HUMAN POSTURE MONITORING DEVICE AND SYSTEM

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HUMAN POSTURE MONITORING DEVICE AND SYSTEM

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ABSTRACT

The purpose of this project is to develop a Human Posture Monitoring device for lumbar region that can be mounted on the backbone. The purpose of this study is to design and analyse pain detection system for the rehabilitation device using various sensors. The target of the user of this prototype is a user who work in office or heavy lifting. The device requires a smart phone application that been developed to control the device as automatic control. The sensors used are bend sensor or also known as flex sensor. This sensor is used to give reading to the ESP32 when user do it daily work. Beside that in this project also SD card module that record every reading received from the sensor. To follow the fast growth of the technology, this study also takes part in developing a monitoring system using Internet of Things (IoT). Phone application programs were heavily researched. The device uses MIT app inventor software with the aid of Bluetooth module in the ESP32. The IoT of the project can further enhance by giving further advance reading to the user which also can monitor their health using the apps and improving the GUI of the application to be friendly and interactive.

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LIST OF SYMBOLS

α	Angle
V	Voltage
A	Ampere

LIST OF ABBREVIATIONS

WHO	World Health Organization
IoT	Internet of Things
OSH	Occupational Safety and Health
ILO	International Labour Organization
RPM	Remote patient monitoring devices
CED	Consumer electronics device
WRD	Wearable robotic device
LLA	Lumbar Lordotic Angle
PCB	Printed Circuit Board
USB	Universal Serial Bus
RTD	resistance temperature detectors
BLE	Bluetooth Low Energy
BIOS	Basic Input/Output System
ROM	Read-Only Memory
EPROM	Erasable Programmable Read-Only Memory
BASIC	Beginner's All-purpose Symbolic Instruction Code
MCU	Microcontroller Unit
GUI	Graphical User Interface
IDE	integrated programming environment
NDK	Native Development Kit
MIT	Massachusetts Institute of Technology

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Low back pain is one of the most prevalent causes of disability, according to the World Health Organization (WHO). It has a similar impact on people's quality of life and work performance across cultures, and it is the most common reason for medical appointments.[1]

In both general and specialist medicine, it is a common and painful condition. The prevalence of low back pain in several studies ranged from 10-63 percent, with a median of 37 percent, and did not differ by gender in the majority of them. Recent Malaysian research have discovered similar results: the prevalence of low back pain was found to be around 12% in a semi-rural community survey, but it was significantly higher (60%) in a group at risk (commercial vehicle drivers).[2]

Back discomfort is a problem. It is a problem that affects patients, health-care professionals, and society. Patients are concerned because they cannot get clear answers about what is causing it, how to cure it, or what their prognosis will be. It is a dilemma for doctors and therapists since many patients do not have a defined condition, so there is no way to provide them a meaningful "therapy". As a result, a lot of individuals are worried about how it is run. In today's culture, back pain is one of the most common reasons of job loss, healthcare use, and sickness benefits. The impact of lost production and higher healthcare expenditures to the government might be in the millions of ringgits.[2] This can be monitored by using posture monitoring device.

Backbone monitoring device is a portable device which provide a service to monitor these problems. The device can monitor the posture of user's backbone. The readings of the data can be access via application on mobile phone. There is plenty posture corrector in the market, mostly are made with fabrics. These product does not

monitor on how long does user sit. For our project, we focused on monitoring on lower spinal cord, which is the lumbar part. This part is affected when a person sits for a long time with wrong posture. The device will calculate the pressure act on the lumbar and will sends warning if user sit more than a period.

1.2 Problem Statement

Posture problem is often among office workers and labour nowadays. A proper guideline is needed for workers to monitor their posture. There is lack of monitoring system or reminder that is convenient to use. Mostly posture monitoring system and device are complex and non-convenient. The monitoring system is used to remind workers about the maximum capacity that can work. Besides, most monitoring system and device are just tools and do not evaluate performance like the angle of worker's posture.

1.3 Objectives

Our main objectives for these projects are to fabricate an electronic human posture monitoring device and system to upgrade an existing posturing system to a be able monitoring and giving reminder towards user. This can be achieved through the following objectives:

- To develop a wearable posture corrector device for office or labour workers.
- To create a user's monitoring system based on Internet of Things (IoT).

1.4 Research Scope

The scope of study for this project focuses on developing a monitoring device which focuses on the lumbar area. The device can be worn onto the backbone specifically for the lumbar region. The posture corrector device can only be used to people who works in the office environment, who sits for a long period. It also can be used for labour workers who needs to use physical strength especially for someone who always carries heavy load.

The device also has a monitoring system which will notifies the user about their posture through an application on their phone. The posture corrector will alert the user only when the user's posture is below the recommended angle of posture. The gadget will

have Internet of Thing (IoT) which connect to cloud storage. The device will communicate with the cloud storage for data storages and sends to the designed application for user's references.

CHAPTER 2

LITERATURE REVIEW

2.1 Injury

Injury which also known as physical trauma is any damage to our body caused by external force. Injuries can be caused by accidents, acts of violence, falls, hits, and others. Injuries may occur at home, work, or play. They can be due to impact from blunt objects or from objects that penetrate the body. There are several common types of injury such as abrasions, lacerations, hematomas, broken bones, joint dislocations, sprains, strains, and burns. Injuries can be minor or even life-threatening. Minor injuries can often be managed with basic first aid techniques whereas major injuries may require medical intervention or evaluation in an emergency setting.

2.1.1 Back Pain

The backbone, which is made up of a column of 33 bones and tissue spanning from the skull to the pelvis, is a significant supporting element of the human body that is responsible for various body postures and bone motions. The spinal cord is a cylinder of nerve tissues that is encased and protected by these vertebrae. The spinal cord is separated into four sections: cervical, thoracic, lumbar, sacral, and coccyx. 7 vertebrae make up the cervical spine, 12 vertebrae make up the thoracic spine, 5 vertebrae make up the lumbar spine, 5 vertebrae make up the sacral spine, and 4 vertebrae make up the coccyx spine. [3]

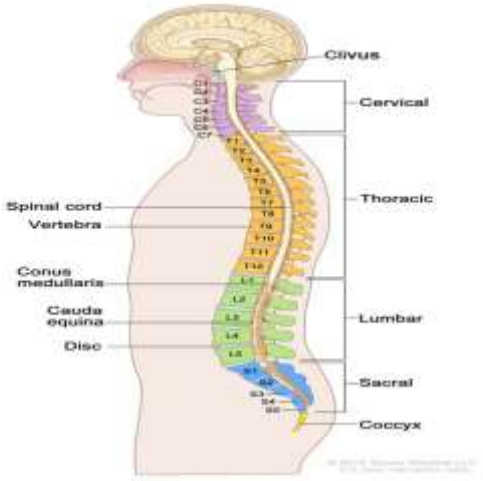

Figure 1: Diagram of Human Spinal Cord

Back pain can range from a muscle aching to a shooting, burning, or stabbing sensation. Moreover, the pain may radiate down our leg or worsen with bending, twisting, lifting, standing, or walking. Back injuries are the most common cause of back pain. Injuries frequently occur when we use our back muscles in activities that do not often do such as lifting a heavy object or doing yard work. Minor injuries may occur from tripping, falling a short distance or excessive twisting of the spine. Severe back injuries may result from car crashes, falls from significant heights, a high-energy fall onto the buttocks, a penetrating injury, and others. The statistic about back pain is investigated below. The purpose of this study is to determine the prevalence of low back pain among Secondary School Teachers at Bentong, Pahang. [4]

Gender	Male (%)	Female (%)	Total (%)
Total subjects included in the study	108/108(100.0)	145/152(95.4)	253/260 (97.3)
Total subjects complaint of pain	50/108 (46.3)	108/145(74.5)	158/253(62.5)

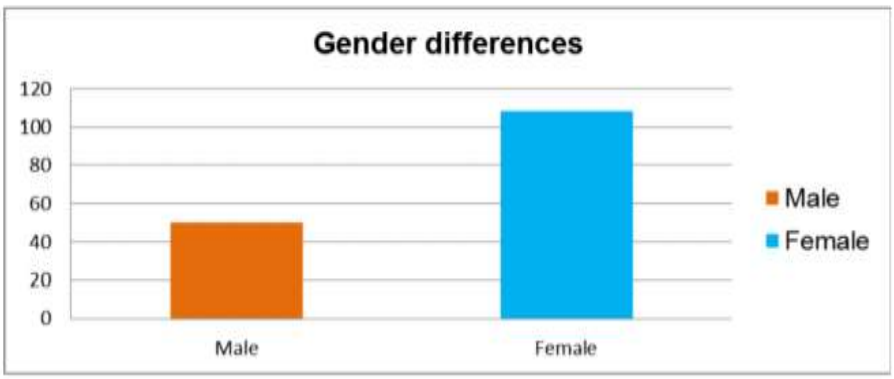

Figure 2: Prevalence of low back pain among gender differences

Age	Male (%)	Female (%)	Total (%)
20-24	2/50 (4.0)	7/108 (6.5)	9/158 (5.7)
25-34	10/50 (20.0)	24/108 (22.2)	34/158 (21.5)
35-44	22/50 (44.0)	36/108 (33.3)	58/158 (36.7)
45-54	13/50 (26.0)	28/108 (25.9)	41/158 (25.9)
55-60	3/50 (6.0)	13/108 (12.0)	16/158 (10.1)

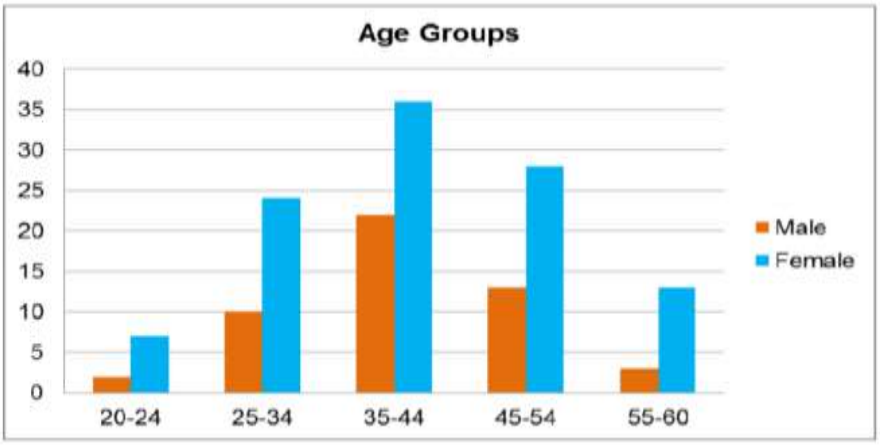

Figure 3: Prevalence of low back pain among age groups

In the study, it is found that prevalence of low back pain is high among secondary school teachers. Female teachers reported a significantly higher prevalence of low back pain when compared to male teachers whereas the middle age group of teachers has reported high prevalence of pain compared to the younger and older age group.

2.1.2 Occupational safety and health (OSH)

Occupational Safety and Health (OSH) is concerned about the health, safety, and welfare of employees in the workplace. Besides, it is also known as Occupational Health and Safety (OHS). The history of OSH is related with Harry McShane with age 16 in 1908. He is pulled into machinery in a factory in Cincinnati that had his arm ripped off at the shoulder and his leg broken but without any compensation. [5] There are many research and regulation of occupational safety and health as these are relatively recent phenomenon. When labour movements arose in response to worker concerns in the wake of the industrial revolution, worker's health become labour-related issue. The purpose of occupational safety and health programs is to foster a safe and healthy working environment for worker. The term occupational health and safety is referred as

occupational health, occupational, nonoccupational safety and also safety for activities outside of work in United States.

World Health Organization (WHO) has defined that occupational health deals with all aspects of health and safety in the workplace and has a strong focus on primary prevention of hazards. Health is defined as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." Occupational health is a multidisciplinary field of healthcare which focused to enable an individual undertake their occupation by causing least harm to their health. On the other hand, by doing the promotion of health and safety at work, it is concerned that preventing harm from any incidental hazards and arising in the workplace.

Since 1950, International Labour Organization (ILO) and World Health Organization (WHO) use same definition of occupational health. It was adopted by the Joint ILO/WHO Committee on Occupational Health at its first session in 1950 and revised at its twelfth session in 1995. [5] The three objectives in occupational health are included the maintenance and promotion of workers' health and working capacity. The second objective is the improvement of working environment and work become conducive to safety, health and development of work organizations. The third objective is working cultures in a direction which supports health and safety at work and in doing so as to promotes a positive social climate and smooth operation and may enhance productivity of the undertakings. The concept of working culture is planned in this condition so as to mean a reflection of the essential value systems which adopted by the undertaking concerned. These cultures are reflected in practice in the managerial systems, personnel policy, principles for participation and others.

The importance of occupational safety is because every business have safety risks. Every industry need to present various kinds of safety hazards to their employees. The safety hazard are physical hazard, biological hazard, chemical hazard, ergonomic hazard and psychological hazard. Physical hazards are environmental factors which can lead to injuries. Biological hazards such as fungi, bacteria and others can lead to diseases, infections and other health conditions. Chemical hazards are about inhaled gases, vapor or come in contact with skin as a liquid and solid. Ergonomic hazards are focused on

muscles, tendons and other connective tissues of the body. Psychological hazards are hazard that can lead to depression, concentration problems, inattention or negligence. [6]

2.2 Health Monitoring

Health monitoring is the monitoring of a worker to identify changes in their health status because of exposure to certain substances. This involves a health monitoring doctor examining and monitoring the health of the workers to see whether those various hazards at work is affecting their health. The purpose of monitoring is to see whether a particular intended result or set of results has actually happened after a clinical process or substance has been applied. Monitoring also provide ongoing oversight to the quality of care given to meet a person's needs. Besides, workers can be monitoring before they develop symptoms which is known as proactive health monitoring. Proactive monitoring is suitable to monitor symptoms after worker have developed such as markers of liver injury or changes in the blood cells of worker. [7] When a worker is exposed to chemicals outside of the workplace either through food or water, this information can be noticed during a worker's health monitoring program. Moreover, this information can help the health monitoring doctor have a better understanding so as to manage your worker's health monitoring program easier. Worker can have more understanding about confounding effects and effects that are difficult to understand in the individual health monitoring guides for hazardous chemicals and other hazards.

2.2.1 Health monitoring system and device

Health monitoring system and device is used to help people devise a plan to enhance our body and monitor our progress so that we can track our gains and improvements. Remote patient monitoring devices (RPM) is using tap digital technology to send communications between patients and providers. [8] Patients can monitor themselves to collect data about their health at various points throughout the day and data then can electronically transmit in messages to their providers. RPM will empower patient population so as to be more engaged and knowledgeable about their own conditions and treatment. There are 88% of healthcare providers have already invested in or currently evaluating remote patient monitoring devices.

Due to the long time poor body postures during the use of consumer electronics device (CED), many people nowadays feel head, neck and back pains. There is a paper designs a wearable robotic system for body postures monitoring, correction, and rehabilitation assist. [9] Wearable robotic device (WRD) is used to monitor the angle of body posture and alert people about their bad posture. CED is used to processing and visualization about the data sent. The human body posture is modelled and simulated so as to show that the different postures of the body segments have large effects about forces acting on the joints and muscles. CED included smartphone, laptop and others which is common in daily life.[10] It is to investigate about the changes of the muscle activation with variation in the posture angles of the neck and trunk when the people used smartphones. Besides, they realize that the neck and trunk flexion increased several minutes after the start of smartphone usage, this will cause muscle pain.

2.3 Lumbar Lordotic Angle

Degenerative alterations and disc herniation have previously been indicated in the literature to begin in the lower lumbar segments with ageing, with increased disc involvement found in an escalating way in older age groups. We did research to see if there was a link between age and the degree of disc herniation, as well as the size of the Lumbar Lordotic Angle (LLA) as measured by Cobb's method [11].

The curve taken by the intact lumbar spine to compensate for the inclination of the sacrum, re-establish an upright spinal alignment, and avoid a forward inclination is known as lumbar lordosis. Its measurement is impacted by a variety of factors, according to different researchers, including age, gender, pelvic bend, and thoracic curvature, among others. The purpose of this study is to determine Effect of Age and Lordotic Angle on the Level of Lumbar Disc Herniation.

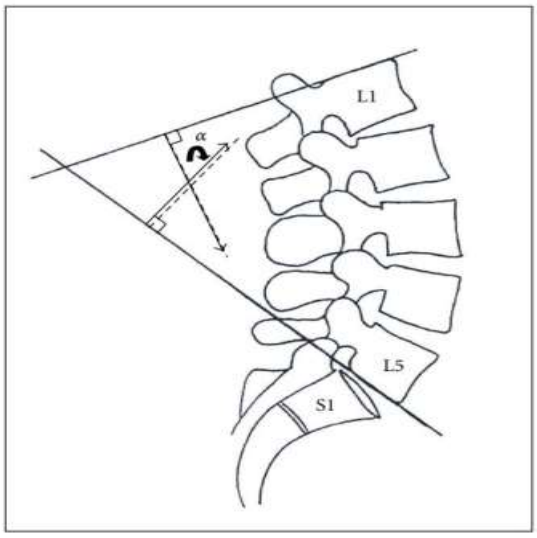

Figure 4: Measurement of lumbar lordotic angle α.

	Total		Group 1		Group 2	
Age	*N*	LLA	*N*	LLA*†	*N*	LLA
30–39	223	32.35°	5	28.6°	218	35.76°
40–49	308	29.8°	11	25.4°	297	30.97°
>70	218	25.26°	115	33.2°	103	24.19°

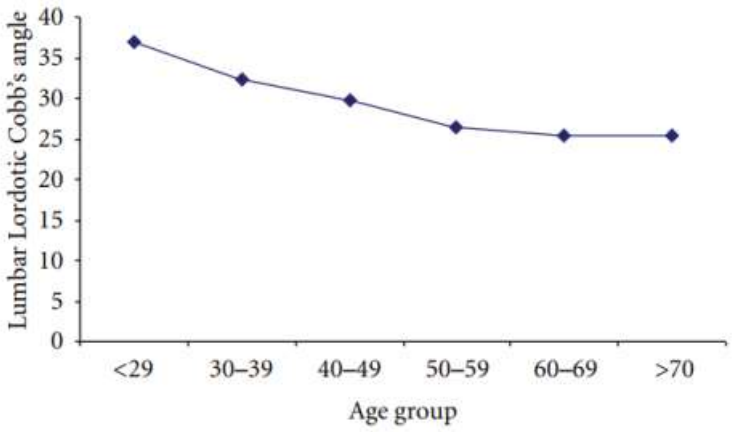

Figure 5: The specific angle of the Lumbar region among group age.

2.4 Comparison Between Arduino Uno and ESP32

Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input / output pins, a USB connection, power jack and a reset button. This

microcontroller can be powered up by using USB connection or by using external power supply. [12] The Arduino board does not consist of any module, but it can be bought separately. The Arduino can be coded via Arduino software.

Figure 6: Arduino Uno R3

Table 1: Specification of Arduino Uno.

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

ESP32 is chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth which contains series of low-cost and low-power system. There are few reasons why ESP32 is choose to be used in this project. One of the reasons is ESP32 is highly-integrated with in-built antenna switches, power management modules and others. ESP32 adds priceless functionality and versatility to many applications with least Printed Circuit Board (PCB) requirements. Besides, ESP32 can be used as a complete standalone system and also as a slave device to a host MCU, it will reduce communication stack overhead

on the main application processor. ESP32 can interface with other systems so as to provide Wi-Fi and Bluetooth functionality which pass through its SPI / SDIO or I2C / UART interfaces.[13] The third reason why ESP32 has been chosen is it's dev kit is cheaper than Arduino Uno. This means that user can get a more powerful board for a lower price. While user choose to work with the ESP32, user will know that the ESP32 is a supercharged Arduino Uno which faster, and better in many aspects.

Figure 7: ESP32 module.

Table 2: Specification of ESP32

Microprocessor	Tensilica Xtensa LX6
Maximum Operating Frequency	240MHz
Operating Voltage	3.3V
Analog Input Pins	12-bit, 18 Channel
DAC Pins	8-bit, 2 Channel
Digital I/O Pins	39 (of which 34 is normal GPIO pin)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
SRAM	520 KB
Communication	SPI (4), I2C (2), I2S (2), CAN, UART (3)
Wi-Fi	802.11 b/g/n
Bluetooth	V4.2 – Supports BLE and Classic Bluetooth

2.5 Cloud Computing Storage

Cloud computing is to deliver message of computing services which including servers, databases, networking, software, and others that over the internet which also known as the cloud. [14] This can offer faster innovation, adjustable resources and economies of scale as the cost advantages reaped by companies when production becomes efficient. The advantages of cloud storage compare with SD card is it can save expenses to buy hardware and software. Cloud storage also eliminates setting up and running on-site datacenters[15]. Another advantages are the protection of data security. Cloud storage ensures the data and videos won't get lost and also protects user's personal and sensitive information. Cloud storage have unlimited storage whereas SD card have limited storage like 32gb and others. If SD card is running out of storage, user need to check, swap or clear the SD card. Cloud storage is more convenient compare to SD card as user can check through the data results instantly.

2.6 Sensor

A sensor is a device that detects and responds to some type of input from the physical environment. Those inputs could be light, heat, motion, and any other environmental phenomena. The output is usually a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network to read or further processing. [16] Those data measured by sensors can be used in operating the system efficiently, monitoring the operations for any abnormalities, controlling the operations and many others usage.

There is different type of sensors that we used in daily life, university, and workplace. All types of sensors are basically divided into analogue sensors and digital sensors. The types of sensors are temperature sensor, IR sensor, ultrasonic sensor, touch sensor, flex sensor and others. Temperature is one of the most measured environmental quantities in our daily life. There are different types of temperature sensors like thermocouple, thermistors, semiconductor temperature sensors, resistance temperature detectors (RTDs) and others.

Figure 8: Temperature sensor

A simple temperature sensor is used with the circuit to switch on or off the load at a specific temperature which is detected by the temperature sensor and thermistor is used here. The circuit of temperature sensor consists of the battery, thermistor, transistors, and relay which are connected as shown in the figure below.

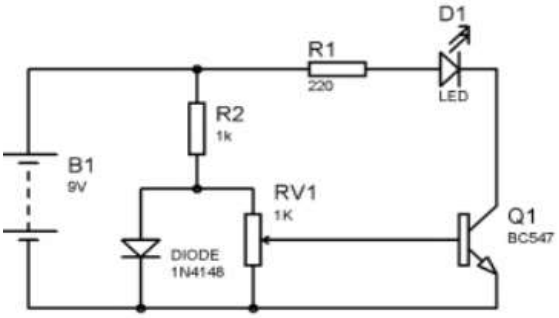

Figure 9: Temperature sensor circuit

Another example of sensor is IR sensor. IR sensors have a small photo chips which having a photocell that are used to emit and detect the infrared light. IR sensors are generally used for designing remote control technology and can be used to detect obstacles of the robotic vehicle to control the direction of the robotic vehicle. There are different types of sensors that can be used for detecting infrared lights.

Figure 10: IR sensor

2.7 Data Logger

A data logger is an instrument that used to monitor and record changes in conditions over time. Data logger can be single, stand-alone units or consist of multiple channels. For this, most stand-alone units are battery-powered to allow them to record while in transit and for extending periods of time. Data loggers are using a microprocessor, an internal memory for data storage, and a sensor for collecting data. They are usually small, and battery powered devices. Data loggers can interface with a computer and then use software to view and analyse the collected data. Besides, data loggers can be used as a stand-alone device with a local interface or connect wirelessly to a device. One of the advantage of data loggers is it can operate independently of a computer which unlike other types of data acquisition devices. Data loggers are available in various shapes and sizes and the range including simple economical single channel fixed function loggers and more powerful programmable devices capable of handling hundreds of inputs. [17]

Data loggers can accept different input types. There are some most common input types such as pressure, temperature, humidity, voltage and current. For pressure, it can measure the pressure of gases and liquids by including atmospheric and water pressure. For temperature, data loggers can be used to measure extremely high and low temperatures including liquid temperatures. Besides, humidity loggers can collect data on relative humidity, dew point and water vapor concentration in the form of standard or metric units. Voltage data loggers are used to adapt to any voltage measurement including pressure to torque and load to force. Current data loggers are included a range of AC and DC data loggers and usually used for monitoring building equipment.

There are four main types of data loggers which are stand-alone USB data loggers, Bluetooth Low Energy (BLE)-enabled data loggers, web-based systems and wireless sensors or also known as data nodes. USB data loggers are compact, reusable, and portable. Besides, it also low-cost, easy setup and deployment. The internal-sensor models are used to monitor at the logger location whereas external-sensor models with flexible input channels for a range of external sensors can be used for monitoring at some distance from the logger. BLE-enabled loggers same as USB data loggers and addition

of offer the added benefit of being able to measure and transmit data wirelessly to mobile devices over a 100-foot range. The third data loggers which is web-based systems enable remote, around-the-clock, internet-based access to data via cellular, WI-FI, and Ethernet communications. The fourth data loggers which is wireless sensors are transmitting real-time data from dozens of points to a central computer by eliminating the need to manually retrieve and offload data from individual data loggers.

2.7.1 Hardware

Hardware is any physical electronic device. The examples of hardware are computers, adapter cards, ethernet cables and others. The SD card module is useful for projects that require data logging. Arduino can create a file in an SD card to write and save data that using the SD library. [18] Although there are different models, they also work in a similar way by using the SPI communication protocol. The Micro SD Card is used for transferring data to and from a standard sd card. The pin out is directly compatible with Arduino but can be used with other microcontrollers. It has also allowed us to add mass storage and data logging to our project.

The advantages of SD card are physical size. Memory cards can offer large amount of storage space although it is small. The size remains the same no matter what storage capacity it holds. Another advantage is its high portability which is generally because of its size. The third advantage is power consumption of SD cards require very low amount of power for them to run. This makes SD card ideal for most of the battery-based devices which are small, and light weighted. On the other hand, the disadvantages of SD card are lifespan. Memory card uses flash memory as they possess limited number of cycles. This means that the number of times of the information can be written and deleted is limited. Other disadvantages are physical damages. The physical size of memory card makes them face vulnerable to physical damages. We need to have proper care so that they are not lost or smashed. Furthermore, there is a problem faced by SD card known as electronic corruption which makes the card entirely unreadable. [19]

2.7.2 Firmware

Firmware is a tangible electronic component with embedded software instructions such as a BIOS in the field of electronic systems and computing. Those software instructions are used to tell an electronic device how to operate itself. Firmware is held in non-volatile memory devices such as ROM, EPROM, and flash memory. There are some firmware memory devices which are permanently installed and cannot be changed after manufacture. ROM integrated circuits is needed to be physically replaced or flash memory to be reprogrammed through a special procedure to update firmware include fixing bugs or adding features to the device. Firmware such as the ROM BIOS of a personal computer may contain only elementary basic functions of a device and only provide services to higher-level software. The type of firmware of the program of an embedded system may be the only program that will run on the system and provide all its functions. [20]

One of the examples of firmware is blynk app. According to Blynk's website, "Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets." [21] Blynk app can support both Arduino and Raspberry Pi over Wi-Fi, Ethernet, or an ESP8266 chip. Besides, we can select USB as the connection type as we are going to control it through serial communication. In USB connection type, we won't require any other device. But if we choose the Bluetooth connection type, we will require the Bluetooth and also the Wi-Fi connection type.

Another example of firmware is visual basic. Programming is defined as designing a set of instructions to instruct the computer to carry out certain jobs which much faster than human beings can do. Visual Basic is a type-safe programming language that designed for people to be easy to learn. It is derived from BASIC which means that "Beginner's All-purpose Symbolic Instruction Code". [22] In Visual Basic, we can create any program depending on our objective. For technology parts, we can create simulation programs such as Projectile, Simple Harmonic Motion, slot machine and others.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The methodology is a system of board principles or rules from which specific methods or procedure may be derived to interpret or solve. This chapter explained in detail about the procedure of the implementation of the posturing device. The methods used in this chapter are aimed to achieve the objectives of the project which will give great results on the performance of the device.

3.2 Block Diagram

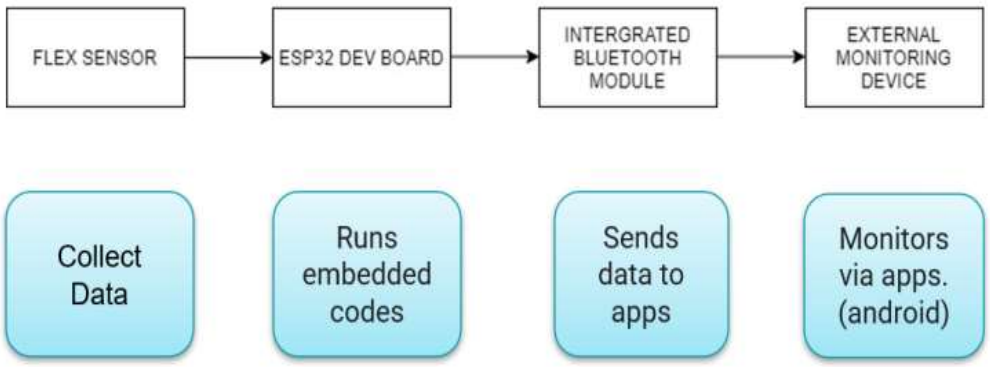

Figure 11: Block diagram of the device.

3.3 Project Flowchart

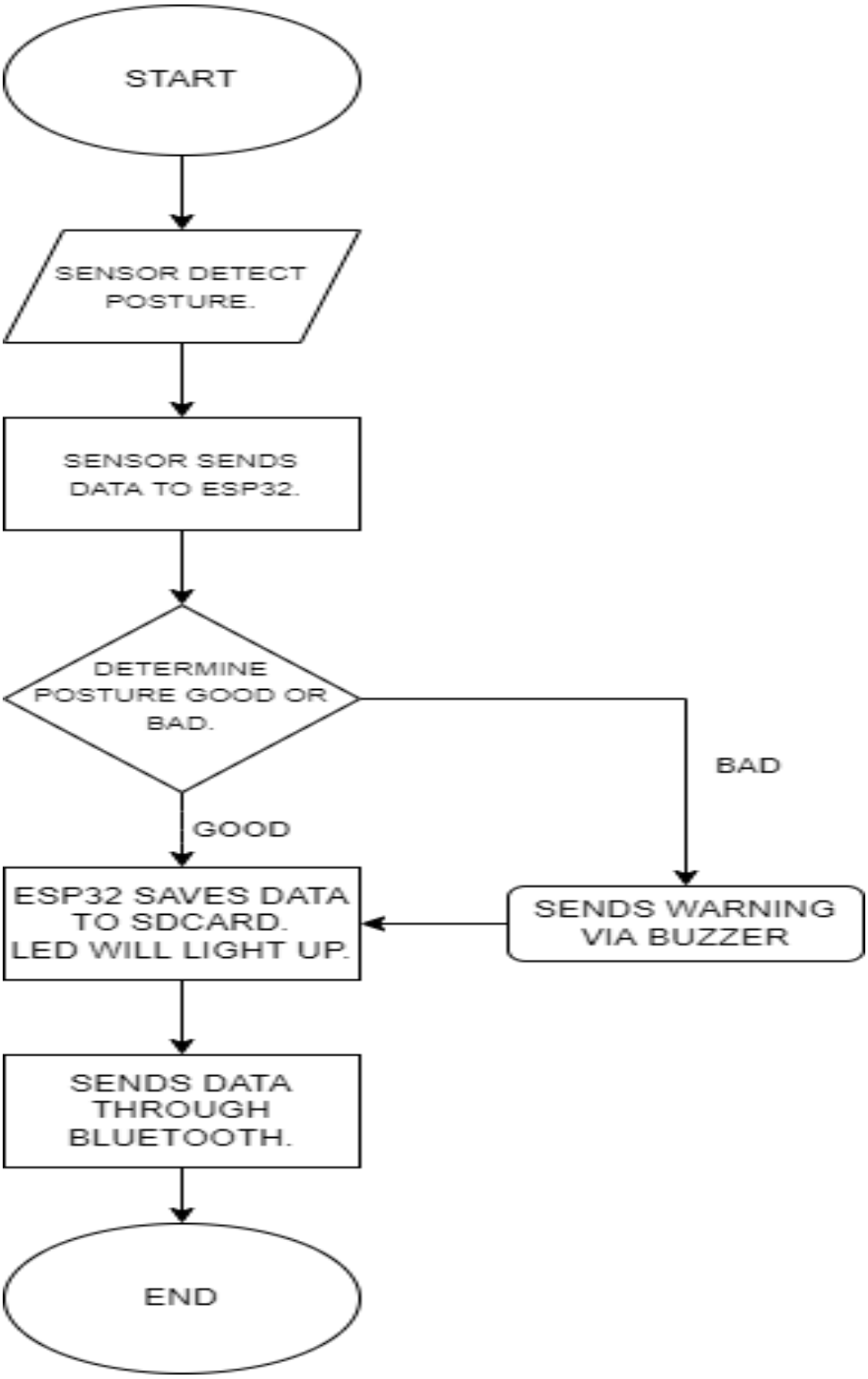

Figure 12: Flowchart of the device.

3.4 Project Design

The design overall consists only a sensor which is a flex sensor. This sensor will be safely attached at a vest for easily use and to received or collected data information from patient. There is an SD card module used in this project. It is placed near the microcontroller. This will be able to record any reading from the sensor. For the safety purpose this device has cover to ensure the safety of the microcontroller. The reading of the sensor is sent to the mobile application for monitoring. Below is the list of the component used in this device.

Table 3: List of components for posture monitoring device.

No.	Components
1	Flex sensor / Bend sensor
2	ESP32 Dev Board
3	Arduino SD card module
4	Buzzer
5	LED

3.5 Component Used

3.5.1 Flex sensor/Bend sensor

Flex sensor is one of the crucial parts in our project. This sensor is used to measure the amount of bending. This sensor can be created by using materials like plastic and carbon. The carbon surface is arranged on a plastic strip as this strip is turned aside then the sensor's resistance will be changed. Flex sensor only has 2 pin configuration and there is no polarized terminal. It can be activated by using a 3.3V to 5V DC. This sensor is widely used in medical instrument, robotics and even in physical therapy.[23]

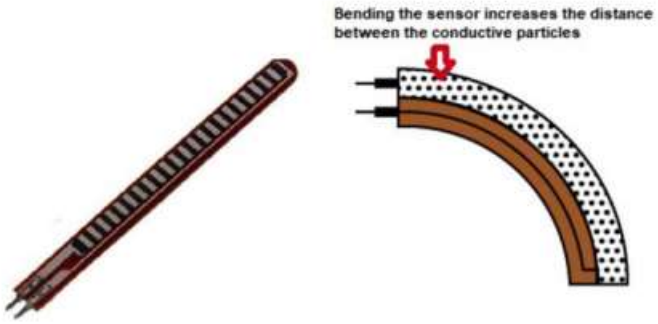

Figure 13: flex sensor.

Table 4: Specification of flex sensor.

Operating voltage of flex sensor	0-5V
Can operate on low voltages	Yes
Power rating	0.5Watt (continuous), 1 Watt (peak)
Life	One million
Operating temperature	-45ºC to +80ºC
Flat Resistance	25K Ω
Resistance Tolerance	±30%
Bend Resistance Range	45K to 125K Ω (depending on bend)

3.5.2 ESP32 MCU with Wi-Fi and Bluetooth

For this project, we are using the ESP32 Microcontroller Unit (MCU) from Espressif Systems. This microcontroller has the Wi-Fi module and Bluetooth module embedded on the board. This board can be program using multiple programming environment such as LUA, MicroPython and Arduino IDE. The reason we choose ESP32 rather than Arduino board is the modules are ready to use. Unlike Arduino, we need to buy the modules separately and it cost a little more than buying the ESP32. ESP32 also support Bluetooth Low Energy (BLE) that can be used for wearable electronic which can extend the battery life.[24] For specification of the ESP32, refer Table 2.

3.5.3 SD card Module

SD card used in this project is to be used for data logging. Data logging is a process of recording data based on a period of time. A lot of devices implemented the

data logging such as in black box in aircrafts. This module will help us records the data from the sensor and stores inside the SD card.

Figure 14: SD card module.

3.6 Interfaces

3.6.1 Operating System

The Android operating system (OS) has been selected as the device's GUI (refer Table 5). Users have a lot of versatility with Android, and developers can create applications for free. This topic will be addressed later. Aside from the cost, the app can be improved and redesigned by another developer with access (co-developer) to improve the user experience to the point that users are completely blown away by its features. It is possible to do this by sharing the files with the co-programmer who will be programming the applications. It is important to enhance user friendliness and enable users to customise the interface according to their preferences. When users choose their own or built-in theme for an application, they can try out different themes that fit their mood, emotion, and so on.

Users' key security issue is when the Android OS is more easily compromised and private information or sensitive data is stolen from the Android server, jeopardising the users' confidence in the Android platform. Even though the iPhone Operating System (iOS) is more secure than Android in terms of protection, this can be solved by installing some strong cyber security apps to ensure the smartphone is safe and secure. As a result, users must make a small investment in security.

Table 5: Differences of Android OS and iOS

Types of OS	Android	iOS
Customizability	Can tweak/change almost everything	Limited unless with jailbreaking
Source Model	Open Source	Closed Source
File Transfer	Via USB file transfer	Via iTunes desktop software
Security	Depends on the manufacturers	High
Voice Command	Google Assistant	Siri
App store, affordability, and interfaces	Google Play, Huawei App Gallery	Apple Appstore
Open source	Kernel, UI, and some applications	Not open Source.

3.6.2 Blynk App and MIT App Inventor

Blynk is an iOS and Android platform that allows users to monitor microcontrollers such as Arduino and Raspberry Pi, as well as their preferences, over the Internet. It is a computerised dashboard where you can use gadgets to create a realistic GUI for your company. Blynk is not tethered to any kind of board or shield. It is a piece of supporting equipment chosen by the engineer. Blynk was created with the Internet of Things in mind. It can monitor equipment remotely, display sensor data, store and simulate data, and do a variety of other cool things.

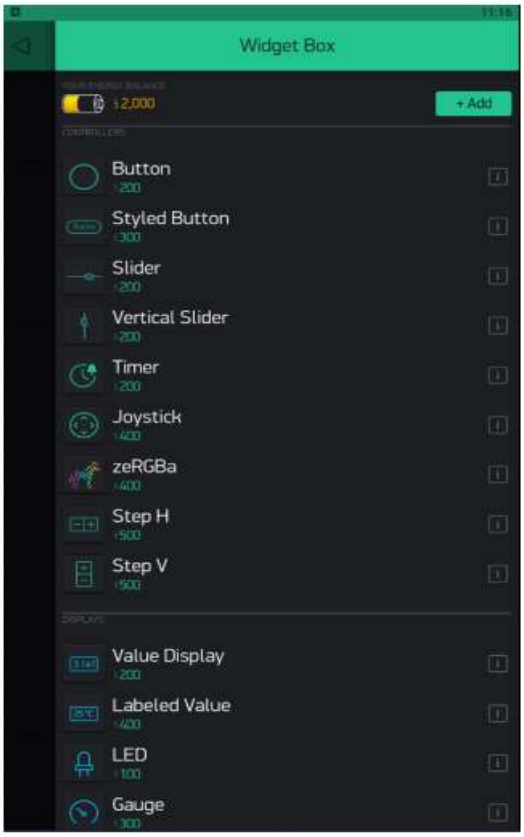

Figure 15: a list of programmable control in Blynk.

The official integrated programming environment (IDE) for Android device development is Android Studio. It is built on IntelliJ IDEA, a Java integrated programming platform for software development that includes code editing and developer tools. To build and design an interface, Android Studio follows the same steps as MIT or Blynk, with the exception that Android Studio uses a formatted coding language. Java is the official programming language for Android. Android is mainly written in Java, and its APIs are designed to be named from Java. The Android Native Development Kit (NDK) can be used to create C and C++ apps, but this is not something Google encourages. MIT Software Inventor is a natural, visual programming environment that allows everyone to create fully functional mobile and tablet apps. MIT Software Inventor is a Google developed mobile application development platform that is now maintained by the Massachusetts Institute of Technology (MIT). It allows beginners to PC programming to create applications for the Android and iOS operating systems. It employs a graphical user interface (GUI) similar to that of the programming

languages such as Scratch and StarLogo, which allows users to drag and drop visual elements to create a mobile app. Google built on important earlier studies in instructive registering, as well as work completed inside Google, to create App Inventor.

Figure 16: The interface of MIT App Inventor.

We use which events the software will respond to when creating the applications, and then we write the code that will execute when those events occur. This is accomplished by putting code in an event handler. To write our code in App Inventor, we use squares. When an event occurs, an Event Handler is a square that executes. Block-based coding programmes, such as the ones seen in figure above, encourage academic and artistic freedom. MIT App Inventor takes things a step forward by empowering kids to make a difference in their neighbourhoods by achieving positive change of immeasurable worth.

For the most part, MIT serves as the project's machine platform. The advantage of using MIT software inventor is that it uses event handlers and block-based scripting, which is easier than coding in Android Studio step by step. Since the scope of this project is more focused on medical applications for patients and therapists, the apps must be designed to be convenient and easy to use for all generations, including the elderly. Owing to their small amount of widget usages, Blynk has limited access to use, which

makes it difficult to add new functionality. Since Blynk needs additional funds for make-up, MIT Software Inventor is a better option since it is free and allows for complete customization when creating and coding the system itself.

3.7 Circuit Connection

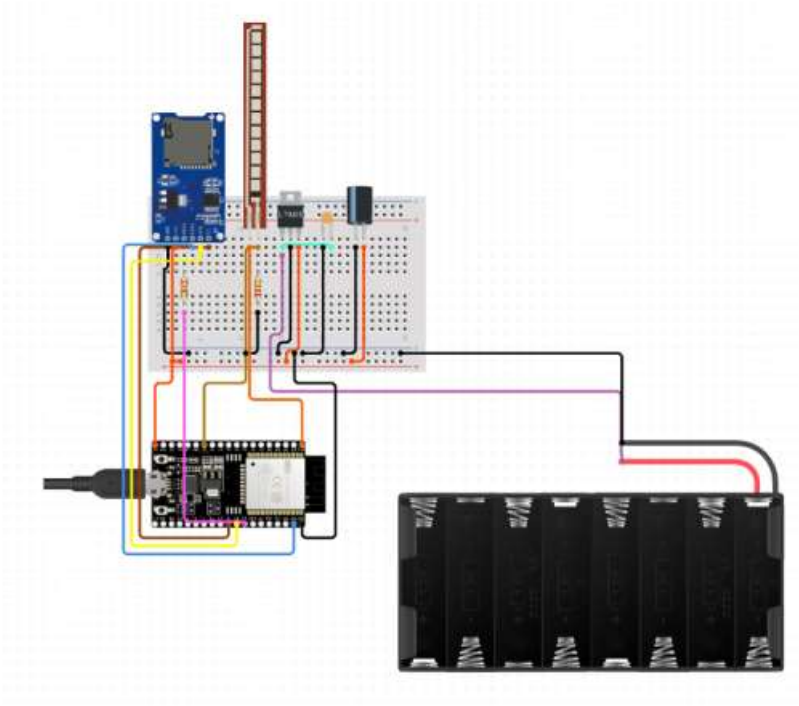

Figure 17: Circuit connection of project

The device is connected as shown on the diagram above. The ESP32 is used as microcontroller to sends and receives data. The battery is used as power supply. In this device, only one sensor is used which is the flex sensor. This sensor will detect the curvature of the spine and sends to the ESP32. Then, the received data will be stored via the SD card module for references. This device can relate to the developed application, through the built-in Bluetooth module on the ESP32. The application can act as a switch for the device and monitors the posture. If the reading of the posture is high, the application will then send out a warning for the user to adjust their posture.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Hardware

4.1.1 Design & Fabrication

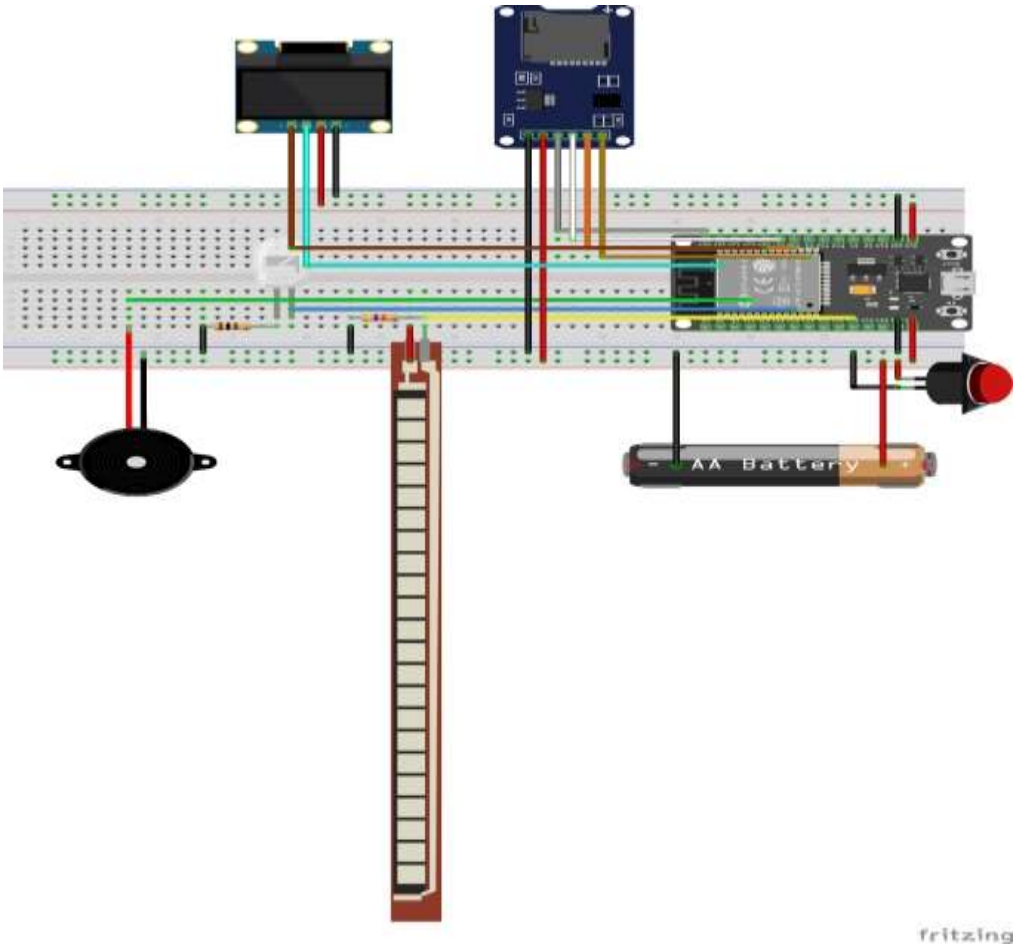

Figure 18: Circuit connection of Human Posture Monitoring Device and System

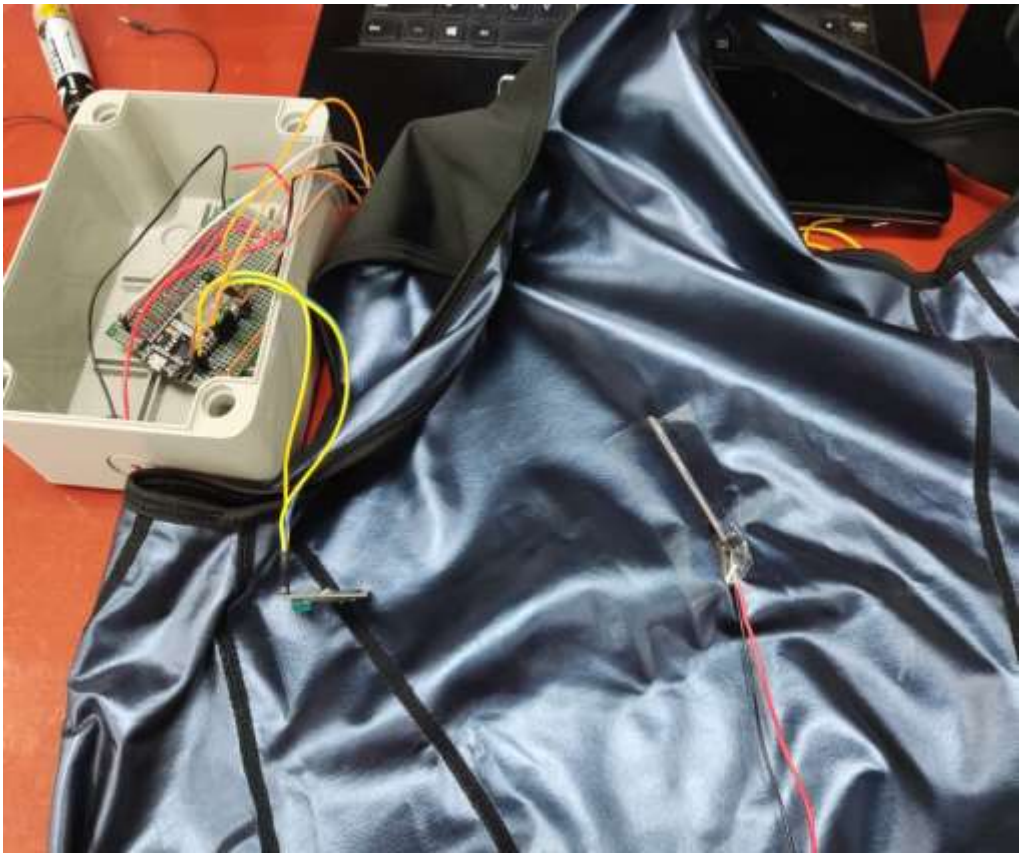

Figure 19: Final circuit connection of project with flex sensor

Figure above show the circuit connection of project. The dimension of the circuit is length x width x height. The dimension value is 9cm x 11cm x 3cm. The function of our project is to prevent musculoskeletal disorders and structural deformity of spine. Besides, it can train users to maintain good back posture until it becomes a daily routine. To use this human posture monitoring device and system, user need to wear the jacket as the user below.

Figure 20: The user is holding the control box and flex sensor is placed on the back of the user.

4.1.2 Result

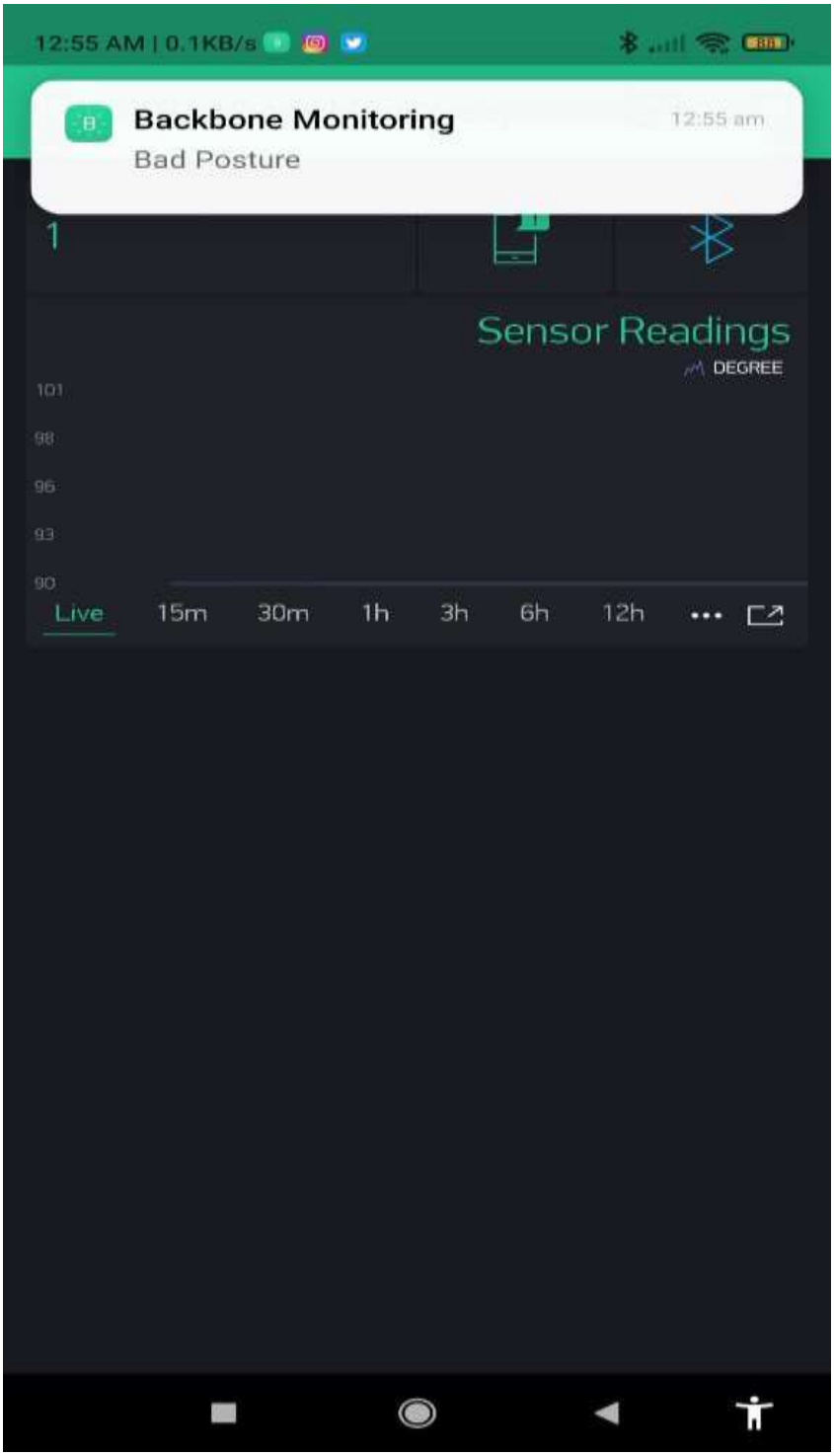

Figure 21: Blynk monitoring application that used

Figure 22: Real-time monitoring system of blynk application

Figure 23: Reading of angle of used for 15 minutes

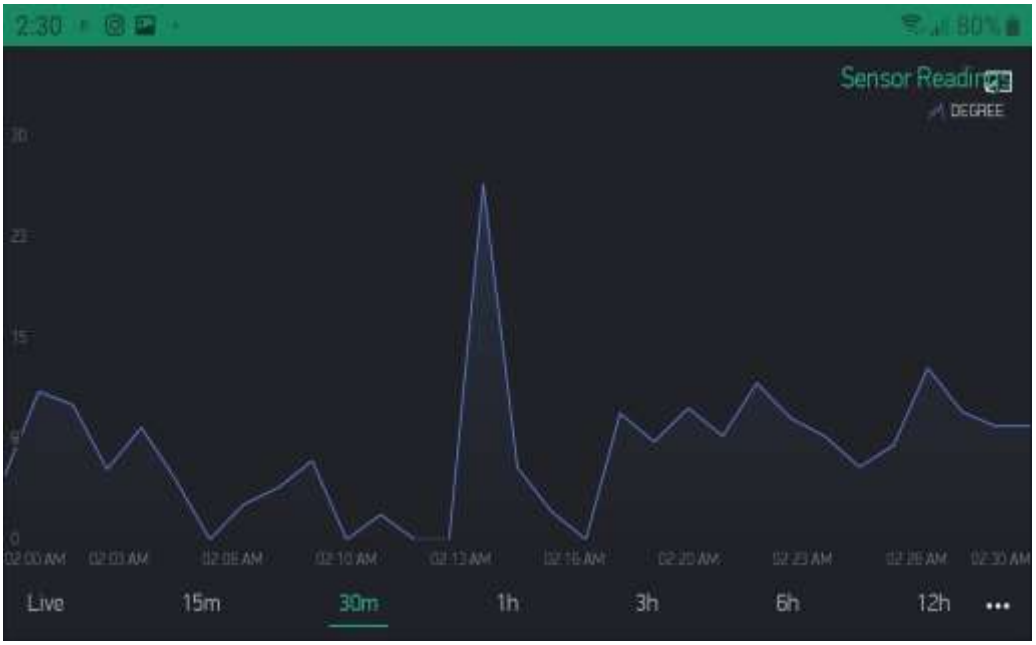

Figure 24: Reading of angle of user for 30 minutes

CHAPTER 5

CONCLUSION

5.1 Conclusion

For conclusion, the results of project are achieved within 14 weeks of our study week. The teammate meets frequently to discuss about the project so as the project can work smoothly to determine and prioritize tasks that needed to be accomplished. Meetings with the supervisor were held frequently.

5.2 Recommendation

The recommendation of this project is to get more sample of user that used this human posture monitoring device and system. Besides, this project can be approved by modify the system and design so that user no need to carry the circuit box.

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APPENDICES

Appendix A:

Budget Report

No	ITEM	Amount	Price
1.	ESP32 NodeMCU	1 x RM32.90	RM32.90
2.	Flex Sensor 2.2 inch	1 x RM55.00	RM55.00
3.	Flex Sensor 4.5 inch	1 x RM 114.00	RM 114.00
4.	Resistor 100Ω x 10 per pack	2 x RM2.00	RM4.00
5.	Resistor 47KΩ x 10 per Pack	1 x RM5.00	RM5.00
6.	Buzzer	1 x RM5.07	RM5.07
7.	OLED Module LCD	1 x 19.60	RM19.60
8.	LED x 10 per pack	1 x RM 1	RM1.00
9.	18650 Lithium Battery Single Cell	1 x RM13.60	RM13.60
10.	Micro USB Wemos ESP32 18650 Battery ShieldV3	1 x RM10.39	RM10.39
11.	SD card module	1 x RM5.30	RM5.30
12.	Jumper cable	1 x RM4.60	RM4.60
13.	Breadboard	1 x RM3.90	RM3.90
14.	Circuit Box	1 x RM6.00	RM6.00

Total	RM 280.36