Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF TRAIN TRACK MONITORING SYSTEM BY USING ESP32

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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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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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