Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF REAL-TIME VEHICLE IDENTITY DATABASE AT TOLL GATE USING RFID TECHNOLOGY

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SRI SELVA PRAKASH A/L NADERAJA

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

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DEVELOPMENT OF REAL-TIME VEHICLE IDENTITY DATABASE AT TOLL GATE USING RFID TECHNOLOGY

SRI SELVA PRAKASH A/L NADERAJA

A project report submitted
in partial fulfillment of the requirements for the degree of
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Disahkan oleh:

Ts. SULAIMAN BIN SABIKAN
Pensyarah
Fakulti Teknologi Kejuruteraan Elektrik & Elektronik
Universiti Teknikal Malaysia Melaka

(TANDATANGAN PENULIS)
Alamat Tetap: NO 214, JALAN DATO DAGANG 6, TAMAN SRI SENTOSA, 41200 KLANG SELANGOR

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Signature :

Supervisor Name : TS. SULAIMAN BIN SABIKAN

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DEDICATION

To my beloved mother, Krishna Vaini, and sister, Sri Suganyaa, thanks a lot for making the project possible. Without those financial and moral support provided by you, it would not be possible to complete this.

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ABSTRACT

The role of RFID technology in real-life applications are making positive impacts on the application's efficiency. A much faster and accurate data can be acquired and stored if associated with database system in real-time. The volume of vehicles on road in Malaysia increasing tremendously every year and yet there is not any effective database system has been developed to record the information of the vehicles passing the toll gates. The current Automatic Number Plate Recognition (ANPR) using integrated camera system facing difficulties in succession rate due to various in features of vehicle number plate. This causes a difficulty in developing a real-time database on vehicles' information accessing toll gates. The objective of this project is to develop a RFID detection system with a real-time database on vehicles' information accessing toll gates, set up a data presentation dashboard as a user interface and to analyze the traffic data from the developed databases. This project used a small single-board computer to process tag's serial number from microcontroller and store it in database in real-time. A microcontroller has been used to connect the RFID scanner. High Frequency (HF) RFID passive tag and reader used for detection. Node-RED acts as a platform to virtually connect the microcontroller, databases, and other string messages output. The databases have been added as data source in Grafana which acts as data visualization platform. Three presentation panels have been created that display the information of the vehicles' information passing the toll gate, traffic volume and bar chart of vehicle type volume. As a solution, an RFID-based real-time database on vehicles' information accessing toll gates with a functional user interface has been developed.

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ABSTRAK

Peranan teknologi RFID dalam aplikasi kehidupan sebenar memberi kesan positif terhadap kecekapan aplikasi. Data yang lebih pantas dan tepat boleh diperoleh dan disimpan jika dikaitkan dengan sistem pangkalan data dalam masa nyata. Jumlah kenderaan di jalan raya di Malaysia meningkat dengan pesat setiap tahun namun tiada sistem pangkalan data yang berkesan telah dibangunkan untuk merekodkan maklumat kenderaan yang melalui pintu tol. Pengecaman Plat Nombor Automatik (ANPR) semasa menggunakan sistem kamera bersepadu menghadapi kesukaran dalam kadar penggantian disebabkan oleh pelbagai ciri plat nombor kenderaan. Ini menyebabkan kesukaran untuk membangunkan pangkalan data masa nyata mengenai maklumat kenderaan yang mengakses pintu tol. Objektif projek ini adalah untuk membangunkan sistem pengesanan RFID dengan pangkalan data masa nyata mengenai maklumat kenderaan yang mengakses pintu tol, menyediakan papan pemuka pembentangan data sebagai antara muka pengguna dan menganalisis data trafik daripada pangkalan data yang dibangunkan. Projek ini menggunakan komputer papan tunggal kecil untuk memproses nombor siri tag daripada mikro pengawal dan menyimpannya dalam pangkalan data dalam masa nyata. Mikro pengawal telah digunakan untuk menyambungkan pengimbas RFID. Tag pasif RFID Frekuensi Tinggi (HF) dan pembaca digunakan untuk pengesanan. Node-RED bertindak sebagai platform untuk menyambung secara maya mikro pengawal, pangkalan data dan output mesej rentetan lain. Pangkalan data telah ditambah sebagai sumber data dalam Grafana yang bertindak sebagai platform visualisasi data. Tiga panel pembentangan telah diwujudkan yang memaparkan maklumat maklumat kenderaan yang melepasi pintu tol, isipadu trafik dan carta bar isipadu jenis kenderaan. Kesimpulannya, penyelidik membangunkan pangkalan data masa nyata berasaskan RFID mengenai maklumat kenderaan yang mengakses pintu tol dengan antara muka pengguna yang berfungsi.

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LIST OF ABBREVIATIONS

RFID	-	Radio Frequency Identification
VIT	-	Vehicle Identity Tag
TEV	-	Toll Entry Vehicle
VIR	-	Vehicle Identity Record
NPs	-	Number Plates
SQL	-	Structured Query Language
RFID	-	Radio Frequency Identification
VIT	-	Vehicle Identity Tag

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Millions of vehicles are passing through toll gates every day yet there is not any effective database system has been developed to record the information of the vehicles passing the toll gates. A database is an organized collection of structured information or data stored electronically in a computer system. Automatic Number Plate Recognition (ANPR) using integrated camera system were developed as a solution for this. The first ANPR system was invented in 1976 in the UK [1][2]. The system then gained the attention after the improvement of digital camera and the increase in computational capacity over the last decades. This system works with the help of camera capturing images of number plates (NPs) of vehicle and then process the images through special algorithm to extract the alphanumeric from the plate.

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However, the challenges begin when the images captured needs to have a high resolution as low-resolution images can result in different output than actual. In real-time application there are possibilities for the image captured gets blurred due to the speed of vehicle movement and environmental factor[3]. An improved optical character recognition (OCR) based ANPR using features trained neural network were proposed by having a three stages of image processing which is Number Plate Localization (NPL), character segmentation and OCR matching [4]. The improved system still achieved 96.9% succession rate under normal circumstances.

More studies were caried out on modifying the algorithm patterns for a better capture and process the image to extract the alphanumeric from the NPs accurately. ANPR system using You Only Look Once (YOLO) detector were also proposed but it is still has some future works to be done in terms of achieving more accurate detection in different scenarios such as inclined number plates and optimizing the speed of the detection stages [5]. However, the current ANPR system facing difficulties in succession rate to recognize the number plate due to various in features of vehicle NPs such as area and aspect ratio of the number plate, background color, foreground color, shape, number of lines, font face/ size of characters, spacing between characters. Moreover, the environmental factor becomes a challenge for this system as the images were capture under various environmental condition such as varying lighting and weather conditions, varying pollution level and wind turbulences [6]. There are articles mentioned ANPR system been a costly technology available only for a limited range of systems[7]. Even though many studies are working on modifying the algorithms, augmentation, and camera technology yet none achieved a satisfying accuracy result for wide range of implementation. In the recent years, research about RFID technology were increased and started to implement on toll collection system and smart parking system yet develop a database system for vehicle using the RFID technology.

This project is about developing a database system with Radio Frequency Identification Technology (RFID) and Vehicle Identity Tag (VIT) .With the implementation of RFID technology, the detection can be done more effectively [8]. When the reader detects the tag, the single-board computer, Raspberry Pi refers to the Vehicle Identity Record (VIR) database through Internet of Things (IoT) based on the unique VIT serial number detected to acquire the information. It is then transmitting the information to store in a new database called Toll Entry Vehicle (TEV) database which stores the information of vehicles passed by the toll gate.

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1.2 Problem Statement

A real-time database on vehicle passing toll gates is an important record to be recorded as it serves number of purposes such as a method of cataloguing the movement of traffic, prevent crimes and helps in police investigation. However, the current Automatic Number Plate Recognition (ANPR) using integrated camera system facing difficulties due to many aspects such as the NPs are various in features such as area and aspect ratio of the number plate, background color, foreground color, shape, number of lines, font face/ size of characters, spacing between characters. Moreover, the current RFID technology are yet used in developing database system for vehicles on road. The system to create a real-time database of vehicles accessing the toll gates yet developed due to the current vehicle identity detection system is still not ready to operate in big scale due to the challenges mentioned above. Moreover, there is also no user interface has been developed to access the real-time database to be used by the relevant traffic department authorities or government authorities such as the police department for investigation purpose and monitor the traffic activity at toll gate. Therefore, the project proposes a system that develop a database on vehicles' information passing toll gates and design data visualization panels as a user interface.

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1.3 Project Objective

The objective of the project are as follows:

i) To develop a vehicle identity detection system using Vehicle Identity Tag (VIT) and RFID technology at toll gate.

ii) To develop a real-time database on vehicle passing through toll gates via internet communication.

iii) To develop a user interface to monitor the system

iv) To analyze the traffic data from developed databases.

1.4 Scope of Project

By narrowing the needs for this project, a few guidelines are proposed to ensure that this project will achieve the stated objectives. The scope of this project are as follows:

i) Raspberry Pi 4 acts as a single-board computer to this project.

ii) NodeMCU ESP32 acts as a microcontroller to this project.

iii) Develop the user interface in Grafana and present the necessary data acquired from the NodeMCU ESP32 and databases.

iv) Develop the database system with the implementation of password security feature as added security in SQL database server.

v) Develop the RFID detection system using Mifare RC 522 High Frequency (HF) RFID reader and tag.

vi) Integrate RFID detection system with Vehicle Identity Record (VIR) and Toll Entry Vehicle (TEV) databases.

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vii) The databases and data presentation panels are accessible by localhost device only.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

In today's world, vehicle production increases tremendously every year as the demand for its usage become vital in human's life. The number of vehicles on road increases but there is not any system has been developed to create a database about the information of the vehicles on road especially at toll gates. Database is an organized collection of structured information or data stored electronically in a computer system for example storing the information of the vehicle such as vehicle number, car type & color, expiry date of road tax and owner information in a server system. Therefore, this project helps to develop a system to create a database on vehicles passing the toll gates with the help of RFID technology. This system will help the government authorities to monitor the vehicle passing toll gates which also helps in police investigation.

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2.2 Radio Frequency Identification (RFID) Technology

RFID technology is an automatic technology and aids machines or computers to identify object, record metadata or control individual through radio waves signal. Over the last decades, RFID becomes so popular among many sectors of industries due to its wide range of usage in many scales. The system consists of tag which also known as transmitters/responders and readers. The RFID reader will communicate with the RFID tag through radio wave signal enables data transfer. Figure 2.1 shows how RFID reader and tag communicates. As shown in Figure 2.1, RFID technology has a wide range of frequency band spectrum such as Low Frequency (LF), High Frequency (HF) and Ultra-High

Frequency (UHF). This promises wholesale changes across a broad spectrum of business activities and aims to cut cost on the traditional bar code system [9].

The basic premise behind the RFID system is marked with tags. These tags contain transponders messages readable by specialized RFID readers. Most RFID tags can store with a Unique Identification Number (UIN), for example, a customer number or product Stock-Keeping Unit (SKU) code. Further, they read and retrieve information through the customer's ID number from the database. RFID tags can also contain editable memory, which can update the information from a Central Database; transfer those updates to RFID trackers which can read from any location. This information can be automatically encrypted at any speed of the tag movement. By accessing and decoding that available information, complete information about the vehicle can be retrieved. Figure 2.1 shows how RFID system works while Figure 2.2 shows the radio frequency band spectrum ranges.

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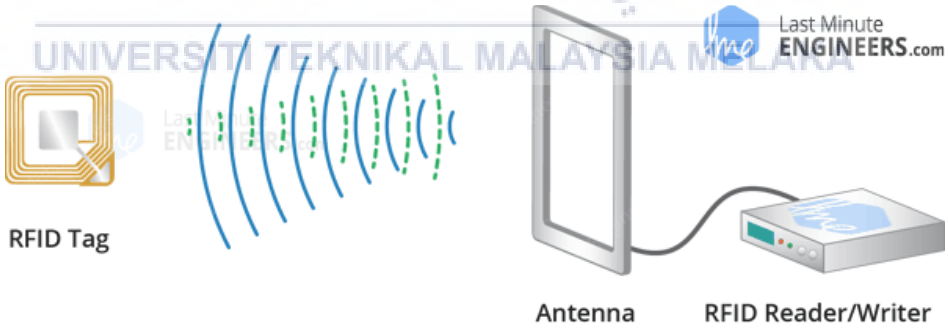

Figure 2.1 How RFID Communicates