DEVELOPMENT OF A REAL-TIME FOG-BASED RAILWAY COLLISION AVOIDANCE SYSTEM

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Telecommunications) with Honours.

by

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I hereby, declared this report entitled Development of a Real-Time Fog-based Railway Collision Avoidance System is the results of my own research except as cited in references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Author: Liew Kit Heng

Date: 18/2/2021

APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

Signature: ……

Supervisor : DR. IDA SYAFIZA BINTI MD ISA

Signature: ……

Co-supervisor: -

DEDICATION

This thesis is dedicated to my parents and family member who give me moral support and encouragement during completing this report. I also would like to dedicate my friends and supervisor that always possibly help me when I have trouble with this project.

ABSTRACT

There are many cases of railway collisions occur worldwide. To prevent the collision, a railway collision avoidance system is needed. A railway collision avoidance system is an automatic device that send an alerts message to pilots or control room when a collision is predicted. Although the railway collision avoidance system has been implemented for decades, the developed railway collision avoidance system still suffers from low reliability. Besides, to get the train 's location during poor weather is still challenging. This project aims to study and develop a railway collision avoidance system to prevent the collision of the railway network that has high reliability even during bad weather. In this project, the railway collision avoidance system is equipped with Radio-Frequency Identification (RFID) reader to scan the RFID tags located along the railway network. This railway collision avoidance system is also equipped with a GSM module to send the data reading by the RFID reader to the control rooms via SMS. Besides, the data is also update to Node-Red applications to create a live dashboard for the railway collision avoidance system. The developed system has been tested under two scenarios, during normal and rainy weather. The results show that the performance of the developed system has high reliability where the system can send out an alert signal via SMS to the control room by determining the location or locate position of the trains time to time under both normal and rainy weather.

ABSTRAK

Terdapat banyak kes perlanggaran kereta api yang berlaku di seluruh dunia. Untuk mengelakkan perlanggaran, sistem pemberitahuan anti-perlanggaran telah diminta. Sistem penghindaran perlanggaran kereta api adalah peranti automatik yang menghantar mesej amaran kepada juruterbang atau bilik kawalan apabila perlanggaran bakal berlaku. Walaupun penghindaran perlanggaran kereta api telah lama diperkenalkan, tetapi sistem penghindaran perlanggaran kereta api masih mengalami kebolehpercayaan. Selain itu, untuk mendapatkan lokasi kereta api semasa cuaca buruk masih mencabar. Projek ini bertujuan untuk mengkaji dan mengembangkan sistem penghindaran perlanggaran kereta api untuk mencegah perlanggaran jaringan kereta api yang menpunyai kebolehpercayaan yang tinggi walaupun Ketika cuaca buruk.. Dalam projek ini, sistem pemberitahuan anti perlanggaran dilengkapi pembaca Radio-Frequency Identification (RFID) untuk mengimbas tag RFID yang terdapat di sepanjang rangkaian kereta api. Sistem pernghindaran perlanggaran kereta api ini juga dilengkapi dengan modul GSM untuk mengirim pembacaan data oleh pembaca RFID ke bilik kawalan melalui SMS. Selain itu, data juga diperbaharui ke aplikasi Node-Red untuk membuat papan pemuka langsung untuk system penghindaran perlanggaran kereta api. Sistem yang dibangunkan telah diuji dalam dua scenario, semasa cuaca normal dan hujan. Hasil kajian menunjukkan bahawa prestasi system yang dibangunkan mempunyai kebolehpercayaan yang tinggi di mana system dapat menghantar isyarat amaran melalui SMS ke bilik kawalan dengan menentukan lokasi atau menentukan kedudukan kereta api dari semasa ke semasa di bawah cuaca normal dan hujan.

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LIST OF SYMBOL

s	Second
MHz	Mega Herts
kHz	Kilo Herts
V	Voltage
mA	Mile Ampere
cm	Centi metre
mm	Mile metre
kB	Kilobyte
g	Gram
%	Percent

LIST OF ABBREVIATIONS

RFID	Radio-Frequency Identification
KTMB	Kereta Api Tanah Melayu Berhad
M2M	Machine to Machine
SMS	Short Message Service
LTE	Long Term Evolution
4G	Fourth Generation of Broadband Cellular Network Technology
GSM	Global System for Mobile Communication
2G	Second Generation of Broadband Cellular Network Technology
WiFi	Wireless Fidelity
MQTT	Message Queuing Telemetry Transport
QoS	Quality of Service
UV	Ultraviolet
GPS	Global Positioning System
PLC	Programmable Logic Controller
CoAP	Constrained Application Protocol
HTTP	Hypertext Transport Protocol

AWS	Amazon Web Service
UART	Universal Asynchronous Receiver/ Transmitter
RTC	Real-Time Clock
GPS	Global Positioning System
SPI	Serial Peripherap Interface
IIC	Industrial Internet Consortium
SRAM	Static Random-Access Memory
LoRa	Long Range

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Nowadays, the whole world is focusing on developing the railway network. This is because the efficiency of the railway network shows the strength of a country is. The train is the perfect transportation for people and transports raw material from one place to the other place as it took a shorter time than ships besides cheaper than airplanes [1]. However, it has been reported that there were around 110 accidents involving trains that took place every year, which killed around 990 people and injured about 1500 people between 2013 – 2018 [2]. As reported by Kereta Api Tanah Melayu Berhad (KTMB), 17 people were killed in 2018 due to a train collision in Malaysia [3]. Railway collision is a disaster and the party concerned need to pay a painful price for the loss of life and cargo. Therefore, the existence of a railway collision avoidance system is vital to prevent disaster.

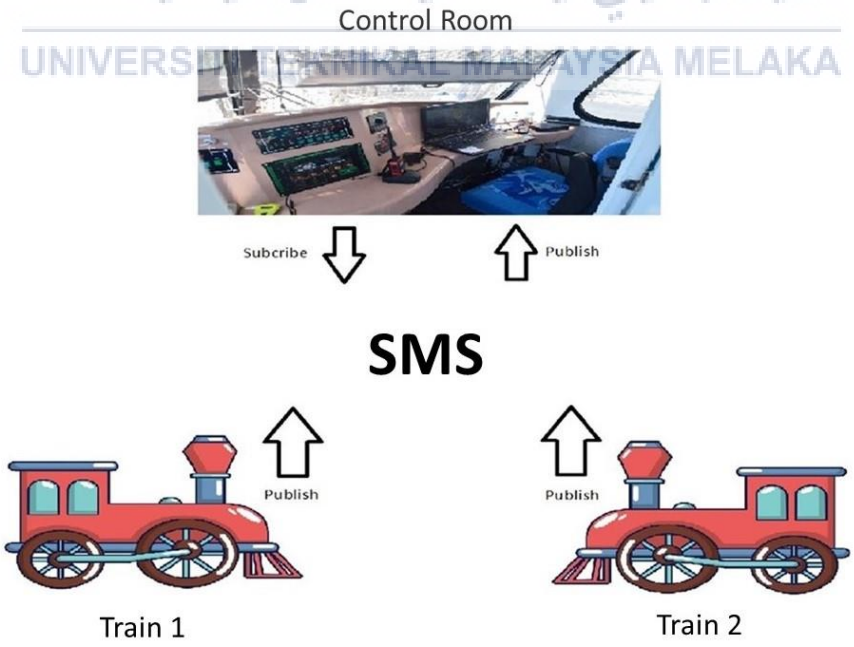

Figure 1.1: Real-Time Fog Based Railway Collision Avoidance System

Machine to machine (M2M) communications is one of the innovative technology for next-generation communications. The rapid development of M2M communication has inspired the development of numerous applications [4]. Many appliances equip with electric properties like Sensors, Smart Television, Car, Fan, Air conditional, Doors, etc give them the ability to perform M2M communications. M2M communication involves at least two machines, and the machines are connected via wireless. M2M communication can be expanded to more machines and create an ecosystem that helps humans in their life. For example, a smart home has become common in our life, and we can control our home applicants by just one click or touch on our smartphone. Short Message Service (SMS) is a text messaging service component first introduced in 1984 in German [34]. The railway tracks are usually built in rural areas, which has a poor internet connection. Thus, the communication method chosen to construct the railway network must be reliable to ensure that the communication between the train and the control room can be done within every corner of the world.

Figure 1.1 shows how the railway collision avoidance system connects to the control room. A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded order [8]. Arduino Mega was used in this project as a microcontroller to send the data received by the RFID reader to the control rooms. Arduino Mega was used in the project as a microcontroller of the control room to receive the data from the transmitter. To enable the communication between the railway collision avoidance system and control room, two IoT module is required. Therefore, the transmitter of the railway collision avoidance system can send data to the control room wirelessly via SMS. By connecting the control with the Node-Red, data can be fetched from anywhere, and it can be moved to the cloud for monitoring. There are many wireless technology standards for IoT module such as Long Term Evolution (LTE) or fourth generation of broadband cellular network technology (4G), Global

System for Mobile communication (GSM) or second generation of broadband cellular network technology (2G), Wireless Fidelity (WiFi), etc. In this work, we considered a 2G IoT module as it is cheaper compare to the 3G or 4G module. Although the 2G module has low speed compared to the other module, but the given transfer rate with the 2G module is enough to transfer small data.

The railway collision avoidance system of the railway network is a system that alerts the control room for incoming danger. This will be done by having an RFID reader and tag to record the location of the trains. A microcontroller will act as a brain of this system, and a 2G IoT module will allow the system to send data to the control room. The data will then send to Node-Red and display the location of the train in the control room. The alarm will be trigger once two trains are not in a safe distance. SMS is used as the messaging protocol in this system to ensure the information exchange between trains and control rooms are reliable.