Faculty of Electrical and Electronic Engineering Technology

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

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

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

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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 insolenya 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.

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LIST OF SYMBOLS

μ	-	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

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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].