An Intelligent Smart Street Light System with Predictive model

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***Abstract*—: This paper proposes the development of intelligent street lights that minimizes the wastage of power by applying the method of reliable smart mangement proposal that is essential for a wealthy lifestyle for upcoming generations living in modern platform. The propsoed model involves three main stages namely maintenence stage, automatic adaptive ON/OFF control stage and prediction of electricity consumption stage. In order to apply this technique, a Wi-Fi module, Light dependent sensor (LDR), accelerometer and ultrasonic sensors are employed. The accelerometer sensor is utilized for identifying the pole inclination and report the emergency condition to control room or user. Then, LDR sensor is employed to turn ON-OFF of street lights with respect to atmosphere intensity level. This switching could be performed using ESP8266 based on the LDR. Ultrasonic sensor helps to sense the presence of any vechicle or person in a specified range, then light glows with 100% brightness else, it is reduced and glow with only with the intensity of 60%. Besides, a predictive model based on imporved bayesian neural netwok (IBNN) model is applied. The need of IBNN model is to report the utilization of the power for a period of specific duration. The propsoed work eliminates the power wastage during night time if there is no vechicle or trespassers passing. Moreover, by applying these three sensors, an intelligent automatic light is developed using IoT frame work that is effective.**

Keywords— ***Street light, IoT, Arduino, Accelerometer sensor, LDR.***

I. INTRODUCTION

The rapid development in novel techniques such as automation and embedded systems that results in scientific approach Internet of things (IoT) [1]. IoT comprises of several intelligent gadgets that is linked [2].These devices could interact with one another and design them with the help of IoT

In order to organize the evolved method various gadgets are equipped using micro-controllers, required sensors and transceivers [3]. IoT utililzes machine-machine interaction that can transforms previous models of human-human and human-machine types of communication. By using the proposed model power wastage is minimized and involvement of human is decreased. IoT offers the merit od energy storage. By the survey, it is known that imdia stores $42 billion every year by applying other technique that decreases the wastage of energy. For supporting smart cities concept in vision, several models using particular applications in urban regions adopts latest IoT approach to facilitate better service. IoT gathers major attention from urban region due to the utilization of smart techniques that is induced by local government. For improving the quality of service (QoS) which is provided to the residants to minimize the computational cost that is consistent, easy IoT system would lead in emerging advantages of converting conventional public services. The local government and public administration systems in several regions involves in adopting proper actions for improving the contribution of people for adoptimg power saving mechanism. By realizing the urban IoT service the atructure needs implementation of more gadgets as well as sensors with monitoring networks. The main aim of urban IoT is combining a optimized automated techniques. With previous architecture of IoT evaluation it requires to analyze service and functions of interconnected deviceto obtain specific outcome. Based on the concept of energy saving, power consumption in street light is mandatory. Particularly, applying scientific IoT models to street lamps, the intensity could be manged with respect to environmental cases andexistence of people.

Existing studies reports various challenging issues that are relevant to street lighting mechanism. In 2016, [3] proposed a

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work which offers a decision to control the street lights in dynamic manner that is served by IoT. In 2017, [4] introduced a novel technique that control street lights which is adaptable for weather conditions. It presented the installation of modern street light that relies on application of solar energy in which the panels absorb sunlight at daytime and streetlamps are turned off and illuminates at nightime in an automatic way. Lights could be glowed remotely by internet. In 2015, [5] deployed a suggestion which offers energy efficient solution for controlling street lights with the application of LED and ZigBee protocol. [6] presented that removing manual contribution to control street lampsmakes it efficient with the help of IoT. In 2016, [7] projected a cheaper price implementation of MQTT with application of ESP8266. The external things are with sensor capabilities, enough electricity and correlation of internet enables IoT feasible. In developing techniques it requires to be cost effective and less bandwidth technqiue named Message Queuing Telemetry Transport (MQTT) Protocol. In 2016, [8] established the combination of LEDs as a substitute of mercury vapor lamp as light source. It serves as a brilliant remote controlling model and capable of adopting ambience level.

This paper proposes the development of intelligent street lights which involves three main stages namely maintenance stage, automatic adaptive ON/OFF control stage and prediction of electricity consumption stage. In order to apply this technique, a Wi-Fi module ESP8266, Light dependent sensor (LDR), accelerometer sensor and ultrasonic sensor is employed. The accelerometer sensor is utilized for identifying the pole inclination and report the emergency condition to control room or user. Then, LDR sensor is utilized to turn ON-OFF of street lamps based on atmospheric intensity levels. This switching could be performed using ESP8266 based on the LDR. Ultrasonic sensor helps to sense the presence of any vehicles or person in a specified range, then light glows with 100% brightness else, it is reduced and glow with only with the intensity of 60%. Besides, a predictive model based on improved Bayesian neural network (IBNN) model is applied. The need of IBNN model is to report the utilization of the power for a period of specific duration.

II. PROPOSED WORK

The street lamps form existing works preserves large amount of energy as it glows the entore night though there is no movement of vechicle are human. Hence it attains inefficiency. Modern street light concentrates to save energy and most importantly to offer satisfaction. Automatic intelligent intensity control the light at nighttime by the detection of moving transports, and trespassers. Then it is switched OFF or ON on the basis of weather condition. Energy could be preserved in street light by considering the optimal automated method named as IoT. It is expensive by means of energy consumption. On the basis of intelligent lighting system expense could be minimized from 50%-70% [9]. This presented is developed using simple infrastructure as depicted in Fig. 1 where ESP8266 and alternate gadgets are linked. It designs an inexpensive, micro-controller and adaptively adjustable luminaries on the basis of atmosphere levels motion of objects for implementing light control patterns. The board is comprised with sensors. The merits of presented model is automated controlling of street lamps, minimum maintenance expense, energy saving and minimized labor.This overall process is depicted in Fig.1.

A. Hardware components

i. LDR Sensor

Light dependent resistor (LDR) is designed with the help of semiconductor material using maximum resistance. LDR is termed as photo resistor. The resistivity is referred as performance of electromagnetic radiations obtained form light. Hence they are light sensitive. LDR consist of a strategy called photo conductivity. It is described as optical phenomenon where the light falls on any object, then conductivity improves.Becasue of photons fall, electrons are excited to conduction band from valence band of semiconductor material. Photon energy must be higher than energy band gap of semiconductor, only then electrons move from valency to conduction band. When light has enough power strike on device various carriers are produced, Consequently, high current flows by device if it is closed circuit. Thus the resistance of a gadget is decresed because the production of charge carriers.

ii. Ultrasonic Senor

It is applicable to estimate the distance of object from street light. It forwards a high frequency sound waves and obtain the return echo from corresponding object. Distance could be calculated to measure delay from transmitted waves to reception echoes.

$$" Distance = (Duration/2) / 29.1" \quad (1)$$

iii. Wi-Fi module

At present, between every integrated wi-fi chip, ESP8266 is the optimal and cheaper wi-fi module. A 32-bit Tensilica Xtensa L106 micro-controller is fixed inside the chip. Only with specific PCB region RF balun, power amplifiers, less noise receiving amplifiers, filter and power controller with mower circuitis incorporated [10]. Circuit connections of presented model combined TCP protocol stack which is already fixed. This module performs in 5 levels such as OFF, alive, wake up mode, sleep mode, deep sleep mode. Powers saving technique to compute ESP8266 is defined. With programmable GPIO pins specific gadgets such as sensors could be operated simply. A link is created among external world and ESP8266 node, MCU board with GPIO pins simpler analysis. The pins consist of alternate multiplexed actions using I2S, I2C, PWM, UART, IR Remote Control and so on [1]. A 10-bit precised SAR ADC is integrated into

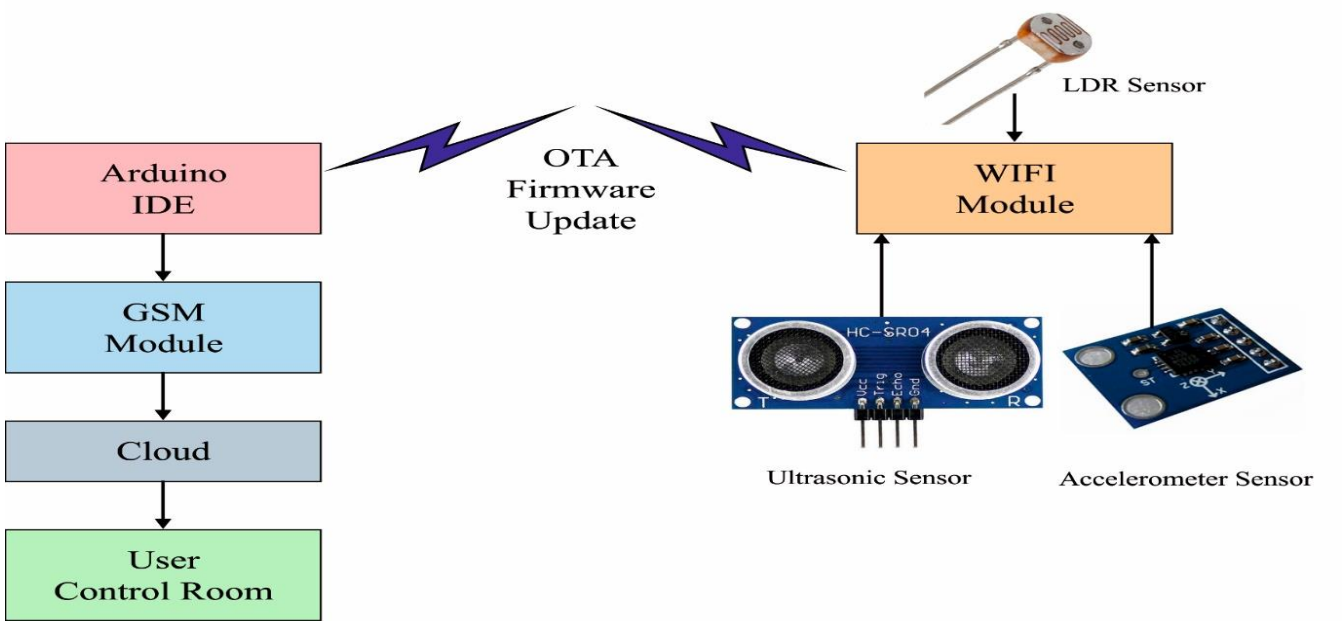

Fig. 1. Architecture of Predictive model

ESP8266 module. ESP8266 could act as wi-fi adapter and micro-controller is included by ireless Internet with the help of serial peripheral interface, UART and I2C. In order to enhance the computation process a cache is embedded. This cache supports few connection activities using Android systems. ESP8266 is majorly developed for IoT tools, mobiles and basic electronic appliances to attain less energy conservation.

iv. SSR 230V 4A Dimmer circuit

SSR ON/OFF switch consist of 16 dimming stages that could be monnitored by the controller. It comprises few merits namely smooth dimming and accurate firing angle control. It has maximum operating voltage of 5V and ideal power source from input. The major benefit provided by this dimmer circuit is to offer low energy consuming and convince with secured metrics. Air firmware upgrading is most satisfied with no contribution of human invention for traditional models. The SSR 230V 4A Dimmer circuit is shown in Fig. 2.

Fig. 2. SSR 230V 4A Dimmer circuit

In exisiting models sketch is induced to module with the application of serial communication from IDE. A serial bootloader process is flashed to the module by the time of producing essential procedure while software uploading. However, OTA firmware updating model which is generated to program a device in air. This component is integrated into wi-fi loader by activating OTA virtual button and the device has the ability for uploading the program. Once it is uploaded, the device works in automated reset of the system. The first firmware updation is performed over the air. The functions offered by ArduinoOTA with enhanced protection.

B. Software details

Arduino IDE

It is a type of software finds helpful in uploading programs straightaway to the board. It is accessed by several operating system (OS). It has open environment to apply hardware and software programs. They emerge with few benifits such as rapid prototyping as well as to assist in obtaining information about electronics and computer programming. Also it is reliable, easy and able to understand by the user.

IBNN forecast model

IBNN model which is induced to measure the time required for energy consumption for a specific duration and notify to the wi-fi controller and the structure is shown in Fig. 3. It is a software program that has the inputs like time and time delay

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and day-type meteorology parameters such as temperature and humidity, also historical load data is induced as inputs. Various conventional time series using frequent historical values, an extended method with maximum prediction of old measures which is developed to attain greater accuracy with less computation time. Historical data which is selected might be single vector that is nearby to forecast vector. Pearson correlation coefficient (P) and Spearman correlation coefficient (S) has been applied for estimating the link among them. If all attributes contain N scalar observations, the Pearson correlation coefficient P is described as

$$P(M_1, M_2) = \frac{1}{N-1}\sum_{i=1}^{N}\left(\frac{M_{1i}-\mu_{M_1}}{\sigma_{M_1}}\right)\left(\frac{M_{2i}-\mu_{M_2}}{\sigma_{M_2}}\right) \qquad (2)$$

where μ_{M_1} and σ_{M_1} denotes the mean and standard deviation(SD) of M_1. Also μ_{M_2} and σ_{M_2} indicates mean and SD of M_2. The above equation is defined as correlation coefficient on the basis of covariance M_1 and M_2. The Spearman correlation coefficient (S),could be determined as follows

$$S(M_1, M_2) = \frac{\sum_i (M_{1i}-\overline{M_1})(M_{2i}-\overline{M_2})}{\sqrt{\sum_i (M_{1i}-\overline{M_1})^2 \sum_i (M_{2i}-\overline{M_2})^2}} \qquad (3)$$

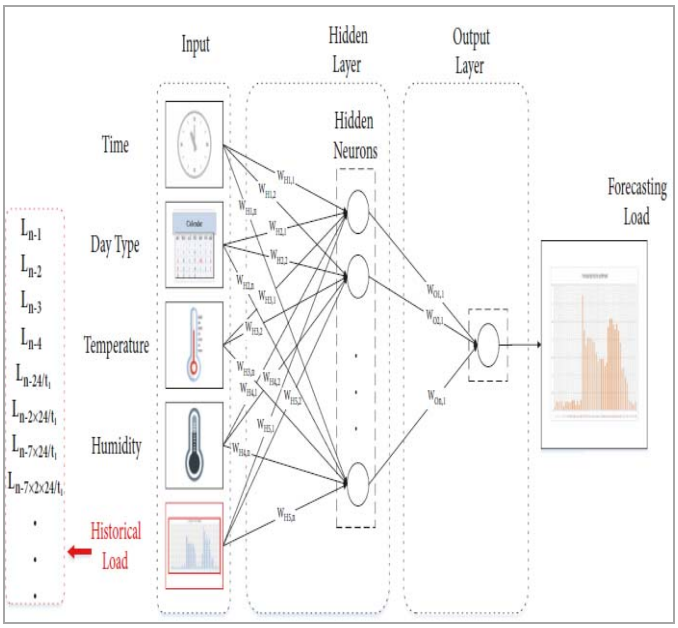

Fig. 3. Structure of BPNN based prediction model

III. Conclusion

Presently, many works have been established to overcome the complexities invloved to attain efficient street light management. This paper has proposed a method which is capable of achieving low power consumption, detection of failures, and notify the time duration to control room. An arduino IDE software programs is helpful to induce these devices for sending the notification to emergency room on detecting any abnormalities. Also IBNN forecast method is involved to predict the energy consumption for particular period of time. Moreover, by applying these three sensors, an intelligent automatic light is developed using IoT frame work that is effective.

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