Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF SMART STREET LIGHTING SYSTEM USING ZIGBEE AND ARDUINO

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

2023

DEVELOPMENT OF SMART STREET LIGHTING SYSTEM USING ZIGBEE AND ARDUINO

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A project report submitted
in partial fulfilment of the requirements for the degree of
Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek: Development of Smart Street Lighting System Using Zigbee and Arduino

Sesi Pengajian : 2022/2023

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I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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DEDICATION

To my beloved mother, Che Roslilawati Binti Yusuf, and father, Wan Mohd Fadzli Bin Wan Mohd Fadzli,

and

To dearest supervisor and lectures, Sir Fauzi Bin Hj Abd Wahab

ABSTRACT

Currently street lights are set to turn on when it gets dark and switch off when it is bright. This is a massive waste of energy worldwide because it is a necessary national service, yet the current execution could be more efficient. This project aims to build a street light control system that will reduce electricity usage. This project proposes a smart street lighting system that uses Zigbee wireless communication and Arduino microcontrollers on each side of Master unit and Slave unit. The system is also equipped with light-sensing module (Light Dependent Resistor) to detect ambient light levels. The system will be active when ambient light falls below certain threshold and stay on sleep mode if ambient lights still high. In this project, the brightness of the lighting is regulated depending on the traffic flow or street activity to reduce power consumption. A sets of motion sensor (Passive Infrared) is used to sense surrounding activity. The lamps fade depending on the pace of detected item motion, such as walkers, bicycles, and autos. The level of light intensity increases as the speed of the moving object increases. The Master unit will transmit the sensors data it collected to the Slave unit via Zigbee wireless transmission. The use of Zigbee wireless communication and Arduino microcontroller allows for a cost-effective and easily scalable solution for implementing smart street lighting. The result and analysis of this project show a smart street lighting system can improve energy efficiency by controlling the brightness of the lights based on the ambient light and the presence of pedestrians and vehicles.

ABSTRAK

Pada masa ini lampu jalan ditetapkan untuk dihidupkan apabila gelap dan dimatikan apabila terang. Ini adalah pembaziran besar tenaga di seluruh dunia kerana ia adalah perkhidmatan negara yang diperlukan, namun pelaksanaan semasa mungkin lebih cekap. Projek ini bertujuan untuk membina sistem kawalan lampu jalan yang akan mengurangkan penggunaan elektrik. Kertas kerja ini mencadangkan sistem lampu jalan pintar yang menggunakan komunikasi tanpa wayar Zigbee dan mikropengawal Arduino pada setiap sisi unit Master dan unit Slave. Sistem ini juga dilengkapi dengan modul pengesan cahaya (Light Dependent Resistor) untuk mengesan tahap cahaya persekitaran. Sistem akan aktif apabila cahaya ambien jatuh di bawah ambang tertentu dan kekal dalam mod tidur jika lampu ambien masih tinggi. Dalam projek ini, kecerahan lampu dikawal bergantung kepada aliran trafik atau aktiviti jalan untuk mengurangkan penggunaan kuasa. Satu set penderia gerakan (Inframerah Pasif) digunakan untuk mengesan aktiviti sekeliling. Lampu pudar bergantung pada kadar pergerakan item yang dikesan, seperti pejalan kaki, basikal dan kereta. Tahap keamatan cahaya meningkat apabila kelajuan objek bergerak meningkat. Unit Master akan menghantar data penderia yang dikumpulnya ke unit Slave melalui penghantaran wayarles Zigbee. Penggunaan komunikasi tanpa wayar Zigbee dan mikropengawal Arduino membolehkan penyelesaian kos efektif dan mudah berskala untuk melaksanakan lampu jalan pintar. Hasil dan analisis projek ini menunjukkan sistem lampu jalan pintar dapat meningkatkan kecekapan tenaga dengan mengawal kecerahan lampu berdasarkan cahaya persekitaran dan kehadiran pejalan kaki serta kenderaan.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, *Sir Fauzi Bin Hj Abd Wahab* and my friends for their precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) and my parents for the financial support throughout the entire studying period which enable me to accomplish the project. Not forgetting my fellow colleague, for their willingness of sharing their thoughts and ideas regarding the project.

My highest appreciation goes to my parents, parents, and family members for their love and prayer during the period of my study. An honourable mention also goes to Muhammad Elwan Bin Mohd Roslan for all the motivation and understanding.

Finally, I would like to thank all staff at UTeM, fellow colleagues and classmates, the Faculty members, as well as other individuals who are not listed here for being cooperative and helpful.

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Ω	-	Ohm, Resistance
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LIST OF ABBREVIATIONS

V	-	Voltage
LED	-	Light-emitting Diode
W	-	Watt
LDR	-	Light Dependant Resistor
PIR	-	Passive Infrared
	-	
	-	
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CHAPTER 1

INTRODUCTION

1.1 Background

Since the invention of the street light, it has been an essential public service that provides a safe environment for night-time travellers as well as pedestrians. The objective of street lighting in metropolitan areas is to improve the streets during the shady portions of the day and the dark periods of the night. As the population of people increases the growth of urban areas increases, and the demand and quantity of street lights have to keep up with the trends. Smart Street Light system is a manageable and strong idea, which is utilized to control the switch ON/OFF and also the intensity of the light when it is ON automatically with the help of Internet of Things technology, microcontroller, and sensors [1]. The system will automatically detect whether there is a necessity for light or not and how much of the light is needed. Street lighting is one of the largest energy expenses for a city and furthermore for a packed and busy city. A smart street lighting system can reduce costs by as much as 50%-70% [2]. The current method is insufficient since it turns on the lights before the sun sets in the evening and turns them off the next morning when the light is already sufficient outside. Every day, streetlights are powered ON the entire time from sunset to sunrise at their fullest potential even when there is no one around.

1.2 Problem Statement

Street lighting is essential in both urban and rural regions, where such lighting systems have been in use since the 18th century [1]. It serves as an alternate light during the night and in inclement weather to ensure the safety of road users. Streetlights were once manually regulated, but in the present period, classic systems are being implemented in environmentally friendly ways [2-4]. Although the management of the currently installed lamps is relatively easy, the number of streets has grown fast in tandem with the rate of urbanization [5]. Its goal is to provide safe night-time roadway conditions while also assisting drivers, pedestrians, cyclists, and others with enhanced visibility. Energy efficiency refers to the use of less energy while maintaining the same level of service through the use of technology.

Traditionally, each streetlight was managed by different switches. This style of streetlight is inefficient and wastes the cost of hiring someone to run the streetlight on a daily basis. Other streetlights feature a timer in conjunction with optical control, whereas others employ a light sensor to trigger the light to turn ON or OFF dependent on light intensity. The current street light system will be turned ON at its fullest potential all night long even when there is no human activity on the street. All of these street light solutions have some inefficiencies in terms of energy efficiency, which will have an impact on energy consumption

1.3 Project Objective

The objectives of the project are as follows:

a) To design and simulate the prototype of the proposed Smart Street Lighting System.

b) To construct a system for identifying the presence of human activity on the street.

c) To optimize and analyze the complete system.

1.4 Scope of Project

The main goal of the project is to develop a Smart Street Lighting using Zigbee and Arduino. The system consists of a microcontroller (Arduino) as the control unit of the system and a RF module (Zigbee) to transmit the information. The LDR will function as a sensor that can regulate the intensity of light in various scenarios. The light will come on if there is less than 80% sunlight detected. Detecting the speed of an entity is done using two IR sensors. The information is then transmitted to the other street light using Zigbee to increase the intensity of the light based on the information received.

The scope of this project is as follows:

a) Identify the component needed in the designed circuit to design the project circuits: type of LED, motion system, wireless communication system

b) Construct the prototype of a smart street light.

c) Troubleshoot the designed system to detect any problems occurring in the project prototype's construction.

d) Test the working system of the designed prototype project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Street lighting systems are one of the greedy consumers of electricity. It is a financial burden on local authorities. Reducing the costs of street lighting is the purpose of many research projects. A town or city used to have a small number of streets, street lights, and management control was fairly modest in the last several decades, but as thecountry grows into an affluent civilization and industrialization grew, the streets in the town increased dramatically. As a result, street light control and management become a challenge. At the moment, most metropolitan street lamps are supervised manually, witha control switch installed in each light. This is the so-called early generation of street lighting control systems, which is inefficient and a waste of personnel. A significant percentage of electrical power is wasted. Individual lights cannot be controlled in this traditional approach since street lights are controlled in groups.

2.2 Introduction to Smart Street Lighting

Smart Street Lighting is a system that is both efficient and reliable. Smart street lighting will automatically switch ON or OFF the lights without the intervention of any man. To enhance quality and efficiency, it should work in a systematic manner. A smart street light system has three primary components. These are LED lamps, sensors unit, and user movement.

A.LED lamps

To reduce energy consumption, the street light should use LED as its light source. All of the consuming High-Pressure Sodium or Metal Halide bulbs (400 W) are being replaced by low-power LED lamps (150 W). This LED bulb improves the lighting system by increasing luminance, visibility, and current rendering capabilities.

B.Sensors Unit

For the light to turn on at night, the system uses controlled sensors to identify pedestrians or cars. The sensor will detect movement if a person crosses the street from position A and, for example, turn on the lights at lamp posts 1 and 2. When a pedestrian approachesposition E, the sensors at lamp posts 3 and 5 detect movements and turn on the lights at these posts, while the lights at lamp posts 1 and 2 dim and eventually turn off after a certain amount of time. Instead of turning on all of the street lights for the entire night, this will save energy.

C. User movement

User movement can be classified into three-speed categories. There are three-speed categories for object movement. For example, the first mode is the low mode, which is intended for pedestrians moving at speeds between 0 and 5 km/h, the second is the medium mode, which is intended for cyclists travelling at speeds between 7 and 15 km/h, and the third is the high mode, which is intended for vehicles moving at speeds greater than 16 km/h. The lighting brightness increases to 80% when the sensor detects an automobile driving at 30 km/h. At the same time, it decreases to 20% then the LED will operate at an low illumination level if no movement is detected.

2.3 Previous Journal Related

2.3.1 An Intelligent Street Light System based on Piezoelectric Sensor Networks

According to [1] the authors proposed a system that can save energy by using the principle of object movement sensing through the piezoelectric sensors that are buried underneath the roads and controlling the intensities of the light based on the decision taken by the microcontroller. The piezoelectric sensor is placed within two metal sheets and filled with rubber material to detect the vibration of the road. The sensor module is the initial component that decides whether the street light should be switched on or off. It uses a light-dependent resistor (LDR), which receives information from ambient light levels. It makes a distinction between daylight and darkness. All of the above units must work at night, but movement sensing units will not work during the day because the lights are always turned off. In their experiment, they make use of Arduino Uno as a microcontroller to connect each sensor output. Each sensor's output will have a charge pump circuit. They employed a Schottky diode in their circuit. The voltage loss of a Schottky diode is 0.15–0.45 Volts. Once the controller's digital values have been generated using Arduino software, they may be delivered to the Xbee device, where the information reaches the street lights. Correspondingly, the intensity of the lights changes during the duration of the timer. The system can be used to monitor large traffic while also being effective on a small street.

2.3.2 Design and Development of Intelligent Wireless Street Light Control and Monitoring System Along with GUI

Authors of [2] devised and built a wireless street light system with GUI, which made it necessary for people to work at night and return home at night, as well as increasing the number of corruptions that occurred at night. The main goal of the system's control