1St. Symposium on Industrial-based Biomedical Engineering Research

SIBER - 2023

5 September

CALL for ABSTRACTS

Important Dates

Abstract Submission: 7 July 2023
Notification of Acceptance: 11 Aug. 2023
Registration Deadline: 25 Aug. 2023 (Free of Charge)

ABOUT

The first IBTec/IEEE Symposium on Industrial-based Biomedical Engineering Research (SIBER) will be held this year in response to the growing interaction between the field of Biomedical Engineering and Healthcare Industries. The Symposium will provide a national technical forum for experts from industry and academia to exchange ideas and present ongoing research results in state-of-the-art in Biomedical Engineering.

Venue:
Auckland
AUT
CITY CAMPUS

Sub-themes:

- **Cardiovascular and Respiratory Systems Engineering**
- **Biomedical Signal and Image Processing**
- **Bioengineering**
- **Computational Systems**
- **Modeling and Simulation in Medicine**
- **Rehabilitation Engineering**
- **Biomedical Sensors and Wearable Systems**
- **Biorobotics and Biomechanics**
- **Diagnostic Systems and Technologies**
- **Health Informatics**
- **Translational Engineering for Healthcare Innovation and Equity**

Preparation of Abstracts:

If you are interested in presenting at this Symposium, please submit a one-page abstract (up to 350 words, only text, no figures, tables, or graphics). The abstracts should be prepared according to the Symposium template. If you want all (co)authors in the Book of Abstracts Authors Index, mention them in your submission!
Abstract Submission Portal:
https://easychair.org/my/conference?conf=siber23
For general inquiries contact us at research.week@aut.ac.nz
For abstract submission inquiries, please contact the Symposium's Chair at hgholamh@aut.ac.nz
Abstract Template available at the QR Code, below.

Publication:

The abstract of the presentations will be published in the Symposium booklet, and with a chance of publishing the extended abstract in ASME J of Medical Diagnostics and Therapy. The best abstract award will be announced at the conclusion of the Symposium.

AUT INSTITUTE OF BIOMEDICAL TECHNOLOGIES

IEEE
EMBS - NZ North Section

AUT

Schedule for the SIBER-23 Symposium[1]

Morning Session- Tuesday 5 September 2023 – WA224 – AUT City Campus

8:30 am (onwards) **In-person registration**

9.00 am **Welcome**

* **Professor Tek Tjing Lie** – Head of School of Engineering, Computer and Mathematical Sciences, Auckland University of Technology & Chair of IEEE New Zealand North Section

9.10 am **Keynote**
* **Professor Poul Nielsen** – Tools for developing reproducible and reusable physiological models

9:40 am – **Submission #12**
* **Dr Mirza Baig** - An efficient mobile application for continuous monitoring of patients

10:00 am **Morning Tea**

10.20 am **Submission #6**
***Dr Yang Yu** - Comparative Analysis of Wrist-based Bioimpedance Analysis and Electrocardiogram for Heart Rate and Heart Rate Variability Monitoring

10.40 am **Submission #9**
***Sudip Ray** - MINERALS IN BIOMEDICAL ENGINEERING AND HEALTHCARE INDUSTRIES

11.00 am **Submission #2**
***Heidarian Mahdi** - EFFECT OF ELECTROSTATIC CHARGE IN HAIR-AIR DOMAIN ON EEG ACQUISITION SYSTEMS

11.20 am **Submission #7**
***Dr Ranpreet Kaur** - AI-ASSISTED MODELS IN IMPROVING SKIN CANCER DIAGNOSIS: CURRENT CHALLENGES AND SOLUTIONS

11:40 am **Submission #16**
***Dr Mirza Baig** – Dynamic Consent Framework for Consumers

12:00 pm **Submission #11**
***Dr Ibtisam Abbas.** Al. Darkazly - A NOVEL BIOMEDICAL POLYURETHANE MATERIAL WITH OPTIMISED MECHANICAL AND OPTICAL PROPERTIES IS DEVELOPED.

12.20 pm **Lunch and Poster Session (50 mins)**

Submission #1, **Hamid GholamHosseini**; Submission #17**, Mirza Baid**;

[1] All times are NZST

13.10 pm **Aftrernoon Session**

Schedule for the SIBER-23 Symposium[2]

Afternoon Session

13.10 pm **Keynote**
* **Associate Professor Peng Du** – Translation of research skillsets to industry: A case study in gut health

13:40 pm **Submission # 4**
***Matin Khalili** – ENHANCING SIGNAL-TO-NOISE RATIO OF CAPACITIVE ECG SIGNALS: OVERCOMING MOTION ARTIFACTS THROUGH ADAPTIVE FILTERING

14:00 pm **Submission # 3**
***Dr Gautam Anand** - SKIN BATTERY PHENOMENON AS A SOURCE OF MOTION ARTEFACTS IN BIOPOTENTIAL SENSING

14:20 pm **Submission # 5**
***Dr Huiyang Zhang** - Advancing Accuracy in Electrical Impedance Tomography-Based Electronic Skins

14:40 pm **Submission # 10**
***Mayuresh Kulkarni** - MECHANICAL CHARACTERISATION OF SILICONE MATERIALS FOR PHYSIOLOGICAL PHANTOM MANUFACTURING

15:00 pm **Afternoon tea**

15:20 pm – **Submission # 13**
* **Kumari Sarla** - Non-invasive Diagnosis of Lung Diseases: A simple tool

15:40 pm **Submission #14 and 15**
*Dr Mirza Baig Enabling personalised self-care at home with Digital Front Door – Co-design approach with Clinicians and End-users
*Dr Mirza Baig Enabling personalised self-care at home with Digital Front Door

16:10 pm – **Submission #8 – online**
***Shereen Moataz** - Proposed Medical Device for SKIN CANCER Classification at the primary healthcare

16:30 pm **Closing remarks and prize-giving**

[2] All times are NZST

First IBTec/IEEE Symposium on Industrial-based Biomedical Eng

5-Sep-23

Submission number. Authors and Abstract Titles

1- Hamid Gholamhosseini. *Can eGP Improve Patient Outcome at Primary Health Care?*

2- Mahdi Heidarian, Andrew Lowe, Arnold Mike and Gautam Anand. *Effect of Electrostatic Charge in Hair-Air Domain on EEG Acquisition Systems*

3- Gautam Anand, Mahdi Heidarian, Andrew Lowe, Harrison Jones and David Budgett. *SKIN BATTERY PHENOMENON AS A SOURCE OF MOTION ARTEFACTS IN*

4- Matin Khalili, Hamid Gholamhosseini, Matthew Kuo and Andrew Lowe. *ENHANCING SIGNAL-TO-NOISE RATIO OF CAPACITIVE ECG SIGNALS:*

5- Huiyang Zhang, Andrew Lowe and Anubha Kalra. *Advancing Accuracy in Electrical Impedance Tomography-Based Electronic Skins*

6- Yang Yu, Andrew Lowe and Wagner Hoffmann. *Comparative Analysis of Wrist-based Bioimpedance Analysis and Electrocardiogram for Heart Rate and Heart Rate*

7- Ranpreet Kaur and Hamid Gholamhosseini. *AI-ASSISTED MODELS IN IMPROVING SKIN CANCER DIAGNOSIS: CURRENT CHALLENGES AND SOLUTIONS*

8- Mohamed Dawod, Radwa Taha, Shereen Afifi and Ranpreet Kaur. *Proposed Medical Device for SKIN CANCER Classification at the primary healthcare*

9- Sudip Ray. *MINERALS IN BIOMEDICAL ENGINEERING AND HEALTHCARE INDUSTRIES*

10- Mayuresh Kulkarni, Tet Chuan Lee and Andrew Lowe. *MECHANICAL CHARACTERISATION OF SILICONE MATERIALS FOR PHYSIOLOGICAL PHANTOM*

11- Ibtisam A. Abbas Al-Darkazly and A.M Al-Jumaily. *A NOVEL BIOMEDICAL POLYURETHANE MATERIAL WITH OPTIMISED MECHANICAL AND OPTICAL*

12- Andrew Emad, Shereen Afifi and Mirza Baig. *An efficient mobile application for continuous monitoring of patients*

13- Kumari Kumari and Ahmed Al-Jumaily. *Non-invasive Diagnosis of Lung Diseases: A simple tool*

14- Mirza Baig, Laura McCrae, Anne O'Hanlon, Sandra Oldfield, Tara Melhopt, Saskia Feltham, Norma Nehren, Melissa Peterson, Kirk Smith and Rosie Dobson. *Enabling personalised self-care at home with Digital Front Door – Co-design approach with Clinicians and End-users*

15- Mirza Baig, Laura McCrae, Anne O'Hanlon, Sandra Oldfield, Norma Nehren, Melissa Peterson, Kirk Smith and Rosie Dobson. *Enabling personalised self-care at*

16- Mirza Baig, Laura McCrae, Anne O'Hanlon and Rosie Dobson. *Dynamic Consent Framework for Consumers*

17- Ehsan Ullah, Anil Parwani, Mirza Baig and Rajendra Singh. *The opportunities and challenges related to the use of Large Language Models (LLM) such as*

Can eGP Improve Patient Outcome at Primary Health Care?

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Abstract:

Electronic General Practitioner (eGP) incorporates the concept of remote patient monitoring into Primary Health Care (PHC), enabling GPs to monitor patients' vital signs and health status from a distance. This research investigates how eGP could revolutionise PHC by reducing the waiting list and improving patient outcomes.

The advancements in digital health technologies, coupled with the increasing prevalence of chronic diseases and the need for efficient healthcare delivery, have paved the way for eGP to become a viable solution. eGP integrates wearable sensors and wireless medical devices into a mobile application to collect and transmit real-time health data to GPs. It allows remote tracking of patients' vital signs, facilitating early detection of health issues and timely interventions. The required safeguards will be in place to protect the privacy and integrity of health information.

Patients can receive personalized care in the comfort of their own homes, reducing the need for frequent clinic visits and improving accessibility, especially for individuals residing in remote areas. Furthermore, eGp enables proactive interventions, as GPs can potentially identify and address health deteriorations before they escalate, reducing emergency hospital admissions/readmissions and costs.

By integrating eGP into PHC, patients become active participants in their own care, empowered by access to their own health data and real-time feedback from their GPs. This shared decision-making and increased self-awareness can promote patient adherence to treatment plans and lifestyle modifications. Moreover, eGP facilitates remote consultations and virtual follow-ups, fostering better patient-GP communication.

However, the adoption of eGP in PHC can present some challenges, such as data confidentiality, security, interoperability of devices and mobile platforms, as well as technical support and cost that need to be carefully addressed.

In conclusion, eGP holds tremendous potential for transforming PHC, reducing workload, and enhancing accessibility. As technology continues to advance, eGP has the potential to revolutionize the way PHC is delivered, enhancing the quality and efficiency of care while empowering patients to take control of their health.

EFFECT OF ELECTROSTATIC CHARGE IN HAIR-AIR DOMAIN ON EEG ACQUISITION SYSTEMS

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ABSTRACT

Electroencephalogram (EEG) serves as a valuable non-invasive tool for monitoring the electrical activities of the brain. It can be acquired using various types of electrodes, including wet, dry contact, and capacitive electrodes. While wet electrodes exhibit excellent performance in clinical applications and short-term tests, they are not the preferred option for continuous daily activities or wearable gadgets. The use of gel in wet electrodes can result in skin allergic reactions and instability in skin-electrode impedance due to gel dehydration. These challenges have motivated researchers to develop dry electrodes that are more compatible with wearable EEG measurement systems.

In the context of dry EEG sensory systems, the impedance of skin electrodes is significantly influenced by the hair-air domain. Interference from the hair-air domain can introduce errors in measurements, through phenomena like hair's static electricity discharge through the system. This effect can potentially lead to long-term blockage in high-gain front-end circuits. The interaction between EEG electrodes and the hair-air domain has not been accounted for in EEG measurement systems, necessitating a closer investigation into the electrical properties of hair and the electrostatic phenomenon at the hair-electrode interface.

This study focuses on examining the effect of electrostatic discharging through the front-end circuitry with high gain in EEG acquisition systems. It investigates the duration of blockage caused by different amounts of static charges. Additionally, the study introduces a compensation strategy aimed at facilitating faster recovery of the front-end circuits from saturation. The compensation circuit incorporates a current pump, which injects a sufficient amount of charge to help the input baseline return to normal working conditions. Simulation results are provided to showcase the efficiency of the designed compensation strategy in mitigating saturation and promoting accurate EEG measurements.

SKIN BATTERY PHENOMENON AS A SOURCE OF MOTION ARTEFACTS IN BIOPOTENTIAL SENSING

Gautam Anand*, Mahdi Heidarian, Andrew Lowe, Harrison Jones and David Budgett

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ABSTRACT

Human skin in the outermost and largest organ of our body. Like all other living tissues and organs, researchers have been interested in skin's properties to aid our interaction with the environment and determine biomarkers of physiological function. Skin has three major layers – epidermis, dermis and subcutaneous. Bioelectric behaviour of skin is primarily characterised by a DC potential which exists between the sublayers of epidermis, called Trans epidermal potential (TEP) or skin-battery phenomenon. One scope of interest is investigating the skin-battery phenomenon as a potential source of motion artefacts in biopotential sensing, particularly Electrocardiogram (ECG)

Established literature and previous research from our group indicates that stretching of skin can significantly corrupt the measured ECG. Our research hypothesizes that skin stretch changes the steady state TEP to induce an injury current between the top two layers of epidermis, which induces motion artefacts in the measured signal. The objectives of this research are – a) Characterise the skin battery phenomenon during stretch, and b) Correlate skin-stretch induced changes in skin potential to motion artefacts in ECG measurements.

This work focusses on the first objective of this research. The design of the experimental setup was divided into three parts – the mechanical setup to induce skin stretch, skin potential electrodes and optical tracking. Custom microneedle electrodes (Stainless Steel, 8mm x 8mm, 10 x 10 array, 300-micron height, parylene coated) were used to measure skin potential from below the epidermis against the surface potential measured by a dry blank electrode (stainless steel). Skin potential measurements were performed simultaneously with ECG measurements for analysis. Additionally, optical tracking allowed to calculate the stretch around the measurement electrodes.

Results at this stage show that the changes in skin potential followed the same trend as simultaneously induced motion artefacts in ECG. This is a major step in agreement with our hypothesis. However, several assumptions need to be considered – such as distance between electrodes, non-uniform stretch application, which need to be investigated further for validating our results. Successful investigation will be followed by implementing cancellation of skin-induced motion artefacts to allow better class of sensors for ambulatory monitoring applications.

ENHANCING SIGNAL-TO-NOISE RATIO OF CAPACITIVE ECG SIGNALS: OVERCOMING MOTION ARTIFACTS THROUGH ADAPTIVE FILTERING

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ABSTRACT

Cardiovascular disease (CVD) remains the leading cause of global mortality and disability [1]. Telemedicine offers a viable solution to significantly reduce CVD-related mortality by enabling timely symptom diagnosis and effective treatment. Remote monitoring of electrocardiogram (ECG) signals through capacitive sensing provides a promising approach for long-term care, reducing the need for specialist visits while ensuring patient comfort. Capacitive ECG electrodes must deliver accuracy, reliability, and performance comparable to traditional electrodes to be viable for medical device applications. Moreover, capacitive sensing technology can be seamlessly integrated into wearable medical devices or everyday furniture, such as chairs, beds, or car seats, to meet the growing demand for such innovations in the market. However, capacitive sensing faces a significant challenge in dealing with motion artifacts (MAs) caused by relative movement between the electrode and the skin. In some cases, the magnitude of the MA signal can be hundreds of times stronger than that of the ECG signal while sharing the same frequency band.

This study aims to improve the signal-to-noise ratio (SNR) of capacitive ECG measurements by applying an adaptive filter, effectively reducing motion artifacts. The adaptive filter requires a reference signal to accurately map the MA and adjust its coefficients for subtraction the MA from the recorded signal. The Electrode-Tissue-Impedance (ETI) signal serves as a suitable candidate for this reference signal due to its high correlation with the ECG signal and lack of additional sensor requirements. The research will investigate the characteristics of motion artifacts, estimate the ETI, and generate a reliable reference signal for adaptive filtering. Additionally, the study will explore the potential need for additional reference signals.

Through simulation, hypotheses were tested, and a capacitive measurement system was designed for the experimental setup. The next research phase will involve data collection, experimental model development, and real-world data validation.

In conclusion, this study focuses on enhancing the SNR of capacitive ECG signals by implementing an adaptive filter that effectively reduces motion artifacts. The use of ETI as a reference signal shows promise in mitigating motion artifacts and improving the overall quality of capacitive ECG recordings, making it an appealing proposition for medical device companies.

References:

[1] 'Cardiovascular diseases'. https://www.who.int/health-topics/cardiovascular-diseases (accessed Feb. 28, 2023).

Advancing Accuracy in Electrical Impedance Tomography-Based Electronic Skins

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ABSTRACT

Electrical Impedance Tomography (EIT) has garnered significant attention due to its transformative potential in converting electrically conductive materials into electronic skins (E-skins) capable of detecting and transducing spatially distributed pressures. EIT-based E-skins have demonstrated promise in wearable devices, human-machine interfaces, and soft robotics. However, their practicality has been hindered by limited accuracy. This study presents a novel strategy to enhance the accuracy of EIT-based E-skins for pressure sensing. To overcome critical limitations in existing approaches, we introduce a methodology that incorporates a new model inspired by the nodal admittance matrix (NAM) and refines the solution space constraints. Extensive simulation studies have been conducted to validate the effectiveness of our proposed reconstruction method. The results demonstrated a remarkable improvement in reconstruction accuracy. These findings have significant implications for practical applications and pave the way for advancements in the integration of EIT technology. This research represents a valuable contribution to the field, enabling the realization of more reliable and precise E-skins.

Comparative Analysis of Wrist-based Bioimpedance Analysis and Electrocardiogram for Heart Rate and Heart Rate Variability Monitoring

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ABSTRACT

Heart rate (HR) and heart rate variability (HRV) monitoring play a crucial role in assessing cardiovascular health and understanding autonomic nervous system activity. The gold standard methods for HR and HRV measurement involve electrocardiogram (ECG) and photoplethysmography (PPG). While wrist-based PPG sensors offer convenience, they may have limitations in terms of penetration depth and accuracy across different skin tones. This study aims to compare the performance of wrist-based bioelectrical impedance analysis (BIA) with ECG for HR and HRV monitoring.

Simultaneous measurements of ECG and four-electrode BIA along the radial artery were conducted, capturing over 200 beats. The mean HR over a two-minute period showed consistent values for both methods, with 80 beats per minute. The average time intervals (mean±SD) between successive beats were 0.75±0.03 s for ECG and 0.75±0.06 s for BIA. However, when comparing each R-R interval of ECG and the peak-peak interval of BIA signals, the mean difference was -0.0026±0.0659 s and the mean absolute error was 0.0455 s, indicating that BIA is capable of monitoring average HR but may have limitations in HRV estimation.

This study highlights the potential of BIA as a non-invasive and convenient alternative to ECG for wrist-based HR monitoring. Its wrist-based approach enables continuous monitoring in real-world scenarios, making it suitable for long-term HR assessment. Moreover, BIA can sense deeper blood flow offers an advantage over commonly used PPG sensors, particularly in overcoming limitations related to different skin tones.

However, the limitations of BIA in accurately estimating HRV should be acknowledged. ECG remains the gold standard method for precise HRV analysis due to its reliable capture of subtle variations in beat-to-beat intervals. Future research should focus on refining BIA methodology and electrode placement to enhance its HRV estimation capabilities.

In conclusion, this comparative analysis of BIA and ECG demonstrates the potential benefits of wrist-based BIA for HR monitoring while recognizing the limitations in HRV estimation. The findings contribute to the field of wearable healthcare technology, emphasizing the importance of selecting appropriate monitoring methods based on specific needs and applications.

AI-ASSISTED MODELS IN IMPROVING SKIN CANCER DIAGNOSIS: CURRENT CHALLENGES AND SOLUTIONS

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ABSTRACT

Melanoma, the deadliest of skin cancers, has a high mortality rate. Melanoma is a cancer caused by the overproduction of melanin, a pigment produced by overexposure to ultraviolet rays. Early diagnosis and accurate prognoses improve survival rates for melanoma. In the present clinical system, a skin lesion sample is captured from a patient using dermatoscopy, and a detailed analysis is performed to diagnose the disease. As trained specialists are in short supply, and manual diagnosis involves high costs, there is a high demand for computerized automated skin lesion analysis techniques. Non-invasive methods are increasingly used to diagnose malignant melanoma, reducing the need for biopsy procedures.

The development of an automatic screening tool for skin cancer involves numerous obstacles and challenges. The skin lesions have a very complex structure that is difficult to understand due to the lesion's asymmetry, irregularity, color, and diameter size. Moreover, the low lighting conditions and limited resources to capture skin images through clinical instruments lead to poor illumination and low contrast. The performance of any image analysis system intensively depends upon the image quality. Another common problem in skin images is the presence of hairlines that may obscure critical information when analyzing skin cancers. Excruciating procedures are usually used to shave or remove hairlines from the infected skin area. As a result, the patient experiences discomfort and stress. Finally, there are major challenges in extracting the region of interest and its correct classification.

This research study focused on finding potential AI-based solutions for each challenge. It investigated the hair removal algorithm to eliminate hairlines and increase their color contrast and resolution for efficient processing. Further, a deep learning-based network has the potential to localize the cancerous region of a skin lesion by detecting and delineating lesion boundaries and classifying melanoma vs benign skin cancer. This study's potential outcome and benefits include a robust classification model to diagnose malignant skin cancer in a minimum time. Hence, it enables practical usability for real-time analysis, such as through mobile and embedded platforms, and a safer and potentially more convenient approach for monitoring health.

Proposed Medical Device for SKIN CANCER Classification at the primary healthcare

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ABSTRACT

Skin cancer is a prevalent and potentially life threatening disease. Early detection plays a crucial role in successful treatment and improves patient outcomes. Deep learning techniques especially Convolutional Neural Networks (CNNs) have shown promising results in classifying between skin cancer types. Developing these models on boards like raspberry pi and FPGA offers a low-cost and portable system for real-time classification [1] [2]. This research focused on developing an optimised skin cancer classification system using a CNN model to be deployed as a medical scanning device for real-time classification at the primary healthcare with low cost. Three popular CNN models, EfficientNetB4, InceptionV3, and MobileNetV2, had been developed to assess their performance in classifying 3 types of skin cancer (Melanoma, Nevus, and Basel Cell Carcinoma), aiming to find the most accurate model to be deployed on a Raspberry Pi device for real-time classification. The CNN models were trained and evaluated on the ISIC-2019 skin cancer dataset. The training process involved preprocessing the data, augmenting the images, and fine-tuning the models. The models were trained using a deep learning framework, and their performance was assessed based on multiple matrices and evaluation metrics (accuracy, precision, F1 score, support, confusion matrix, AUC). Among the three CNN models, MobileNetV2 achieved the highest accuracy of 91% in skin cancer classification. This model's superior performance made it the most suitable choice for deployment on a Raspberry Pi. The conversion to TensorFlow Lite format facilitated efficient utilization of computational resources, enabling real-time classification on the edge device. The findings of this research demonstrates the effectiveness of MobileNetV2 as a CNN model for skin cancer classification. The developed model on the Raspberry Pi achieved real-time classification on images uploaded to the Raspberry Pi and on images captured from a camera connected to it, which is promising for on-site and remote screening applications. This research contributes to the field of skin cancer detection at the primary healthcare by providing an optimised deep learning-based medical device that combines accurate classification and portability at low cost.

[1] Afifi, S., Gholamhosseini, H., Sinha, R., & Lindén, M. (2019, January). A Novel Medical Device for Early Detection of Melanoma. In *pHealth* (pp. 122-127).

[2] R. K. Shinde, M. S. Alam, M. B. Hossain, S. Md Imtiaz, J. Kim, A. A. Padwal, and N. Kim, "Squeeze-mnet: Precise skin cancer detection model for low computing iot devices using transfer learning," Cancers, vol. 15, no. 1, p. 12, 2022.

MINERALS IN BIOMEDICAL ENGINEERING AND HEALTHCARE INDUSTRIES

Sudip Ray

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ABSTRACT

Minerals are naturally occurring solid inorganic substances with characteristic chemical compositions that provide unique physicochemical properties. They play an essential role in controlling the physiological system, such as bone formation, regulating heart rhythm by cardiac muscles, supporting brain health necessary for cognitive function, and producing enzymes and hormones. Minerals are also crucial in biomedical engineering for developing and manufacturing innovative medical implants and devices for diagnosing, monitoring, or treating clinical conditions.

NZIMMR aims to research economic opportunities for adding value to New Zealand's rich endowment of mineral resources. New processing technologies are being developed to recover the fine gold particles from alluvial deposits, emission-free production of high-value and porous carbon-based materials from hydrocarbon feedstocks, separation of critical and rare earth elements bearing minerals, and other commodities from West Coast mineral sands. These materials have commercial uses in smart electronics and emerging biomedical engineering applications, including fluorescence imaging, sensing, and controlled drug delivery.

The presentation will emphasise deep insight into exploring mineral-based materials and their integration into healthcare technologies that contribute to scientific advancements and holds great promise for improving patient outcomes in the future.

MECHANICAL CHARACTERISATION OF SILICONE MATERIALS FOR PHYSIOLOGICAL PHANTOM MANUFACTURING

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ABSTRACT

In the burgeoning field of sophisticated medical training phantoms, understanding the mechanical properties of construction materials is essential. This study undertakes the rigorous task of characterizing silicone materials, earmarked for the development of physiological phantoms that hold transformative potential for medical device validation.

The study addresses three fundamental research questions: What are the mechanical properties of silicone under various stress conditions? How do these properties contribute to the successful development of physiological phantoms?

Comprehensive mechanical characterization of selected silicone materials was performed, involving tensile testing, compression testing, and shear testing. Through meticulous experimental procedures and subsequent analysis, critical properties like elasticity, compressibility under different strain rates were established.

The findings indicate a diverse range of mechanical properties among the tested silicone materials, affording a versatile selection for phantom construction. Of note is the strong correlation between these properties and the realistic simulation of tissue behaviour, emphasizing their role in designing effective phantoms.

Implications of this research are multifaceted. By characterizing silicone materials, a solid foundation is provided for the manufacture of realistic physiological phantoms, poised to enhance medical device validation and potentially contribute to improved patient outcomes. The established correlations offer a sturdy basis for material selection for future phantom designs.

In conclusion, the pivotal role of mechanical characterization in phantom development is emphasized by this study, setting a scientific precedent for material selection in this critical healthcare application. The study enriches the existing body of knowledge, pushing the boundaries of phantom manufacturing and device testing methods.

TITLE OF YOUR ABSTRACT:

A NOVEL BIOMEDICAL POLYURETHANE MATERIAL WITH OPTIMISED MECHANICAL AND OPTICAL PROPERTIES IS DEVELOPED.

Al – Darkazly, I.A.and Al-Jumaily, A.M

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ABSTRACT

Polyurethanes (PU) materials exhibit a wide range of properties that suit medical applications including cardiovascular devices, tissue replacement, artificial corneas, and intraocular lenses. The aim of this work is to design and develop a novel polyurethane (PU) material and investigate its potential in biomedical optical applications.

Method: A one-step solution polymerization method is utilized to chemically synthesize a series of polyurethane elastomers (PUE) from polyester, poly (3-methyl-1,5-pentandioladipate) (PMPA), Diisocyanate, 4,4-methylene bis (phenyl isocyanate) (MDI), and the chain extender 1,4 butanediol (BD). The MDI was purified by dissolving it in methylene chloride, filtered and precipitated by adding n-heptane, and dried under a vacuum. 3.9558g of PMPA and 0.360g of BD were dried at 85 ^{o}C for 20 minutes under vacuum and the reaction mixture was warmed to 120 ^{o}C and spun at 50 RPM for 3 hours at normal pressure. The reaction mixture was then cooled to 60 ^{o}C and 2.002g of MDI was added to the mixture. The reaction mixture was warmed again to 100 ^{o}C and stirred for 2 hours. Dimethylformamide (DMF) solvent was added to dilute the reaction mixture followed by coagulation in water, filtration, rinsing, and drying. The resulting white fibrous polymer exhibited rubber-like properties. The fibrous polymer was filtered and rinsed with water and methanol several times to remove the excess monomer and then dried in a vacuum oven at 90 ^{o}C for 24 hours at laboratory temperature for 7 days. Analysis by infrared spectroscopy, Refractometer, UV/ visible spectrophotometer, and Tensile Tests were performed to confirm the chemical structures of the developed PMPAPUE materials and to investigate the Refractive indices, transmission spectra, and the Young's Modulus respectively. PMPAPUE films of different thicknesses were prepared using the solvent casting technique with Tetrahydrofuran (THF) as a solvent and tested for transmission and reflection.

Results: The spectroscopy test confirmed the formation of the required polyurethanes by identifying bands related to the amine groups (NH) and the carboxylic groups (COOH) and the H-bonding interactions. The tested samples of 0.03 thickness exhibited excellent transparency, with a Refractive index of n =1.59 and 89.63 % of total transmitted light and compare well with those of plastic lens n =1.498 and flint glass n =1.70. The Tensile Test of the PMPAPUE film exhibited excellent mechanical properties with Young's modulus in the range of 10.974 – 14.735 MPa which is within the standard range (3.5 - 14 MPa) of the PellPUE 2363-80A.

Conclusions: A new PMPAPUE material with desirable optical properties for biomedical applications is developed. The optimization of the material's properties was achieved by adjusting the raw material ratios and reaction conditions. This research serves as a valuable resource for researchers and engineers interested in advancing the development of polyurethane materials for biomedical purposes.

An efficient mobile application for continuous monitoring of patients

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Egypt

ABSTRACT

Clinicians prefer to have precise health information for every individual to receive therapy in a timely manner. The task of ongoing patient monitoring is carried out by nurses in the interim, but the availability of a skilled and sizable team of nurses is a major concern around the world. This is somewhat eased by the Internet of Things(IoT) technology, which is gaining much popularity nowadays especially in the field of healthcare as it is used for connecting different wearables together [1]. This research proposes the implementation of an IoT-based application for continuous monitoring of the patient's vital signs. The application was designed to be used by both the patient and the doctor, as the doctor can track the patient's parameters remotely in real-time to make the diagnosis easier, efficient and to early detect the patient's health status. The designed application enables patients to spend more time in the comfort of their own homes and communicate with their care facilities and it can also improve the patient's independent living. The sensor technology used are the biosensors provided by the smart watch or the mobile phone. These sensors measure the health parameters of the patient using applications such as Google Fit and Samsung Health where these data are sent to the implemented application for further processing and efficient visualization using charts and diagrams. The main health parameters and vital signs that are measured and monitored are respiratory rate, heart rate and oxygen saturation. A notification is sent to the monitoring team/ rapid response clinician once the patient's vital signs exceed the normal range. The application is designed to show and visualize all the measured vital signs using graphs and charts and it analyzes these parameters where it checks if the measured vital signs is within the predefined normal range or not. The developed application could be integrated with an existing hospital system or could be made available to individuals (patient's) via their smartphone.

References

[1] Mirza Mansoor Baig, Shereen Afifi, “A systematic review of wearable sensors and iot-based monitoring applications for older adults – a focus on ageing population and independent living,” 2019

Non-invasive Diagnosis of Lung Diseases: A simple tool

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The exchange of gases (CO_2 and O_2) take place through human and all living organisms. Healthy lungs breathe about 12-15 times each minute. Shortness of breath may result from respiratory disorders, such as asthma, Obstructive Sleep Apnea (OSA), emphysema, and Chronic Obstructive Pulmonary Disease (COPD). Asthma and COPD are common prevalent widespread respiratory diseases. According to past research, asthma is most often confused with COPD. Although the diagnosis of a chronic obstructive pulmonary disease is based on clinical doubt and spirometry confirmation, a cost-effective tool that could be used by general practitioners to identify diseases without using personal findings or complex and expensive testing procedures is very desirable. This research focuses on developing relationships between various diseases and the frequency spectrum of the lung. The research will investigate the frequency spectrum using lung modelling which will be a good support for a non-invasive testing methodology which is cheap and accessible to medical staff, GPs, and the community. An electrical lung model has been developed and is ready to be tested to help prepare clinical trials for such a technology. Even though the pulmonary-chest wall composition is complex, the number of elements used in these models is relatively less than they required. The model is promising and helps in preparing the clinical trials for the proposed technology.

Developing an affordable, reliable, fast (timesaving) and portable diagnostic technique to determine the frequency spectrum of the lung, and determine the correlation between diseases with similar presentation, in particular asthma and COPD will be useful. A pilot study will be done on selective patients to validate the above findings.

Keywords: Respiratory System, Asthma, Obstructive lung diseases, Frequency Spectrum, Compliance, Resistance

References:

1. Global Initiative for Chronic Obstructive Lung Disease (GOLD) Global strategy for the diagnosis, management, and prevention of COPD. Available from: http://www.goldcopd.org/uploads/users/files/GOLD_Report_2011_Feb21.pdf. 2011.

2. Nikolaos Siafakasa, Nikoleta Bizymi, Alexander Mathioudakis, Alexandru Corlateanu. EARLY versus MILD Chronic Obstructive Pulmonary Disease (COPD). Respiratory Medicine (2018).

3. Emily P. Brigham MD, Natalie E. West MD. Diagnosis of asthma: diagnostic testing. 03 September 2015.

Enabling personalised self-care at home with Digital Front Door – Co-design approach with Clinicians and End-users

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This project aims to understand the dynamics of patient engagement and interactions with existing and new technologies and tools to support self-care of health conditions at home. We aim to develop and evaluate an integrated solution to enable access to comprehensive, patient-centred, self-management applications to support patients from Te Hiku Hauora in the Far North of Aotearoa New Zealand to manage their own health and well-being. The solution will be designed to help end-users access a wide range of services/applications (apps); education, information, interactions (video/audio and chat), workflow, and utilisation of personal device data to better inform their decision-making (and support services) on a day-to-day basis.

The current phase of the project focuses on the co-designing of the solution with the clinicians and patients and involves consideration of:

- Usability: The feedback should focus on the usability of the solution. This includes how easy it is to use, how well it meets user needs, and how intuitive the overall design is.
- Functionality: The feedback should address whether the solution is working as intended and whether it provides users with the expected features and functionality.
- Satisfaction: The feedback should assess the overall satisfaction of the end-users with the solution. This includes how enjoyable it is to use, how well it solves their problems, and how likely they are to continue using it.
- Accessibility: The feedback should address whether the solution is accessible to all users, including those with disabilities or impairments.
- Performance: The feedback should address the performance of the solution, including speed, responsiveness, and reliability.
- Context: The feedback should consider the context in which the solution is being used, including the user's environment, device, and goals.
- Communication: The feedback should address the clarity of communication between the solution and the user.
- Actionability: The feedback should provide actionable insights and suggestions for improving the user experience. This includes specific recommendations for changes that can be made to the solution.
- Diversity: The feedback should come from a diverse group of end-users, including people of different ages, genders, cultures, and backgrounds, to ensure that the solution is inclusive and meets the needs of all users

Enabling personalised self-care at home with Digital Front Door

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Consumers have many digital tools available today to support aspects of their healthcare, but there is no easy way to evaluate, select and engage with the ones that would be most beneficial to them.

This project aims to understand the dynamics of patient engagement and interactions with existing and new technologies and tools to support self-care at home. We aim to develop and evaluate an integrated solution to enable access to comprehensive, patient-centred, self-management applications to manage their own health and well-being needs for individuals from Te Hiku Hauora in the far north region of Aotearoa New Zealand. The solution will be designed to support an end-user to access a wide range of services/applications (apps); education, information, interactions (video/audio and chat), workflow, and utilisation of personal device data to better inform the decision-making around their health on a day-to-day basis.

Putting patients at the centre of their own health by using self-care and self-management approaches have the potential towards improving their health outcomes. Self-care empowers individuals to take their health and well-being into their own hands, giving them the encouragement to improve their quality of life. It plays a key role in the prevention of certain long-term conditions and improves recovery times where trying 'total prevention' has failed. It's a critical part of well-being at all stages of life.

Currently, one of the biggest challenges to the success and adoption of patient engagement (self-care and self-management) solutions is a lack of a holistic approach that focuses on the individual's needs. Most patient engagement solutions are either designed for a particular condition, health requirement, or specific cohort or have generally only targeted one (often narrow) facet of health. Consequently, they only provide utility to a limited number of people and often support part of their healthcare needs. We intend to enable access to a breadth of tools and evaluate the impact within a cohort identified as being at risk of developing a long-term condition.

Dynamic Consent Framework for Consumers

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Dynamic consent is an approach to informed consent that allows communication and engagement (digitally) in ways that have not been possible before, with individuals at the centre, and being able to grant, revoke and review consent decisions and preferences in real-time. By using a digital platform, information can be presented in new ways to reach broader and more diverse audiences, but also enabling individuals with right information and education to obtain informed consent.

This project aims to design a patient-centred and personalised consent solution that empowers individuals to control, guard and manage their own information, thus placing individuals at the core of decision-making. We propose to develop an electronic dynamic consent framework to facilitate two-way communication to enable more engaged and informed individuals with greater autonomy to tailor and change their consent preferences over time.

We would like to digitise and enhance the key principles of informed consent for every individual as set by the Medical Council of New Zealand; trust, compliance, information, education, effective communication and involving others in decision-making. Recent research found that patients in Aotearoa New Zealand are largely happy and trusted their healthcare provider to use of their health data but that they wanted better communication about the storage and use of their health information.

The implementation of a dynamic framework for consent means that consent directives can be defined and tailored to primary use cases (e.g. use of the person's healthcare records for their own care and treatment) as well as secondary use cases (e.g. population health initiatives and advancing medical research) requirements. The framework can be designed to address the many issues that are raised using digital technologies in delivering health and medical care to capture, integrate and link diverse data sets for use in artificial intelligence and big data analyses.

This project will involve the design and build a dynamic consent framework, registry and digital interface that will support informed, ongoing consent capture. The aim for this project is to preserve a patient's (or their representative's) rights while opening the opportunity to increase the availability of data to enable the delivery of effective care and support clinical and service improvements.

The opportunities and challenges related to the use of Large Language Models (LLM) such as GhatGPT in Digital Pathology

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The integration of large language models (LLMs) like ChatGPT in diagnostic medicine, with a focus on digital pathology, has garnered significant attention. However, understanding the challenges and barriers associated with the use of LLMs in this context is crucial for their successful implementation. A scoping review was conducted to explore the challenges and barriers of using LLMs, particularly ChatGPT, in diagnostic medicine with a focus on digital pathology. A comprehensive search was conducted using electronic databases, including PubMed and Google Scholar, for relevant articles published within the past four years. The selected articles were critically analyzed to identify and summarize the challenges and barriers reported in the literature. The scoping review identified several challenges and barriers associated with the use of LLMs in diagnostic medicine. These included limitations in contextual understanding and interpretability, biases in training data, ethical considerations, impact on healthcare professionals, and regulatory concerns. Contextual understanding and interpretability challenges arise due to the lack of true understanding of medical concepts and the black-box nature of LLMs. Biases in training data pose a risk of perpetuating disparities and inaccuracies in diagnoses. Ethical considerations include patient privacy, data security, and responsible AI use. The integration of LLMs may impact healthcare professionals' autonomy and decision-making abilities. Regulatory concerns surround the need for guidelines and frameworks to ensure safe and ethical implementation. The scoping review highlights the challenges and barriers of using LLMs, specifically ChatGPT, in diagnostic medicine with a focus on digital pathology. Understanding these challenges is essential for addressing the limitations and developing strategies to overcome barriers. Further research, validation, and collaboration between AI developers, healthcare professionals, and regulatory bodies are necessary to ensure the responsible and effective integration of LLMs in diagnostic medicine.