AUTOMATIC AND INTELLIGENT STREET LIGHTING SYSTEM USING IOT AND CLOUD

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Abstract: In developing countries like India, street lighting system is being controlled based on the timing and lighting conditions that are available, but there are no detectors for foggy conditions and due to the poor lighting conditions, there are many accidents taking place in the country. In this project we present a NodeMCU-based automation system to control the streetlights based on solar rays and object detection. We aim to design a system which no longer require time-consuming manual switching of the streetlights. The proposed work is accomplished by using a NodeMCU microcontroller, a light dependent resistor (LDR) and infrared-sensors(IR sensor) while, three main contributions are presented in this work. Firstly, we show that the streetlights can be controlled based on the climatic conditions and object's detection. Here, the streetlights automatically go to DIM state during night-time and fog, to HIGH state on object's detection and during day-time the streetlights will remain OFF. Secondly, the system will report the statistics of street lights operations and daily report of each street light to whether they are functioning as expected to the cloud. In addition, the system also reports the climatic conditions occurring during the day and solar panels are implemented in order to recharge the battery. Thirdly, the system is also being built for the pedestrian's safety. In which, there is a beep sound generated at the zebra crossing when a vehicle is approaching. This system is designed for lab-scale prototype to experimentally validate the efficiency, reliability, and low-cost of the systems. The proposed systems can be easily implemented and tested under real conditions at large-scale, that will be useful in the future applications for automation systems.

Keywords: NodeMCU; IR sensors; LDR; automation; energy consumption; low-cost; microcontroller; solar panels; streetlights; smart homes

I. INTRODUCTION

Automation systems have the advantage over the manual systems because it increases the productivity, efficiency and reliability, and minimizes the usage of resources to save energy, and reduce the operating cost etc. This automation system, example "smart home", make our life more comfortable, and facilitates users with ceiling fans to ovens, and in other applications. One among all these exciting applications is the streetlights which play a vital role in our environment and also play a critical role in providing light for safety. In the current scenario, where the streetlights are lit over the whole night, which consumes more energy and also reduce their lifetime. In this regard, an automation system is required to control the lights and use it according to needs.

It is common these days to see solar PV based street lights. People are now aware of the importance of moving from conventional resources-based energy production to renewable energy-based power production. It is known that fossil fuel resources are going to fed us for only 50-60 years from now. So,the shift to renewable energy-based power production in necessary as it is the only alternative available. It is sure that one can't live in a society without power. So, there is need to maximize the usage of renewable energy so that conventional resources can be preserved. Normal solar PV based street lighting system does not have automation. The problem is that it will be in HIGH state even though there is no need of light at that point of time and hence it causes loss of power. Yet another problem is power is wasted during late night when there is no usage of light by anyone. In this project a new technique is suggested to automate the entire system. Here when there is no necessity of

light, the system will go into a power down mode and the lights won't glow. Sensors sense the intensity of light and also sensor is used to detect the presence of humans or cars and then it gets turned on automatically.

II. RESEARCH METHODOLOGY

Fathima Dheena P.P, Greema S Raj,Gopika Dutt3, Vinila Jinny S proposed a system on November 2017. This project provides a better solution for streetlight control and automation. The system consists of LDR, relays, microcontroller, temperature & humidity sensor, and some electronic components. A single system is capable of controlling four to eight lights and it can also monitor the temperature and humidity of that particular area. Here, the authors used cost-effective ESP-12 Wi-Fi module. Arduino microcontroller is used to control the relays and to fetch the data from the sensors to the database through Wi-Fi module. The entire system can be monitored and controlled by a central system through a web interface. A central database is created to fetch data from all individual systems which can simultaneously control up to eight lights. The conventional lamp is replaced by smart LED light technology which consumes low power and provides high-intensity light and effectively illuminates the surrounding. The Light Dependent Resistor (LDR) helps in controlling the intensity of LED lights. The resistance of LDR varies according to the amount of light falling on its surface. When the LDR detects light its resistance will get decreased, thus if it detects darkness its resistance will increase, therefore high-intensity light can be provided during the needful conditions. Advantages are that, Smart system is connected to a group of LEDs street lights, and all the systems are connected to the internet and used to send and receive all the data the server and provides a central control to the managing board through web application and Mobile apps. Disadvantages are that the initial cost and Maintenance is high and they do not consider pedestrian safety. [1]

Akansha kaul, Tina chaudhary, Nathi Ram Chauhan proposed a system on February 2017. In this energy efficient street light project cycle, first the requirement of the lighting system of the streets are examined. Then a best technology has been implemented so that a good energy efficient system can designed. The operation and maintenance are required for a system. The values obtained by the mechanism from the sensor can be measured and evaluated from the values that are already given. The values obtained from the sensor during the task performance and then these values are compared with the given values and the errors can be found out. The measured values show the efficiency of system. The projected intellectual LED system of street light for the detection of fog includes ARDUINO software strategy, LED and colour sensor. Advantages are that the proposed system is cost effective, low budget and can install at every street of a country and Provides efficiency. [2]

Yashaswini N, Raghu N & Yashaswini S proposed the system on January 2018. In this work the LED lights are used for street arrangement, the Photo diodes and IR sensors are used to sense vehicle moments. The control signals of sensors have been fed to microcontroller 8051.The microcontroller is programmed to control lights based on vehicles and pedestrian moments. From the proposed method the energy being utilized for lighting can be minimized.Advantages are that, the implemented model is of less cost, pragmatic, eco-friendly and uses the most secure approach of saving energy. It also be utilized for security surveillance in corporate buildings, businesses centres, school premises etc. [3]

Mr.T.Gowdhaman & Mr. Dr.D.Surendran proposed a system on May 2018. The objective of the project is to provide automatic control and fault detection on street lamps. The lighting system which targets the energy and automatic operation on economical affordable for the streets and immediate information response about the street lamp fault. Moreover, errors which occur due to manual operation can also eliminate. The street light switched ON/OFF through an Internet of Things (IoT). The street light control and fault detection with cloud storage system is implemented through an Arduino program. Nowadays, the street lamps are operated manually. But, the street light control and fault detection with cloud storage system operates the street lamps ON/OFF and find the fault in the street lamps automatically. The system checks the weather condition for the street lamp ON/OFF. The LDR (light dependent resistor) is used to check the weather condition. If weather is light/dark check through a LDR. If weather is bright then it is considered as the day time. If the weather is dark then the system considers it as the night time. So, the system allows to switching ON the street lights. Advantages are that, this system is very useful to Municipal Corporation. Disadvantage is that it is not cost effective. [4]

Mustafa Saad, Abdalhalim Farij, Ahamed Salah and Abdalroof Abdaljalil proposed a system on May 2013. In the present system, the street lights will switch on during the evening before the sun sets and they are switch off the next day morning after there is sufficient light on the roads. The proposed system gives the best solution for electrical power wastage. Also here, the manual operation of the lighting system has completely been eliminated. In this project the two sensors are used which are Light Dependent Resistor LDR sensor to indicate a day/night time and the photoelectric sensors to detect the movement on the street. The microcontroller PIC16F877A is used control the street light system, where the programming language used is C-language. The system has been successfully designed and implemented. Advantages are that, it reduces power consumption and this control circuit can be used in a long roadway between the cities. [5]

Sunayana S.Badgelwar & Mrs.Himangi M. Pande proposed a system on March 2017. The proposed system Smart Street Light, is a hardware application which takes the video as an input to the system and it detect the movement of the vehicles and human beings to switch ON a chunk of the street lights that are ahead of it, and to switch OFF the trailing lights in order to save the energy or power consumption. The authors are using the Object Level Frame comparison methodology to detect the vehicles and humans that are passing by. In this project, they are also including the sensors to detect the temperature and the poisonous gases that are exceeding in particular area and send the SMS immediately to the corresponding department. It also senses the change in environmental conditions i.e. sometimes it become dark in the afternoon due to cloudy weather and should immediately send the SMS to switch ON the lights. Advantage is that, the proposed system is the power saving. Disadvantage is that the performance of the proposed system is poor. [6]

Philip Tobianto Daely, Haftu Tasew Reda, Gandeva Bayu Satrya, Jin Woo Kim and Soo Young Shin proposed a system on April 2011. The proposed architecture comprises LED streetlights in groups, which connected to web based management system to provide interface to authorized user. The authors defined an algorithm for the request and reply transmission between the SGC to SGMs and vice versa along with tuning between the 3000 K and 5000 K colour temperatures and dimming functionality when necessary. In addition, here streetlight network has a central web server called streetlight web server where the control signalling goes through the coordinator first then to each router according to their ID and the other way. Advantage is that it mitigates the chance of traffic accident happening due to low visibility during climatic issues such as heavy fog, haze, etc. [7]

Karthikeyan. M, Saravanan. V, Vijayakumar. S proposed a system on February 2014. This is a cloud-based system which has read and update of data in cloud using internet for an efficient street light monitoring system. The proposed system is ZigBee based wireless devices. It uses a dimming control and Infrared sensor; the information is transferred using ZigBee and is sent to the base station which is used to check the state of street lamps and to take appropriate measures during failures. The proposed system is particularly suitable for urban and rural areas where the street lights glow continuously bright for the whole night, even when there is no movement of humans. The independent nature of the power-supply network enables implementing the system in remote areas where installations are expensive. The ZigBee is simple and reliable to electronic components, the feature of the sensor network; the processing speed, the reduced cost, and the ease of installation are the features that characterize the proposed system. Advantage is that it offers high efficiency and considerable savings of power and cost. [8]

Sharath Patil G.S, Rudresh S.M, Kallendrachari.K, M Kiran Kumar & Vani H.V proposed a system on February 2017. A new model is presented in this project which will reduce the power consumption of the street lighting system about 20-35 % compared to conventional design. Here a lot of power saving takes place without any wastage, by these advanced technologies, designing of many more systems can be done by solar lights and through these solar lights there is a vast usage at the same time an automatic system instead of doing it manually like with LDR's. Advantages are that, it helps in reducing the power consumption and provides efficiency. [9]

Ms. M. Kokilavani, Dr. A. Malathi proposed a system on November 2017. This project is focused on the controlling intensity of the light considering the object movement near the light. Two different sensors named light sensor and photo electric sensor are used. Once if the sun light goes under the visible region then this system automatically switches ON light. As soon as the sun rises then automatically switches OFF lights. This Smart light system is used to reduce energy consumption. This smart

system uses some sensors. This smart system is used to avoid wastage of electricity. The entire smart system operates using artificial energy source. The PIR sensor and LDR sensors, senses the human being and light intensity of a particular area and transmits the data wirelessly to the EB section. This smart system is best suited for street lighting in remote urban and rural areas where the traffic is very low. Advantages are that, it is mainly used to enhance power efficiently and not much manpower is required in this system. [10]

2.1 SYSTEM ARCHITECTURE

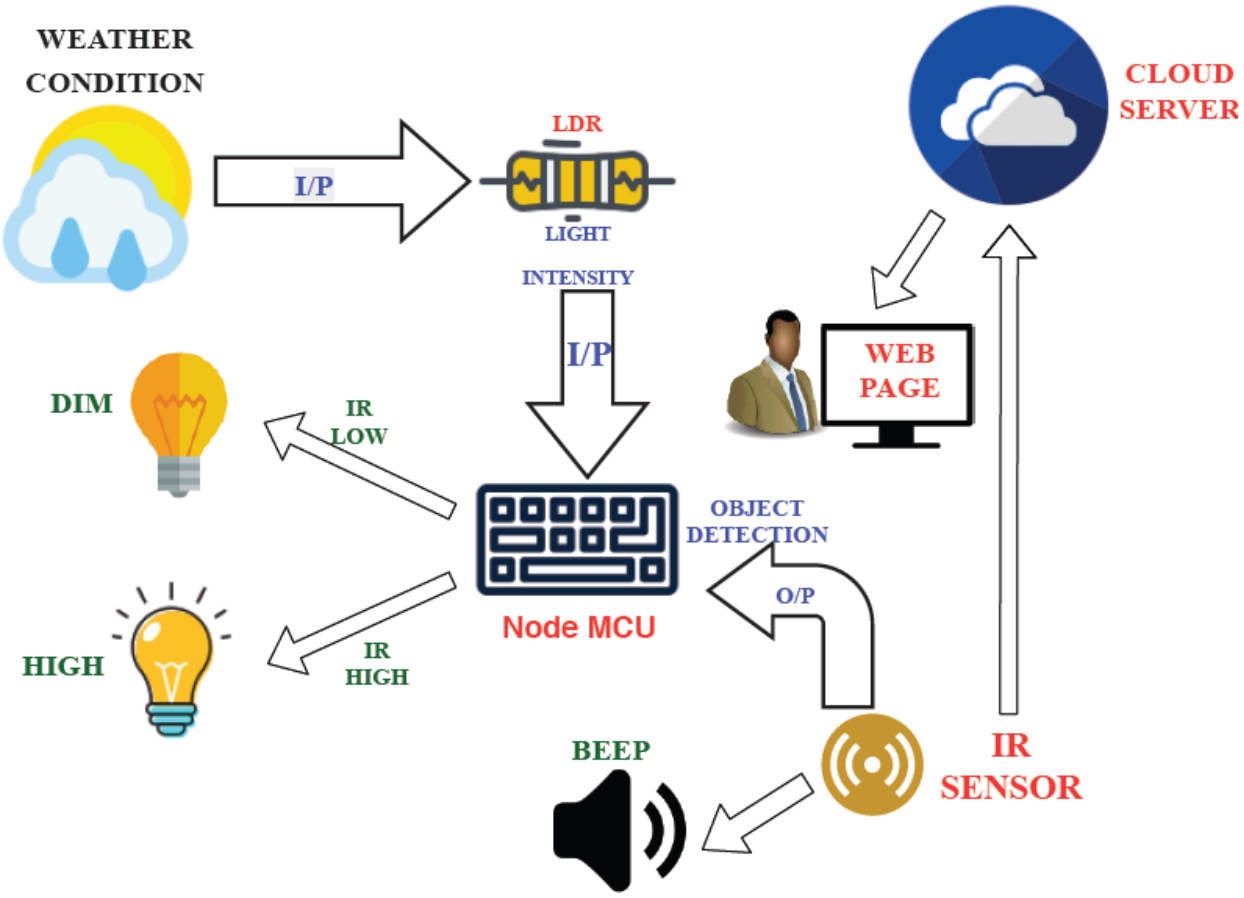

Figure 1: Block diagram of proposed system

The light intensity is given as an input to the LDR which is a light dependent resistor. This light dependent resistor, obstructs the flow of current based on the surrounding brightness. If the brightness is high, then LDR increases the resistance, hence obstructing the flow of current. If there is less brightness then, LDR decreases the resistance, hence allowing easy flow of current. The input from the LDR is in turn given to the NodeMCU. This Microcontroller is programmed using C language. This controls the brightness of the LED's in the street lights. The IR sensor (infrared sensor), is responsible for object detection. It detects the object and gives the data as input to the NodeMCU and also generates a 'Beep' sound. The data is given to the cloud as input with the help of NodeMCU. This is required for result analysis, which can be accessed through the mobile application.

2.2 METHODOLOGY

The block diagram of the proposed system is depicted in figure 1. Here NodeMCU is used as controller, so as to perform the controlling actions. Apart from this, there are certain sensors namely, IR sensor and LDR sensor. These sensors are connected to the ports of the microcontroller through connecting wires. The output from all the sensors are taken as input by the controller. The output from NodeMCU will give the result whether street light should be in on/off state. This system works mainly with the presents

of sensors. The main idea behind the system is that the lights will be in off position at day time. Even during the day if the intensity of light is lower due to weather conditions like fog, thunderstorm etc. then the lights will get switched on. IR sensor will detect the presence of any cars. When IR sensor detects the vehicles then brightness of the LED will be increased, when there are no vehicles then brightness will be decreased. This is done so as to minimize the power consumption. Here there is a need for light only when it is needed. At night sometimes, roads will be empty and hence there is no use of illuminating all the lamps. So, the intensity of LEDs can be lower and can conserve the power. When any car is approaching towards the zebra crossing, then an alert is provided to the pedestrian who is trying to cross the road. All the sensors performance is sent to the cloud server and is analyzed.

LDR is a light dependent resistor with very high resistance. Whose resistance decreases when light impinges on it. This kind of sensor is used in light sensor circuits in open areas, to control street lamps. LDR is mainly used for different lighting conditions of day and night light. LDR gives the discrete output of the resistance values, this analogue should be converted into digital. So, an analogue to digital converter is required which is interfaced with microcontroller. The microcontroller is programmed such that, during morning or evening intensity of light increases or decreases so according to that intensity it is programmed with 5 level intensity so this can conserve power.

IR sensor senses the vehicles on the street and sends data to NodeMCU. When vehicles are present it gives bright light. During late night low traffic density so brightness of the LED is automatically lowered. This dimmed light is enough for pedestrian, a lot of the power is conserved and which can be utilized for other purposes.

NodeMCU is an open source IoT platform. It has firmware which runs on the ESP8266 WIFI SoC from Espressif Systems. The hardware which is based on the ESP-12 module.NodeMCU is having inbuilt WIFI, we can connect NodeMCU to internet without much effort.

III. RESULT ANALYSIS

The figure 2 shows the information about led lights in the entire system, this system can be monitored and controlled by the administrator. The LED lights are ON when the LDR does not detect light. This effectively saves a lot of electricity for the government since there is a very less amount of electricity drawn by the LED lights and used only when there is a lack of light.

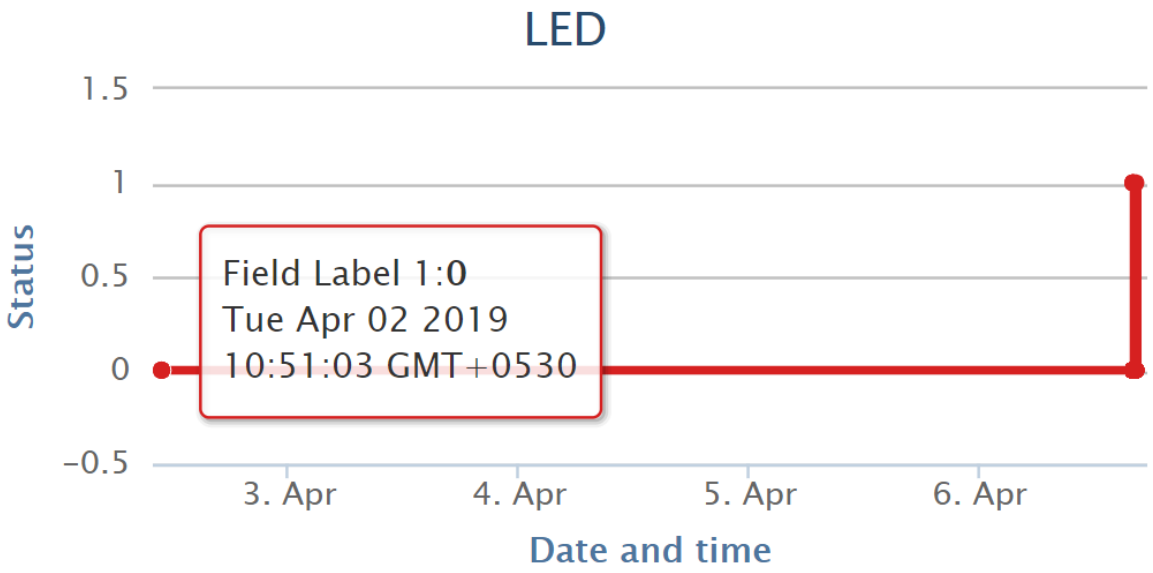

Figure 2: Status of LED reported to the cloud.

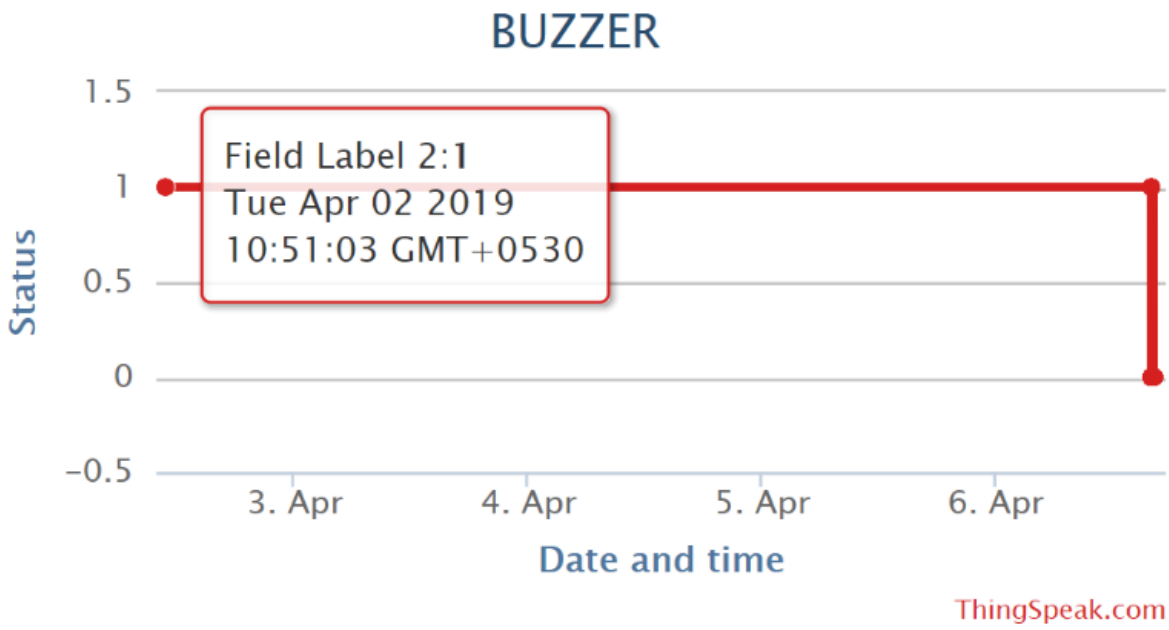

Figure 3: Status of BUZZER reported to the cloud.

The figure 3 shows the information about Buzzer. When there is a vehicle approaching the Zebra crossing then the IR sensor senses this vehicles movement and produces a beep sound through the buzzer. In this way the pedestrian is given a caution that a vehicle is approaching and needs to stay alert while crossing the road.

The above statistics can be monitored from a mobile application which only the administrator can access and control, which makes it more reliable. Maintaining this particular system is also very easy since the defective LED status will be reported to the cloud and with help of this data, the required action can be done. This system also reduces the average cost of the streetlights since LED lights are cheaper and more energy efficient when compared to the sodium vapor lamps.

These results show that the objectives have been achieved by the proposed methodology. This system can save a lot of electricity and ensures very easy maintenance. The solar panels and low-cost LED help in renewable energy generation and consumption respectively. The IR and LDR sensors are used to control the LED's and the brightness varies depending on the amount of light incident on the LDR sensor which further decreases the amount of electricity consumed.

IV. CONCLUSION

This project elaborates the design and construction of automatic streetlight control system. System works properly to turn streetlights ON/OFF. LDR sensor and the IR sensors are the two main conditions in working the circuit. If the two conditions have been satisfied the circuit will do the desired work based on program. Each sensor controls the turning ON or OFF the lights. The street lights have been successfully controlled by the microcontroller. With commands from the controller the lights will move to ON state, in the places where there is some movement, when it is dark. Furthermore, the drawback of the street light system based on timer controller has been overcome, where the now system depends on photoelectric sensor. Finally, this control circuit can be used at highways.

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