

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



UNIVERSITI TEKNIKAL MALAYSIA MELAKA  
2020



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

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

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.

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## 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:



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## 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 pelanggaran kereta api yang berlaku di seluruh dunia. Untuk mengelakkan pelanggaran, sistem pemberitahuan anti-pelanggaran telah diminta. Sistem penghindaran pelanggaran kereta api adalah peranti automatik yang menghantar mesej amaran kepada juruterbang atau bilik kawalan apabila pelanggaran bakal berlaku. Walaupun penghindaran pelanggaran kereta api telah lama diperkenalkan, tetapi sistem penghindaran pelanggaran 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 pelanggaran kereta api untuk mencegah pelanggaran jaringan kereta api yang mempunyai kebolehpercayaan yang tinggi walaupun Ketika cuaca buruk.. Dalam projek ini, sistem pemberitahuan anti pelanggaran dilengkapi pembaca Radio-Frequency Identification (RFID) untuk mengimbas tag RFID yang terdapat di sepanjang rangkaian kereta api. Sistem pernghindaran pelanggaran 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 pelanggaran 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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## TABLE OF CONTENTS

	<b>PAGE</b>
<b>DECLARATION</b>	
<b>APPROVAL</b>	
<b>DEDICATION</b>	
<b>ABSTRACT</b>	<b>I</b>
<b>ABSTRAK</b>	<b>II</b>
<b>ACKNOWLEDGEMENTS</b>	<b>III</b>
<b>TABLE OF CONTENTS</b>	<b>IV</b>
<b>LIST OF TABLES</b>	<b>VIII</b>
<b>LIST OF FIGURES</b>	<b>IX</b>
<b>LIST OF APPENDICES</b>	<b>XII</b>
<b>LIST OF SYMBOLS</b>	<b>XIII</b>
<b>LIST OF ABBREVIATIONS</b>	<b>XIV</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Background	1
1.2 Objectives	4
1.3 Problem statement	5
1.4 Project scope	6
<b>CHAPTER 2 LITERATURE REVIEW</b>	<b>7</b>
2.1 Introduction	7
2.2 Existing Anti-collision system.	8
2.2.1 Train collision avoidance system.	8
2.2.2 An approach to avoiding train collision in railway sectors using	

	multi-agent system.	9
2.2.3	MQTT based vehicle accident detection and alert system.	10
2.2.4	Automatic emergency and security system for railway tunnel using programmable logic controller (PLC).	11
2.3	Type of railway collision.	12
2.4	Messaging Protocol.	14
2.4.1	Message Telemetry Queuing Transport (MQTT).	14
2.4.2	Constrained Application Protocol (CoAP).	15
2.4.3	Hypertext Transfer Protocol (HTTP).	15
2.4.4	Comparison of MQTT, CoAP, and HTTP.	16
2.5	Hardware.	18
2.5.1	Arduino Mega 2560.	18
2.5.2	RFID reader.	20
2.5.3	GSM Module	22
2.5.4	Global Positioning System (GPS)	24
<b>CHAPTER 3      METHODOLOGY</b>		<b>26</b>
3.1	Introduction	26
3.2	Block Diagram	26
3.3	Circuit Diagram	28
3.4	Operation flow	30
3.5	C++ Programming Language	31
3.6	Hardware	32

3.6.1	List of component	32
3.6.2	Arduino Mega 2560	33
3.6.3	MFRC522 RFID Module	37
3.6.4	SIM 900A GSM Module	39
3.6.5	LED	40
3.6.6	Buzzer	41
<b>CHAPTER 4 RESULT AND ANALYSIS</b>		<b>42</b>
4.1	Introduction	42
4.2	The Developed Real-Time Fog Based Railway Collision Avoidance System	42
4.3	Railway Collision Avoidance System Hardware Interface	45
4.4	Result Analysis	48
4.4.1	Response Time	48
4.4.2	Reliability	51
4.5	Display Of Result Of The System	55
4.5.1	Arduino IDE	55
4.5.2	Node-Red	58
4.6	Summary	59
<b>CHAPTER 5 CONCLUSION AND RECOMMENDATION</b>		<b>60</b>
5.1	Introduction	60
5.2	Conclusion	60
5.3	Recommendation And Future Work	62
5.4	Project Potential	63

**REFENRECES**

**64**

**APPENDIX**

**70**



## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
Table 3.1:	List of component to develop Real-Time Fog Based Railway Collision Avoidance System.	32
Table 3.2:	Arduino Mega 2560 details.	35
Table 3.3:	Arduino Mega 2560 pinout function.	36
Table 3.4:	MFRC 522 RFID Module pinout function.	38
Table 4.1:	Response time of the Real-Time Fog Based Railway Collision Avoidance System using Arduino Uno and Arduino Mega.	48
Table 4.2:	Reliability of the Real-Time Fog Based Railway Collision Avoidance System during normal and rainy weather.	51

## LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1.1:	Real-Time Fog Based Railway Collision Avoidance System.	1
Figure 2.1:	UV sensors.	8
Figure 2.2:	GPS based system.	9
Figure 2.3:	Dashboard design.	10
Figure 2.4:	Block diagram of system.	11
Figure 2.5:	Head-on collision.	12
Figure 2.6:	Rear-end collision.	12
Figure 2.7:	Operation of HTTP.	15
Figure 2.8:	Reliability/ QoS vs Interoperability.	16
Figure 2.9:	M2M/ IoT Usage vs Standardisation.	17
Figure 2.10:	Arduino Mega 2560.	19
Figure 2.11:	Arduino Uno.	19
Figure 2.12:	MFRC 522 RFID Reader.	20
Figure 2.13:	RFID smart card reader EM4100.	21
Figure 2.14:	SIM 900 GSM Module.	23
Figure 2.15:	SIM900a GSM Module.	23
Figure 2.16:	GPS Neo 6m Module.	24
Figure 2.17:	GPS Neo m8n Module.	25
Figure 3.1:	Block diagram.	26
Figure 3.2:	Circuit diagram of transmitter.	28
Figure 3.3:	Circuit diagram of control room.	29

Figure 3.4: Flowchart of the Real-Time Fog Based Railway Collision Avoidance System	30
Figure 3.5: Arduino Mega 2560 pinout diagram.	34
Figure 3.6: MFRC522 RFID Module.	37
Figure 3.7: SIM900A GSM Module.	39
Figure 3.8: LED	40
Figure 3.9: Buzzer	41
Figure 4.1: Transmitter	42
Figure 4.2: Receiver	43
Figure 4.3: Node-Red Flow	44
Figure 4.4: Train 1 arrived at location A and Train 2 arrived at location E	45
Figure 4.5: Train 1 arrived at location B and Train 2 arrived at location D	46
Figure 4.6: Siren trigger when both trains are too closed	47
Figure 4.7: Response time using Arduino Mega	49
Figure 4.8: Response time using Arduino Uno	49
Figure 4.9: Average response time using Arduino Uno and Arduino Mega	50
Figure 4.10: Time response of the Real-Time Fog Based Railway Collision Avoidance System during normal weather	52
Figure 4.11: Time response of the Real-Time Fog Based Railway Collision Avoidance System during rainy weather	53
Figure 4.12: Average time response of the Real-Time Fog Based Railway Collision Avoidance System during rainy and normal weather	54
Figure 4.13: The Serial Monitor tool of Arduino IDE	55
Figure 4.14: The transmitter's data shows in Serial Monitor of Arduino IDE	56



Figure 4.15: The receiver's data shows in Serial Monitor of Arduino IDE 57

Figure 4.16: Node-Red dashboard 58



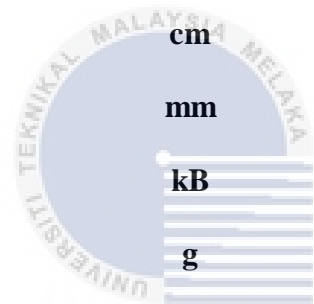
**LIST OF APPENDICES**

<b>Appendix</b>	<b>Title</b>	<b>Page</b>
Appendix A:	Gantt Chart of the project	70
Appendix B:	Coding of Receiver	71
Appendix C:	Coding of Train 1	81
Appendix D:	Coding of Train 2	85



## LIST OF SYMBOL

<b>s</b>	Second
<b>MHz</b>	Mega Hertz
<b>kHz</b>	Kilo Hertz
<b>V</b>	Voltage
<b>mA</b>	Mile Ampere
<b>cm</b>	Centi metre
<b>mm</b>	Mile metre
<b>kB</b>	Kilobyte
<b>g</b>	Gram
<b>%</b>	Percent



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## LIST OF ABBREVIATIONS

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

<b>AWS</b>	Amazon Web Service
<b>UART</b>	Universal Asynchronous Receiver/ Transmitter
<b>RTC</b>	Real-Time Clock
<b>GPS</b>	Global Positioning System
<b>SPI</b>	Serial Peripheral Interface
<b>IIC</b>	Industrial Internet Consortium
<b>SRAM</b>	Static Random-Access Memory

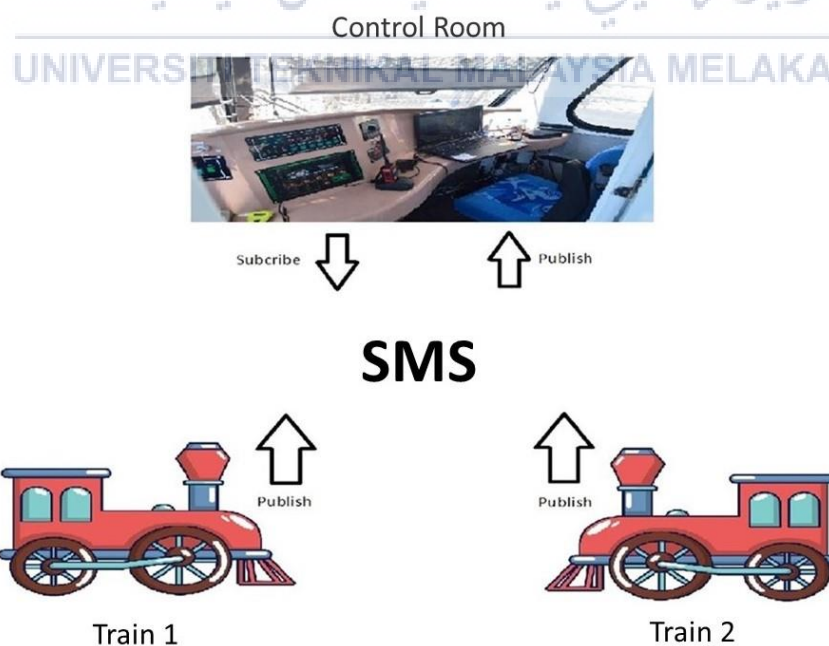


## CHAPTER 1

### 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.

