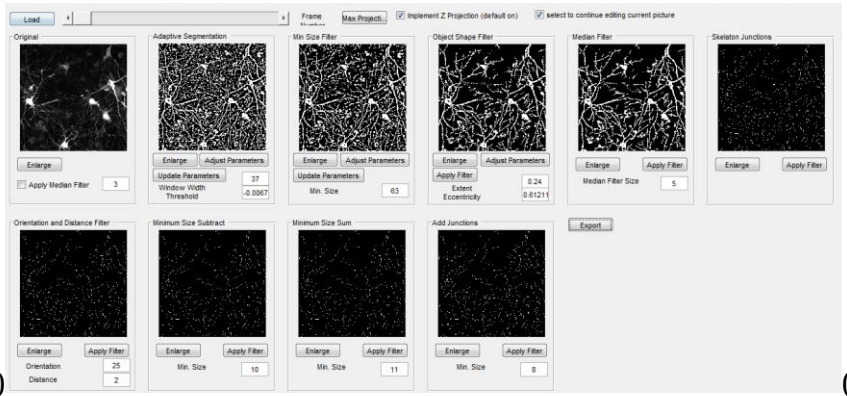
Introduction: In-vitro Models of the central nervous system serve as a powerful tool for basic research and development of medical therapy. 3D models represent a more complex model of the nervous system exhibiting in-vivo like behavior. Here, we developed a tool to investigate and characterize the morphology of various neural-vascular 3D constructs.

Methods: We acquired confocal images of fluorescently marked neural cultures and co-cultures of neurons, glia and endothelial cells. These three dimensional images were analyzed by a customized image processing application we developed. We characterized the morphology of the constructs using 2D and 3D image processing algorithms.

Results: Quantitative measurement of parameters such as number of cells, axon length, orientation, branching points was obtained for different scaffolds and for different cell cultures. Further quantification of the relationship between the vascular and neural network was carried out.

Conclusions: Using the tools we created we were able to quantitatively characterize the properties of different neural constructs and observe how vascularization modulates the morphological behavior of neural networks.

(a) 

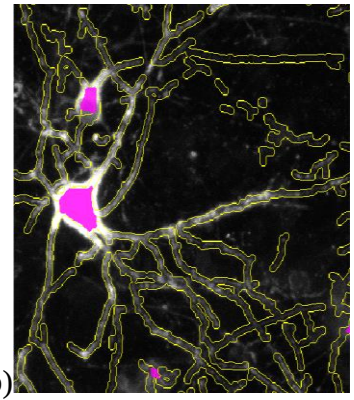
(b) 

Figure 1: Implementation example of our Image processing algorithm on a 3D cell culture. (a) GUI - allowing the user to efficiently extract and quantify the relevant data. (b) Image features recognition and location extraction. Yellow – cell axons. Magenta – cell soma.

Characterization of Fast Oscillations in Effectively Excitatory Networks of Cortical Neurons Ex-Vivo

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[2] Department of Physiology, Faculty of Medicine, Technion—Israel Institute of Technology, Haifa, Israel, [3] Network Biology Research Laboratories, Faculty of Electrical Engineering, Technion—Israel Institute of Technology, Haifa, Israel

Introduction:

Synchronization events in neural networks may contain different oscillation frequencies. Inhibitory neurons are considered to play pivotal role in generating fast oscillations; however, we were able to detect fast oscillations in effectively excitatory networks during the falling phase of network synchronization events. The goal of this project is to characterize these oscillations.

Methods:

In order to characterize these fast oscillations, effectively excitatory network, induced pharmacologically, were recorded. Each network was stimulated at different rates. The falling phase of synchronizations events were extracted and characterized by autocorrelation and CWT.

Results:

In recordings from different networks (n=7), gamma and beta range oscillations were detected (20-45 Hz); mainly during the first 100 milliseconds of the falling phase. No consistent effect of the stimulation rate over the frequency content was identified.

Conclusions:

Thses results suggest that cellular level restoring forces may generate fast oscillations in cortical networks, at the absense of synaptic inhibition

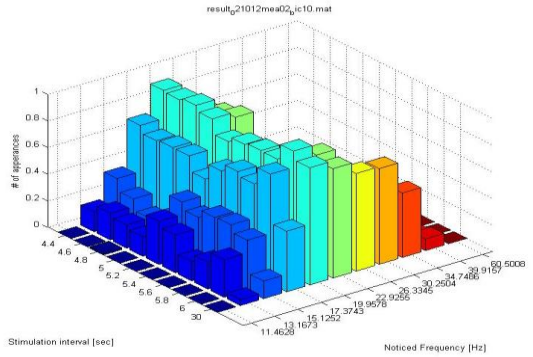

Figure1: Number of oscillation frequencies appearances for different stimulation intervals (normalized to the number of stimulation at each time interval).

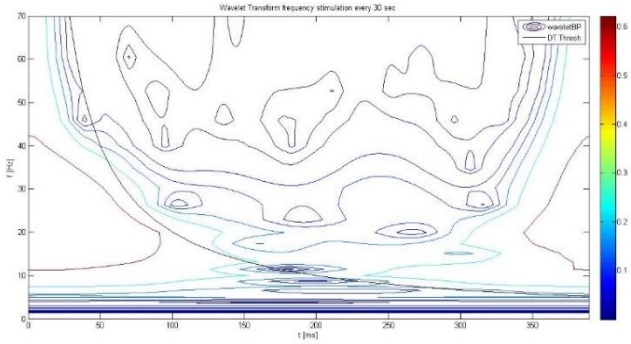

Figure2: Counter plot of wavelet transform for the average data of the 30 sec time interval stimulation.

Elimination of Motion Artifacts from DCEUS Cines in Tumor Imaging

Leah Samet, Avinoam Bar Zion, Prof Dan Adam

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Introduction:

Dynamic contrast enhanced ultrasound (DCEUS) scans are among the most prevalent methods used to gauge tumor micro-vascularization. Before accurate perfusion quantification can be achieved, motion artifacts must be removed from the cines. Currently, no accurate methods exist for compensation of non-rigid deformations in DCEUS scans. This project's aim is to improve the removal of movement artifacts by implementing non-rigid registration in order to compensate for in-plane movement/deformation and by automatically removing out-of-plane frames.

Methods:

Global motion due to respiration is modeled by an affine transformation and compensated using a rigid registration algorithm. Out-of-plane frames are then detected and discarded using clustering methods based on select features. Finally, local deformations are removed using a non-rigid registration algorithm based on a B-spline free form deformation model.

Results:

Phantom studies testing rigid registration techniques with simulated respiratory artifacts showed notable reduction in global movement. The algorithm was then applied to clinical data and successfully compensated for in-plane movement and filtered out out-of-plane frames (figure 1). Non-rigid registration algorithms showed promising results, but were limited by high computational complexity.

Conclusions:

Overall, the methods developed showed reduction of motion artifacts in CEUS cines, though further work remains on optimization of non-rigid methods.

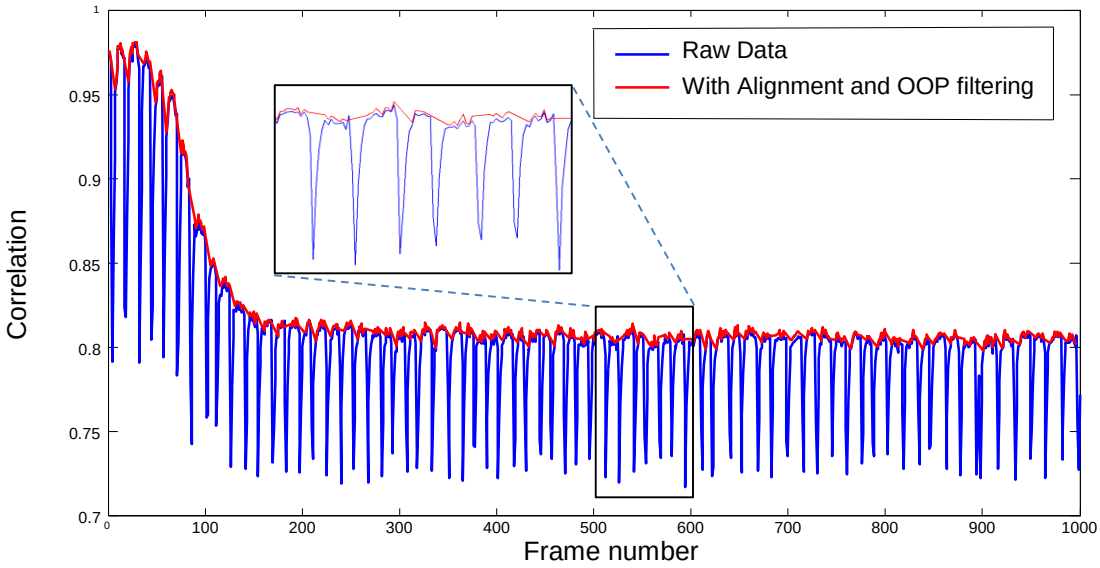

Figure 1. Correlation with reference frame before and after rigid registration and out-of-plane filtering.

Height Measurement of Live Keratocyte Cells and Correlation to 2D Shape Modes

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Introduction & Methods: Using a fluorescent negative staining method, we measure the height of a large population of motile cells. The method consists of placing live cells in a chamber of uniform height, and adding a fluorescent dye that is impermeable to the cells into the extracellular region. The cells are then observed using conventional epi-fluorescence microscopy, and the height is extracted from the reduction in the fluorescence signal due to the volume occupied by the cell. This method allows simple and fast measurement of the height profile of many dozens of cells, and is sensitive enough to measure the thickness of thin protrusions like the lamellipodium which is only ~100 nanometers high.

Results: Using this method we constructed a database of measurements of both height and 2D shape in a large population of keratocytes. We find that while the lamellipodial height varies considerably between cells, the height does not appear to be correlated with the 2D area or aspect ratio of the cell. We are currently investigating the influence of various biochemical perturbations on the height distribution in populations of cells. Experimental information on the distribution of lamellipodial height and its dependence on different factors will provide important input for theoretical models that aim to predict the 3D shape of motile cells.

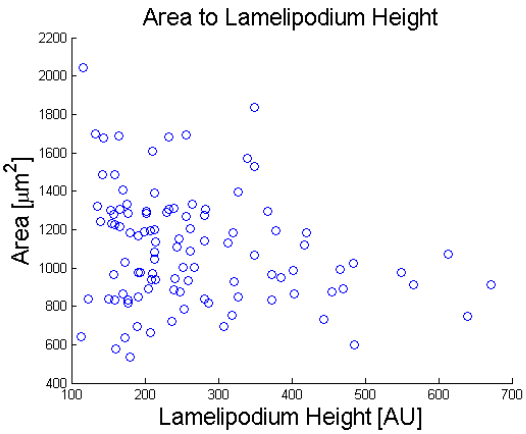

Figure 1: Measured lamellipodial height Vs Cell's area, in a sample of 105 cells. No Correlation is observed.

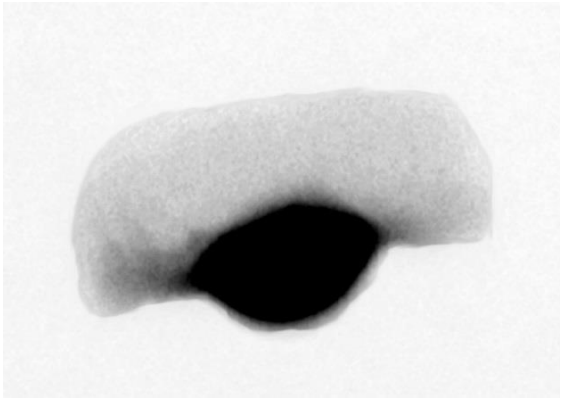

Figure 2: Picture of a typical Keratocyte. Intensity indicates thickness.

Eye tracking and eye movement detection

Noy Mark , Eugene Konyukhov

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Introduction:

Eye movement refers to the voluntary or involuntary movement of the eyes . The involuntary movement of the eyes can indicate the presence of some pathologies, therefore, the use of eye tracking for detecting those movements has a significant potential for diagnosing those pathologies.

Methods:

In this project, eye tracking system was developed using Labview – Vision. The system included an acquisition module, a detection module including two classifiers for the pupil identification, recording module, data analysis module and the main module.

Results:

The system was able to detect the pupil in separate images and in a full AVI file (offline). The X and Y positions of the center of the pupil were displayed in graphs and we can see its movement in both directions.

Conclusions:

The offline system and software developed enabled for accurate pupil identification and tracking. The system can be extended to real time using the same algorithm with the usage of exterior fast unit for the data analysis.

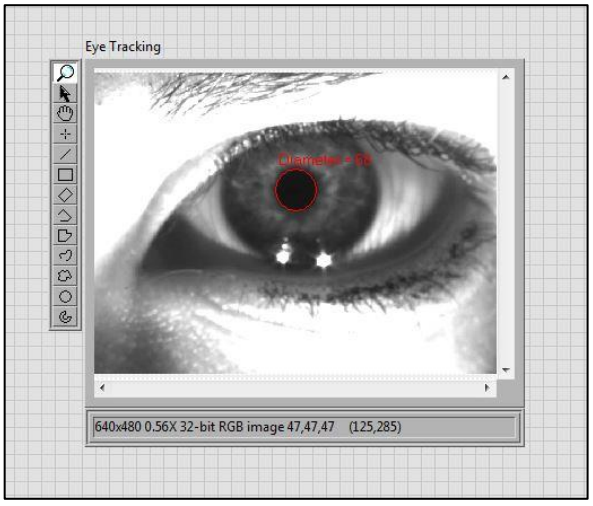

Figure 1 pupil detection by the system

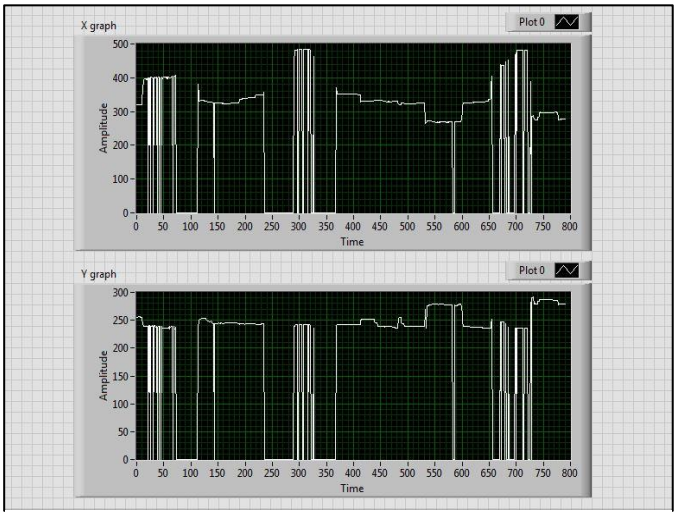

Figure 2 detected eye movements in the X and Y directions

בס"ד

Surfactant and Liquid Plug Delivery in Asymmetric Microfluidic Models of Airways

Oshrit Zeevi, Sigal Tugendhaft, Molly Mulligan, Hagit Stauber, Josué Sznitman
Department of Biomedical Engineering, Technion - IIT, Haifa, Israel

Introduction: Pulmonary surfactant is a surface-active lipoprotein complex, secreted by alveolar epithelium at the terminal units of our lungs. Surfactant importantly lowers surface tension built at the interface between the air-filled alveolar lumen and the liquid lining created by the epithelium. However, in infants born at a gestational age of 25-29 weeks, surfactant production is in minor quantities and its quality is low. This condition may cause respiratory distress syndrome (RDS) and is commonly treated with exogenous surfactant injection by liquid boluses whereas the infant is tilted while ventilated.

Methods: To evaluate efficiency of such treatment, we examined the effect of airway orientation, specifically the difference between injection of surfactant to horizontally lined airway (0°), and air-ducts tilted at 45°. For that purpose, we used microfluidic devices mimicking proximal generations of infants' pulmonary tree where we instilled surfactant under (i) varying inlet pressures and (ii) length of surfactant plug. We measured and analyzed the influence of those two parameters on the surfactant flow in the microchannels of our microfluidic device at 0°, in order to compare the two orientations. We further developed a fluidic system combined with an optical setup to examine our channels while held at 45°.

Conclusions: Further investigation should examine the same set of parameters of surfactant delivery within the microfluidic model describing the more therapeutic scenario, where infants are lifted by 45^0.

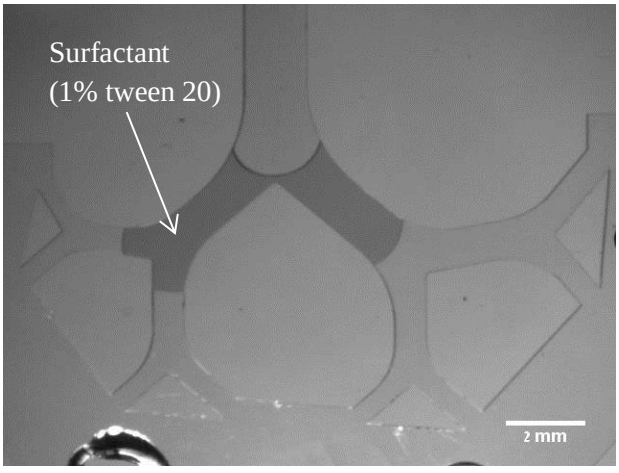

Figure 1: Surfactant (1% tween 20) flow inside an asymmetric microfluidic model, at horizontally lined position