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Intelligent Street Lights System for Energy Saving Using Power Line Communication

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***Abstract*: Point of robotized streetlight the executives framework utilizing IOT is the preservation of vitality by decreasing power wastage and also to lessen the work. Streetlights are the natural piece of any city since it encourages better night dreams, secure streets, and introduction to open zones yet it expends a very extensive extent of power. In the manual streetlight framework lights it is fueled from dusk to dawn with most extreme power notwithstanding when there is adequate light accessible. This vitality wastage can be maintained a strategic distance from by turning off lights naturally. The spared vitality can be proficiently used for different purposes like private, business, transportation and so forth. This can be accomplished utilizing an IOT empowered streetlight the board framework. The task utilizes Light Emitting Diodes (LED) that don't devour a huge measure of power to supplant the power expending customary HID lights. Driven lights alongside LDR empowers the power variety, which is infeasible with the HID lights. As LEDs are directional light sources it can radiate light explicit way, in this way streamlining the proficiency of the streetlights this framework incorporates an extra DHT11 Temperature-Humidity sensor. This gives the correct temperature and stickiness of a specific area. DHT11 is a composite sensor that contains an adjusted advanced flag yield of the temperature and stickiness. It guarantees high dependability and incredible long haul strength. This work is executed utilizing a modified Arduino load up for giving the required force of light at different occasions. The proposed work has accomplished a superior execution contrasted with the current framework.**

***Keywords*: Internet of Things (IoT), Arduino Nano, LDR, DHT11, Relay, Wi-Fi module, LED.**

1. Introduction

Point of robotized streetlight the executives framework utilizing IOT is the preservation of vitality by decreasing power wastage and also to lessen the work. Streetlights are the natural piece of any city since it encourages better night dreams, secure streets, and introduction to open zones yet it expends a very extensive extent of power. In the manual streetlight framework lights it is fueled from dusk to dawn with most extreme power notwithstanding when there is adequate light accessible. This vitality wastage can be maintained a strategic distance from by turning off lights naturally. The spared vitality can be proficiently used for different purposes like private, business, transportation and so forth. This can be accomplished utilizing an IOT empowered streetlight the board framework. The task Utilizes Light Emitting Diodes (LED) that don't devour a huge measure of power to supplant the power expending customary HID lights. Driven lights alongside LDR empowers the power variety, which is infeasible with the HID lights. As LEDs are directional light sources it can radiate light explicit way, in this way streamlining the proficiency of the streetlights this framework incorporates an extra DHT11 Temperature-Humidity sensor. This gives the correct temperature and stickiness of a specific area. DHT11 is a composite sensor that contains an adjusted advanced flag yield of the temperature and stickiness. It guarantees high dependability and incredible long haul strength. This work is executed utilizing a modified Arduino load up for giving the required force of light at different occasions. The proposed work has accomplished a superior execution contrasted with the current framework.

2. Overview

The control unit (FU1) is the center of the system. It controls the oscillator is used to generate the carrier signal required for the transmission of the data. A carrier frequency of 80 kHz is chosen. A Wien bridge oscillator topology is chosen for the simplicity of design. The design has automatic amplitude control with the use of a diode resistor network and operates with dual rail power supply with a positive and negative rail of 5V. The modulation of the data signal is done through a bilateral switch. A CD4066B bilateral switch was used to modulate the signal. The switching of the switch is done at the frequency of the information signal, which is at 1000 bits/s or 1000 Hz. The CD4066B can operate on dual or single power supply rails. Single supply rails were chosen as the information signal has a maximum voltage of ±3.3V and minimum voltage of 0V and to keep the switch closed at 0V when inactive. The carrier signal was offset, so as not to lose the negative part of the signal when sent through the switch. The final stage before the signal is coupled to the power line is amplification of the signal and increasing its power. The power amplification depends on the load and the turn's ratio of the coupling transformer. The power line coupling of the transmission and reception of the data signal is done with a high voltage capacitor and a power line communication transformer. A transient voltage suppressor (TVS) diode is added at the secondary side of the coupling transformer before the low voltage capacitor. This diode is

added to ensure that the device is protected in the case of an overvoltage.

A. Street light control system

The functional system is shown in Fig. 1. The input processes and output of the system is shown and the relationship between the system components is also indicated. The control unit (FU1) is the center of the system. It controls all the input and output data. The input components of the system are the different sensors which monitor and acquire the necessary data needed for fault finding and energy optimization. The light sensor (FU2) reads the light intensity levels which are used to calculate the time of day, in order to switch the light on during the correct times, and output the result (FU4).

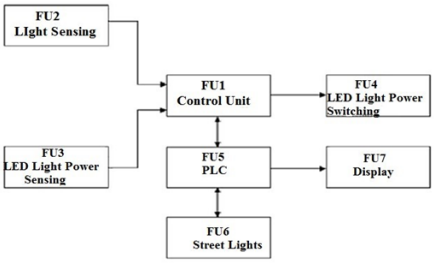

Fig. 1. Block Diagram of Street Light Control System

B. PLC Unit

The LED light power sensor (FU3) input is utilized to decide the deficiencies of the framework. These shortcomings are sent to a showcase/server (FU7) through the PLC unit (FU5). Correspondence between streetlights is accomplished through (FU6) with the utilization of the PLC unit (FU5) which is shown in fig. 2.2 underneath. The PLC unit comprises of a balance and demodulation organize (FU5.1) to make it conceivable to send and get the information on the electrical cable. The sifting stage (FU5.2) is utilized to secure and put the right information motion on the electrical cable. The information flag is set and recovered from the electrical cable through the simple front end association (FU5.3). The Fig. 2, shows beneath square outline of PLC unit. Electrical cable bearer correspondence method has begun to be utilized in shrewd local lattices. It can likewise be utilized for checking and controlling force utilization, for computerization of doctor's facilities, industrial facilities and other business structures. New electrical cable correspondence models like PRIME and G3PLC has prevailing in unwavering transmission with tight band. The enhancement in these models opens more extensive future conceivable outcomes.

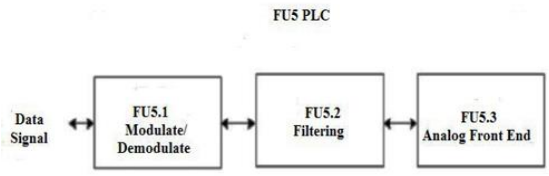

Fig. 2. Block Diagram of PLC Unit

C. Components required

1) Smart lights

The light emitting diode (LED) is one on the greatest technological advancements in the field of photonics in recent history. These LED's allow for the generation of highly controllable light and are 20 times more efficient than conventional light sources such as incandescent and fluorescent lamps. It is estimated that if they were to replace conventional light sources on a global scale, then in only 10 years this would result in a large reduction in pollution and save energy to the magnitude of 1.9 × 1020joules. It is also estimated that the cost savings could be as much as 1 trillion over that period. In addition to these saving LED's also allow for the addition of new smart functionalities because these lights are highly controllable. Smart lighting systems are popular for both domestic and industrial use not only because of the resultant energy savings, but also due to the visual comfort induced by the optimal control of the light level within the area. In fact, a recent empirical study has also showed interactive smart lighting can both increase the attractiveness of commercial shops and improve the overall user experience. Smart lighting can also help with the system maintenance by partially automating the process by performing fault diagnoses and predicting the time frame for any required maintenance. Smart lights are therefore an attractive solution for many lighting systems because of the energy savings and added convenience and street lights are no exception.

2) Power line communication

Adding the ability of communicating to and from streetlights adds more control and more effective monitoring of street lights. A few solutions exist which can be used to create an advanced communication network between street lights. A few of these are zigbee, GSM (global system for mobile communications) WSN (wireless sensor networks) and PLC (power line communication). This system proposed in this paper uses PLC, which is a communication method, implemented on an existing power line. It is a convenient method since the power lines are already in place and part of the street light infrastructure. The fundamental concept of PLC is that both energy and information can be in a single noisy power line. This is done by placing a modulated signal onto the power line using different types of modulation techniques to send and receive data. It is important to ensure that the modulation does not significantly reduce the power efficiency of the system.

3) Light sensor

The light sensor is designed using an LDR. The LDR's resistance range was measured at different light levels with a lux meter. The LDR values for different lux levels were used to design a scaling circuit for a specific range of lux levels. The resultant voltages are scaled to obtain a larger range of step sizes for the ADC. A voltage reference and voltage supply of 3.3 V is chosen. This supply voltage is chosen to ensure the output will not exceed 3.3 V to ensure the ADC and

microcontroller does not receive voltages above the 3.3 V supply of the microcontroller. The range of light levels chosen to scale for the ADC is from a lux of 200 to a lux of 30. The required transition light level is at ± 35 lux.

4) LED luminaire

The LED luminaire is specified to have a luminous output of between 3000 and 6000 lumens. This required specification will equate to a luminous output of between a 100 and 200 lumens/m2. The average area to be illuminated by the street light is 30 m2. Three high power LED's were chosen to be used in conjunction with a high power MOSFET. The MOSFET will act as a switch to turn the streetlight on or off.

5) Voltage sensor

The voltage sensor is added between the resistors and the LED's in the luminaire. This voltage is scaled down to 3 V which is sent to the ADC when the light is of, and will be 2.4 V if the light is on. This voltage is used to monitor if the light is on or off. The The venin resistance of the voltage divider is much larger than the resistance path of the current through the LEDs. Thus little current will flow through the voltage divider.

6) Data modulation and line coupling

The data modulation and line coupling is verifying that a data signal was modulated and placed onto the power line correctly to ensure data is sent correctly. The two ground connectors of the voltage probes where connected to a ground terminal on the circuit and the measuring connector of the first probe was connected to the output of the power amplifier and the input of the coupling circuit. The second probe was connected to the output of the microcontroller's transmission pin. The power supply to the circuit was turned on to supply the circuit with power. A test signal of value 85 was used for transmission, this is 01010101 in binary. The measured output response of the transmitted signal and output of the power amplifier. The output responses of both signals and the transmitted data signal in blue and the signal coupled to the power line in yellow. The data signal of binary value 01010101 can be seen with the start and stop bits of the UART module. A start bit is a binary 1 and the stop bit is a binary 0. This is in total 10 bits which are modulated. The data signal is modulated with the carrier and coupled to the power line.

3. Circuit description

A. Complete smart street lamp monitoring system

Fig. 3, demonstrates the disentangled square graph of the total brilliant road light checking framework. Inside the light module, it comprises of LDR module, microcontroller module and transmission module. The light module will speak with the control focus through remote utilizing Xbee in the LDR module, it comprises of two LDR. One of the LDR is introduce over the road light for the checking the day/night status condition. Another LDR is put under the road light to screen and checking the light wellbeing status. The aftereffects of the LDR's send to microcontroller, where the microcontroller will process the information and send the information to the transmission module. In the transmission module, there is remote Xbee that transmit the information through remote to the control focus. In the control focus, it will screens every one of the road light status, and additionally controlling the activity of the road lights capacity of delicate startup, Full ON and OFF is accomplished Public lighting in boulevards, burrows, downtown areas, ports and squares and so on. Can represent about 30% of the urban vitality utilization and the upkeep costs are high. India is confronting an enormous vitality emergency which must be routed to at the most punctual utilizing gadgets that are vitality effective dependent on ecological and monetary components, urban areas require savvy vitality the executives frameworks direly for vitality sparing, support costs decrease.

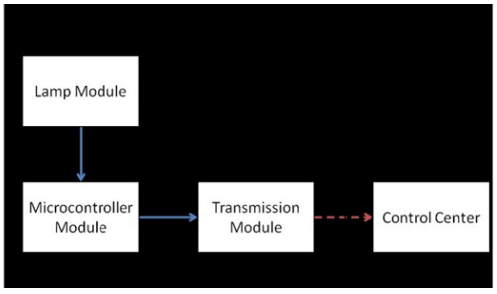

Fig. 3. Block Diagram of Complete Smart Street Lamp Monitoring

B. LDR Sensor

The fundamental test of equipment is to deliver minimal effort and modest sensor hubs. As for these destinations, current sensor hubs are chiefly models. It incorporates diverse sensors for different parameters and a LED light installations i.e. LDR, CO_2 gas sensor, sound sensor (amplifier). The imagined size of a solitary sensor hub can fluctuate from shoebox estimate hubs down to gadgets the extent of grain of residue. LDRs are extremely valuable particularly in light/dull sensor circuits. Regularly the opposition of a LDR is high, some of the time as high as 1000000 ohms, yet when they are lit up with light obstruction drops significantly. At the point when the light dimension is low the obstruction of the LDR is high.

Fig. 4. Light Dependent Resistor

C. Oscillator output

The output of the oscillator and if the oscillating frequency was within the designed specifications, the voltage probe's ground connector was connected to a ground terminal on the circuit and the measuring connector was connected to the output

of the oscillator. The power supply to the circuit was turned on to supply the circuit with power. The measured output response of the oscillator is shown in Fig. 5, and is shown in the time domain with the peak to peak amplitude of the signal. The oscillator output is observed to be stable with a running frequency of 77.41 kHz and peak to peak amplitude of ±4v.

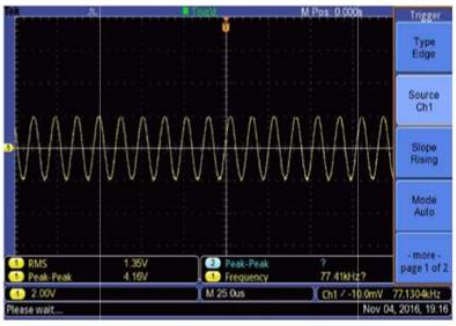

Fig. 5. Oscillator Output

D. *Normal operating conditions*

Operating ranges define the limits for functional operation and parametric characteristics of the device as described in the electrical characteristics section and for their liability specifications. Total cumulative dwell time outside the normal power supply voltage range or the ambient temperature under bias, must be less than 0.1 percent of the useful life. Functional operation above the stresses listed in the recommended operating ranges is not implied. Extended exposure to stresses beyond the recommended operating ranges limits may affect device reliability.

E. *Communication technology agnostic*

To ensure that the framework is adaptable and versatile to any client and explicit conditions, the adjusted savvy controllers to utilize a few IoT correspondence advancements Lon works PLC, Lora wan, IoT, Sigfox. Contingent upon neighborhood organize inclusion and explicit prerequisites, it is conceivable to utilize one open correspondences convention or join them in cross breed executions to meet the framework needs. This creates phenomenal usage alternatives, yet in addition permits exceptionally quick organizations and appointing in the event of existing open system inclusion. New road lighting advances have the potential advantages of enhanced effectiveness, better support qualities and enhanced control abilities that can decrease the vitality utilization and upkeep costs for a general net gain for the city and its residents. White light advancements likewise have the potential for enhanced visual execution and favored visual feel that can result in an uncalculated yet obvious advantage also. The data assembled through this paper will give guidance to the city for future road lighting applications. Further, different districts are thinking about comparable road lighting frameworks and divisions into open observation and evening time perceivability factors worth considering. This paper speaks to the white light effect on road and roadway lighting.

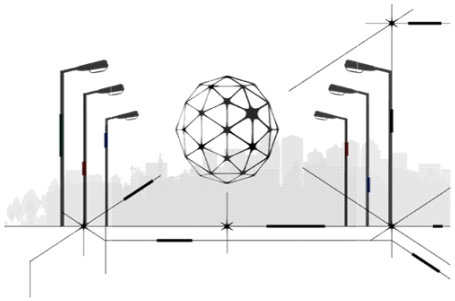

Fig. 6. Intelligent Lightning System

4. Software details

A. *Monitoring stations*

The monitoring station located in each lamp post consists of several modules the presence sensor, the light sensor, the failure sensor, and an emergency switch. These devices work together and transfer all of the information to a microcontroller which processes the data and automatically sets the appropriate course of action. A priority in the transmission of information is assigned to each sensor, for example, the emergency switch takes precedence over any other device. For automatic Street lights maintenance and to reduce power consumption. The application is designed in such a way that we place light sensors in all street light circuits, which is responsible to switch on and off automatically. Once the lights are switched on current sensors placed at every street light circuits are responsible to report problem status to the centralized system with help of GSM module attached with the circuit.

B. *Control unit*

The Control unit controls all the lighting system through a graphical user interface application window we can control all the lights and we can monitor and status of the lights. The sensors transfer the collected information to a pc. The control unit can be extended so that other electrical systems, not solely lampposts are connected, and might send data regarding power consumptions to a central system. The working of this control unit can be represented in a flow chart shows in fig.4.2 below. The control center software is the core of the remote streetlight monitoring and control system. The central application should have following features first, the software should be easy to use and interface must be friendly. Secondly, the application should be configurable and extendable.

C. *Software development*

Arduino projects might be written in any programming dialect with a compiler that produces twofold machine code. Atmel gives an advancement domain to their microcontrollers, AVR Studio and the more current atmel studio, which can be utilized for programming Arduino. The arduino gives the arduino incorporated improvement condition (IDE), which is crosswise over stage application written in the programming dialect java. It started from the IDE for the dialects handling and wiring. It was made for individuals with no significant

information of hardware.

It incorporates a code manager with highlights, for example, sentence structure high lighting, support coordinating, cutting/gluing content, seeking/supplanting content and programmed space, and gives straightforward a single tick system to aggregate and transfer projects to an arduino board. It likewise contains a message zone, a content comfort, a toolbar with catches for normal capacities and a progression of menus. A program composed inside the IDE for arduino is known as an outline. Save money on the advancement PC as documents with the record expansion. Arduino programming (IDE) preceding 1.0 spared draws with the expansion. The Arduino IDE bolsters the dialects C and C++ utilizing exceptional tenets to compose code. The arduino IDE supplies a product library, which gives numerous regular information and yield methodology. Client composed code just requires two capacities, for beginning the portray and the principle programs circle that are arranged and connected with a program stub primary into an executable cyclic official program with the GNU instrument chain, likewise included with the IDE conveyance. The arduino IDE utilizes the program to change over the executable code into a content document in hexadecimal coding that is stacked into the Arduino board by a loader program in the board's firmware.

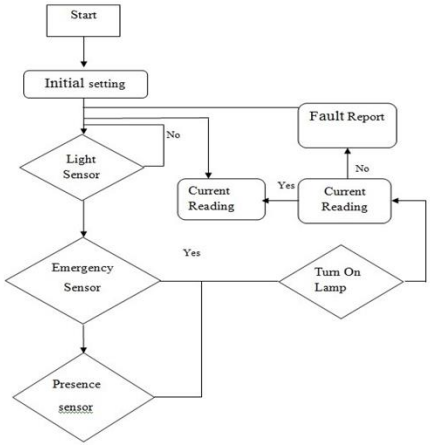

Fig. 7. Flowchart of Street Light Control System

D. Arduino UNO

Arduino is an open source physical platform based on microcontroller board having the atmega32 series controllers and integrated development environment for writing and uploading codes to the microcontroller. It has input and output pins for interaction with the outside world such as with sensors, switches, motors and so on. To be precise it has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and are set button. It contains everything needed to support the microcontroller. It can take supply through USB or we can power it with an AC/DC adapter or a battery arduino acts as the processing module of the system. It takes input from the LDR, processes the data and gives the output to LEDS directly or through a relay and a transistor mechanism arduino is open source computer hardware and software company, paper and user community that designs and manufactures microcontroller based kits for building digital devices and interactive objects that can sense and control objects in the physical world. The paper is based on microcontroller board designs, manufactured by several vendors, using various microcontrollers. These systems provide sets of digital and analog input/output pins that can be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, urban some models, for loading programs from personal computers.

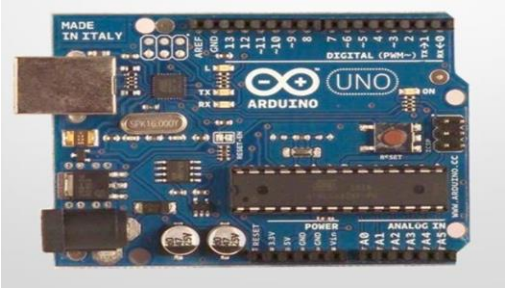

Fig. 8. Arduino Kit

5. Conclusion

In this paper, a smart street lighting system which provides an intelligent method of conserving energy and monitoring street light faults with the use of communication over the power line is proposed. The developed system communicates over power lines using modified frequency shift keying modulation. The communication component worked very well and the overall system worked is deemed feasible for practical implementation. For future work, more intelligent features will be added to the system. I also consider some embedded device security and monitoring network management. Street lamp manufacturers, automation integrators, and communication OEMs are developing solutions that use PLC to deploy automated street-lighting systems to conserve power, reduce maintenance costs, and provide rapid pay back to operators and the environment. The transceiver can automatically associate, choose the best routing path, communicate through transformers, and support IPv6 networking. These optimized capabilities greatly simplify deployment of an automated street-lighting system. The device delivers leading-edge performance to enable larger networks, additional savings, and greater safety.

6. Acknowledgment

We take this opportunity to express our gratitude and indebtedness to our guide Ms. P. V. Raut, Assistant Professor, Electrical (E & P) Engineering department, who has been constant source of guidance and inspiration in preparing this paper.

References

[1] Vaishali Gupta, Krutika Thakur, and Ritesh Thakur, "Based Smart Street Lights," International Journal of Research (IJR), Volume 2, Issue 10, October 2015.
[2] J. Arthi, W. Lydiapreethi, and B. Gunasundari," IoT Based Smart Led Street Lighting System," IJRTI Volume 2, Issue 4, 2017.
[3] Snehal Bhosale, Komal, Dipali, Pallavi, "IoT Based Dynamic Control of Street Lights for Smart City," International Research Journal of Engineering and Technology (IRJET), Volume 04 Issue 05, May 2017.
[4] Shreesh Mishra, Shivakant Gupta, Santosh Singh, Tripuresh Tiwari, and Anand Mohan, "Arduino Based Led Street Light Auto Intensity Control System" International Journal of Advanced Research in Engineering, Volume 3, Issue-4, April 2016.
[5] Fabio Leccese, Marco Cagnetti and Daniele Trinca, Article on "A Smart City Application: A Fully Controlled Street Lighting Isle Based on Raspberry-Pi Card, a ZigBee Sensor Network and WiMAX," Sensors Journal, 14 (12): 24408–24424, December 2014.
[6] Sindhu.A.M, Jerin George, Sumit Roy, Chandra J, "Smart Streetlight Using IR Sensors," IOSR Journal of Mobile Computing & Application (IOSR-JMCA), Volume 3, Issue 2, March/April 2016.