Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF TRAIN TRACK MONITORING SYSTEM BY USING ESP32

MUHAMMAD SHAMIL BIN MOHD NAZIR

Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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in partial fulfillment of the requirements for the degree of
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DECLARATION

I declare that this project report entitled "Development of Train Track Monitoring System by Using ESP32" 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 SHAMIL BIN MOHD NAZIR

Date : 27/01/2023

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 : TS. DR. ADAM WONG YOON KHANG

Date : 27/01/2023

DEDICATION

This report is dedicated to my parents, who gave the little they had to ensure I would have the oppurtunity of an education. It helps me realise that the finest sort of information to have is knowledge gained for the purpose of learning. They also reminded me that even the most difficult task can be completed if done one step at a time.

ABSTRACT

Train is one of the most important and widely used transportations in this world. Train can be use as cargo train, and it is also can be use as public transportation. Train is a safe land transport system when compared to other transportations such as car, motorcycle, and bus. Even though train is safer than the others, its railway still should always be in a good condition so that the accidents can be avoided. To maintain the good condition of the railway, the railways need to be monitored all the time. The problem occurs when the keyman monitor the railway by themselves. The outcome may not be precise or the worse that could happen when the keyman will miss the broken or crack area of the railway and later the accidents can easily occur and there may have casualty. Other than that, the keyman may be late to inform or alert the main station about the cracks. Due to this problem, a new technology should be created with a system solely for monitoring the train track all the time. Next, the system also will alert the main station about the cracks plus with the exact location of the railway. The main components in this project are ESP32, Laser sensor and GPS sensor. The main function of Laser sensor is to detect the cracks or broken part of the railway and it will transmit and receive the signal to detect the broken or crack area of the railway. Then, the data will be sent to ESP32. The system will alert and tell the main station about the condition of the track. Lastly, the purpose of this project is to assure the safety of the passengers, packages, and the train itself. This project provides a very good solution which the system can be easily detect the exact location or area of the track that might be in a bad condition.

ABSTRAK

Kereta api adalah salah satu pengangkutan yang paling penting digunakan secara meluas di dalam dunia. Kereta api digunakan sebagai kereta api kargo, dan juga sebagai pengangkutan awam. Kereta api adalah pengangkutan darat yang paling selamat jika dibandingkan dengan pengangkutan lain seperti kereta, motosikal, dan bas. Walaupun kereta api lebih selamat daripada yang lain, ladasannya masih perlu sentiasa dalam keadaan baik supaya kemalangan dapat dielakkan. Untuk mengekalkan keadaan landasan kereta api yang baik, landasan kereta api perlu di pantau sepanjang masa. Masalah berlaku apabila *keyman* memantau jalan kereta api sendiri. Hasilnya mungkin tidak tepat atau lebih teruk apabila *keyman* akan terlepas pandang landasan kereta api yang pecah atau retak dan kemudiannya kemalangan boleh berlaku dengan mudah dan mungkin ada korban. Selain itu, *keyman* mungkin lewat untuk memaklumkan atau memberi amaran kepada stesen utama tentang keretakan. Disebabkan masalah ini, teknologi baru harus dicipta dengan sistem semata-mata untuk memantau landasan kereta api sepanjang masa. Seterusnya, sistem juga akan memaklumkan kepada stesen utama tentang keretakan ditambah pula dengan lokasi landasan kereta api yang tepat. Komponen utama dalam projek ini ialah ESP32, sensor laser dan sensor GPS. Fungsi utama sensor laser adalah untuk mengesan keretakan atau bahagian landasan kereta api yang pecah dan ia akan menghantar dan menerima isyarat untuk mengesan patah atau kawasan retakan di landasan kereta api. Kemudian, data akan dihantar ke ESP32. Sistem akan memberi amaran dan memberitahu stesen utama tentang keadaan trek. Akhir sekali, tujuan projek ini adalah untuk memastikan keselamatan penumpang, bungkusan, dan kereta api itu sendiri. Projek ini menyediakan penyelesaian yang sangat baik yang sistem boleh mengesan dengan mudah lokasi atau kawasan trek yang mungkin berada dalam keadaan buruk.

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My highest appreciation goes to my parents and families for their love and prayer during the period of my study. Not forgetting to all my friends for the willingness of sharing their thoughts and ideas regarding the project.

Last but not least, I wanna thank the biggest support system I have during finishing this report which is my cats. To Bobby, Max, Fani, and Momot. Thank you.

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LIST OF SYMBOLS

δ	-	Voltage angle

LIST OF ABBREVIATIONS

V	-	Voltage
GPS	-	Global Positioning System
IDE	-	Integrated Development Environment
GSM	-	Global System for Mobile Communication
IoT	-	Internet of Things
IR	-	Infrared
Wi-Fi	-	Wireless Fidelity
LED	-	Light-Emitting Diode
DC	-	Direct Current
SD	-	Secure Digital
LCD	-	Liquid Crystal Display

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CHAPTER 1

INTRODUCTION

1.1 Background

Safety and reliability are paramount in all modes of transportation, particularly in the case of railways. With the recent introduction of high railroads in recent years, train speed and capabilities have steadily improved, and traffic density has become increasingly serious. As a result, high-speed train operations and reliability are becoming increasingly important. However, the safety of a high-speed train is heavily reliant on its surroundings. The number of collisions involving railway mishaps are increasing year after year across the world. The ever-increasing operation velocities result in a growing number of serious repercussions, including human death and significant damage to the train and other railway equipment [1]. The suggested setup would make the discovery and maintenance of railway tracks easier, as well as aid in the monitoring of rail cracks. The proposed design and related software are basic and easy to implement in the current system. Railroad engineering methods and the Federal Railroad Administration's inspections for physical problems at predetermined periods. These inspections are carried out visually by train track inspectors, although only a limited amount of detail can be gained due to practical considerations [2]. One sobering fact is that for track inspection and defect discovery, the entire railroad system relies heavily on manpower rather than automation. People make mistakes, far more than machines, regardless of how skilled their eyes are [3]. Many organisations and companies' technical methods for detecting fractures in rails include routine maintenance combined with periodic monitoring, usually once a month or in a similar time frame. However, robotics has the intrinsic advantage of permitting daily rail track surveillance during the night, when normal train activity is suspended [4]. The Railway Service currently employs machine vision technology to detect flaws or symptoms in digital photographs of track elements, and unique algorithms for image analysis. These devices are larger and require a human to operate them manually. The proposed technology is compact and simple to operate [5].

1.2 Problem Statement

Nowadays, train is one of the widely use transportation in this world for a very important role such as to transport goods and also can bring a large group of people from point A to point B. So, the railways must always be in a very good and safe condition to use so that the accidents can be avoided. To avoid accidents to happen, the railway needs to be monitored all the time. The problem arises when a group of workers (Keyman) are in responsible for supervising and patrolling around the railway, which sometimes will lead to ineffective due to negligence. Other than that, the exact location of the cracks area is not precise, and the main station may have difficulty to find the exact area.

1.3 Project Objective

The main objective of this project is to develop the train track monitoring system by using ESP32. The objectives are as follows:

- To design a system to monitor the railways that can detect the cracks area and pinpoint the location.
- To save data collected by the sensor in the cloud for analysis and action.
- To design an automated Radio-Controlled CAR (RC Car) which to drive the system along the railway.

1.4 Scope of Project

This section is made to tell the components and features included in this project. Among the scope of the project is using ESP32 microcontroller which control all components in this project. Next, using the Internet of Things (IoT) platform which is Blynk Application for communication between the microcontroller and mobile phone which connected to the internet to display the information regarding the monitoring process. Laser sensor is used to detect the cracks area, and Global Positioning System (GPS) is used to pinpoint the exact location of the cracks area. Furthermore, an automated rail cart will be used to drive the system along the railway. Lastly, this project solely dedicated to railway industry only.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter studies what has been accomplished based on past research. In order to apply information, methodology, and approach from prior study to this project, some research has been evaluated for this chapter. By reviewing other people's projects, readers can identify problems or challenges that develop on their initiatives. In order to avoid the same issues in this project. Reading other people's books or journals will also enable readers to compare, contrast, summarize, and evaluate their works. The subtopics of this chapter will be about discussion of development of train track monitoring system, which ESP32 will be the microcontroller of this project, and to construct an automated vehicle system. This chapter will examine 10 different literary works and it is full of information and research collected from the internet, books, and journal papers. A search of related to train track monitoring system yielded the literature.

2.2 Monitoring System

The authors Valerie Gay and Peter Leijdekkers with the title A Health Monitoring System Using Smart Phones and Wearable Sensors have proposed this system in 2007. The system is employing a smart phone and wireless (wearable) sensors to create a tailored health monitoring application. The sensor data is monitored and recorded by the system, which is then entered into the patient's health record and analyzed by an expert. Personalization is a priority in the system's design. A cardiac specialist can choose one or more sensors for a specific patient and set the appropriate threshold levels for that patient. When thresholds are exceeded, the application generates alarms or warnings. Specialists can look after a patient without being directly connected to health-care facility since ECG is being processed and other sensor data locally on the smart phone. The system is intended to continuously monitor the patient, and one concern is the battery life of the gadgets employed. The battery in the ECG sensor can last approximately lasts about 60 hours. When linked to the ECG Bluetooth device continually, the smart phone's battery lasts for about eight hours, and if the wearer is not close to the charger, this can be a very big problem (less than 10 meters). However, studies have shown that many heart patients are sedentary, allowing them to charge their phones while being monitored. The smart phone can instantly inform pre-assigned cares or call an ambulance depending on the situation. Based on the sensors and environmental data, it can also give recommendations (e.g., exercise more) or reassure the patient [6].

The authors of Real Time Water Quality Monitoring System which are Mithila Barabde and Shruti Danve have proposed this system back in 2015. It is stated that to prevent water pollution, we must first evaluate water characteristics such as pH, turbidity, conductivity, and so on, because deviations in these parameters indicate the presence of contaminants. Water parameters are currently detected via a chemical test or a laboratory test, in which the testing apparatus is stationery and samples are fed into it. Data monitoring nodes, a base station, and a remote station make up the system architecture. All of these stations are connected by wireless communication lines. The nodes' data is transferred to the base station, which is made up of an ARM controller designed for a small space application.

The remote monitoring station receives data from the base station, such as pH, turbidity, and conductivity. With the help of MATLAB, data collected at the distant site can be shown in a visual style on a server PC and compared to standard values. If the obtained result goes above and beyond the threshold value, the agent will receive a warning SMS message. The suggested work is unique in that it aims to provide a high-frequency, mobile, and low-power water monitoring system. Overall, a proposed implementation of a high-power Zigbee-based WSN for water quality monitoring is provided, with low power consumption and cheap cost. Another essential feature of this system is its ease of installation, which allows the base station to be located near the target region and the monitoring work to be performed by anyone with very little training at the start of the system installation [7].

The Smart Noise Monitoring System Implemented in the Frame of the Life MONZA Project proposed by Chiara Bartalucci, Franceso Borchi, Monica Carfagni, Rocco Furferi, Lapo Governi, and Alessandro Lapini in 2018. One of the key objectives is to minimize the district's average noise levels. Noise monitoring devices, both smart and traditional, have been devised and installed to track changes in noise levels before and after actions. The smart monitoring system comprises of ten low-cost noise monitoring units strategically placed across the district, each recording the sound pressure in terms of broadband and 1/3 octave band levels per second. A protocol for on-site verification was devised, and three verifications have been completed to date. The structure and positioning of the smart noise monitoring system, as well as indications on how data can be viewed in the server, are described in this paper. In addition, the first data acquired following the first monitoring period are shown. Some processes for verifying performance maintenance on a regular basis have been devised and tested on the prototype system. Periodic long-term on-site verifications have allowed the system's operational state to be monitored throughout time. Following the initial examinations, it was discovered that all MEMS microphones fitted to a 12-inch stand saw a sensitivity drop over their first life period. Electret microphones installed on a 14-inch stand, on the other hand, do not exhibit the aforesaid behavior. To avoid a period of sensitivity, decrease that must be adjusted by software, a preliminary phase of microphone break-in is scheduled before the monitoring period begins [8].

Internet-of-Things Garbage Monitoring System proposed by Mustafa M.R and Ku Azir K.N.F in 2017. Ultrasonic sensors would be used to measure garbage levels, an ARM microcontroller would be used to control system functioning, and everything would be connected to ThingSpeak. This paper demonstrates a system for waste management to monitor the depth of garbage inside the dustbin depending on the garbage level. The system employs LCD and ThingSpeak to display the status of four different types of garbage in real time, including domestic waste, paper, glass, and plastic, as well as to save the data for future use and research, such as anticipating garbage bin fullness peaks. This device is anticipated to help create a greener environment by intelligently monitoring and controlling garbage collection via the Internet of Things. The information about the trashcan may be retrieved from anywhere and at any time using this method. The status of each trashcan will be updated in real time by this system. When the trashcan is full, the garbage collector may be dispatched to collect it. The range of distance that an ultrasonic sensor can detect is between 2cm and 400cm. This sensor will compare the depth of the trash can to determine the amount of waste within. The data will be collected by this sensor and transferred to the microcontroller for display on the LCD. Then, the data from this sensor will be sent to ThingSpeak using the ESP8266 Wi-Fi module. In ThingSpeak, the data will be displayed in real time [9].

Dr. N. Suma, Sandra Rhea Samson, S. Saranya, G. Shamugapriya, and R. Subhashri are the authors for IOT Based Smart Agriculture Monitoring System in 2017. Among the features of this project are GPS-based remote monitoring, moisture and temperature sensing, intruder alarming, security, leaf wetness, and proper watering facilities. It monitors soil properties and ambient variables in real time using wireless sensor networks. Sensor nodes are placed across the farm in various areas. Sensors, Wi-Fi, and a camera with a microcontroller are used to carry out the tasks, and these parameters can be managed from any remote device or internet service. This concept is turned into a product and distributed to farmers for their benefit. It can be improved in the future by expanding this system to cover enormous areas of land. The technology can also be used to monitor soil quality and crop growth in individual soils. The sensors and microcontroller have been successfully interfaced, and wireless communication between the nodes has been established. Putting such a system in place in the field will surely help to boost crop yields and overall production. [10].

2.3 Internet of Things (IOT)

The Internet of Things (IoT) has grown in popularity regardless of the overall number of users. The Internet of Things (IoT) is a term used to refer to the connectivity and communication of embedded technologies that enable humans to perform daily operations. It can integrate all gadgets and allowing them to communicate with one another and the user. Numerous daily human activities can be facilitated and improved as a result of the rapid advancements in the IoT. The internet is then used for a wide range of communication reasons. The Internet of Things (IoT) can aid with communication, control, and data processing across a number of transportation systems. In many aspects of transportation, the Internet of Things is being employed (i.e., the vehicle, the infrastructure, and the driver or user). The dynamic interplay between various components of a transportation system enables inter- and intra-vehicular communication, vehicle control, safety, and road assistance. Other than that, Monitoring and regulating the operations of sustainable urban and rural infrastructures such as bridges, railway tracks, and on- and offshore wind farms is an essential usage of the Internet of Things. Any events or changes in structural conditions that could imperil safety or put people in danger can be tracked using the Internet of Things (IoT) infrastructure. In terms of cost reductions, time savings, better quality workdays, paperless workflow, and increased productivity, the construction industry can profit from the Internet of Things. Critical infrastructure, such as railroad tracks, can also be controlled via IoT devices. In all infrastructure-related fields, the use of IoT devices for monitoring and running vehicles is anticipated to improve incident management and emergency response coordination, as well as quality of service, up-times, and cost of operation.

2.4 Railway Track Monitoring System

Train tracks also known as simply track or permanent way is to ensures train mobility by providing a stable surface on which their wheels can roll. Train tracks have five (5) common components which Steel rail, Railway sleeper, Railway fish plate & fish bolt, Rail fastening system and Railway switch. Steel rail act as two parallel lines at all times. Steel rail is typically utilized to give a train's surface and to direct the train forward. Steel rail also transmits locomotive pressure to railway sleepers. For railway sleeper, it is perpendicular to the steel rail when the train passes through, it can be suitably distorted to reduce pressure, and then it can be covered as much as possible. It can also be classified into three types: wooden, steel, and concrete sleepers. Its tasks include providing firm and even rail support, acting as an elastic medium between rail and ballast, absorbing locomotive vibrations and transporting the load from rail to ballast, and aligning the rails and maintaining the correct rail gauge. Next is railway fish plate & fish bolt, is a metal bar used by fish bolts to join the ends of two rails. Railway fish plate is used in conjunction with steel rail as a connector element between two rails. Railway fish plate is divided into three categories by the steel rail standard: light rail, heavy rail, and crane rail. Then, for rail fastening system, steel rail is fastened to railway sleepers with this device. Rail clip, railroad spike, rail bolt, rail tie plate, rail pad, washer, plastic dowel, rail insulator, and rail shoulder are all common rail fastening system components. The basic purpose of a rail fastening system is to prevent lateral and horizontal movement of steel rail. Rail fastening systems can also absorb and transfer pressure from the locomotive to the railway sleeper. In a nutshell, the rail fastening system keeps the rail in place and provides rail safety. Lastly, which railway switch, a specific type of railway track component used in railway crossings. It is basically a rail component for converting track that improves railroad track trafficability and is critical to transportation safety and efficiency. All of these railway track components work together to ensure the safety and reliability of the railway. Furthermore, numerous other railway track pieces, such as rail anchors and rail clamps, perform the same function.

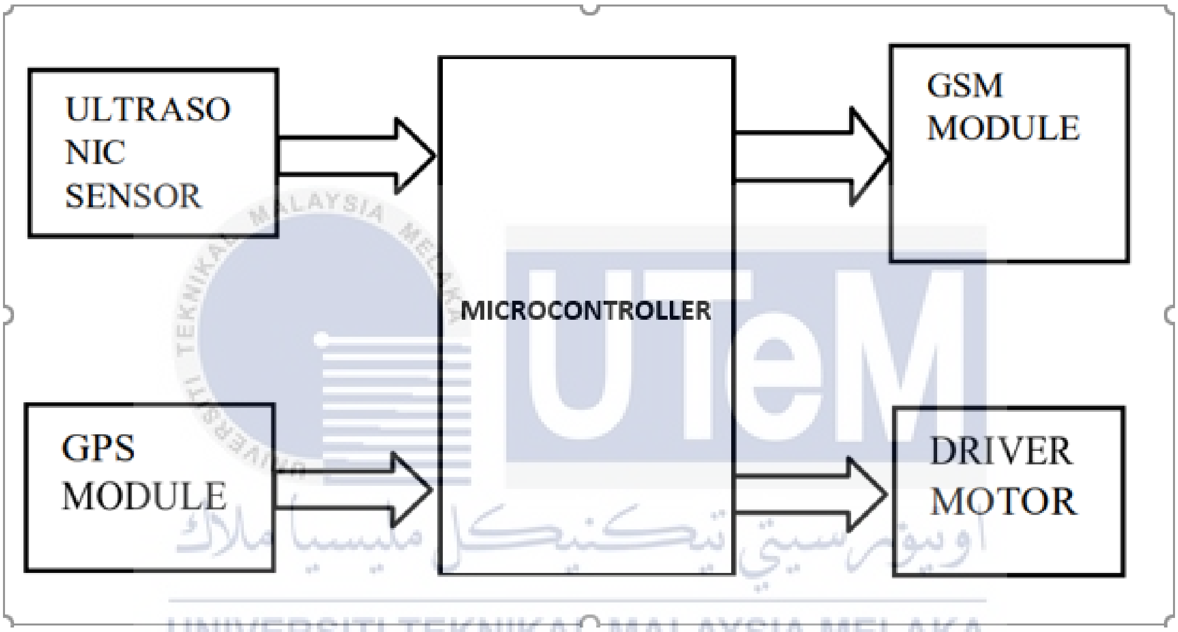


Figure 2.1: Block diagram

The project block diagram is shown in Figure 2.1, which contains ESP32 as microcontroller, ultrasonic sensor, motor drive, GPS module and GSM module. The board has digital and analog input/output (I/O) pins that can be used to connect to different expansion boards (shields) and other circuits. The board features 14 digital I/O pins, six analog I/O pins, and six PWM output pins. In a tiny form factor and with low power consumption, the GSM module provides GSM/GPRS 900/1800MHz capability for voice, SMS, Data, and Fax. SIM900A may fit practically all space needs in your applications, especially for slim and compact design demands, thanks to its small size of 24mm x 24mm x 3mm. The module can also be used to create Internet of Things (IoT) and Embedded Apps. Motor drivers are used to connect motors and control circuits. The controller circuit operates on low-current signals, yet the motor consumes a lot of current. Motor drivers are used to transform a low-current control signal into a higher-current signal that can drive a motor. Lastly the Ultrasonic sensor, like bats, uses sonar to estimate distance to an object. In a simple-to-use design, it provides outstanding non-contact range detection with high accuracy and reliable readings. Ultrasonic transmitter and receiver modules are included.

2.5 Related Work

The proposed work by DR. K. Karuppasamy, Pavithra, Shalini Gunasekha, and Mariya Antony (2019) starts with the robot will proceed onward the railroad track constantly and when the IR sensors gets the information flag low, it will stop the robot and sends the careful area of that point to the server by means of Internet. The sensors leave the circle and sends the flag, so GPS follow the area the sends the directions to the ESP32 content. The python is written in such a way, that it will give the information in terms of scope and longitude way. When the directions are available, the information is sent over the internet to the server so that it can be refreshed on the site or on the customer's python terminal. Then the directions are sent via a USB Wi-Fi dongle that is connected to the internet. Lastly, if it is vice versa, if the info flag is set to high, it means the inductive sensor is still sensing metal and is moving down the track to distinguish the genuine divides.

Geethanjali, Nadiya N, Nandhini S, Nivethitha N, and Pavithra U (2018) proposed that the crack detection in the track is continuously checked using sensors connected to a ESP32. The data is transmitted to a ESP32, which serves as a central processing unit, and the identified crack is tracked using a monitoring device. This system enables for the detection of track defects and the notifying of neighbouring stations. The ESP32 is used to connect the computer to the sensors and to monitor and detect the railway track crack. The track's signal is transmitted and received using an infrared sensor. The signal is transmitted by the transmitter through the track; if a crack appears in the track, the signal is chopped down and returned to the receiver. The location is tracked via GPS, which is connected to the ESP32. When sensor senses the crack, GPS tracks the location and it send the message to the nearby station through way to SMS.

S. Sam Jai Kumar, T. Joby Titus, V. Ganesh, V. S. Sanjana Devi (2016) proposed that the microcontroller unit is switched to low-power mode, which preserves the register contents while deactivating all other chip functions until the next External Interrupt or hardware reset. Next, the Timer continues to run in Power-save mode, allowing the user to keep a timer basis while the rest of the device is turned off. The ADC Noise Reduction option disables the CPU's efforts to reduce switching noise during ADC conversions. For Standby mode, while the rest of the gadget is dormant, the crystal or resonator or oscillator is functioning. Both the main Oscillator and the Asynchronous Timer continue to run in Extended Standby mode. Whenever the vehicle sensors detect any crack or deformation, an automated SMS will be delivered to a pre-defined phone number. Lastly, the inflator is used to fill the pneumatic air cylinders with air. It runs on 12 volts DC. It uses an integrated propeller to turn provided voltage into air. The solenoid valve is used to control the air cylinder. It works as a compressor.

N. L. Bhojwani, A. S. Ansari, S. S. Jirge, M. B. Baviskar, D. N. Pawar (2021) proposed that ultrasonic sensor and Arduino microcontroller detect a crack in the tracks, measuring distance for two railroads. If a crack appears in the track, the location's longitude and latitude coordinates must be sent to the nearest station or control room, and an ultrasonic sensor must be used to measure the distance between the two tracks. If a small variance is discovered, a message containing the location's coordinates must be sent to the nearest station or control room using the GPS and GSM module. This project will be undertaken in order to transform the railway crack detection system into one that is not only cost effective but also accurate and time efficient.

BS. Dhande and US. Pacharaney (2017) proposed two systems i.e., unmanned gate crossing controller and Crack detection system. For unmanned gate crossing controller system, it has one railway arrival point on one side and one train departure point on the other side of the level crossing. The arrival IR sensor detects the train's arrival and sends a signal to the level crossing while simultaneously closing the gate. For the departure IR sensor, it detects the train's departure and sends a signal to the level crossing, where the gate is opened. Next, the crack detecting system has been set to self-calibrate the IR transmitter and receiver. After calibration, the robot waits for the GPS module to start reading the proper geographic coordinate for the predetermined amount of time. The main purpose of the process is that the amount of light reaching the IR receiver is related to the crack's intensity. Both the IR transmitter and receiver will be mounted on the rail in a straight line. When the light from the transmitter does not fall on the receiver during operation, there is no crack identified. When light from the transmitter falls on the receiver, i.e., when light deviates from its course due to a crack in the railway track, the outcome is a crack. Lastly, to determine the train's current location in the event of a crack, we used a GPS receiver, which receives current latitude and longitude data. This latitude and longitude data will be sent to the IOT website via GSM modem.

2.6 Table of comparison

Table 2.1: Comparison of previous studies

AUTHOR(S)	PROJECT TITLE	COMPONENTS USED	TECHNIQUE
DR.K. Karuppasamy, Pavithra.S, Shalini Gunasekhara, Mariya Antony	Railway Track Breach Detection Using Raspberry Pi	- Raspberry Pi 3 Model - GPS - Web Camera - SD Card - IR Sensor	- Raspberry Pi and the Internet of Things with GPS device is used to determine the exact location of the crack track. A robot will move across a railway track equipped with infrared sensors to detect the crack. Its location is copied and sent to the most remote server.
Geethanjali C, Nadiya N, Nandhini S,	Railway Track Security System Using Raspberry Pi	- Raspberry Pi - IR Sensor - DC Gear Motor - GPS	- Use Raspberry Pi and an infrared sensor to detect faults in train roads. The sensor aids in the detection of cracks. GSM technology is used for communication. A message

Nivethitha N, Pavithra U		- Web Camera	will be sent to the nearest station when the system detects the crack.
S. Sam Jai Kumar, Joby Titus, V. Ganesh, V.S. Sanjana Devi	Automotive Crack Detection for Railway Track Using Ultrasonic Sensorz	- CC3200 Microcontroller - 12V DC - GSM Modem - Sensor - Inflator	-The sensor detects a crack in the railway track. The microcontroller recognizes that there is a crack. Another sensor will detect the train that may approach during the monitoring process.
N. Karthick, R. Nagrajan, S. Suresh, R. Prabhu	Implementation of Railway Track Crack Detection and Protection	- LED - Infrared LED - IR Sensor	- The train will move slowly when a crack is detected then the location will be sent to control room. When sensor detects the same signal from opposite train, then the train will stop. An emergency brake will be deploy when the other of train is derail.
N. L. Bhojwani, A. S. Ansari, S.	Railway Track-Crack Detection System by	- Raspberry Pi - Arduino	- Controlled by microcontroller using sensors with real - time solution that combines GPS tracking system and a

S. Jirge, M. B. Baviskar, D. N. Pawar	Using Arduino Microcontroller	- Ultrasonic Sensor - Motor Driver - Motor DC - GPS Module -GSM Module	GSM module to give alert messages together with pinpoint the crack's location.
BS. Dhande and US. Pacharaney	Railway Management System Using IR Sensors and Internet of Things Technology	- LPC2148 microcontroller - Stepper Motor - GPS Module - GSM Module - Sensor	- Using GPS to get the precise location of the crack. GSM modem to send the alert message. IOT (Internet of Things) is used to control the crack detection system on a real-time basis.
Rijoy Paul, Nima Varghese, Unni Menon, Shyam Krishna K	Railway Track Crack Detection	- Raspberry Pi - Camera - Wi-fi - GPS Module	- Using raspberry pi 3 to control all components. Image processing together combines the usage of a GPS tracking system and Wi-Fi to transmit alert messages as well as location's geographical coordinates.

		- Ultrasonic Sensor	
Prof.S.B.Deokar, Ashwini D.Kadam, Neha D.Pachupate, Nilam. D.kudale	IoT Based Railway Track Monitoring System Using Ultrasonic Sensor	- Raspberry Pi 3 Model-B - IR Sensor - Ultrasonic Sensor - GPS Module - Motor Driver	- Controlled by microcontroller. Built on Internet of Things (IoT) idea. The GPS Module is used to track the location. The data is then collected by sensors, and cracks at railway rails are found via computational analysis.
Chinmayi Athvale and Manali Athavale	Obstacle Detection & Gate Automation at Railway Crossings	- Raspberry Pi - Motor - Buzzer - LED Lamp - IR Sensor - Ultrasonic Sensor	- Microcontroller will send signals to all sensors at the same time. A timer has been established to allow vehicles to pass. To identify obstacles, it employs sensors and measure the distance between obstacles. The train's departure is detected also by a sensor.

Shubham Dhoke and Sandip A.Desai	Advanced Method to Detect Railway Track Damage Using Raspberry Pi and Internet of Things	- Raspberry Pi 2B Model - GPS Module - Wi-Fi - IR Sensor - Motor Driver	- Microcontroller and IOT are used. A device is used to pinpoint the exact location of the crack track. A robot will move across the track with sensor to detect crack. Then, information will be sent to the main server.

2.6.1 Elaboration for comparison table

The main reason this subtopic is made to elaborate more about the technique from the table above. Elaboration is the process of combining old data with new data to create a more complex, emergent whole. It can be defined as "broadening on" an idea or adding more details to it. It entails expanding an idea by adding details to accentuate the original simple concept. By adding nuance and detail to ideas and objects, elaboration improves them.

The main goal of this project is to use Raspberry Pi and the internet of things to create a simple, effective, and smartphones system for detecting railway track faults. It utilises a GPS technology to determine the exact location of the damaged track. A vehicle may move across a railway track equipped with infrared sensors to detect crack track. Its location is recorded and sent to the most remote server [1]. Next, this project uses a Raspberry Pi as microcontroller and an infrared sensor to detect cracks track. The IR sensor aids in the detection of cracks. After detecting the crack, a message containing the position of the crack is sent to the nearest station. As a result, the technology is easy to use and has advantages over both day and night crack detection. The detection of cracks in the track is constantly monitored [2].

The ultrasonic sensor is used to detect a crack in the train track by measuring the distance between track and sensor. If the distance is greater than the exact value, the microcontroller recognises a crack and tells the exact location of the crack using the formula "DISTANCE=SPEED*TIME." The train may approach during the checking process, which is detected by the vibration sensor and alerted to the microcontroller, reducing the size of the robot between the two tracks. When the train has completed its crossing, it returns to its original location and continues its inspection [3]. The sensor will be installed in the locomotive's engine. If a crack is detected on the track, the train will automatically slow down and halt at the designated location, and the exact location of the crack will be sent to the control room. The second source of accidents is averted by using the same sensors installed in the engine to detect the same signal from the other train. If the sensor detects the same signal from the opposite train, it automatically applies the brakes and stops the train at a set distance. Each locomotive's front end is equipped with Bluetooth device. If the train begins to derail, the signal is automatically broken, a warning is provided to the engine driver, and an emergency brake is deployed automatically on the other side [4].

This study explores the use of sensors to identify railway track cracks and is a dynamic strategy that combines the use of a GPS tracking system and a GSM module to transmit alert messages as well as the location's geographical coordinates. This device's actions are controlled and coordinated by an Arduino Microcontroller. The suggested system includes a robot that will run on the tracks automatically. LED and LDR sensor assembly in a system. This system includes a GSM and GPS module that will send real-time location or coordinates to the nearest railway station through SMS. The Railway Service currently employs machinevision technology to identify problems or symptoms in digital photographs of track elements, and unique algorithms for image analysis [5]. The suggested study proposes the concept of railway gate automation and crack detection, which has been enhanced with the use of IR sensors and IOT (Internet of Things) technology to perform autonomous gate operation and aid in the detection of broken track. Xammp server which is an IOT website is created solely to find the exact location of crack track. GPS and GSM also been used. The current latitude and longitude values are read using GPS. The current latitude and longitude data are sent to the hosted server via GSM modem [11].

The goal of this project is to use the Raspberry Pi 3, Image Processing, and ultrasonic sensors to construct a railway track break detecting system. A Raspberry Pi 3 serves as the system's key component. It is a proactive strategy that combines the usage of a GPS tracking system and a Wi-Fi to transmit alert messages and the location's coordinates. To control and coordinate the operations of various devices, a Raspberry Pi 3 is employed. Using internet of things technology, this concept prevents train derailment by detecting a crack in the railway track [12]. All of the operations are controlled by a Raspberry Pi. The system is built on the Internet of Things (IoT) idea. The location of the crack track is detected by using GPS. This system is fully in motion. It travels via this system before the train arrives. Three sensors are required. One IR sensor is used to follow the line and detect obstacles on the track, while two ultrasonic sensors are used to measure the perpendicular distance and send a message to the Raspberry Pi if a crack or other obstacle is discovered. Begin by establishing some distance thresholds. When the distance between two points changes, there is almost always an obstruction or a crack. The train system and the monitoring system are both synchronized [13].

The Raspberry Pi will send signals to the motor, buzzer, LED lamp, and sensors together at the same time. A timer has been established to allow vehicles to pass. When there's no obstacle at the end of the time period, the motor will close the gate. If an obstacle is detected, the gate will remain open at the end of the period time. To identify obstacles, the Obstacle Detection System employs infrared, ultrasonic sensors, and LEDs. The obstacle detection system is engaged as soon as the IR sensor senses the arrival of the train. It detects obstacles with an ultrasonic sensor and measures their distance in order to define the zone [14]. The main goal of this work is to use Raspberry Pi and the Internet of Things to create a simple, practical, and portable robot for detecting serious railway track defects. A GPS device is also used to pinpoint the exact location of the damaged track. A robot will move across the train track with infrared sensors to detect track flaws. The location of the crack track will then be determined and relayed to the main station [15].

2.7 Summary

This section of the literature study focuses on the project-related article, which is more about the application we used to monitor utilizing IoT. This chapter contains a summary of all associated approaches, as well as accompanying figures to facilitate comprehension. The majority of research is mainly focused on train track surveillance. The development of an application will bring several benefits to both parties in terms of monitoring the condition of train tracks. Aside from that, other research incorporates a variety of techniques, such as the usage of server-connected mobile applications. Users benefit from the user-friendly application, which supports them in times of tight spot, as demonstrated by the methods stated above.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will discuss the overall structure of the implementation process for any project system component or feature. It will explain briefly about the design and concept of this project. It will require three phases that are development, design, and testing the real-time monitoring system for user to monitor through the phone.

3.2 Methodology

The arrangement of work must be done carefully and with suitable accuracy in order for a project to be effective. This project can be implemented in a variety of methods or techniques. All of the techniques have been meticulously drafted to ensure that no errors or erroneous results are obtained.

3.2.1 Flowchart

A flowchart is a diagram that depicts the steps of a workflow or process. A flowchart is a visual representation of an algorithm or a step-by-step process for accomplishing a goal. The steps are represented as various sorts of boxes in the flowchart, with arrows connecting the boxes in a logical order. This diagrammatic depiction depicts a solution model for a specific problem. Flowcharts are used to assess, construct, document, and manage a process or program in a range of sectors.

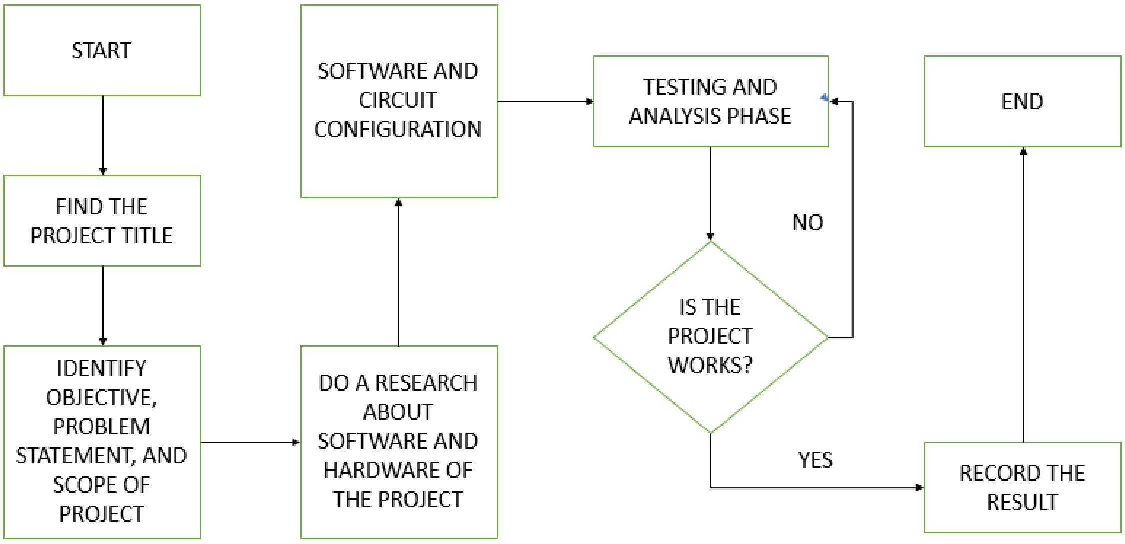


Figure 3.1: Process flowchart

The first step is to find the project title. It needs to be discussed and decide on to make sure the confirmation of the project. Second, is to identify objective, problem statement, and scope of project that related to the title. This part is important because the level of understanding needs to be very high related to the title. Third, do a research about software and hardware of the project. To understand this part, the researcher needs to read more journals, research papers, and articles to get more ideas and information. Next, the main purpose for testing and analysis phase is to do a simulation so that can detect the error from earlier stage of the project, and then can adjust the error. Then, if the project is working, then proceed to the next phase which is record the result and put it in the table. But, if it is vice versa, then repeat the testing and analysis phase.

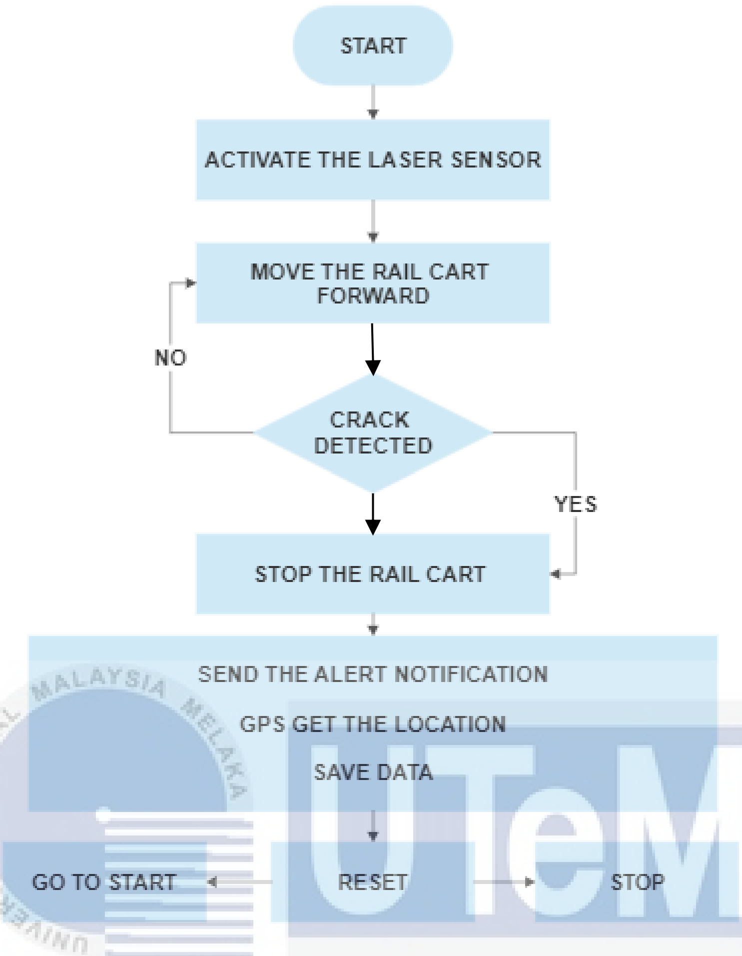


Figure 3.2: Algorithm flowchart

The algorithm flowchart starts with activate the laser sensor, then at the same time the rail cart will move forward through the railway. Next, when the sensor detect crack, the vehicle will stop but if not then it will continue move forward. After that, GPS will get the coordination of the location of the crack. Later, the coordination will be saved (data) to the Blynk Application which will act as the main station in this project. Lastly, the system will be reset again and if it wants to continue, then ‘go to start, if vice versa, then ‘stop’.

3.2.2 Block Diagram

To begin, the block diagram is the most important tool for ensuring that the project is completely operational. The monitoring system is the most important aspect of this project. The ESP32, which will serve as the project's microcontroller, will control the monitoring system's output. The ESP32 will be programmed with the program or coding needed to make the monitoring system work. The output will then be shown, together with each railway parameter of the monitoring system.

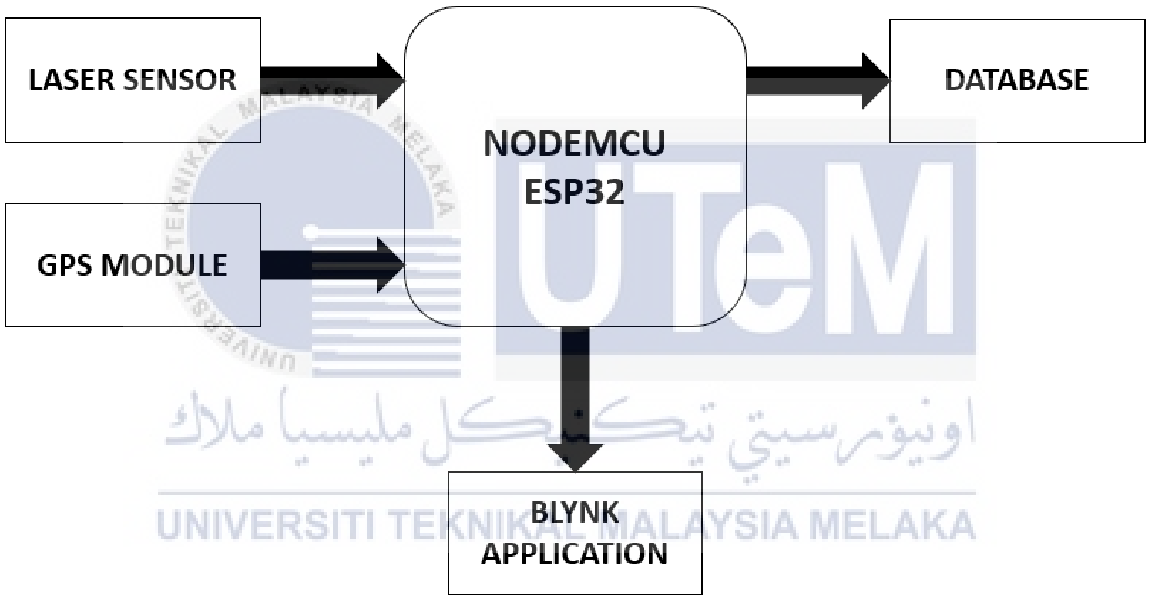


Figure 3.3: Block diagram of the project

3.3 Software Development

To ensure that the project runs well, the software that will be used must meet the project's requirements. There will be a software used in this project, which is listed below.

3.3.1 Arduino Integrated Development Enviroment (IDE)

The Arduino IDE is a cross-platform development environment created in the C and C++ programming languages. It's used to program and upload code to Arduino-compatible boards and other vendor development boards with third-party core support. On an Arduino board, the programming will take place. Transfer the coding to the Arduino board or module once it has been successfully verified. To control the program's operation, the Arduino board will act as a microcontroller.

Figure 3.4: Arduino IDE [17]

3.4 List of Components

3.4.1 NodeMCU ESP32

As an embedded system, a microcontroller with a CPU, memory, and peripherals can be employed. NodeMCU is an open source ESP32-based device that can connect to objects and transport data using the Wi-Fi protocol. It also develops Internet of Things (IoT) platform creation and prototype.

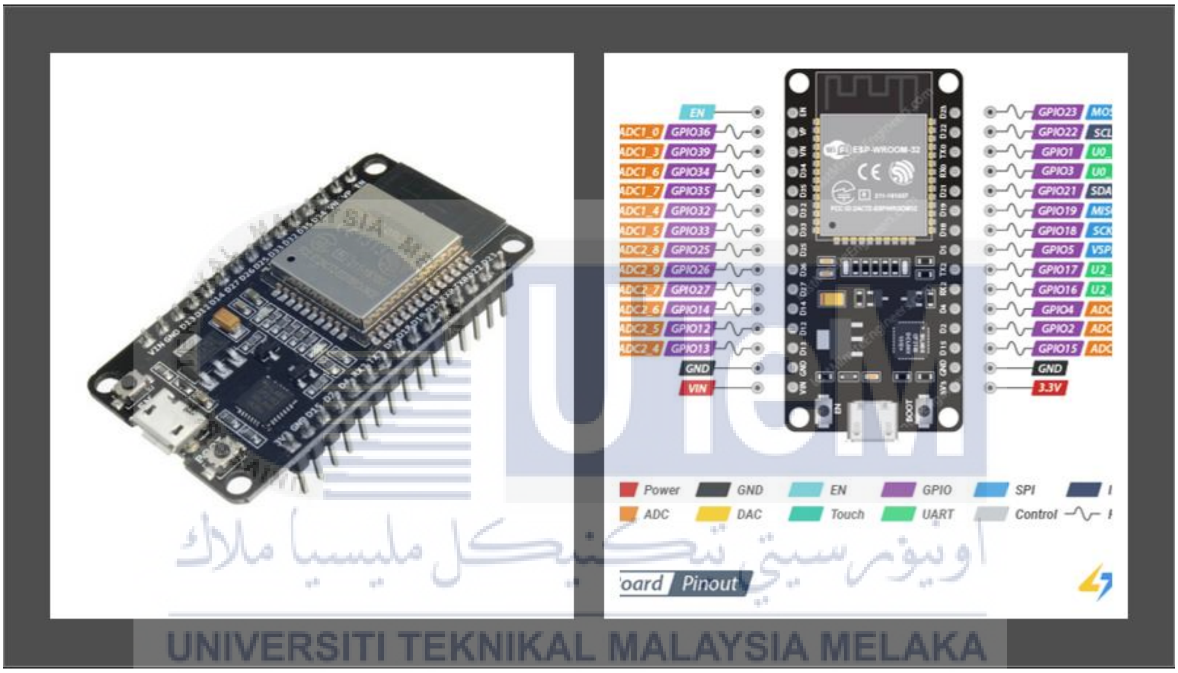


Figure 3.5: ESP32

3.4.2 Laser Sensor

Laser sensor detects distance from a target by using laser beam (i.e., railway steel). The difference between the time the wave signal was broadcast and the time the same wave was received after it bounced off the surface is used to calculate distance. For tracking, the ultrasonic sensor sends a sign which then bounces off of the railway metal's floor. This signal then returns returned to the sensor which measures the spherical-experience time it takes for the sign to journey. The sensor uses the measured time to calculate the distance to the surface of the railway steel. The sensor reviews that distance to a show and/or a controller.

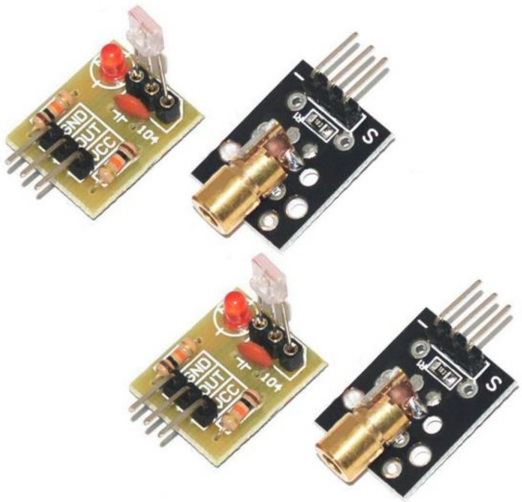


Figure 3.6: Laser sensor (HC-SR04)

3.4.3 GPS Module

The Global Positioning System, or GPS, is a global radio navigation system. The Global Navigation Satellite System (GNSS) Network is used by the GPS tracking system to track the device's location. This network comprises of a number of satellites that communicate data via microwave waves, which are then received by the GPS receiver module. The NEO-6M module has a packaging that measures 16 x 12.2 x 2.4 mm. It features six Ublox positioning engines that provide unrivaled performance. It's a high-performance GPS receiver with a small footprint, low power consumption, and dependable memory. Its architecture and power requirements make it perfect for battery-powered mobile devices.

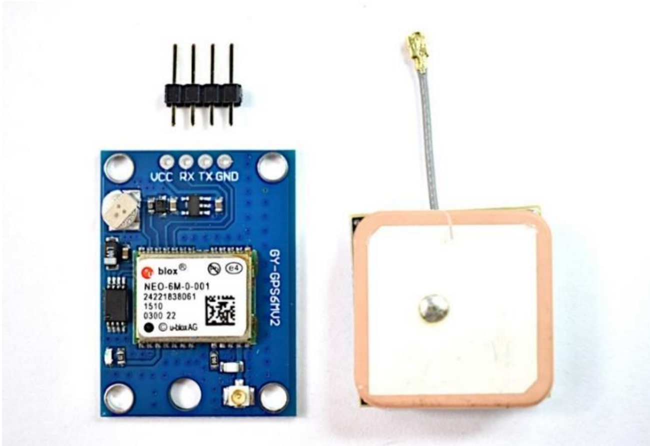


Figure 3.7: GPS module (Neo 6M)

3.4.4 Wiring Pipe (Electrical Conduit)

A tube used to cover and route electrical wires in a building or structure is known as an electrical conduit. Metal, plastic, fibre, or burned clay can all be used to make electrical conduit. Most conduit is stiff, although flexible conduit is employed for some applications. A wiring pipe serves as the holder for laser sensors which left side and right side. The diameter for this pipe is 20mm or 2cm. Length of the pipe is 146cm and its center will be put at the middle of the RC car. Both laser sensors will be put at 50cm from the center of the pipe. One at left side and one at right side.

Figure 3.8: Wiring pipe

3.4.5 Radio Controlled Car (RC CAR)

Radio-controlled or remote-controlled toys, sometimes known as RC toys, are self-powered and may be operated from a distance using a radio-frequency remote. The transmitter emits a specified amount of electrical pulses over the air in response to our action. The transmitter has its own power source, which is often a 9-volt battery. The transmitter will not be capable of transmitting radiowaves to the receiver if the battery is not there. When the RC toy receives radio signals, the motors start up to perform a certain activity. All operating elements, including the motor, receive electricity from the power source. The transmitter sends radio waves to control the motors, and the receiver activates them. A pair of electrical contacts touch when we push a button on the transmitter to make the RC toy go forward or backward. The receiver detects signals and transmits them to the circuit. A circuit board converts a series of electrical pulses (signals) into action.

Figure 3.9: RC Car

3.5 Summary

This chapter has described the methodology that will be used in this project as well as the development process. One by one, the explanations for the hardware and software used in this project are also provided. This will let the reader understand the project's development more clearly. A plan will be necessary to complete the project and achieve the project's goal. A plan will include the creation of a work flow and a timeframe for project development. This is to ensure that each component of this project is completed on time and successfully. Following the strategy, create a flow chart that depicts all of the operations and workflow for this project, as well as a Gantt chart to determine the needed time for accomplishing each job each week. Finally, an algorithm chart will be created.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter will provide a quick overview of the project's early development and outcomes in order to ensure that the sensor functions correctly. The prototype, which consists of a sensor and a microprocessor, will be discussed, and extended further. This chapter's design is not the finalized system; rat her, it is meant to gather information and understanding about the prototype design.

4.2 System Design

Figure 4.1: Final system design

Figure 4.2: System in the box

From figure 4.1, the two red attachments are the mounting for the laser sensors in between the left and right rails. The GPS module and ESP32 is located inside the box as shown in Figure 4.2. It also has a moving device (RC Car) to move the sensor for crack detection along the rail track and it is a motorized system. In actual usage on site, the sensors will be mounted on to the rail cart itself.

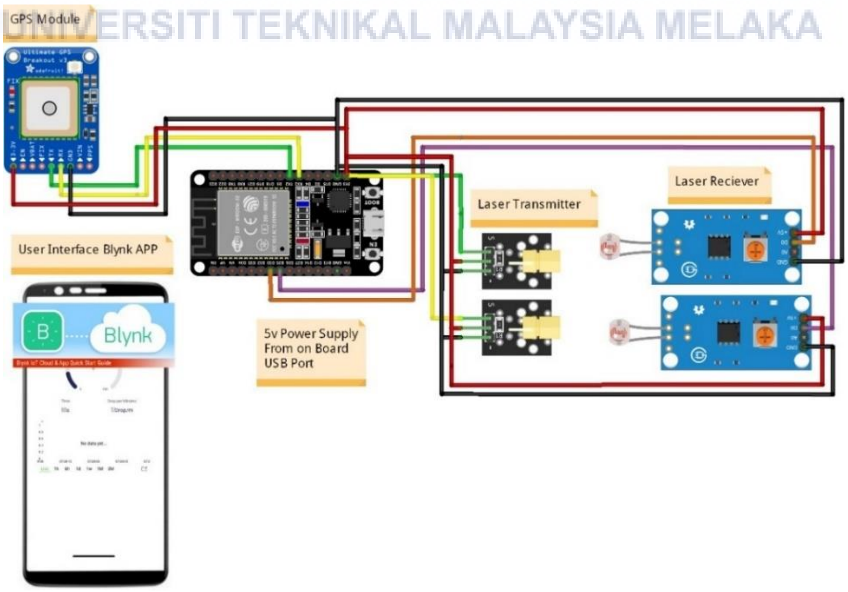


Figure 4.3: Circuit connection

Figure 4.3 shows the final circuit connection of the system. It combines the sensors and GPS module together. The coding of algorithms for the sensors, GPS module, Blynk application and data cloud storage is uploaded into the ESP32 using the Arduino IDE software.

4.3 Blynk Application

The Blynk programme serves as the foundation for the system's coding. The sensors' and GPS module's functionality is carried out by Blynk. As a result, using the Blynk programme, cracks could be recognised as well as their position. The system is also monitored using the Blynk programme. As the laser receiver receives light from the laser transmitter, Blynk may alert the user of which sensor has been identified while also determining its location. All of the information, including sensor detection, time, date, and position, is saved in a specified spreadsheet. Figure 4.4 depicts what occurs when the laser receiver detects light from the laser transmitter. The user will be notified on the spot where the fracture has been identified.

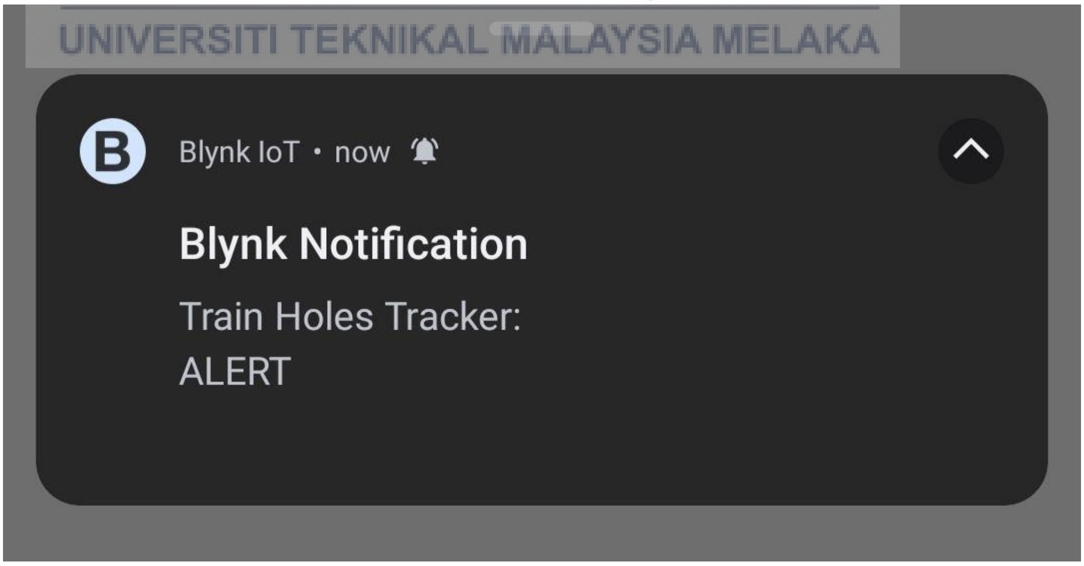


Figure 4.4: Notification alert

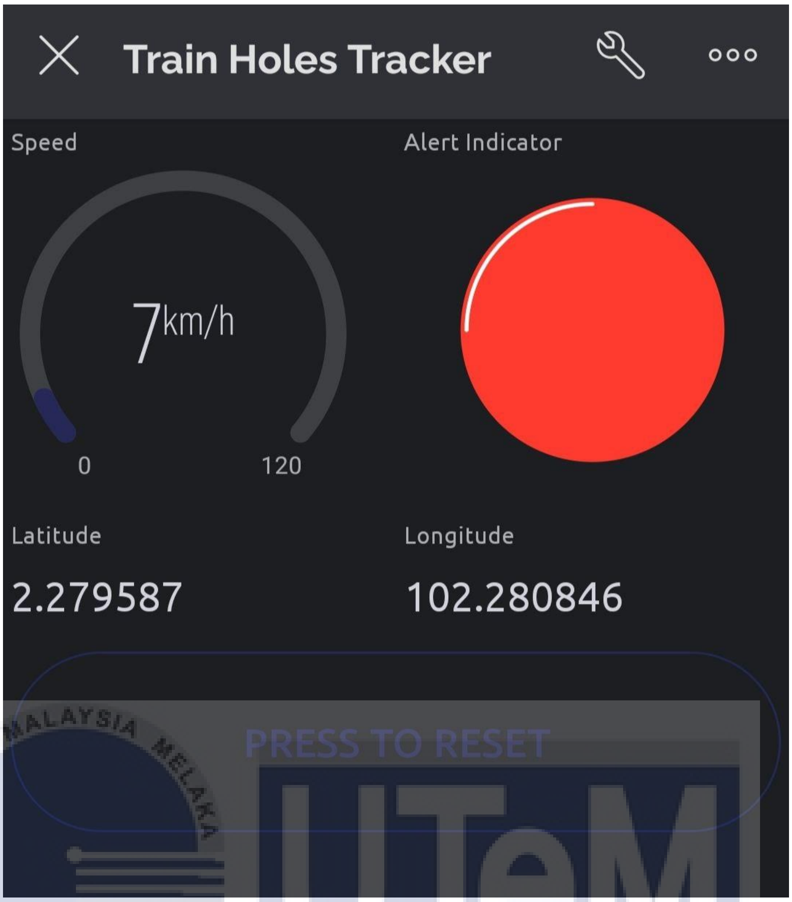
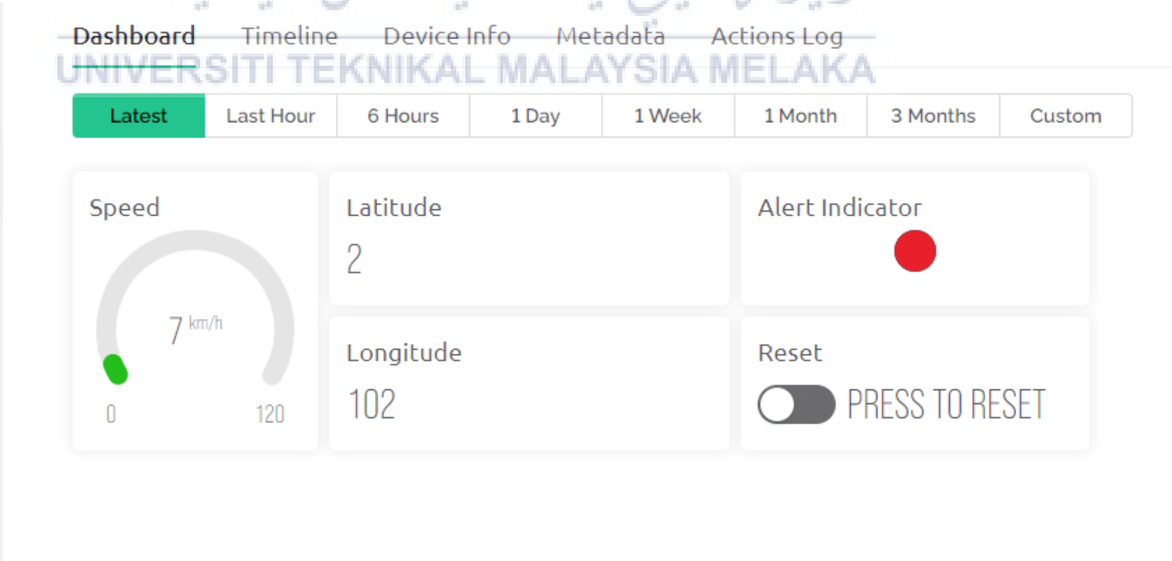


Figure 4.5: Blynk Interface (Handphone)



4.6: Blynk Interface (Laptop)

4.4 Data Storage

If This Then That (IFTTT) is used to store data collected by the laser sensor and GPS module. This information will be saved in the user's Google spreadsheet. The spreadsheet will show the time and date, which sensor is detecting the crack, and the position of the detected cracking in longitude and latitude coordinates. Figure 4.7 depicts a sample of the collected data in a Google spreadsheet.

A	B	C	D	E
January 12, 2023 at 10:30PM	coordinate_data			Right
January 12, 2023 at 10:34PM	coordinate_data			Left
January 12, 2023 at 10:34PM	coordinate_data			Left
January 12, 2023 at 10:36PM	coordinate_data			Left
January 12, 2023 at 10:37PM	coordinate_data			Right
January 12, 2023 at 10:40PM	coordinate_data			Right
January 12, 2023 at 10:46PM	coordinate_data			Right
January 12, 2023 at 10:46PM	coordinate_data			Left
January 12, 2023 at 10:46PM	coordinate_data			Right
January 12, 2023 at 10:48PM	coordinate_data			Right
January 12, 2023 at 10:48PM	coordinate_data			Right
January 12, 2023 at 10:49PM	coordinate_data			Left
January 12, 2023 at 10:50PM	coordinate_data	2.279762	102.280602	Left
January 12, 2023 at 10:50PM	coordinate_data	2.279699	102.280701	Left
January 12, 2023 at 10:53PM	coordinate_data	2.279679	102.280708	Left
January 12, 2023 at 10:53PM	coordinate_data	2.279738	102.280685	Right
January 12, 2023 at 10:55PM	coordinate_data	2.279785	102.2808	Right
January 12, 2023 at 10:55PM	coordinate_data	2.279792	102.280685	Left
January 12, 2023 at 10:58PM	coordinate_data	2.279805	102.28064	Right
January 12, 2023 at 10:58PM	coordinate_data	2.279698	102.280563	Left
January 12, 2023 at 10:58PM	coordinate_data	2.279649	102.280594	Left

Figure 4.7: Spreadsheet for data storage

4.5 Testing

Two types of testing have been conducted to examine the utility and accuracy of this prototype. One is sensor testing and the other is GPS testing. The job's specifics will be described more below. The case study will be made at two different places which at house porch and Ruin of Port Dickson Railway Station. First, case study at house porch, the railway track is made up of many long metal bars. Second, at Ruin of Port Dickson Railway Station, the actual railway will be used. To identify fractures, the sensor is moved along the metal bars or railway.

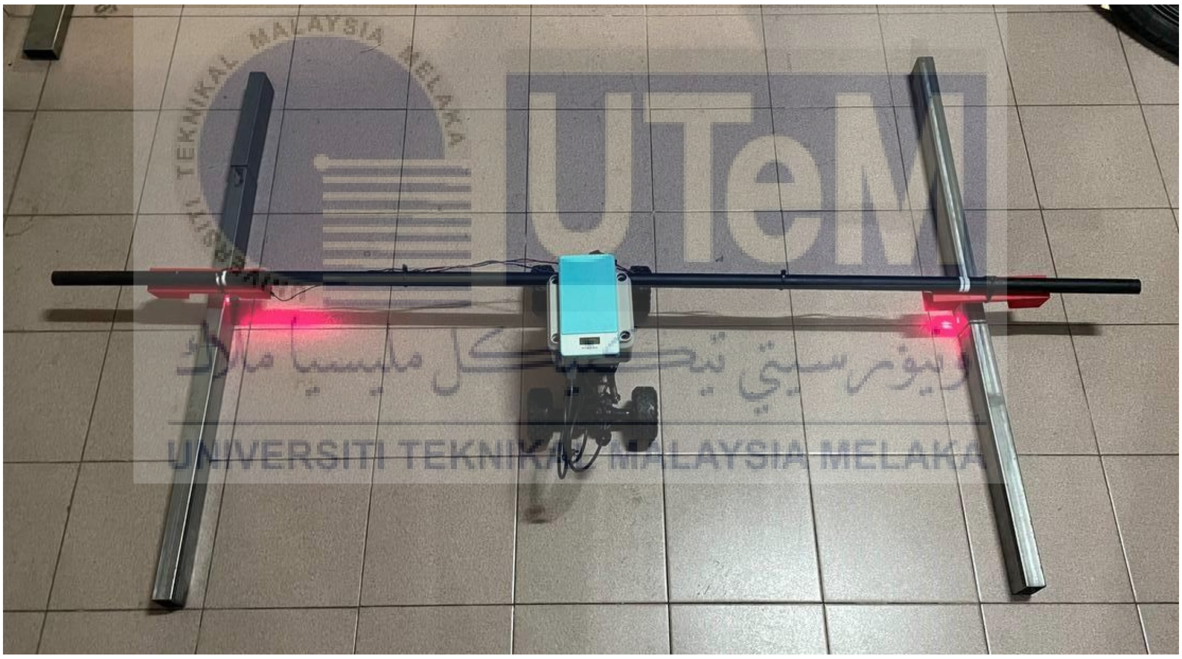


Figure 4.8: Case study at house porch (metal bars)

Figure 4.9: Case study at Ruin of Port Dickson Railway Station (actual railway)

4.5.1 Sensor Testing

The laser has two parts which transmitter and receiver. Transmitter part will emit a laser beam at the metal bars or railway, and if the receiver receive the laser beam from transmitter then it means that there is crack detected. To test the system's sensor, a few cracks are created and found on the metal bars or railway for the sensor to detect. The main reason for test at house porch is being conducted to determine the sensor's performance. A crack size test is performed to determine how small the crack may be for the sensor to detect. Table 4.1 shows the different size of crack made for this test.

4.5.1.1 Sensor Testing (House Porch)

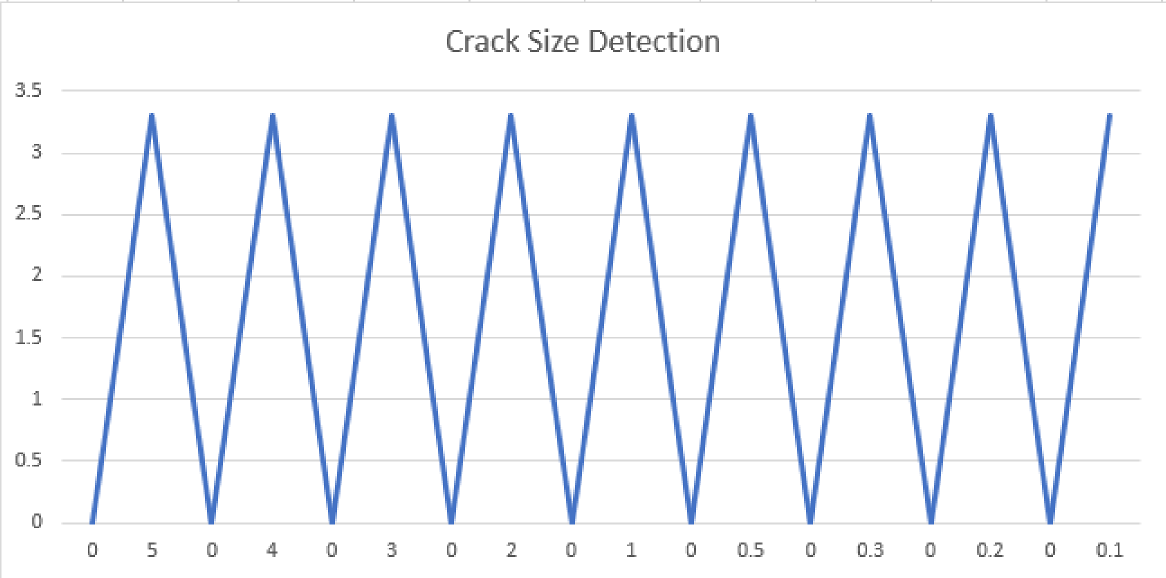
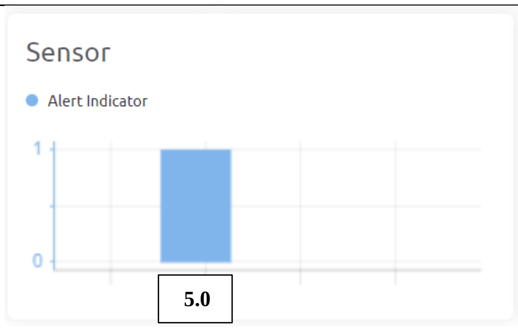
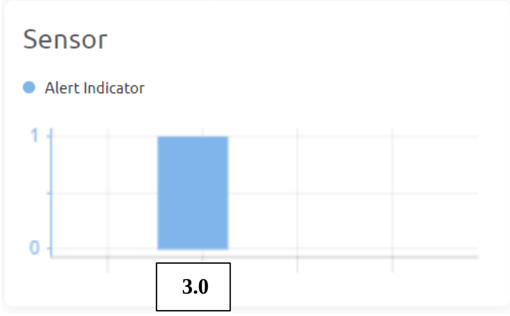
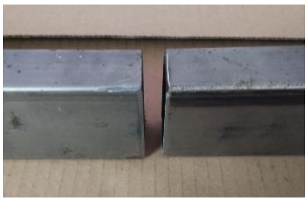
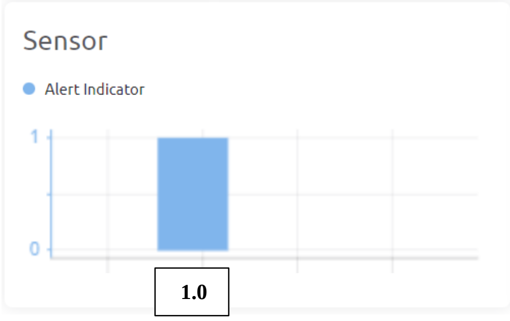
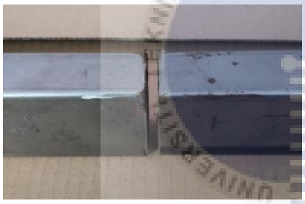
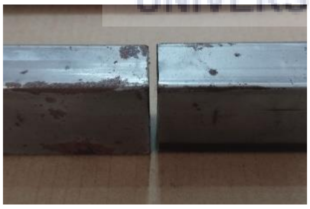
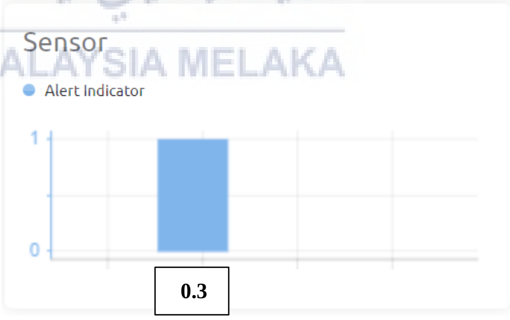
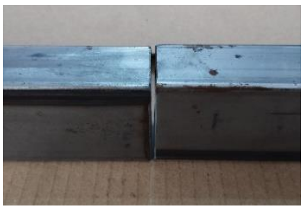
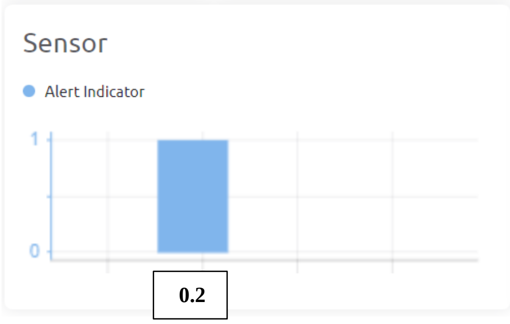


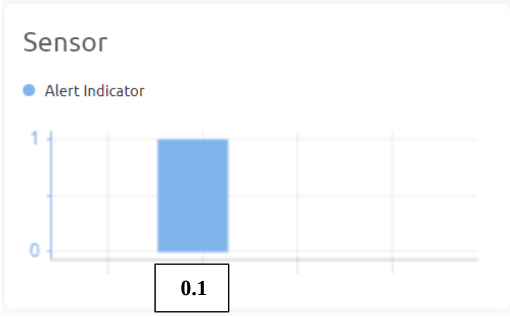
Figure 4.10: Crack size detection graph (Excel)

When the voltage at the laser receiver reaches 3.3V, the crack is detected. According to the graph above, the sensor may detect fractures since there are signals that exceed the 3.3V voltage.

Table 4.1: The sensor's perfomance (house porch)

CRACK	SIZE (in cm)	STATUS
	5	

	3	Sensor Alert Indicator 1 0 3.0
	1	Sensor Alert Indicator 1 0 1.0
	0.5	Sensor Alert Indicator 1 0 0.5
	0.3	Sensor Alert Indicator 1 0 0.3
	0.2	Sensor Alert Indicator 1 0 0.2

	0.1	

According to Table 4.1, the graph in STATUS column indicates the sensor can detect the crack as small as 0.1cm.

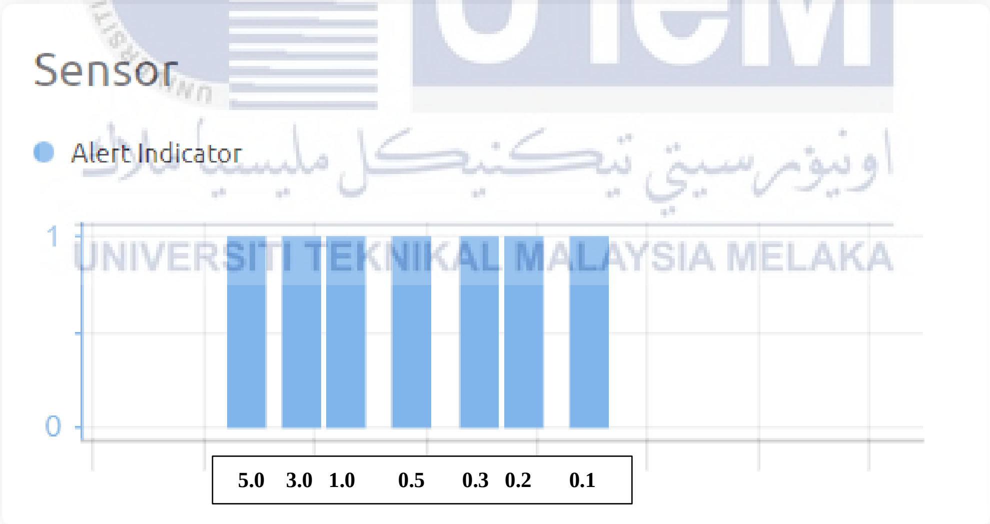


Figure 4.11: Crack size detection graph (Blynk)

4.5.1.2 Sensor Testing (Ruin of Port Dickson Railway Station)

Figure 4.12: The crack at the railway

Figure 4.13: The crack size is 1cm

4.5.2 GPS Testing

The GPS testing is performed twice, the first time to establish position connecting between the sensor and Blynk. The second test is performed with the GPS turned off. The second test's goal is to determine why the location acquisition is inconsistent. For the first test, the GPS can retrieve a location and the longitude and latitude of the site as soon as the sensor detects the fracture. Figure 4.13 depicts the outcome of test 1 of the data storage location provided on the spreadsheet.

4.5.2.1 GPS Testing (House Porch)

A	B	C	D	E
January 12, 2023 at 10:50PM	coordinate_data	2.279762	102.280602	Left
January 12, 2023 at 10:50PM	coordinate_data	2.279699	102.280701	Left
January 12, 2023 at 10:53PM	coordinate_data	2.279679	102.280708	Left
January 12, 2023 at 10:53PM	coordinate_data	2.279738	102.280685	Right
January 12, 2023 at 10:55PM	coordinate_data	2.279785	102.2808	Right
January 12, 2023 at 10:55PM	coordinate_data	2.279792	102.280685	Left
January 12, 2023 at 10:58PM	coordinate_data	2.279805	102.28064	Right
January 12, 2023 at 10:58PM	coordinate_data	2.279698	102.280563	Left
January 12, 2023 at 10:58PM	coordinate_data	2.279649	102.280594	Left
January 12, 2023 at 11:02PM	coordinate_data	2.279648	102.280586	Right
January 12, 2023 at 11:03PM	coordinate_data	2.279871	102.280685	Right
January 12, 2023 at 11:03PM	coordinate_data	2.279862	102.280685	Right
January 12, 2023 at 11:06PM	coordinate_data	2.279766	102.280645	Right
January 12, 2023 at 11:07PM	coordinate_data	2.279686	102.280711	Right
January 12, 2023 at 11:10PM	coordinate_data	2.279684	102.280718	Right

Figure 4.14: Location result at house porch

4.5.2.2 GPS Testing (Ruin of Port Dickson Railway Station)

A	B	C	D	E
January 15, 2023 at 03:58PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:06PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:07PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:08PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:09PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:09PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:11PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:15PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:16PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:17PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:21PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:21PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:40PM	coordinate_data	2.521818	101.795035	Right
January 15, 2023 at 04:42PM	coordinate_data	2.521818	101.795035	Right

Figure 4.15: Location result Ruin of Port Dickson Railway Station

Column C represents the longitude while column D represents the latitude. From here, the location is taken as the sensor detects any cracks.

4.6 Limitations

More testing of this prototype reveals one drawback, which is the performance of the GPS module. It was discovered that the GPS module was unable to obtain the location under certain conditions. Figure 4.14 depicts the GPS module's inability to pinpoint the position of detected fractures. Another GPS test is performed to back up this claim. The GPS module is in a stand-alone mode for this test, and it is being tested with an Arduino uno. Table 4.1 displays the GPS module's performance under various conditions. After testing the GPS module with the Arduino UNO, the serial monitor display from the Arduino IDE programme is shown in Figure 4.15. That display does not provide any geographical coordinates. This indicates that the location could not be obtained.

October 18, 2022 at 07:05PM	coordinate_data			Right
October 18, 2022 at 07:05PM	coordinate_data			Right
October 18, 2022 at 07:06PM	coordinate_data			Right
October 18, 2022 at 07:07PM	coordinate_data			Right
October 18, 2022 at 07:07PM	coordinate_data			Left
October 18, 2022 at 07:08PM	coordinate_data			Left
October 18, 2022 at 07:08PM	coordinate_data			Left
October 18, 2022 at 07:11PM	coordinate_data			Left
October 18, 2022 at 07:12PM	coordinate_data			Left
October 18, 2022 at 07:12PM	coordinate_data	2.279762	102.280602	Right
October 18, 2022 at 07:14PM	coordinate_data	2.279699	102.280701	Left
October 18, 2022 at 07:14PM	coordinate_data	2.279679	102.280708	Left
October 18, 2022 at 07:15PM	coordinate_data	2.279738	102.280685	Right
October 18, 2022 at 07:15PM	coordinate_data	2.279785	102.2808	Left
October 18, 2022 at 07:15PM	coordinate_data	2.279792	102.280685	Right
October 18, 2022 at 07:15PM	coordinate_data	2.279805	102.28064	Right
October 18, 2022 at 07:16PM	coordinate_data	2.279698	102.280563	Left
October 18, 2022 at 07:16PM	coordinate_data	2.279649	102.280594	Left
October 18, 2022 at 07:16PM	coordinate_data	2.279648	102.280586	Left
October 18, 2022 at 07:16PM	coordinate_data	2.279871	102.280685	Right
October 18, 2022 at 07:17PM	coordinate_data	2.279862	102.280685	Left

Figure 4.16: Inconsistent location result

Table 4.2: GPS module performance

Condition	Location Received
Indoors with clear skies	No
Indoors with cloudy skies	No
Outdoor with clear skies	Yes
Outdoors with cloudy skies	No

According to Table 4.2, the GPS module can only get a location when the module is outdoors and under clear skies.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Finally, the purpose of this project is to create and execute a system that ensures train track always in a safety condition. The suggested approach not only solves these issues, but it also improves rail accuracy and fracture detection. It is the most cost-effective approach available in order to improve the performance of our country's railways and reduce the number of accidents that occur. The technology has the ability to pin-point a place, and by deploying this autonomous vehicle for railway track inspection and crack identification, it will have a significant impact on track maintenance, resulting in a significant reduction in train accidents. This will facilitate in the maintenance and monitoring of railway lines without errors, resulting in the tracks remaining in good shape. When compared to the traditional approach, the proposed solution has numerous advantages. Less cost, higher accuracy, lower power usage, and faster analysis are just a few of the benefits. Finally, the system can be adopted on a wide scale in the long run to help improve train track safety standards and provide effective testing infrastructure for future outcomes.

5.2 Future Works

The best approach to continue forward with this project is to overcome the GPS module's drawbacks. In terms of accuracy, precision, and performance, a far better GPS module is required. With a higher performance GPS module, position may be retrieved more quickly and without regard to weather or circumstance.

Another method for optimizing this project is to use image processing and machine learning. In other words, install two cameras from both sides for visual results purposes. This is accomplished by having the system look for not just cracks, but also a variety of other irregularities on the railway track along the train track's journey. With this approach, the procedure is significantly faster, and the data is lot clearer and easier to examine.

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APPENDICES

APPENDIX A

```
//-----------------------------------------------------------------------------
// Template ID, Device Name and Auth Token are provided by the Blynk.Cloud
// See the Device Info tab, or Template settings
#define BLYNK_TEMPLATE_ID "TMPLEV_PoV3_"
#define BLYNK_DEVICE_NAME "Train Holes Tracker"
#define BLYNK_AUTH_TOKEN "mhrOm0TXCrs9wyV7KjwPAleD_D-s9O1A"
//-----------------------------------------------------------------------------
// Comment this out to disable prints and save space
#define BLYNK_PRINT Serial
//-----------------------------------------------------------------------------
#include <WiFi.h>
#include <WiFiClient.h>
#include <HTTPClient.h>
#include <BlynkSimpleEsp32.h>
//-----------------------------------------------------------------------------
char auth[] = BLYNK_AUTH_TOKEN;
// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "RedmiNote11"; // Name of your network (HotSpot or Router name)
char pass[] = "Shamil18";
//-----------------------------------------------------------------------------
// IFTTT Function
String server = "http://maker.ifttt.com";
String eventName = "coordinate_data";
String IFTTT_Key = "dEK-q0nWr6uGdEuG0paeI9GPJ3QyXBv_u4BROlHltlc";
String IFTTTUrl = "http://maker.ifttt.com/trigger/coordinate_data/with/key/dEK-q0nWr6uGdEuG0paeI9GPJ3QyXBv_u4BROlHltlc";
```

```
String value1;
String value2;
String value3;
//-----------------------------------------------------------------------------
//GPS Module Settings
//GPS Module RX pin to ESP32 17
//GPS Module TX pin to ESP32 16
#include <TinyGPS++.h>
#define RXD2 16
#define TXD2 17
HardwareSerial neogps(2);
TinyGPSPlus gps;
float latitude = 0;
float longitude = 0;
float speed = 0;
//-----------------------------------------------------------------------------
//Physical pin on ESP32 from laser receiver
#define laserLeft_pin  32
#define laserRight_pin 33

int laser_left = 0;
int laser_right = 0;
String ALERT = "alert";
String szNotification_Text;
WidgetMap myMap(V5);
WidgetLED alertLED(V3);
//-------------------------------------------------------------------------------
BlynkTimer timer;
#define INTERVAL 1000L
//-------------------------------------------------------------------------------
/*************************************************************************************
    This function sends Arduino's up time every second to Virtual Pin.
    In the app, Widget's reading frequency should be set to PUSH. This means
    that you define how often to send data to Blynk App.
 ************************************************************************************/
void sendGps()
{
  //-----------------------------------------------------------------
  while (neogps.available())
  {
    if (gps.encode(neogps.read()))
    {
      break;
    }
  }
  //-----------------------------------------------------------------
  if (!gps.location.isValid())
  {
    Serial.println("Failed to read from GPS Module!");
    return;
  }
  //-----------------------------------------------------------------
```

```
//------------------------------------------------------------
//get latitude and longitude
float latitude = gps.location.lat();
float longitude = gps.location.lng();
value1 = (String(latitude, 6));
value2 = (String(longitude, 6));
float speed = gps.speed.kmph();
//------------------------------------------------------------
//comment out this block of code to save space
//used for debugging in serial monitor
//Serial.print("Latitude:  ");
//Serial.println(latitude, 6);
//Serial.print("Longitude: ");
//Serial.println(longitude, 6);
//Serial.print("Speed: ");
//Serial.println(speed, 6);
//------------------------------------------------------------
// You can send any value at any time.
// Please don't send more that 10 values per second.
//Blynk.virtualWrite(V5, 1, latitude, longitude, "gps location");
Blynk.virtualWrite(V5, longitude, latitude);
Blynk.virtualWrite(V1, String(latitude, 6));
Blynk.virtualWrite(V2, String(longitude, 6));
Blynk.virtualWrite(V0, String(speed));

szNotification_Text = "Go to Coordinate:";
szNotification_Text += String(latitude, 6) + "," + String(longitude, 6);
//------------------------------------------------------------
```

```
void setup()
{
  //------------------------------------------------------------
  //Debug console (Serial Monitor)
  Serial.begin(115200);
  pinMode(laserLeft_pin, INPUT_PULLUP);
  pinMode(laserRight_pin, INPUT_PULLUP);
  //------------------------------------------------------------
  WiFi.mode(WIFI_STA);
  WiFi.begin(ssid, pass);

  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("Viola, Connected !!!");
  Blynk.begin(auth, ssid, pass);
  //You can also specify server:
  //Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);
  //Blynk.begin(auth, ssid, pass, IPAddress(192,168,1,100), 8080);
  //------------------------------------------------------------
  //Set GPS module baud rate
  neogps.begin(9600, SERIAL_8N1, RXD2, TXD2);
  Serial.println("neogps serial initialize");
  delay(10);
  //------------------------------------------------------------
  // Setup a function to be called every second
  timer.setInterval(INTERVAL, sendGps);
  //------------------------------------------------------------
//============================================================ void sendData
void sendDataToSheet(void)
{
  String url = server + "/trigger/" + eventName + "/with/key/" + IFTTT_Key + "?value1=" + String(value1) + "&value2=" + String(value2) + "&value3=" + String(value3);
  Serial.println(url);
  //Start to send data to IFTTT
  HTTPClient http;
  Serial.print("[HTTP] begin...\n");
  http.begin(url); //HTTP

  Serial.print("[HTTP] GET...\n");
  // start connection and send HTTP header
  int httpCode = http.GET();
  // httpCode will be negative on error
  if (httpCode > 0) {
    // HTTP header has been send and Server response header has been handled
    Serial.printf("[HTTP] GET... code: %d\n", httpCode);
    // file found at server
    if (httpCode == HTTP_CODE_OK) {
      String payload = http.getString();
      Serial.println(payload);
    }
  } else {
    Serial.printf("[HTTP] GET... failed, error: %s\n", http.errorToString(httpCode).c_str());
  }
  http.end();
}
//============================================================
```

```
//==============================================================
void loop()
{
  Blynk.run();
  timer.run();
  laser_left = digitalRead(laserLeft_pin);
  laser_right = digitalRead(laserRight_pin);

  if (laser_left == LOW) {
    sendGps();
    alertLED.on();
    Blynk.logEvent(ALERT, szNotification_Text);
    value3 = "Left";
    sendDataToSheet();
    delay(3000);
    while (digitalRead(laserLeft_pin) == LOW) {
      // do nothing while laser left is detected
    }
  }
  else if (laser_right == LOW) {
    sendGps();
    alertLED.on();
    Blynk.logEvent(ALERT, szNotification_Text);
    value3 = "Right";
    sendDataToSheet();
    delay(3000);
    while (digitalRead(laserRight_pin) == LOW) {
      // do nothing while laser right is detected
    }
  }
  else {
    Serial.println("Both laser not detected");
    delay(1000);
  }
}
//=====================================================
BLYNK_WRITE(V4) {
  int virtualButton = param.asInt();
  if (virtualButton == HIGH) {
    alertLED.off();
  } else {
    // do nothing
  }
}
```

APPENDIX B

Gantt Chart PSM 1

APPENDIX																		
No.	Project Activity	Expected /Actual	Weeks															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Registration for PSM	Expected															
		Actual															
2	Final year project briefing	Expected															
		Actual															
3	Title discussion and decision with supervisor	Expected															
		Actual															
4	Study Related Research	Expected															
		Actual															
5	Complete Chapter 1: Introduction	Expected															
		Actual															
6	Progress Update to supervisor	Expected															
		Actual															
7	Complete Chapter 2: Literature Review	Expected															
		Actual															
8	Complete Chapter 3: Methodology	Expected															
		Actual															
9	Submit report	Expected															
		Actual															
10	Preparation for presentation	Expected															
		Actual															
11	Submit presentation video	Expected															
		Actual															
12	PSM 1 presentation	Expected															
		Actual															

Gantt Chart PSM 2

	W 1	W 2	W 3	W 4	W 5	W 6	W 7	W 8	W 9	W 10	W 11	W 12	W 13	W 14	W 15
Study Related Research															
Meeting with supervisor															
Doing Log book															
Research for project coding															
Complete Chapter 3: Methodology															
Progress Update to supervisor															
Chapter 4: Result and Discussion	BDP Briefing								Mid Term Break						
Chapter 5: Conclusion															
Doing project coding															
Buying project component															
Submit Draft Report															
Submit Report															
Submit Log Book															
PSM 2 Presentation															