DESIGN OF ENERGY EFFICIENT STREET LIGHT FAULT MONITORING SYSTEM USING GSM NETWORKS

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Abstract

Intelligent lighting is designed to optimize energy consumption for street lighting. The project aims to reduce energy consumption through designing a Smart lighting control system so as to cut down carbon footprint. Government agencies have also pushed for Green Mark certification in plants, systems as well as electronics products and gadgets. [2] using a microcontroller. Lighting alone accounts for approximately 20% of global electricity consumption. In the current situation, public lightings are usually turned on before the local sunset and turned off after the local sunrise where visibility is sufficient. Sensory network incorporating infrared sensor, temperature sensor, light sensors are used for real-time vehicular detection and ambient light monitoring. Programmable displays, alert system, and a real-time clock dimming scheduling, notification and measurements are implemented.

II. INTRODUCTION

The microcontroller acts as a microcomputer to govern the operations Public lighting accounts for a high amount of energy consumption in Singapore as well as in other cities. [3] Hence effective energy management and conservation to reduce energy consumption in the system is crucial. This is especially so during the off-peak hours when traffic is light, the street lamps could be dimmed down so as to reduce energy consumption. Intelligent lighting with the sensory network, [4] and of the Intelligent Street Lighting system. The evaluation shows that the implementation of the real-time light dimming scheme using pulse through combiningthe different methodology allows more energy.width modulation of LEDs for street lighting can be adopted. In and cost saving in street lightingthis work, we proposed the use of light sensors to monitor the ambient light and infra-red sensors to detect oncoming vehiclesIndex Terms— Light Emitting Diodes. Street Lighting, Microcontroller, sensors, Communicationalong the road with Xbee modules, Arduinos and Arduino mega to provide the wireless communication channel for the intelligent street lighting. This system will not only act as an I. NOMENCLATURE LTA- Land Transport Authority LEDs- Light Emitting Diodes PWM- Pulse Width Modulationcontroller, but it provides feedback of valuable information to the Land Transport Authority (LTA) of Singapore to obtain relevant road condition and to share this with other road users. This implies that the intelligent lighting system would be collecting data at the individual street lamps and transmitting HPS- High-Pressure Sodium lamps it's using the wireless network to the master command center at the Public Road Regulator.

III. EXPERIMENTAL SETUP

This section will share on the different aspect of the SMART electrical energy is a basic part of our life and it is generatedstreet Lighting System from the hardware involving the lighting from power station through the burning of fossil fuels. Withunit, the sensor unit, and the communication units the natural resources being consumed faster than it is being replenished, renewable energy becomes an alternative option

A. LEDs and the lighting controls for electrical generation. However, renewable energy is notLighting Emitting diodes have been prevalently used due to capable of meeting the existing growing demand for energy its energy efficiency, better color rendering and longer lifetime

over traditional sodium lamp.[5] The high-pressure sodium streetlights have an average of 2000k color temperature as compared to the LED streetlamp of 4000K – 6000k color temperature. At lower color temperature it gives an orange gleam appearance to HPS street-lighting while for LEDs, the vast majority of its light is discharged downwards. This minimizes wasteful reflections in the lighting fixture, giving more uniform lighting on the ground and making it more conducive to pedestrian and road users. [6] The lifetime of LEDs module

is 50,000hrs as compared to 5,000 hrs of typical HPS, reducing the maintenance work cost in changing the light source. The LEDs driver regulate the AC voltage to DC voltage and ensure a constant current to the LEDs module. Figure 1 shows the connection of the LEDs driver which provides a DC supply to the LEDs modules and the Arduino Mega which serves as the dimming device (supervisory system) in this circuitry. To provide dimming function to the LEDs module in the street lamp, pulse width modulation (PWM) is adopted with Arduino Mega to provide digital pulse signals to switch on and off the LEDs module at a rate faster than our eyes can perceive.The peak voltage Vpk, it's current, I and period width, Tw is kept constant. To achieve dimming, the pulse width, Tp, can be narrowed from 0.04ms to 0.015 ms with T = 0.05 ms. This allows the average voltage to be lowered from 0.8 Vpk to 0.3Vpk and the average power consumption to be reduced to 0.14P0. The use of pulse width modulation also extends the lifespan of the LEDs module and its driver by preventing excessive heat buildup in the enclosure of the street lamp.

B. Sensors control units An intelligent lighting system is a network-based lighting control system which permits communication between the control center and the lighting points. Each streetlight is digitally connected to the network and can be interconnected to each other to provide higher accuracy of data collection. [7] The ambient temperature, air quality, and traffic condition are data which can be collected from the streetlight and this information can be data mined to provide better scheduling for preventive maintenance, health and quality of life for the city dwellers. Street lighting can serve as feelers for town planners in smart city management using sensory units incorporated to attain these parameters. Afshari et al[8] presented a systematic approach through modeling and optimization of a color- tunable LED lighting control system to provide energy saving, efficient and high-quality lighting ambient to home dwellers.Other technique involved the use of automatically set lighting schedules for public light point installation based on historical information on the patterns of the commuters using the stretch of the street. [9,10] In this work, we considered adopting scene and linkage control which allow the illumination to be adjusted based on the on-going activities in the area through integration of sensing devices to ensure efficient light delivery.[11] The linkage controls have the capability of switching on/ off the specific applicable sector by interpreting and anticipating user behavior. [10]An Arduino Mega board is used for the microcontroller function because it has a ready to use platform for hardware, software and the endless possibility of its open-source electronics platform. The microcontroller on the Arduino Mega is an ATmega1280 chip that has the ability to powers up 16 analog input pins and 54 digital input or output pins of which 15 of them provide pulse wave modulation outputs. Each of its digital pins can be programmed to be either an ***input*** or an output and either sends or receives a maximum of 40 milliamperes each.The Mega can communicates through its T_X and R_X pin with another computer, microcontroller or even another Arduino platform. It operates at 5V and could be easily powered via universal serial bus connection from a computer or an external power supply. As a platform for transmitted data (messages for road users) to be stored. The control station for the public road regulator can programmed the message to be send to the Arduino board. It will then processed and transferred the message to the Xbee module incorporated at the receiving end (eg. real time traffic alert sign via a LCD display). At the receiving end, there is a need to incorporate a Ardunio Mega to decode the binary data and display the selected message which traffic controller of the public road regulator wanted to be displayed as shown in Fig 2b

II IMPLEMENTATION AND DISCUSSION

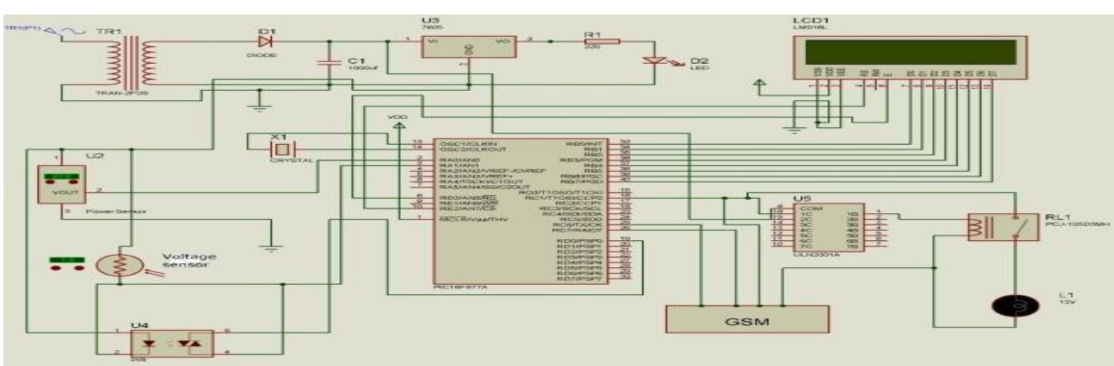
This section will described the implementation of the intelligent street lighting with Arduino as the microcontroller, light sensors and Infra-red sensors to provide input signals for microcontroller to make decision to modulate the power supplied to the LEDs module. An in-built lab-scale intelligent LEDs street lighting model will be used for discussion of potential lighting/dimming schedules as proposed.

The block diagram of the Intelligent Lighting System consists of the microcontroller, sensory units, LEDs street lamp module, power supply and the LEDs driver. Each of these block represents a component used in the entire system as shown in Fig 3a. The programmable street signs are designed to inform users of real-time traffic conditions as shown in Fig 2a and b. A Xbee shield is used to allow communication between the Xbee module and the Arduino.

Arduino microcontroller with addiotnal communication devices

The Arduino that is connected serve the sensor block serves as an input to the microcontroller, which is used for multiple application such as motion detection,light intensity indication or temperature measurement. Themicrocontroller receives data from the sensor and make the decision based on the desired outcome programmed into the Arduino microcontroller. It sends the instruction wirelessly to the driver of the LEDs modules at the street lamp (via a Xbee module through serial communication as shown in Fig 1). This will prompt the LEDs driver to either dim or increase its light intensity by pulse width modulation. The controller of the public road regulator can also make adjustment to the sensing unit based on the data collected. The street lighting system will directly receive the AC power from the power supply unit with the flow chart in Fig 3b for the intelligent lighting system list the criteria for the adjustment of the LEDs street lamp intensity

The microcontroller will check if the light sensor value is above or below 400 lux to determine if the sun has already set (as ambient illumination for sunset or sunrise is approximately 400 lux). Once the lux level is below 400 lux, the system will go into operation. It will now check if a specific infrared sensor (SENSOR as labeled in the flow chart) has detected any motion of vehicles or pedestrian. The microcontroller will immediately turn on that streetlamp to operate at 100% intensity if SENSOR =1, affirming the presence of traffic and loop back otherwise to read from Light sensor. After the system has turned on its streetlamp to 100%, it will now check if the vehicle is still in the vicinity via the neighbouring infrared sensor. If it is affirmed to be positive, the street lamp will continue to operate at 100% intensity. If not, it will activate a counter and count for a fixed period of time (as determined by the user) to reduce back to operating intensity at dimmed level, (eg at 50% of its full intensity).



The prototype is made up of 6 lampposts like structure mounted with an infrared sensor at the base of the figurine as shown in Fig 4. For the ease of motion detections, the sensors are installed at the side of the streetlamps. A toy car is used in this experimental set up to simulate a moving vehicle. The numbers above the streetlamps are to indicate the position of the vehicle or a specific lamppost prototype, the streetlamps are programmed to switch off after 10 seconds after the two criteria have been met. Fig 4b demonstrated a vehicle which just stopped to park at point 3 for more than 10s which ends up lighting lamppost 2 to 4 while the

B. In-built lab-scale intelligent LEDs street lighting model

The entire set up is to simulate a two- way traffic and the position of the moving vehicle is at lamppost 2 initially as shown in Fig 4a. When the infrared sensor picks up the moving vehicle, it activates the LED lighting around the detected lamppost as well as lamppost 3 to be lighted up as shown in Fig 4a. In scenario when the car has already gone past the lamppost for a period, the streetlight can be automatically dimmed to 50% light intensity or be switched off to save more electrical energy. There are two criteria for the streetlight to be switched off. First; the position of the infrared sensor and itnearby infrared sensors must not detect any motion. Secondly, the LEDs light modules has to be switched on initially. In trest are tuned to operate at 50% lux intensity. As dependent on the set condition, all the lamppost can be turned off after an extended period of time. Fig 2 demonstrated that when the ambient light sensor detected that the ambient lighting is above 400lux, the Intelligent Lighting system will off all the LEDs.

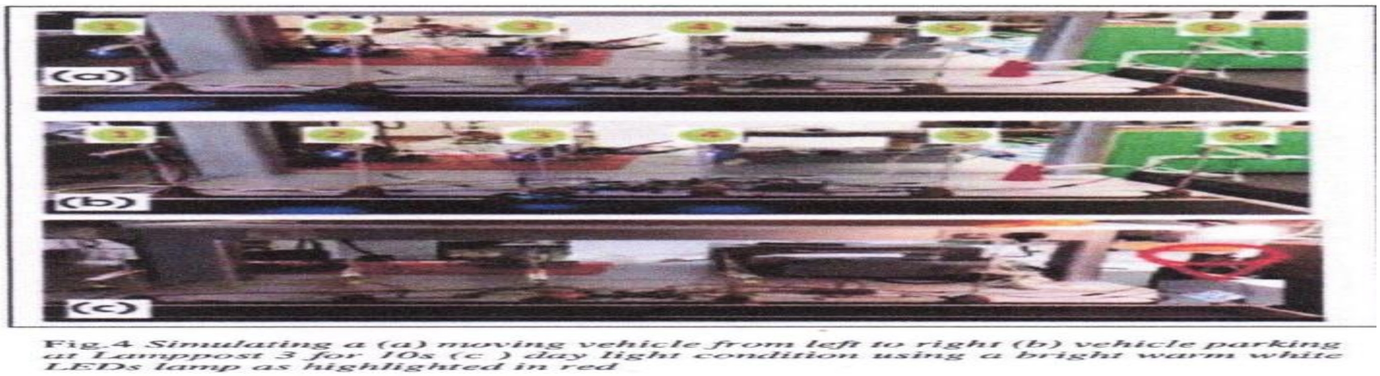


Fig 2: sensors

Dimming Scheduling

In this section, we proposed 3 types of dimming schedules which can be considered. These 3 modes of energy saving method are named economic mode, intense mode and balanced mode. Each mode has a specific dimming schedule and is formulated based on the assumption that road users are minimal during certain hours during the night while the rest of the timing has a moderate amount of vehicular activity. The operating hours of a streetlamp throughout the year are calculated based on the lighting standards set by LTA as tabulated in Table I to maintain a minimal of 20 lux on the road for users. [12]. The time to switch on and off the streetlight is based on the local sunrise and sunset time at different period of the year The timer will be scheduled minimum with 8 timing segments. Table I shows the 8 different segments for 8 different periods of time over the year.

Fig.3 Dumping Schedule

The schedule is plotted from light intensity against its operating hour from Sunset till Sunrise. The cost of electricity in Singapore is current1.39 cents per kilowatt-hours based on Singapore Energy Market Authority [13].Figure 5 shows a total of 4 modes of dimming schedule, inclusive of a lighting system that totally has no dimming function. The coloured boxes in the graph represent the dimmed percentage at a specific time slot during the night. In the economic dimming schedule, it has the least area occupied by the coloured box because it is designed for low occupancy streets. While on the other end, the intense dimming schedule has more area occupied by the coloured box because it is designed for a higher intensity traffic flow. The intense dimming schedule operates its street lamps at 100% from sunset till 9 pm and at 80% light intensity from 9 pm till 5 am and at 100% from 5 am till Sunrise. The dimming schedules are designed for different road user pattern For each and every dimming schedule, the total power consumption per day, per period for each segment and over the entire year is calculated and tabulated under total power usage in Table II. The calculation of total power consumption involves the multiplication of the operating hours by the power consumption of the lamp and by the dimmed value at every specific time slot. An illustration of the calculation is shown below for Economic Dimming schedule.

IV . CONCLUSION

The intelligent street lighting model has been successfully built and reveal the full capability of an actual lighting system. Varies real time monitoring functions which includes operating dimming schedules with integrated advanced lighting for oncoming vehicle on the street, a programmable street signs to divert traffic or notify of important road condition and a light sensor that constantly tracks ambeint lghting is incorporated. The system is fully equipped with multiple sensors are useful for data collection to understand the city's management needs and to perform preventive maintenance. The implementation of a microcontroller with sensors in the intelligent lighting system for street lighting enables controller of the public road regulator to adopt scene as well as linkage controls to street lighting on the road. This ensure that the adequate lighting is provided for all road users and at the same time optimizing the usage of our energy resources with the adoption of suitable diming schedule based on volume of traffic at different time of the day and the different stretches of the road.

V.REFERENCES

[1] Juan F. De Paz, Javier Bajo, Sara Rodríguez, Gabriel Villarrubia, Juan M. Corchado, Intelligent system for lighting control in smart cities, Information Sciences, Volume 372, 1 December 2016, Pages 241-255.

[2] Yansong Liang, Zhouding Jia, Huanzhong Yao and Jing Chen, "Housing intelligent lighting control strategy research," *2014 IEEE 3rd International Conference on Cloud Computing and Intelligence Systems*,
The results suggested that Economic Dimming schedule is
Shenzhen, 2014, pp. 728-731

[3] Suresh S., H. N. S. Anusha, T. Rajath, P. Soundarya and S. V. P. Vudatha, advisable to be implemented especially for stretched
of road which is in the sub-urban area and there is volume of traffic especially during the period from 12 midnight to 4am. This can substantially reduce the energy consumption and cost incurred "Automatic lighting and Control System For Classroom," *2016 International Conference on ICT in Business Industry & Government (ICTBIG)*, Indore, India, 2016, pp. 1-6.