



**Faculty of Electrical and Electronic Engineering Technology**



**DEVELOPMENT OF AN IOT-BASED SMART SHOE VIA  
BLUETOOTH WITH GPS TRACKING SYSTEM**

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**MUHAMMAD AFIQ BIN AHMAD FAUZI**

**Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics)  
with Honours**

**2022**

**DEVELOPMENT OF AN IOT-BASED SMART SHOE VIA BLUETOOTH WITH  
GPS TRACKING SYSTEM**

**MUHAMMAD AFIQ BIN AHMAD FAUZI**

**A project report submitted  
in partial fulfillment of the requirements for the degree of  
Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics)  
with Honours**



**Faculty of Electrical and Electronic Engineering Technology**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2022**

BORANG PENGESAHAN STATUS LAPORAN  
PROJEK SARJANA MUDA II

Tajuk Projek : Development of an IoT-based Smart Shoe via Bluetooth with GPS Tracking System

Sesi Pengajian : 2022/2023

Saya Muhammad Afiq Bin Ahmad Fauzi mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

**SULIT\***

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

**TIDAK TERHAD**

Disahkan oleh:



(TANDATANGAN PENULIS)

Alamat Tetap: No 39 Lot 8529

Jln Nakhoda Kanan  
Kg Nakhoda 68100  
Batu Caves Selangor

(COP DAN TANDATANGAN PENYELIA)

**Ts. MASLAN BIN ZAINON**  
Pensyarah Kanan (Senior Lecturer)  
Fakulti Teknologi Kejuruteraan Elektrik & Elektronik  
Universiti Teknikal Malaysia Melaka

Tarikh: 19/1/2023

Tarikh: 20/01/2023

## DECLARATION

I declare that this project report entitled “Development of an IoT-based Smart Shoe via Bluetooth with GPS Tracking System” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature

:



Student Name

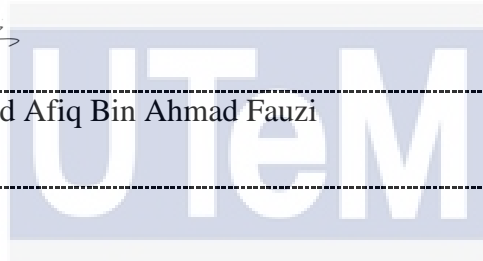
:

Muhammad Afiq Bin Ahmad Fauzi

Date

:

19/1/2023



اوپيور سیتی تیکنیکل ملیسیا ملاک

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

Signature

Supervisor Name

Date

Signature

Co-Supervisor

Name (if any)

Date

  
Ts. MASLAN BIN ZAINON  
Pensyarah Kanan (Senior Lecturer)  
Fakulti Teknologi Kejuruteraan Elektrik & Elektronik  
Universiti Teknikal Malaysia Melaka  
20/01/2023

اونيورسيتي تيكنيكل مليسيا ملاك  
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

.....  
.....  
.....  
.....

## DEDICATION

*To my beloved mother, Zabariah Binti Awi, and father, Ahmad Fauzi Bin Muhammad*

*Noor,*

*and*

*To my supervisor, Ts. Maslan Bin Zainon and*

*all my friends,*

*Thank you for their encouragement and unconditionally support.*



## ABSTRACT

This project is about an IoT-based product. Our current market is still lacking affordable product of smart shoes for health monitoring and location finder. Shoe's functions can be improved by using technologies that enable a comprehensive view of an individual's movement and mobility, potentially supporting healthy living as well as complementing medical diagnostics and the monitoring of therapeutic outcomes. Besides that, it can measure athletic performance by tracking fitness and evaluating health metrics. In other words, it can provide personalized health feedback to users. This smart shoe consists of steps counting, posture controlling, and GPS tracking system. It will be controlled by a microcontroller and its insoles feature acts as a Bluetooth-connected accessory that can link activity or position to a smartphone app. A variety of sensors will be used to acquire data such as pressure sensors, ambient environmental sensors, satellite navigation systems, and inertial-magnetic measurement units. The smart shoe is projected to be very useful in maintaining comfort, convenience, and good health as well as security to users.



## ***ABSTRAK***

Projek ini adalah mengenai produk berasaskan IoT. Pasaran semasa kini masih kekurangan produk kasut pintar mampu milik untuk pemantauan kesihatan dan pencari lokasi. Fungsi kasut boleh dipertingkatkan dengan menggunakan teknologi yang membolehkan informasi menyeluruh mengenai pergerakan dan kondisi individu, yang berpotensi menyokong kehidupan sihat serta melengkapkan diagnostik perubatan dan pemantauan hasil terapeutik. Selain itu, ia boleh mengukur prestasi pengguna dengan menjejaki kecergasan dan menilai metrik kesihatan. Dalam erti kata lain, ia boleh memberikan maklum balas kesihatan yang diterima kepada pengguna. Kasut pintar ini mampu mengira langkah, mengawal postur dan pencari lokasi (sistem pengesanan GPS). Ia akan dikawal oleh mikropengawal dan ciri insolena bertindak sebagai aksesori bersambung kepada Bluetooth yang boleh memautkan aktiviti atau kedudukan ke aplikasi telefon pintar. Pelbagai sensor akan digunakan untuk memperoleh data seperti sensor tekanan, sensor persekitaran ambien, sistem navigasi satelit dan unit pengukuran magnet inersia. Kasut pintar ini diunjurkan sangat berguna dalam mengekalkan keselesaan, kemudahan dan kesihatan yang baik serta keselamatan kepada pengguna.

اونيورسي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA



## ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Ts. Maslan Bin Zainon for his precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) for the financial support which enables me to accomplish the project. Not forgetting to all my fellow colleague, for the willingness of sharing their thoughts and ideas regarding the project.

My highest appreciation goes to my parents, and family members for their love and prayer during the period of my study.

Finally, I would like to thank all the fellow colleagues and classmates, the Faculty members, as well as other individuals who are not listed here for being co-operative and helpful.



## TABLE OF CONTENTS

	<b>PAGE</b>
<b>APPROVAL</b>	
<b>ABSTRACT</b>	<b>i</b>
<b>ABSTRAK</b>	<b>ii</b>
<b>ACKNOWLEDGEMENTS</b>	<b>iii</b>
<b>TABLE OF CONTENTS</b>	<b>i</b>
<b>LIST OF TABLES</b>	<b>iii</b>
<b>LIST OF FIGURES</b>	<b>iv</b>
<b>LIST OF SYMBOLS</b>	<b>vii</b>
<b>LIST OF ABBREVIATIONS</b>	<b>viii</b>
<b>LIST OF APPENDICES</b>	<b>ixx</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Background	1
1.2 Problem Statement	1
1.3 Project Objective	2
1.4 Scope of Project	2
<b>CHAPTER 2 LITERATURE REVIEW</b>	<b>3</b>
2.1 Introduction	3
2.2 Smart Shoes	3
2.2.1 Example of Smart Shoes for health	5
2.2.2 Example of Smart Shoes for sports	6
2.3 Internet of Things (IoT)	7
2.4 Internet of Health Things (IoHT)	8
2.5 Gait analysis	10
2.6 IoT-based Smart Shoe	11
2.7 Bluetooth Module	12
2.8 Mobile app	14
2.9 Internet of Things Based Smart Shoe Using ESP32   IoT project	14
2.10 Comparison between each development	18
2.11 Summary	27
<b>CHAPTER 3 METHODOLOGY</b>	<b>28</b>
3.1 Introduction	28
3.2 Methodology	28
3.3 First Milestone	34
3.4 Second Milestone	36

3.4.1	Design and Construction of IoT smart shoes system	36
3.4.2	Design of base for smart shoes system	37
3.5	Third Milestone	37
3.5.1	ESP32	38
3.5.2	GY-NEO6MV2 GPS Track Location	38
3.5.3	Force Sensor	39
3.5.4	MPU 6050	40
3.5.5	6V 5W Solar Panel Battery Charger	41
3.6	Parameters	41
3.7	Limitation of proposed methodology	43
3.8	Summary	44
<b>CHAPTER 4 RESULTS AND DISCUSSION</b>		<b>45</b>
4.1	Introduction	45
4.2	Streaming firmware configuration from Blynk to Arduino IDE	45
4.3	Streaming hardware project with Blynk application	46
4.4	Analysis of the function of the project	50
4.4.1	Smart shoe power system	50
4.4.2	Data collected	51
4.5	Summary	56
<b>CHAPTER 5 CONCLUSION AND RECOMMENDATIONS</b>		<b>57</b>
5.1	Conclusion	57
5.2	Future Works	58
5.3	Project Potential	58
<b>REFERENCES</b>		<b>60</b>
<b>APPENDICES</b>		<b>63</b>

## LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1	Bluetooth LE is a step forward from traditional Bluetooth.	12
Table 2.2	LE Bluetooth and Wi-Fi Direct are compared	13
Table 2.3	shows comparison is based on IoT smart shoes development that have been done by previous researcher. Each developer uses different parameter of sensor, application of smart shoe and types of users.	18
Table 3.1	A comparison study of Bluetooth, ZigBee, and Wi-Fi protocol	42
Table 4.1	Test one	52
Table 4.2	Test two	54



## LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1	FeetMe app	5
Figure 2.2	3L Labs	5
Figure 2.3	Boltt Sports Technologies	6
Figure 2.4	RunScribe Plus	6
Figure 2.5	Medical and technological needs for ambulatory gait monitoring via the the Internet of Health Things (IoHT)	8
Figure 2.6	Smart shoe applications in the IoHT include recording gait signals from people with impaired gait (during the day), data storage, and battery charging (nighttime use)	9
Figure 2.7	Block diagram	15
Figure 2.8	Hardware image	15
Figure 2.9	Software image	16
Figure 2.10	Results image	17
Figure 3.1	Flowchart of methodology	29
Figure 3.2	Systems Flowchart	31
Figure 3.3	Breadboard Implementation	32
Figure 3.4	Patched Circuit Diagram	32
Figure 3.5	Charging Box	33
Figure 3.6	Mobile Application Interface with a Specified Devices	33
Figure 3.7	Algorithm on Smartphone for Bluetooth communication	34
Figure 3.8	Flowchart of literature review	35
Figure 3.9	Circuit diagram	37

Figure 3.10	ESP32 model	38
Figure 3.11	GY-NEO6MV2 GPS Track Location model	39
Figure 3.12	Force sensitive resistor	40
Figure 3.13	MPU 6050 model	40
Figure 3.14	6V 5W Solar Panel Battery Charger	41
Figure 3.15	When data is obtained via Wi-Fi communication, the blue curve depicts battery levels; when data is collected via Bluetooth communication, the red curve depicts battery levels	43
Figure 4.1	Firmware code in Blynk.Console	45
Figure 4.2	Hardware component	46
Figure 4.3	Uploading coding program	47
Figure 4.4	Phone display	47
Figure 4.5	Data collected using different devices	49
Figure 4.6	Battery indicator	50
Figure 4.7	Different charging port	51
Figure 4.8	Simulated smart shoe	51
Figure 4.9	Test one speed graph	53
Figure 4.10	Test one GPS data	53
Figure 4.11	Test two speed graph	55
Figure 4.12	Test two GPS data	55

## LIST OF SYMBOLS

$\mu$	-	Micro
%	-	Percentage
G	-	Giga
m	-	Mili
M	-	Mega
n	-	Nano

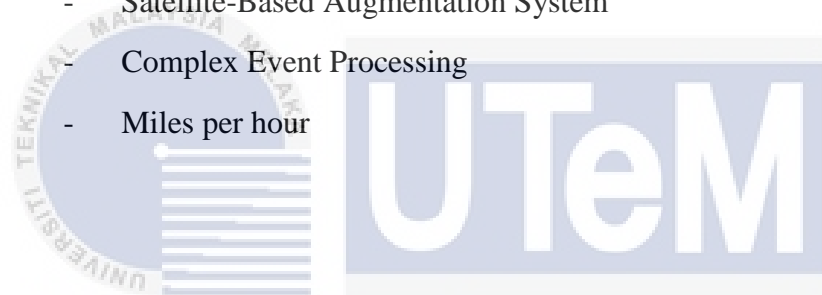


## LIST OF ABBREVIATIONS

V	-	Voltage
IoT	-	Internet of Things
GPS	-	Global Positioning Systems
LE	-	Low Energy
MANET	-	Mobile Ad Hoc Network
App	-	Application
3D	-	Three Dimensional
IoHT	-	Internet of Health Things
IMMU	-	Independent Media Monitoring Unit
Hz	-	Hertz
ISM	-	Industrial, Scientific and Medical
RF	-	Radio Frequency
ZigBee	-	Zonal Intercommunication Global-standard
Wi-Fi	-	Wireless Fidelity
m	-	Meter
IEEE	-	Institute of Electrical and Electronics Engineers
A	-	Ampere
bps	-	Bit per seconds
s	-	Second
AES	-	Advanced Encryption Standard
USART	-	Universal Synchronous/Asynchronous Receiver/Transmitter
kg	-	Kilogram
ECG	-	Electrocardiogram
PAN	-	Personal Area Network
BAN	-	Body Area Network
LED	-	Light Emitting Diode
RFID	-	Radio Frequency Identification



PCB	-	Printed Circuit Board
TSMC	-	Taiwan Semiconductor Manufacturing Company
DC	-	Direct current
USB	-	Universal Serial Bus
GSM	-	Global System for Mobiles
GPRS	-	General Packet Radio Service
SMS	-	Short Message Service
h	-	Hour
GLONASS	-	Global Navigation Satellite System
QZSS	-	Quasi-Zenith Satellite System
SBAS	-	Satellite-Based Augmentation System
CEP	-	Complex Event Processing
mph	-	Miles per hour



اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A	Codding of the project	63
Appendix B	Gantt Chart of the project	68



# CHAPTER 1

## INTRODUCTION

### 1.1 Background

For an athlete, or those who like to do sport, sports attire is one of the most important things that they will consider wearing. Due to the rapid increase in the revolution of sports attire which includes smart shoes, the users can measure more accurate athletic performance by tracking fitness and evaluating health metrics while maintaining comfort, convenience, and safety.

### 1.2 Problem Statement

The accuracy for step counting and GPS tracking system for a device such as a smartwatch is still unprecise and sometimes can suddenly lose connection. This is because the device may use classic Bluetooth MANETs, a terminal can cause an excess of connection retries and connection conflicts [7]. This poses great challenges to analyze the improvement of using the smart shoes that will be controlled by a microcontroller and its insoles feature acts as a Bluetooth-connected accessory that will give a big improvement and solution for the problem before.

### 1.3 Project Objective

The main aim of this project is to propose a systematic and effective methodology to create an affordable product for health monitoring and location finder with reasonable accuracy. Specifically, the objectives are as follows:

- a) To design and develop microcontroller-based circuit and hardware for tracking fitness and evaluating health metrics.
- b) To analyze the performance of the steps counting, posture controlling and GPS tracking system effectiveness upon receiving commands.
- c) To apply an IoT technology on the steps counting, posture controlling and GPS tracking system via a smartphone for monitoring purposes.

### 1.4 Scope of Project

To avoid any uncertainty of this project due to some limitations and constraints, the scope of the project are defined as follows:

- a) GPS tracking system with balanced load condition.
- b) Smartphone app that were developed cover the majority types of smartphone found in the Malaysian users, covering a typical urban, sub-urban and rural areas with different load distribution along smartphones.
- c) The connection are considered for Bluetooth-connected of smart shoes and smartphones.
- d) Investigation of load profiles of athlete, citizen and patients with foot problems segments to determine pattern steps and pressure steps were considered in the analytical models.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

In today's modern society, many gadget that has been used to help us in doing daily activities. Technology developments especially new smart wearable technologies has being popular and get high demand among the society. Continuous, automatic monitoring of sensor-based data on walking capacity and mobility is increasingly being used to support objective assessment for preventative and proactive disease management, diagnostic workup, and treatment decision-making [1]. Nowadays, the application of gait analysis using shoe insole pressure sensors is increasing, and is available in laboratories or markets with respect to its application [14]. Therefore, the smart shoes is one of the gadget that were created to satisfy the objectives. This project will emerging Internet of Things (IoT) to enable the real-time monitoring supported by microcontroller.

#### 2.2 Smart shoes

Smart shoes are designed to provide remote gait evaluation, which necessitates a data gathering system that will collect sensor data relevant to crucial gait events while assuring long-term compliance [1]. Smart shoes are coming to deliver individualized feedback to users, from gauging athletic performance to tracking fitness and reviewing health data [2]. For three reasons, smart shoes are an appealing sort of intelligent technology for a mobility evaluation: (i) smart shoes include a fixed sensor position on the foot that allows for accurate and adaptable biomechanical examination; (ii) gait, a highly

stereotyped movement that enables the automated assessment of functional biomechanics, can be monitored using smart shoes; and (iii) smart shoes make it possible to integrate technology in a non-obtrusive and non-stigmatizing way, resulting in increased patient acceptance and long-term adherence [1].

The existing drawbacks of this technology, such as limited patient usage, limited battery runtime, and especially limited availability of instrumentation to only one shoe type, will be overcome in the future if mass-market availability is secured [1]. To produce smart shoes, shoe businesses need a lot of money and technical know-how. It necessitates knowledge, inventive engineering, and a large amount of money. There are also certain societal difficulties to overcome. Many customers do not consider smart shoes to be a part of their daily lives [2]. Particularly, wireless transmission of recorded data prevents patients from tampering with the gadget and also serves as a data gateway for pushing the data to the cloud [1].

Energy-aware software implementation methods should be used in the case of wearable systems, and hardware selections should be made with low energy consumption in mind. Second, the context of the application should be considered. If the smart shoe detects that no data is being generated, the system may switch to a low-energy (e.g., sleep) mode. Regardless, especially in medical monitoring circumstances, constant and reliable system operation must be maintained. Energy harvesting is a viable approach for efficient energy management in smart shoes. Energy harvesting from electromagnetic fields, other ambient energy sources, and human movement, for example, have gotten a lot of interest in the scientific community and will be applied in end-user systems soon [1].

### 2.2.1 Example of Smart Shoes for health



Figure 2.1 FeetMe app

FeetMe has already produced FeetMe Diagnosis, a connected insole that focused on post-surgical evaluation and patient analysis. The FeetMe insoles are covered in 25 pressure sensors, far more than the two to three sensors found in a typical pair of smart shoes. This implies that sensors cover the whole insole and foot, providing for a more detailed examination of the user's performance [3].

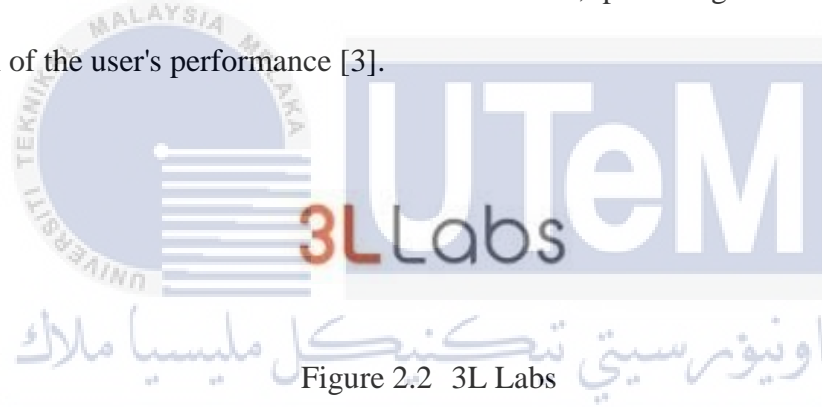


Figure 2.2 3L Labs

FootLogger, a pair of smart shoes developed by 3L Labs, uses biometric data collected from its users to offer recommendations on how to improve gait, diagnose probable ailments, and increase athletic performance. It features eight sensors and one accelerometer to help track the wearer's activity levels. The FootLogger, which can save up to 50,000 footprints, provides the information to the user by text message or via a smartphone app. Smart shoes can also aid in patient rehabilitation, particularly for issues involving the spine or neurological system, and can be used to detect early signs of arthritis and dementia [3].

### 2.2.2 Example of Smart Shoes for sports



Figure 2.3 BoltT Sports Technologies

BoltT Sports Technologies creates a smart shoe with features like balanced gripping control and impact absorption to improve the user's performance. These shoes may measure performance in a range of field sports, including hockey and soccer. BoltT collaborated with Garmin, a company that makes wearable sensors, to assist them to develop sensors that can record whole-body data [3].

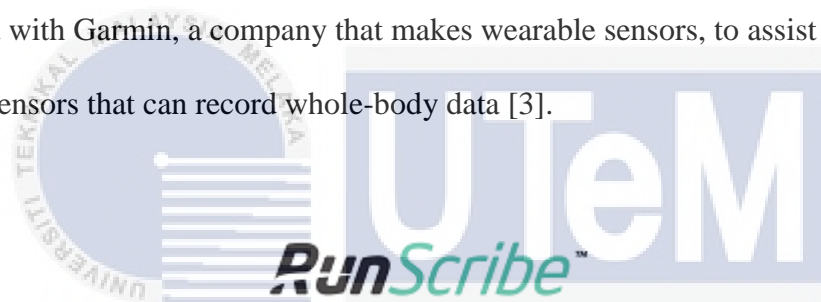


Figure 2.4 RunScribe Plus

RunScribe Plus is a running wearable developed by Scribe Labs that provides a 3D perspective of an athlete's performance, including data on stride rate, contact time, and foot strike type. To fine-tune its motion tracking feature, the smart shoes use nine-axis motion sensors. RunScribe also includes power measures, which allow users to track the amount of energy required to maintain their speed regardless of how the terrain varies [3].