UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of Energy Saving Street Lighting System Using Arduino Uno

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

by

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DECLARATION

I hereby, declared this report entitled Development of Energy Saving Street Lighting System Using Arduino Uno is the results of my own research except as cited in references.

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APPROVAL

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ABSTRAK

Projek ini bertujuan untuk merekabentuk dan membangun sistem penjimatan lampu jalan tenaga. Secara amnya, sistem lampu sedia ada akan dihidupkan pada waktu petang sebelum matahari terbenam dan dimatikan pada keesokan harinya selepas matahari terbit apabila terdapat pencahayaan yang mencukupi di luar. Sebilangan besar tenaga dibazirkan untuk mengekalkan lampu ON dalam tempoh itu walaupun tiada siapa di jalan dan lampu tidak digunakan. Projek ini menyediakan penyelesaian terbaik untuk penjimatan tenaga di mana pemancaran dan kecerahan lampu boleh dikawal secara automatik menggunakan mikrokontroler. Sistem ini diprogramkan supaya lampu jalan akan dihidupkan secara automatik semasa gelap dan ditutupkan semasa siang hari. Pencahayaan lampu bervariasi menggunakan PWM mengikut kehadiran benda bergerak dan keadaan cuaca. Sistem ini memerlukan tiga sensor untuk menjadikan keseluruhan idea berfungsi, mereka adalah sensor PIR, sensor hujan dan LDR. Sensor PIR digunakan untuk mengesan sebarang objek bergerak melalui lampu jalan. LDR digunakan untuk mengenal pasti keadaan pencahayaan di luar sementara sensor hujan digunakan untuk mengesan hujan. Memandangkan faktor keselamatan pengguna jalan raya waktu malam, lampu tidak akan ditutupkan walaupun tiada pergerakan yang dikesan di jalan raya tetapi dihidupkan dalam keadaan meredup. Sistem ini juga memberikan penyelesaian untuk mengesan lampu yang rosak di mana sistem itu akan menjana mesej amaran dan menghantarnya ke nombor telefon bimbit penyelenggara melalui modul GSM apabila terdapat lampu yang rosak yang dikesankan oleh LDR. Ini boleh mengurangkan risiko kemalangan jalan raya kerana lampu rosak diperbaiki secepat mungkin

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ABSTRACT

This project aims for designing and developing an energy saving street lighting system. Generally, the existing lighting system will be switched on in the evening before the sunset and switched off in the next morning after the sunrise when there is sufficient lighting on the outside. A huge amount of energy is wasted in keeping the lights ON in that period although there is no one on the road and the lights are not in use. This project provides the best solution for energy saving where the switching and brightness of the lights can be automatically controlled using microcontroller. The system is programmed in such a way that the street lights will be automatically switched ON during dark and switched OFF during daytime. The illumination of the lights is varied using PWM according to the presence of moving objects and the condition of weather. This system needs three sensors to make the entire idea functional, they are PIR sensor, raindrop sensor and LDR. The PIR sensor is used for detecting any moving object going through the street light. The LDR is used to identify the outside lighting condition while the raindrop sensor is used for detecting rainfall. Considering the factor of night-time safety of the road user, the lights won't be turned OFF even though there is no movement detected on the road but is switched ON in dimming state. This system also gives the solution for tracking faulty lamps where the system will generate an alert message and send it to the mobile number of maintainer worker via GSM module when there is any faulty lamp sensed by the LDR. This may reduce the risk of road accidents since the faulty lamps is repaired in time.

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DEDICATION

To my beloved parents,

All my lectures, especially my supervisor, Mr. Tg Mohd Faisal Bin Tengku Wook.

All my friends and relatives.

Thousands of thanks and appreciates for their supports,

encouragements and understands.

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TABLE OF CONTENT

Abstrak		**i**
Abstract		**ii**
Dedication		**iii**
Acknowledgment		**iv**
Table of Content		**v**
List of Tables		**x**
List of Figures		**xi**
List of Abbreviations, Symbols, and Nomenclatures		**xiii**
CHAPTER 1: INTRODUCTION		**1**
1.0	Introduction	1
1.1	Project Background	1
1.2	Project Objective	2
1.3	Problem Statement	3
1.4	Project Scope	3
1.5	Report Outlines	4
1.6	Conclusion	4
CHAPTER 2: LITERATURE REVIEW		**6**
2.0	Introduction	6
2.1	Microcontroller	6
2.1.1	Arduino UNO	6

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	2.1.2	PIC16F877A	7
2.2	Vehicle Detector		8
	2.2.1	Photoelectric Sensor	8
	2.2.2	Ultrasonic Sensor	9
	2.2.3	PIR Detector	9
	2.2.4	IR Transmitter and Receiver	9
	2.2.5	Comparison between Different Types of Vehicle Detector	10
2.3	Street Light Lamp		11
	2.3.1	LED	11
	2.3.2	HID Lamps	12
		2.3.2.1 Metal Halide	12
		2.3.2.2 High-Pressure Sodium	13
		2.3.2.3 Fluorescent Lamp	13
	2.3.3	Incandescent Lamp	14
	2.3.4	Comparison between Different Types of Street Lights Lamps	15
2.4	Research by Journals		16
	2.4.1	Research: Intelligent Street Light System using Arduino Uno	16
	2.4.2	Research: Smart Street Light using Arduino Uno Microcontroller	16
	2.4.3	Research: Energy-Saving Street Lighting System Based on the Waspmote Board	17
	2.4.4	Research: Energy Efficient Street Lighting System	18

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2.4.5 Research: Automatic Street Light Control System using Microcontroller 19

2.4.6 Research: Street Light Energy Conservation System Using PIR Sensor 20

2.4.7 Research: Smart Street Light 21

2.4.8 Research: Streetlight Control System Based on Wireless Communication over DALI Protocol 22

2.4.9 Research: Internet of Things Based Intelligent Street Lighting System for Smart City 23

2.4.10 Research: Control of Solar LED Street Lighting System Based on Climatic Conditions and Objects Movement 24

2.4.11 Research: Development of a Smart Solar-Powered LED Street Lighting System for Greener Community 25

2.4.12 Research: Smart Roadways Lighting Prototype System for Public Awareness 26

CHAPTER 3: METHODOLOGY **27**

3.0 Introduction 27

3.1 Hardware Design 27

3.2 System Block Diagram 28

3.3 Project Work Plan 30

3.4 Associates of Components 36

3.4.1 Arduino Uno 36

3.4.2 LDR sensor 37

3.4.3 LED 38

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3.4.4 PIR sensor 38
3.4.5 Raindrop sensor 39
3.4.6 GSM Modem 40
3.5 Software Design 41
3.5.1 Arduino IDE 41
3.5.2 Proteus 42
3.6 Conclusion 42

CHAPTER 4: RESULTS & DISCUSSION 43
4.0 Introduction 43
4.1 Energy Saving Street Lighting System Circuit Design 43
4.2 Printed Circuit Board (PCB) 44
4.3 Prototype 46
4.4 Analysis Data 47
4.4.1 Analysis of the Data Sensed by the LDRs 48
4.4.2 Analysis of the Response Time of PIR Sensor 50
4.4.3 Analysis of the Response Time of GSM Module 52
4.4.4 Analysis of the Power Consumption of Street Lighting System 53
4.5 Discussion 61

CHAPTER 5: CONCLUSION & FUTURE WORK 64
5.0 Introduction 64
5.1 Conclusion 64

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5.2 Future work 65

REFERENCE 66

APPENDIX 68

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LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1	Comparison of vehicle detectors	10
Table 2.2	Comparison of street light lamps	15
Table 2.3	Comparison between the existing system and proposed system	24
Table 3.1	Arduino Uno specification	37
Table 4.1	Discrete level for the given data sensed by the LDRs	48
Table 4.2	The response time of the PIR sensor	50
Table 4.3	The response time of the GSM module	52
Table 4.4	The power consumed by a street light based on different condition	54
Table 4.5	Power consumed and energy saved by the automation street lighting system based on different condition	59

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LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1	Arduino Uno board	7
Figure 2.2	Pin diagram of PIC16F877A	8
Figure 2.3	(a) Schematic of LED and (b) Led based street light	11
Figure 2.4	Metal Halide Street Light	12
Figure 2.5	High Pressure Sodium Street Light	13
Figure 2.6	Fluorescent Street Light	14
Figure 2.7	Incandescent Street Light	14
Figure 2.8	Working of Smart Street Light System	17
Figure 2.9	Block Diagram of the system components	19
Figure 2.10	Prototype of Street Lighting System	20
Figure 2.11	(a) Transmission side and (b) Receiving side of the system.	22
Figure 3.1	Prototype model of the system	28
Figure 3.2	Block diagram of the system	29
Figure 3.3	Gantt Chart	31
Figure 3.4	Flowchart of methodology	33
Figure 3.5	Flowchart of the system	35
Figure 3.6	LDR sensor	38
Figure 3.7	PIR sensor	39
Figure 3.8	Raindrop sensor	40
Figure 3.9	SIM900A GSM modem	41
Figure 4.1	Schematic circuit of the street lighting system	43

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Figure 4.2	PCB layout	44
Figure 4.3	PCB with all copper removed except the circuitry	45
Figure 4.4	Prototype of the street lighting system	46
Figure 4.5	Prototype output when LDR detecting the darkness	47
Figure 4.6	Prototype output when PIR sensor detecting the vehicle	47
Figure 4.7	Prototype output when raindrop sensor detecting the rain	47
Figure 4.8	The graph of discrete level for the given data of LDRs	49
Figure 4.9	The graph that shows the average of the discrete level	49
Figure 4.10	The graph for the response time of the PIR sensor	51
Figure 4.11	The graph for the response time of the GSM module	53
Figure 4.12	The graph that shows the power consumed and energy saved by the street lighting system per day based on different condition	60

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

LED	-	Light Emitting Diode
GSM	-	Global System for Mobile communication
IDE	-	Integrated Development Environment
PWM	-	Pulse Width Modulation
USB	-	Universal Serial Bus
ICSP	-	In-Circuit Serial Programming
AC	-	Alternating Current
DC	-	Direct Current
TMR	-	Timer
RAM	-	Random-Access Memory
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
PIR	-	Passive Infrared
IR	-	Infrared
HID	-	High-Intensity Discharge
CRI	-	Colour Rendering Index
LDR	-	Light Dependent Resistor
ESSL	-	Energy-Saving Street Lighting
GUI	-	Graphical User Interface
PC	-	Remote Concentrator
DALI	-	Digital Addressable Lighting Interface
SCADA	-	Supervisory Control And Data Acquisition

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ATR	-	Astronomical Time Relays
DLB	-	Double-Level Ballast
CO_2	-	Carbon Dioxide
LCD	-	Light Crystal Display
PSM	-	Projek Sarjana Muda
AT	-	ATention
SMS	-	Short Message Service
SSR	-	Solid State Relay
SIM	-	Subscriber Identity Module
PCB	-	Printed Circuit Board
α	-	Directly Proportional

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CHAPTER 1

INTRODUCTION

1.0 Introduction

In this chapter, the introduction of the project with the title "Development of Energy Saving Street Lighting System Using Arduino Uno" is given, which including the project background, the project objective, the problem statement, the project scope, and the project outline.

1.1 Project Background

The project is about developing the energy-saving street lighting system. Street lighting is an important infrastructure for a city where the major function is for illuminating the streets of the city during dark. Nowadays, the number of streets increases rapidly due to the high traffic density. Similarly, the street lighting systems are being asked to do more than ever before to enlighten these streets, so that the road users can reach their destination even in the dark. In the beginning, the street lighting system was manually controlled where a control switch was fitted in every street lights. The street lights existing today generally switch on automatically at night and switch off automatically when there is sufficient lighting in the morning. As we have witnessed, the lights were still kept on even though there are no any vehicles on the road. Thus, a large amount of electricity wasted every year for keeping these lights constantly working.

Automatic street lighting control and energy management system is the perfect solution for saving energy. The lights on the street would automatically switch on when

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there are vehicles passing by while automatically switch off when there is no one using it. This project intends to develop an automatic street lighting control system that the intensity of lights are varied based on the detection of moving vehicles while the switching ON-OFF of the lights are controlled based on the surrounding lighting condition. Take into account the factor of night-time safety for society members and road users, the street lights will not completely switch off during dark but keep switching on in dim condition when there are no any objects detected on the road. For this purpose, the project utilizes both the light sensor and vehicle detector for detecting sunlight and moving objects.

The system will use Arduino Uno microcontroller for receiving input from these sensing elements and sending its output to the LEDs. The switching and intensity of the LED module are controlled based on the received data from the microcontroller. This proposed system utilizes the LED technology instead of generally used street lamps due to several advantages it offered, like environmentally friendly, simple to mount and retain, as well as provides enormous light output. Besides that, SIM900A, a GSM or GPRS modem, is integrated with the Arduino to use for wireless communication. With the use of the GSM modem, the system will generate an alert message and send it to the operator if there are any faulty lights been detected.

1.2 Project Objective

The main objectives of this project are presented below:

i. To study an automatic street lighting control system based on the vehicle movement and climatic condition.

ii. To develop an energy saving street lighting system which equipped with a microcontroller and the several types of sensing element.

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iii. To provide the solution for the wastage of energy supplied to the lighting system and for the faulty lamps detection.

1.3 Problem Statement

The existing street lighting system generally switches ON the lamps in the evening and will be switched OFF only when there is enough illumination outside in the next day morning. Thus, there is a large quantity of energy wasting between the ON and OFF timing when there are no vehicles on the roads. Inefficient lighting obviously wastes financial resources every year, making the street lights to be the tremendous energy expenditure for a town. Apart from this problem, there is another issue related to the existing system. Folk is seldom taking the action to reflect defective streetlights in their area. The malfunction of street lights causing unsafe lighting on the road which would then increasing the risk of vehicles accident. These problems might be solved by developing an automated street lighting system which is controlled using microcontroller along with various sensors and a GSM module. This project provides the best solution for the wastage of electricity and the faulty street lights detection.

1.4 Project Scope

The scope of this project is limited to the construction of the controller board and the small-scale prototype for the proposed energy saving street lighting system. The street light controller which consists of an Arduino Uno microcontroller along with various sensors and GSM module would be installed in the light pole. The prototype of this project will be designed in such a way that LED is used as the street lamp, and is controlled by the controller based on the data received from the sensing element. This project saves the energy supplying to the street light by adjusting the intensity of the

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emitted light which will be increased only if any moving objects and raining weather are detected. The analysis of the power consumption of the street lighting system is conducted using this prototype.

1.5 Report Outlines

The whole detail regarding the project is outlined in each chapter of this report as shown below.

Chapter 1 provides the introduction of the energy-saving street lighting system which is controlled using Arduino Uno microcontroller along with various sensor and a GSM module. This chapter also clearly outlines the project objectives, problem statement, and scope.

Chapter 2 discusses the journals that related to the field of the street lighting system. In this chapter, the mechanisms and equipment used in the previous work are compared and the summary is made regarding these journals after researched.

Chapter 3 describes the methodology that would be implemented in this project. The methodology is illustrated using the flowchart and each of the steps would be explained. Besides that, this chapter also provides the description of the hardware and software applied in this project.

1.6 Conclusion

This chapter provides an overview of the project which contains project background, project objectives, problem statement, and project scope. The existing street lighting system is used as a reference and is integrated in order to generate the

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new idea that can be implemented in this project. The system is improved based on the problems stated in this chapter so that the created system will be more effective than the current street lighting system. The project scope set the limitation of this project. Based on that limit, students will keep focusing to achieve the desired outcome instead of getting the outcome that is out of ranges.

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CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

There is a lot of sources and journal which related to the field of the street lighting system. This chapter will discuss these researched journals and summarize the proposed street lighting system. Details about this project can be simply understood after studying the related journal.

2.1 Microcontroller

The microcontroller is a computer control system on a single chip. There are numerous electronic circuits integrate with it, which able to decrypt written instructions as well as transform them into electrical signals. (Mustafa Saad, 2013) Based on the researched journal, a different type of microcontroller is selected as a brain to control each of the proposed street lighting systems, depending on the system application and operation.

2.1.1 Arduino UNO

Arduino is an open-source physical platform based on microcontroller board having the ATmega32 series controllers and IDE for writing and uploading codes to the microcontroller. It possesses input and output pins for interacting with sensors, switches, motors and so on. To be exact, the Arduino own 14 digital input/output pins (which 6 provide PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP

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