

DEVELOPMENT OF STREET LIGHT ENERGY SAVING USING ARDUINO

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**A thesis submitted in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering (Control, Instrumentation and Automation) with
Honours**

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I hereby declare that I have read through this report entitle “*Development of Street Light Energy Saving Using Arduino*” and found out that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)”

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Date :

I hereby declare that this report entitle “*Development of Street Light Energy Saving Using Arduino*” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : NOOR ADLIA SYUHADA BINTI MAAMIN

Date :

To my
Beloved Father and Mother
Hj.Maamin bin Dollah and HjH Rusnani binti Asan,
My respectful Lecturers,
Also my faithful friends

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ABSTRACT

The large quantity of electricity of many countries is consumed in lighting the streets. Most of basic street lighting systems are switched ON/OFF at regular intervals of time. In this thesis, the system is to develop a street light energy saving control system to reduce energy if no vehicles pass through certain roads. Logically, this system may save a large amount of the electrical power. In addition, it may increase the lifetime of the lamps and reduce the pollutions. Operation of this system is to maintain the intensity of street lighting to 40% of the maximum intensity if no vehicles passing through the road. When the PIR sensor detects movement of the vehicle, block the street lights will be switched to 100% intensity. Arduino microcontroller has been used as a controller for the project. In addition, among other components used for this system is PIR sensor and current sensor. PIR sensor functions as a vehicle detector will be send a signal to the arduino will be control the intensity of the LED while the current sensor is used as the current detector LED lamp. The prototype for the street lighting energy saving control system is also has safety usage that is the light will not turn OFF completely but only dimming and the user can easily see from far away and the light will full turn ON if it detecting movement. The system has shown a great energy savings and if the system can be upgrade with many functions and user friendly the system can be commercialize and the cost for retrofitting the street lighting energy saving control system can be lowered.

ABSTRAK

Kuantiti besar tenaga elektrik di kebanyakan negara digunakan pada lampu jalan. Kebanyakan sistem lampu jalan asas beralih ON / OFF pada selang masa yang tetap. Dalam tesis ini, sistem ini adalah untuk membangunkan satu sistem kawalan penjimatan tenaga lampu jalan untuk mengurangkan tenaga jika tiada kenderaan melalui jalan-jalan tertentu. Secara logiknya, sistem ini boleh menyimpan sejumlah besar kuasa elektrik. Di samping itu, ia boleh meningkatkan jangka hayat lampu dan mengurangkan pencemaran. Operasi sistem ini adalah untuk mengekalkan keamatan lampu jalan 40% intensiti maksimum jika tiada kenderaan yang melalui jalan raya. Apabila sensor PIR mengesan pergerakan kenderaan, menghalang lampu jalan akan beralih kepada keamatan 100%. Mikropengawal Arduino telah digunakan sebagai pengawal untuk projek tersebut. Di samping itu, antara komponen lain yang digunakan untuk sistem ini adalah sensor PIR dan sensor arus. PIR sensor berfungsi sebagai pengesan kenderaan yang akan menghantar isyarat ke Arduino yang akan mengawal keamatan LED manakala arus sensor digunakan sebagai pengesan arus lampu LED. Prototaip bagi sistem kawalan tenaga penjimatan lampu jalan juga mempunyai penggunaan keselamatan yang ringan tidak akan berubah OFF sepenuhnya tetapi hanya 'dimming' dan pengguna boleh melihat dari jauh dan cahaya penuh akan bertukar ON jika ia mengesan pergerakan. Sistem ini telah menunjukkan penjimatan tenaga yang besar dan jika sistem boleh menaik taraf dengan banyak fungsi dan mesra pengguna sistem boleh dikomersialkan dan kos untuk mengubah suai sistem kawalan lampu jalan penjimatan tenaga boleh diturunkan.

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CHAPTER 1

INTRODUCTION

1.1 Overview

In this section will give a short introduction of the project. Some explanations about a development of street light energy saving will be considered to acknowledge the system. The problem statement, objectives, scopes and the project outline for the whole project are clearly explained in this chapter.

1.2 Project Motivation

Smart cities and green technology are becoming one of the world agenda in preparing for a better future. The smart street lighting system is one of the technologies that support green environmental related work. The technology that evolves with the advance in wireless communication and low energy street light has become the foundation in the development of smart cities [1].

Apart from supporting works toward better future, smart city technologies allow improvement in the area of response and maintenance where failures or breakdowns within

the deployment area is almost real time detectable, allowing immediate response from the respective person.

Street lighting is one of the important parts of a city's infrastructure where the main function is to illuminate the city's street during the dark hours of the day. There are several factors that should be considered for the design of road lighting systems, such as a safety night for members of the public and other road users, provide public lighting at a cost effective, reduce crime and reduce its impact on the environment.

Generally, street light is switched on for the whole night and during the day the street light is switched off but during the night time, street light are not necessary if there is no traffic user. Saving of this energy consumption is a very important factor these days as energy resources get reduced day by day. Alternatives for natural resources are very less and our next generations may face lots of problems because of lack of these natural resources [2].

Photoelectric control unit (PECU), wireless control system by using ZIGBEE, Programmable Logic Controller (PLC) controller circuit and microcontroller programming control system is the previous automatic control system that has been used. All this technique will be operated based on the decreasing or increasing of light level. The system was declared either to switch on or switch off the street lamp. The previous control system sometimes it does not operate efficiently due to less sensitivity of the light, problem to the receiving part of the wireless system and imperfect time to switch on and switch off the street lamp. Based on the consideration of previous work and street lighting problem, the improvement of street lighting control system was proposed by using Arduino microcontroller system. The Arduino microcontroller system has some advantages such as inexpensive, easy to run the programming, simple and clear programming environment, have open source and extensible software and also have extensible hardware. This is the reason why Arduino microcontroller has been chosen as the controller for the system. Arduino microcontroller system is the device that can very fast and capable of running thousands of lines of code each seconds [3].

1.3 Problem Statement

It is very common to see the street light alight all night, which is a great waste of energy. The power consumption is relatively high day by day. Some streets are not fully occupied like the main city streets; sometimes they are empty for a certain period time. For example, the highway towards the main entrance of Universiti Teknikal Malaysia Melaka (UTeM), only during the day it fully utilized but at night the road less user. In addition, the route along the main road and hostel at the main campus also underutilized at night.

Based on the problem, the observation of street lighting was done to improve the street lighting control system to make sure the street light can operate properly. By applying this system, it can reduce energy consumption and also can reduce electricity wastage. Therefore it is important to know the ways how to minimize the power consumption of the street light.

1.4 Objectives

There are several objectives for this project which are:

1. To build an intelligent street lighting system equipped with vehicle presence sensors.
2. To provide a better solution to reduce electricity wastage in controlling street lights by using Arduino microcontroller and reduce the power consumption of the street lighting.

1.5 Scope of the Project

This project focuses on the development of street lighting energy saving in the areas of UTeM. The focus is more on the low road users such as road at the main campus UTeM that requires the speed below 30km/h. Besides, the project is to save energy consumption by dimmed the Led light and the Arduino Uno will be main the controller for the system. This system is to reduce energy if no vehicles pass through certain roads and this system also will control the intensity of the street lighting to the minimum intensity if no vehicles passing through the road but when the sensor detect movement of the vehicle the street light will be switched to maximum intensity.

1.6 Thesis Outline

The street lighting energy saving control system by using Arduino thesis was described about the problem that always occur and the new design or improvement of street lighting based on the street lighting control design. All of the detail about this project was defined in every chapter of this thesis as shown below.

Chapter 1: In this section will give a short introduction of the project. Some explanations about a development of street light energy saving will be considered to acknowledge the system. The problem statement, objectives, scopes and the project outline for the whole project are clearly explained in this chapter.

Chapter 2: This chapter will discuss about sources or articles that related to the project. There are many sources or researchers done before and from there details about this project are known and can understand briefly about the project. In this chapter the theoretical background, literature review of previous work, and the summaries about the previous work will be covered.

Chapter 3: This chapter will discuss on steps involve completing the project. There are several steps to be applied in designing street light energy saving. This part provided of

project flowchart, methodology that being used and the explanation about hardware and software for this project.

Chapter 4: In this section will shows the result obtained that have been achieved throughout the whole semester. In this section also will show the result of the project based on the software and hardware testing.

Chapter 5: This chapter will describe about conclusion and recommendation for the street lighting energy saving control system. This section includes project summary, project finding and further recommendation to improve the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter will discuss about sources or articles that related to the project. There are many sources or researchers done before and from there details about this project are known and can understand briefly about the project. In this chapter the theoretical background, literature review of previous work, and the summaries about the previous work will be covered.

2.2 Theory and Basic Principle

2.2.1 Street Light Control System

For the installation of street lights in Malaysia, street lights must be designed in accordance with the criteria and specifications set by the Public Works Department. Type of light, type of lamp posts and distance between the light pole installations must follow the guidelines that have been specified. For example, according to LS-20 (refer to appendix C) the distance between the poles must between 40 meter to 50 meters. The purpose of street lighting is to allow the road users to travel safely. Street light also to

allow pedestrians to see hazards, orientate themselves, recognize other pedestrians and give them sense of security. The street light was designed to make all the road junctions and roundabouts must be clearly visible from a distance for road users to recognize other vehicles. Street lights also to improve the night time appearance of the environment. Street lights must be selected according to the correct category of road to provide sufficient light that suitable to the road user [4].

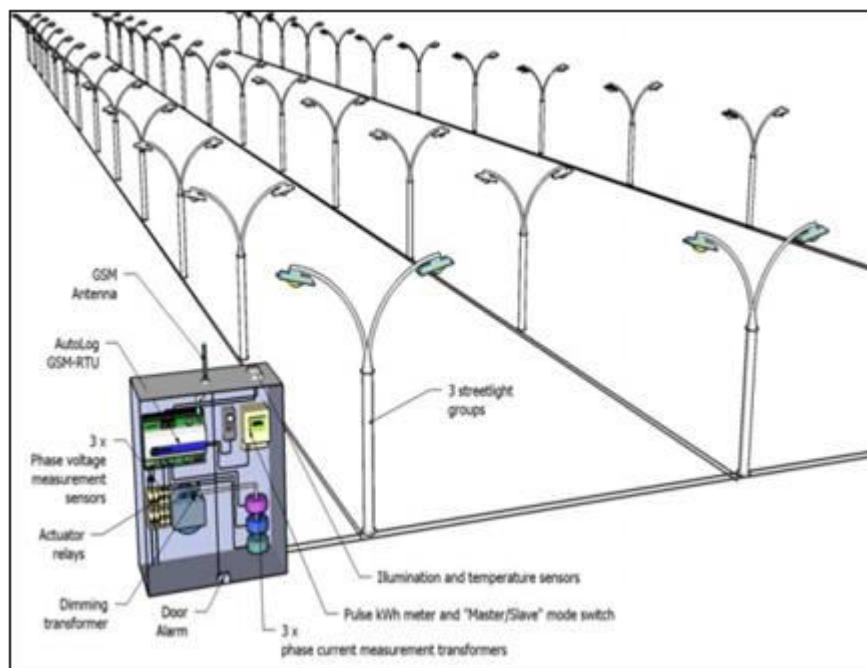


Figure 2.1: Street light control system architecture [15]

One of the examples that exist in the market for automatic lighting control are Manual dimming, Photo sensors, and Occupancy Sensors, Clock switches or timers. Manual dimming control allows space to adjust the light output or lighting. This can lead to energy savings by the decrease input power, as well as a reduction in maximum power demand and improved lighting flexibility.

In the Philippines, the manual operation of lighting in different establishment, schools, roads and recreational areas are being replaced by automatic switching system. Street light in some part of Metro Manila has photo sensors attached to it, that will automatically turns the light ON and OFF. Other street lights are installed on a

programmable timer which controls the switching of light from dusk until dawn but in other areas are still on the manual switching using a panel switch.

Street light in the city of Iloilo is controlled by a timer, which is preset by an operator to its desired time. In other areas there is also a street light that uses a photo sensor as a switch. The Central University of the Philippines, every street lamp located on the campus has its own photo sensor mounted on it [5].

2.2.2 Street Lighting Technology Comparison

Nowadays, there are various types of lighting technology such as incandescent light, metal halide, mercury vapour, high pressure sodium, low pressure sodium, fluorescent, compact fluorescent, induction and LED. The street lighting technology can be classified according the type of lamps, lamp service life, luminous efficiency, ignition time and their consideration.

Table 2.1: Lighting technology comparison based on luminous efficiency, life time and their consideration [9].

Light Technology	Life time	Lumens per watt	Ignition time	Considerations
incandescent light	1000 -5000	11 - 15	instant	very inefficient, short life time
mercury vapour light	12000 - 24000	13 - 48	up to 15 min	very inefficient, ultraviolet radiation, contains mercury
metal halide light	10000 - 1.000	60 - 100	up to 15 min	high maintenance UV radiation, contains mercury and lead, risk of bursting at the end of life
high pressure sodium light	12000 - 24000	45 - 130	up to 15 min	low CRI with yellow light, contains mercury and lead
low pressure sodium light	10000 - 18000	80 - 180	up to 15 min	low CRI with yellow light, contains mercury and lead
fluorescent light	10000 - 20000	60 - 100	up to 15 min	UV radiation, contains mercury, prone to glass

				breaking, diffused non-directional light
compact fluorescent light	12000 - 20000	50 - 72	up to 15 min	low life / burnout, dimmer in cold weather (failure to start), contains mercury
induction light	60000 - 100000	70 - 90	instant	higher initial cost, limited directionality, contains lead, negatively affected by heat
LED light	50000 - 100000	70 - 150	instant	relatively higher initial cost

In term of energy saving, LED lighting is the best way to be installed due to its characteristic in 40% - 80% energy consumption. LED street lights can efficiently replace High Intensity Discharge (HID) lamps with numerous advantages such as long life time, high lumen per watt and do not have long warm-up times. Apart from that, the light from LED shines at full brightness as soon as the switch is turned on and can be dimmed for added energy saving during low traffic.



Figure 2.2: The different lighting between HPSV lamp and LED lamp [16]

2.2.3 Type of Street Light

a) High Pressure Sodium Vapor (HPSV)

High pressure sodium vapor (HPSV) lamps are a member of the high intensity discharge (HID) lamp family. HPSV were developed and introduced in 1968 as energy-efficient sources for exterior, security, and industrial lighting applications, and are particularly prevalent in street lighting applications.

In a HPSV lamp, a compact arc tube contains a mixture of sodium, mercury and xenon. The xenon gas is easily ionized and facilitates striking the arc when voltage is applied across the electrodes. The heat produced by the arc then vaporizes the mercury and sodium. The mercury vapor raises the gas pressure and operating voltage and the sodium vapor produces light when the pressure within the arc tube is sufficient. High pressure sodium lamps are the most efficient artificial white light source with about 29% of the energy used by the lamp producing light.



Figure 2.3: 400W High pressure sodium vapor Lamp Street light [6]

Due to their high efficiency and long life, today's HPS lamps are also suitable for interior applications, particularly where color rendering is not a crucial concern [6]. However, the light produced by HSPV is a golden white