

Smart Health and Sustainability: Innovations in Biomedical Engineering

Editors:

Farhanahani Mahmud

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Abstract: Smart Health and Sustainability explore how innovations in electronics, biomedical engineering, and IoT are addressing today's healthcare and environmental challenges. Showcasing real-world projects from the Faculty of Electrical and Electronic Engineering, UTHM, this book highlights smart systems for health monitoring, environmental safety, and personal well-being. Aimed at inspiring students and researchers, it underscores how interdisciplinary engineering can drive intelligent, sustainable solutions for a better future.

Keywords: Smart Health, Sustainability, Internet of Things (IoT)

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FARHANAHANI MAHMUD
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PREFACE

Technologies in electronics, biomedical engineering, and the Internet of Things (IoT) are transforming how we address some of the most pressing challenges in healthcare and sustainability. Today's engineers are not limited to the design of circuits and physical systems, they are at the forefront of developing intelligent, connected technologies that prioritize human well-being, safety, and comfort. As the role of technology in daily life continues to expand, the impact of engineering solutions on society becomes increasingly profound.

Smart Health and Sustainability: Innovations in Biomedical Engineering brings together a diverse collection of research and design projects from the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia (UTHM). These projects exemplify how foundational knowledge in electronics and computer systems can be translated into practical applications that directly benefit individuals and communities.

This volume highlights an array of forward-thinking innovations. Among them are IoT-based sensor systems developed for real-time monitoring of ethylene oxide residue in sterilization processes, offering a safer and more effective way to maintain hygiene standards in medical environments. Another project explores the biosynthesis of silica nanoparticles from wheat husk, demonstrating a sustainable approach to removing arsenic from biomedical systems using agricultural waste. These examples reveal not only technical ingenuity but also a commitment to sustainability and environmental responsibility.

The book also features smart health monitoring solutions, such as IoT-integrated blood glucose and blood pressure measurement devices that make health tracking more accessible and efficient for users. Additionally, a pregnancy fall detection, and alert system aims to enhance maternal safety through early intervention, while an inflatable posture care cushion, designed

using precise anthropometric data, offers comfort and health benefits for users who spend extended periods seated.

Together, these chapters demonstrate how diverse disciplines, including electronics, embedded systems, data science, and biomedical engineering, can converge to produce impactful, real-world innovations. They highlight the importance of interdisciplinary collaboration, creative thinking, and user-centered design in building solutions that respond to complex health and environmental needs.

This book is intended to serve as both a resource and an inspiration. For students, researchers, and practitioners, it provides insight into the practical applications of engineering education and research. It encourages the next generation of engineers to think beyond traditional boundaries, explore emerging technologies, and recognize their potential to contribute meaningfully to society.

Ultimately, this collection aims to spark curiosity, foster innovation, and empower readers to take an active role in shaping the future of healthcare and sustainability through intelligent, connected, and human-centered technology.

Farhanahani Mahmud
Rohaida Mat Akir
Zarina Tukiran

CHAPTER 1

REAL-TIME DETECTION OF ETHYLENE OXIDE RESIDUE IN STERILIZATION PROCESSES USING IOT-BASED SENSORS

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1.1 INTRODUCTION

Medical devices have advanced significantly in recent decades. Medical devices help diagnose, monitor, and treat many diseases. The constant hunt for cutting-edge technology to better medical diagnosis, treatment, and patient care drives this sector. Robotic-assisted surgery and other diagnostic imaging modalities like X-ray, CT, MRI, and ultrasound have improved surgical equipment for more accurate and minimally invasive treatments. Pacemakers and prosthetic joints have transformed the treatment of musculoskeletal and chronic diseases. Remote diagnosis and customised therapy have also advanced thanks to wearable

CHAPTER 2

BIOSYNTHESIS OF SILICA NANOPARTICLES (SI-NPS) FROM WHEAT HUSK FOR ARSENIC HEAVY METAL REMOVAL FOR BIOMEDICAL APPLICATIONS

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2.1 INTRODUCTION

Arsenic contamination of soil and water is a critical global public health concern that has been linked to a variety of adverse health effects, including skin lesions, cardiovascular disease, diabetes, and neurological disorders [1]. The World Health Organization (WHO) has set the utmost allowable arsenic concentration in drinking water at 10 g/L [2]. However, many regions across the globe exceed this threshold, necessitating the development of efficient remediation strategies. In recent years, nanotechnology-based methods have emerged as promising alternatives for

CHAPTER 3

DEVELOPMENT OF BLOOD GLUCOSE MEASUREMENT WITH IOT APPLICATION

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3.1 INTRODUCTION

Diabetes is an unending health condition at which related to with anomalous large amounts of sugar (glucose) in the blood. Diabetes is majorly occurring when there is absence or insufficient insulin production by the pancreas; hence in other conditions, it is due to the inability of the body to properly utilize the function of the insulin [1]. Diabetes can be categorized into two types, Type 1 and Type 2. Type 1 diabetes usually starts in childhood or young adulthood, whereas type 2 diabetes usually starts in adulthood. In people with type 1 diabetes, the body's immune system attacks and destroys pancreatic cells (Beta cells) that produce insulin. In people with type 2 diabetes, the pancreas is not attacked and

CHAPTER 4

DESIGN AND DEVELOPMENT OF PREGNANCY FALL DETECTION AND ALERT SYSTEM

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4.1 INTRODUCTION

Falls are a serious global public health hazard, accounting for the second highest cause of unintentional injury fatalities globally. Falls kill roughly 684,000 people per year, with more than 80% of those deaths happening in low- and middle-income nations. Adults aged 60 [1][2] and over are more susceptible, emphasizing the necessity for comprehensive preventative actions. Non-fatal falls also have serious repercussions, causing approximately 37.3 million severe injuries each year and contributing to widespread disability and financial hardships [3].

This study addresses the risk factors associated with falls, including age, gender, occupation, socioeconomic status, and health conditions, and emphasizes the importance of preventive interventions. The propose a fall detection system designed for

CHAPTER 5

INFLATABLE POSTURE CARE CUSHION USING ANTHROPOMETRIC MEASUREMENT

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5.1 INTRODUCTION

Students spend most of their time sitting in their classroom during lecture, workshop or seminar, as it is provided by the institution using the normal class chair [1]. Sitting in most common positions puts greater pressure on the lumbar discs compared to standing [2]. Malaysia students have different body sizes and shapes, including variations between genders. This diversity makes it difficult to find suitable ergonomic chairs in classrooms. Furthermore, the lack of comprehensive anthropometric data and the prevalence of ready-made chairs contribute to the absence of ergonomic seating options. Here, a lumbar depth of between 0.6" (1.524 cm) to 2" (5.08 cm) work well for most people, which means that the lumbar support should be adjusted according to your body shape, size, and comfort [3]. As this work is to develop an ergonomic chair that is able to fit different body sizes, the risk

CHAPTER 6

THE DEVELOPMENT OF BLOOD PRESSURE DEVICE USING PULSE TRANSIT TIME (PTT)

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6.1 INTRODUCTION

Cardiovascular disease-related deaths, accounting for over 17 million deaths globally, are primarily caused by hypertension, a significant risk factor [1]. High blood pressure is a silent condition, with 61% of Malaysians with hypertension undiagnosed [2]. Hypertension is a sustained elevation of blood pressure, with systolic and diastolic pressures of 140 mmHg or greater. Uncontrolled or improperly controlled hypertension increases cardiovascular, cerebrovascular, and renal morbidity and mortality. In Malaysia, heart attacks and strokes are the leading causes of mortality.

Blood pressure (BP) is a vital indicator of cardiovascular health and can be influenced by physical exertion, depression, medications, and emotions. Three variables reflect blood

Smart Health and Sustainability explores how innovations in electronics, biomedical engineering, and IoT are addressing today's healthcare and environmental challenges. Showcasing real-world projects from the Faculty of Electrical and Electronic Engineering, UTHM, this book highlights smart systems for health monitoring, environmental safety, and personal well-being. Aimed at inspiring students and researchers, it underscores how interdisciplinary engineering can drive intelligent, sustainable solutions for a better future.

THE HIGHLIGHTS INCLUDE:

- *Real-Time Detection of Ethylene Oxide Residue in Sterilization Processes using IoT-based Sensors.* Introduces an IoT-enabled sensor system designed to detect ethylene oxide residues in real time, enhancing safety and compliance in medical sterilization processes.
- *Biosynthesis of Silica Nanoparticles (Si-NPs) from Wheat Husk for Arsenic Heavy Metal Removal for Biomedical Applications.* Explores an eco-friendly method to synthesize silica nanoparticles from agricultural waste for the effective removal of arsenic in biomedical and water purification applications.
- *Development of Blood Glucose Measurement with IoT Application.* Presents a smart blood glucose monitoring device integrated with IoT capabilities, allowing users and healthcare providers to track glucose levels remotely and efficiently.
- *Design and Development of Pregnancy Fall Detection and Alert System.* Details the creation of a wearable system that detects falls in pregnant users and sends immediate alerts, aiming to improve maternal safety through real-time monitoring.
- *Inflatable Posture Care Cushion Using Anthropometric Measurement.* Describes an intelligent cushion that adjusts inflation based on user-specific body measurements to support proper posture and reduce discomfort during extended sitting.
- *Development of Blood Pressure Device using Pulse Transit Time (PTT).* Introduces a non-invasive blood pressure monitoring system that estimates pressure levels using Pulse Transit Time, offering a more comfortable and continuous alternative to traditional cuffs.

