

DEVELOPMENT OF AUTOMATIC TOLL PAYMENT SYSTEM BY USING
PASSIVE RFID AND GSM TECHNOLOGY

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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**BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II**

Tajuk Projek : Development of Automatic Toll Payment System by Using Passive RFID and GSM Technology

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Specially dedicated to my beloved family...

My parent Ghazali Bin Baharudin and Kasmahwaty Binti Samsudin

Thank a lot for supporting me

My siblings...

Thank a lot for cheering me up

My Supervisor, My beloved friends...

Thank for helping me and always there when I need

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ABSTRACT

This proposed development of Automatic Toll Payment System was design in order to make the process of paying the toll fees become more efficient when the system applied in the actual situation. This system was upgrading from using infrared to the use of passive Radio Frequency Identification (RFID) that is proven as the technology with the low cost with high performance. As we already know, Malaysia have been used toll payment system such as Touch n Go and Smart Tag that is proven can be used for a long time of period especially during the festive seasons. So with the uses of RFID tag that are mounted on the windshield of the vehicle make the traffic become smooth due to the vehicle that that does not need to stop when passing the tollbooth. As the vehicles does not have to queue to make a payment the time use are saving , fuel conservation , contributing in saving money also reduce pollution. The passive RFID tag is provided which the information that is embedded into it that will make the tag can be read by long range of reader by depending on the frequency used. Since this project use passive RFID, the cost is affordable because it does not use internal power supply to operate. Next the uses of GSM (Global System for Mobile communication) for this project is only to sends an SMS to the customer's registered cell phone one they have passed the tollbooth while as to displayed the output Arduino was used as a microcontroller. The message that they have received contain how much they paid for the fees and also the balance from the deduction. While Visual Basic are need for the implementation of the system to running the database that is created using Microsoft Access. The frequency analysis is carried out based on the reading range from 1 meter to 5 meter. Every single frequency between 902.4 MHz to 927.8 MHz has been analysing.

ABSTRAK

Tujuan Sistem membayar tol secara automatik direka adalah untuk menjadikan proses membayar tambang tol yang dikenakan menjadi lebih cekap apabila sistem rekaan ini diaplikasikan pada sistem tol yang sebenar. Sistem ini ditambah baik dengan menggunakan teknologi Identifikasi Frekuensi Radio (RFID) pasif dimana ia terbukti sebagai teknologi yang murah dengan prestasi yang tinggi. Malaysia telah menggunakan sistem berteknologi infrared seperti *Touch n Go* dan juga *Smart Tag* namun teknologi ini menyumbang kepada berlakunya kesesakan terutamanya pada musim perayaan dimana pengguna di lebuh raya meningkat. Jadi dengan penggunaan RFID yang akan dilekatkan pada cermin hadapan kenderaan pengguna menjadikan laluan menjadi lebih lancar kerana kini kenderaan tidak perlu lagi berhenti untuk membayar tol. Sekaligus keadaan ini akan menjimatkan masa, minyak, wang ringgit serta merta mengurangkan pencemaran udara. Tag RFID tersebut akan dilengkapi dengan maklumat pengguna dan akan dikesan oleh alat pembaca. Memandangkan sistem ini menggunakan teknologi RFID pasif secara tidak langsung dapat menjimatkan kos kerana teknologi ini tidak memerlukan bekalan kuasa untuk beroperasi. Penggunaan sistem *GSM* pula sebagai penambahbaikan dimana pengguna akan menerima satu pesanan yang menyatakan berapa nilai yang telah ditolak serta baki yang tinggal di dalam kad tersebut selepas sahaja pengguna melalui tol serta micropengawal Arduino digunakan untuk memaparkan keluaran pada *LCD*. Perisian *Visual Basic* yang digunakan adalah sebagai pelaksanaan keseluruhan system serta *Microsoft Access* pula sebagai pangkalan untuk menyimpan semua data pengguna. Analisis frekuensi di rekod dari jarak satu meter sehingga lima meter untuk mengesan kecekapan kelajuan. Setiap frekuensi antara 902.4 MHz sehingga 927.8 MHz juga direkod untuk kecekapan terhadap masa.

CONTENTS

CHAPTER	TITLE	PAGES
	PROJECT TITLE	i
	REPORT STATUS VERIFICATION FORM	ii
	STUDENT'S DECLARATION	iii
	SUPERVISOR'S DECLARATION	iv
	DEDICATION	v
	ACKNOWLEDGEMENT	vi
	ABSTRACT	vii
	ABSTRAK	viii
	TABLE OF CONTENTS	ix
	LIST OF TABLES	xiii
	LIST OF FIGURES	xiv
	LIST OF ABBREVIATIONS	xvii
	LIST OF APPENDICES	xviii
I	INTRODUCTION	1
	1.1 Project Introduction	1
	1.2 Problem Statement	3
	1.3 Project Objective	4
	1.4 Scope of Project	4
	1.5 Thesis Outline	5

II	LITERATURE REVIEW	7
2.1	Previous Study and Research Development	7
2.1.1	Electronic Toll Collection (ETC) Overview	8
2.1.2	ETC Development in Malaysia	8
2.1.3	ETC Development	10
2.1.4	ETC Research	13
2.2	Touch 'n Go / SmartTag Disadvantage	17
2.3	RFID (Radio Frequency Identification)	19
2.3.1	RFID Tag	20
2.3.2	RFID Reader	21
2.4	GSM Technology	23
2.5	Arduino	24
2.6	Software	24
2.6.1	Microsoft Visual Basic Express	24
2.6.2	Microsoft Access	25
III	METHODOLOGY	26
3.1	Flowchart Methodology	26
3.1.1	Data Flow Diagram	26
3.1.2	Flowchart Diagram for Automatic Payment System User Registration	33
3.1.3	Flowchart Diagram for Automatic Payment System Manual Reload	34
3.1.4	Flowchart Diagram Automatic Payment System Auto for Deduct	35

3.2	Hardware Development	36
3.2.1	RFID Tags	36
3.2.2	RFID Reader	37
3.2.3	Design Analysis	37
3.2.4	Component and Circuits	38
3.3	Arduino	39
3.4	LCD Keypad Shield	40
3.5	GSM Module SIM900A	41
3.5.1	AT Command	41
3.6	Software Development	42
3.6.1	VB Programming	42
	3.6.1.1 Transaction related operations	43
3.6.2	Microsoft Access	43
3.6.3	Programming Language	44
IV	RESULT AND DISCUSSION	46
4.1	Result	46
4.2	Software Part	47
4.2.1	System Graphical User Interface	47
4.2.2	Project Database	50
4.2.3	Reader Configuration	50
4.3	Hardware Part	51
4.3.1	Detection Analysis	51
4.3.2	Demonstration Analysis	55
4.3.3	Hardware Result	56

		xii
	4.4 Overall Discussion	62
V	CONCLUSION AND RECOMMENDATION	64
	5.1 Conclusion	64
	5.2 Future Recommendation	65
	REFERENCES	67
	APPENDICES A - D	70

LIST OF TABLES

NO	TITLES	PAGES
2.1	Differences among Other System with Proposed System	10
2.2	Frequency range and its application	14
2.3	Comparisons among heterogeneous positioning technologies	18
2.4	Frequency range and its application	22
3.1	Specification of system design	38
3.2	RS232 Interface Specification	39
4.1	Demonstration Analysis	55

LIST OF FIGURES

NO	TITLE	PAGES
2.1	Canada 407 Express toll route (ETR)	11
2.2	Poland National Automatic Toll Systems	12
2.3	Basic Block Diagram of RFID	19
2.4	Layering of communication between tags and readers	21
3.1	Methodology of Project	27
3.2	Data flow for proposed system	28
3.3	Flowchart of the whole system	31
3.4	The process takes place	32
3.5	Flowchart Diagram for Electronic Toll Payment System Use Registration	33
3.6	Flowchart Diagram for Electronic Toll Payment System Manual Reload	34
3.7	Flowchart Diagram for Electronic Toll Payment System Auto Deduct	35
3.8	Passive RFID Tag	36

3.9	UHF-RW-MP-232 V1 Readers	37
3.10	Arduino Uno	40
3.11	Arduino LCD Keypad Shield (SKU: DFR0009)	40
3.12	GSM Module SIM900A	41
3.13	Software Development Process	45
4.1	Authorization Form	47
4.2	Registration Form	48
4.3	Sub - Registration Form	49
4.4	User ID Information	49
4.5	Project Database	50
4.6	Reader Configuration	51
4.7	Graph of distance against output power	53
4.8	Frequency analysis for 1 meter	53
4.9	Frequency analysis for 3 meter	54
4.10	Frequency analysis for 5 meter	54
4.11	GSM Modem after connect with jumper	56
4.12	GSM Modem provide with RS232	56
4.13	From the above side	57
4.14	From side	57
4.15	GSM combines with LCD and Arduino	58
4.16	Output Produce at LCD	58
4.17	Coding for display output	59
4.18	Message received by the user	59

4.19	Overall process of the system	61
4.20	Expected position of the system	61

LIST OF ABBREVIATION

RFID	Radio Frequency Identification
GSM	Global System for Mobile Communication
LCD	Liquid Crystal Display
SMS	Short Message Service
LF	Low Frequency
HF	High Frequency
UHF	Ultra High Frequency
ETC	Electronic Toll Collection
SIM	Subscribers Identity Module
RS232	Recommended Standard 232
MHA	Malaysian Highway Authority
SLEX	South Luzon Expressway
OBU	On - Board Unit
ETR	Express Toll Route
OCR	Optical Character Recognition
MLFF	Multi Lane Free Flow
IR	Infrared

LIST OF APPENDICES

NO	TITLES	PAGES
A	Function of Component Arduino Uno	70
B	Pin Allocation Arduino LCD Keypad Shield (SKU: DFR0009)	73
C	UHF-RW-MP-232-V1 Datasheet	74
D	AT Command	75

CHAPTER I

INTRODUCTION

1.1 Project Background

By referring to the research that was made by Projek Lebuhraya Usaha Sama Berhad (PLUS) it is shown that almost 30 000 number of vehicles going out simultaneously on the time peak that is start from seven in the morning to nine in the morning and also from five in the evening until eight in the evening. From this research, this condition are contribute to the critically traffic jam. The problem about the vehicles to make a long que in order to make a toll payment are being expected to fully solve on 2020 when the „Multi Lane Free Flow“ (MLFF) were introduced later.. The evolution of electronic toll collecting system were

introduced on Mac 1997, the first Touch „n Go card were released to be used to pay the toll fee. Next, on Mac 1999 SmartTag were introduced as the most effective method to pay the toll fee. Currently both of this system are being used as an automatic toll payment system in Malaysia, but both of the system are just the attention as a new system has an improvement on performance and less expensive in cost. This is because even the system are being used widely, the tollbooth are still operated manually and just only one or two tollbooth that operated automatically. Eventhough it is less use, through the both system can slowing down traffic significantly [1].

Basically the project that will developed are that the system that already provided were replace with Radio Frequency Identification (RFID) instead of infrared that is used for transmit the information. As we already know the uses of high technology will provide more advantages. Thus the use of RFID to replace infrared system is that by using infrared are easy to interfere and and low speed detection. For this project, it is compulsory for the vehicle owner to have a registered RFID tag that attached to their vehicles windshield. The tag should contain the information such as ID number, username, address, phone number and also car registration number to be saved on database. It is not complete to the RFID tag to be working by itself. This is because in order to operated the RFID tag will need the RFID reader. Thus the reader are installed at the entrance and also at the exit point of the expressway. It is also not completed by the both component to work by themselves if there is no a place to store the database. These reader are connected directly to the Personal Computer (PC) unit via RS232 interface. The role of the PC is to monitoring the system as it will controlled, monitor and provide the database and the signal received to process the information signal from registered tag.

To make it more understand firstly, once the vehicles going through the expressway and arrived at the entance tollbooth RFID reader will transmit the signal to the tag on the windshield of the vehicles. The tag will received the signal and charged enough energy to transmit back the information that embedded on the in the form of electromagnetic waves. Then the reader will send the information data

received to the PC via RS232 wired interface. PC will process the signal by separating the ID and saved on the database. Global System for Mobile communication (GSM) for this project is only used to send an SMS to the customer's registered cellphone once its remaining load balance goes below the toll fee equivalent to the fee for the longest end-to-end toll gates. Once the balance is insufficient, the vehicles are not allowed to pass through the tollbooth and the barrier is not lifted. The owner of the vehicles needs to add-in the card first or just pay up the toll fee, only then it can pass the tollbooth. For the implementation of the system, Arduino is used as a display as there is the monitor that users can refer to once the RFID tag is detected. Thus, from that they can know directly the cost of fee instead of waiting for a message to be sent to their cellphone.

1.1 Problem Statement

Traffic congestion is a developing issue in numerous metropolitan areas. Congestion will expand travel time, air contamination, carbon dioxide (CO₂) discharges and fuel use in light of the fact that autos can't run productively. Congestion starts when a larger number of vehicles attempt to utilize a street than the street can move. This can happen when vehicles can't exit rapidly enough to clear a path for others. The situation is going to be the same in toll plaza where the traffic congestion tends to increase significantly with the number of vehicles that produce every day. Thus, the number of expressway users increased and caused jammed along the routes either in toll booth also, the congested especially during festive seasons tend to happen. Chances of escaping the payment of toll tax are there. It leads to queuing up of following vehicles.

Suppose the manual toll collection system is very efficient then for one vehicle to stop and pay taxes total time taken is 50 seconds. And suppose 200 vehicles cross the toll plaza. The figure is staggering if on an average we take 200 vehicles pass through the toll plaza each day, then yearly 72000 vehicles pass

through the toll plaza. And each year 72000 vehicles just stand still for 5.0 hours in engine start condition thereby aiding pollution and wasting fuel and money [2].

Next, the uses of previous system, Smart Tag and Touch n Go being used as an automatic toll payment system in Malaysia. SmartTag, Touch n Go used infrared are low speed detection and easy to interfere. SmartTag is a device that works with combination of Touch n Go card to allow users to pay tolls to drive through convenience. It transmits the information via infrared. However, the constraints of infrared are low speed detection and easy to interfere. The device is also expensive [3].

Thus Automatic Toll Payment System is used for toll collection without making traffic congestion and waiting in long queue with help of RFID technique. Also, by using this system, it will save time, by avoiding long queue as no need to stop the vehicle and no need of manual transaction [4].

1.2 Project Objective

- To develop high performance and low cost Automatic Toll Payment System by using RFID and GSM technology that deal with speed detection and secure transaction.

1.3 Scope of Project

- a) Literature review on hardware and software used in this project.
- b) This project will used passive RFID Tag where it is more convenient due to its can operate without power supply.
- c) The uses of Arduino as a displayed.
- d) Developing SMS sending process via GSM modem.

- e) Both software that is Microsoft Visual Basic and Microsoft Access have their own use that is for the framework or as an interface and also for storing database respectively.
- f) Several parameter analysis such as reading range, output power and also times per tagging.
- g) Running the system at frequency of 902.4 MHz – 927.8 MHz.

1.4 Thesis Outline

In this thesis, there are five chapters which will briefly explain all the efforts and flows in completing this project. The first chapter will give the overview of the project. By mean that even people does not follow the development of project until end they can still know about the project through the overview. The overview include of Project Introduction, Project Objectives, Problem Statement, Scope of Work and Project Methodology.

Chapter II is about the literature review that will describe all the information that was referred as a reference in order to finished up the project. Basically literature review will contains the facts or other aspect that we need that correspond to the project that will build. For this project, the literature review covers the thing about toll payment system that are used all around the world. The chosen literature review also explains the basic knowledge of RFID, GSM technology and also Arduino.

Chapter III will states and discuss about the methodology taken to complete this project successfully with a given period of time. Methodology is the important aspect as it is the beginning process of planning. If the methodology are not organize only then will encountered the problem involve with the project.

Chapter IV implies the results obtained from the system testing and troubleshooting in order to achieve the overall objectives required to complete this project. Chapter IV are consider as an important part also because the project will fully finished if the result are obtained as well as planned. Thus a lot of time have to put to carry out this chapter.

Finally, Chapter V after gone through all the process and successfully achieved all the objectives as stated in the earlier chapter, the overall project can be conclude and explains well in chapter 5. Future recommendation part for this project is included as well for future improvement and further enhancement.