Integrated Smart Pole

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Abstract: Beyond the infinite lighting options, smart poles offer many Smart City technologies, including electric car/vehicle (EV) charging unit, panic button, CCTV, Audio Speakers and Mobile equipment, weather stations and photovoltaic (PV) units within internal batteries and inverter, sized as applicable. Smart poles can improve parking and traffic management through real-time data, leading to a reduction in congestion and emissions. It can also monitor air quality and detect and notify officials about street flooding. The heart of the system is the solar panel which makes the entire project self- sustained. The entire system is powered by solar panel. It is equipped with the most efficient solar panel technology to power the smart pole. The proposed work uses ESP8266 WiFi module which analyses the input data and acts according to it. Multiple environmental sensors like humidity and temperature, gas sensors for measuring, monitoring, and recording environmental parameters and for pollution deduction. Smart pole integrates SOS button that will help our citizens to communicate with the services like hospitals or police, in emergency situations like thefts, and accident. Live streaming camera to provide surveillance of the surroundings gives security. This will be monitored by the authorities for providing the responses through the control room. Display board provides information of the environmental conditions and conveys messages to the public. Loud speaker system is used to alert the public in case of emergency and dissemination of information regarding pollution level and traffic

Keywords: Smart Pole, DBOOT model, Internet of Things (IoT), Solar Power

I. INTRODUCTION

Smart Poles are potential building blocks of smart city infrastructure. Traditional electric poles just power the street light and nothing else. In this proposed model a system is proposed which performs multiple functions smartly like controlling street light autonomously based on the ambient light, emergency SOS button, car charging system, environment monitoring system such as gas sensors and temperature sensor. The batteries of the vehicle charging circuit will be charged through a solar panel. In addition to this, streaming functionality is also added where authorities can watch the live stream from the camera attached to the smart pole, so that they can monitor the traffic and such. The smart poles provide multi-utility functions and are potential building blocks of a developing village/city. Smart pole can be implemented on DBOOT model (Design, Build, Own, Operate, Transfer) providing a win-win situation for the citizen, government and business. The proposed system will provide multiple functions from a single pole. These poles can be installed in various places throughout the cities. The system will provide a better living life for the people of the cities. Smart Cities Mission was launched by the Hon' Prime Minister on 25 June, 2015. The objectives of the mission are to promote cities that provide core infrastructure, provide clean and sustainable environment, give a decent quality of life to their citizens through the application of 'smart solutions' and drive economic growth.

II. LITERATURE REVIEW

According to a 2004 report from USAID, the majority of street lighting loads use 21 TWh of energy annually. An idea of developing an IoT based application to monitor and control streetlights efficiently and improve its maintenance facilities to develop a system using controller Raspberry Pi3 which will assist in message generation and passing is proposed [1]. The LDR sensors will sense the intensity of light of the pole. In the currently existing system, the workers need to manually check for faults in the streetlights for immediate action. This system has a huge drawback as it increases manual effort and the need of manual maintenance. The system enables maintenance and control of the street lights and makes it easier to monitor and control its operation. The architecture of the WSN and the methodology used for data transmission and reports the experimental results derived during the implementation of the presented system has been proposed [2]. To develop this system PIC24F16KA102 microcontroller is incorporated and consists of temperature and humidity sensor, CO2 sensor and wireless transceiver. This system is useful to provide services such as air quality management, weather monitoring in public places and home automation in a smart city. The reliability of the system is approximately 65% and can be improved to 99% reliability in future work. The solution for deterioration of air quality is

proposed [3] to address the issues of global warming, and continuous depletion of fossil fuels-based generation and electrification of transportation. The electrified transportation offers a noise free, clean and efficient means of transportation system as compared to the internal combustion engine vehicle. A design model is proposed using solar street light design towards energy efficiency development for managing facility planning [4]. This system uses solar energy radiation as primary energy source. The solar panel act as a medium to collect and transform to electricity.

The electricity generated is stored in a battery and convert to light energy during working hour of streetlight system. With detailed comparison conventional streetlight, was able to save 64.7% of total cost compared to conventional street lighting system. Arduino Mega2560 was proposed [5] in a similar model, which has 54 digital I/O pins and 16 analog inputs and it is programmed using Arduino Software (IDE). The proposed system provides various features such as zone barriers, facial recognition, remote camera surveillance and power failure detection all in one. It also provides the feature of instruction logging so that the data about instructions can be accessed by the owner of the secured property and anywhere. A better efficiency, better lighting and better interface and interaction are the sole objective of an intelligent smart pole [6]. It will also address problem of stray animals camping around the poles, which are rarely addressed in yet significantly contribute to street problems we face. The Internet of Things provides a platform to remotely monitor, manage and control a variety of devices and help extract information from real time data collected by the devices [7].

They also consume huge power for their operations and transmission of data. Many legacy wireless systems use frequency shifting keying (FSK) modulation as the physical layer because it is a very efficient modulation for achieving low power [8]. An energy comparison amongst Halogen Lighting, LED Lighting and Smart Adaptive Lighting [9] provides energy consumption in smart street lighting. Based on the energy source models and their efficiency, an integrated smart pole be designed by integrating solar panels so as to use solar energy. Solar streetlight is self-generated electricity that helps to reduce the usage of energy thereby controlling issues related to environmental pollution.

Fig. 1 Smart Pole

With the rise in development of smart cities, smart poles are becoming mandatory. The smart poles can provide different functionalities in a single pole as shown in Fig. 1. In this proposed paper, multiple sensors are integrated in a single pole, which makes it much more efficient than scattering the sensors in different locations. The design of integrated smart pole can provide street light control and Electric vehicle charging using solar panels, collect information and monitor environmental parameters using sensors, provide surveillance of the surroundings using CCTV cameras and communicate to the control room during emergency and communicate with public through displays and speakers for disseminating information.

III. METHODOLOGY

The heart of the system is the solar panel which makes the entire model self- sustained. The entire system is powered by solar panel. The smart pole is equipped with the most efficient solar panel technology to power the smart pole Another main component of this model is the ESP8266 WiFi module which analyses the input data and acts according to it. Multiple environmental sensors like humidity and temperature, gas sensors for measuring, monitoring, and recording environmental parameters and for pollution deduction.

Smart pole integrates SOS button that will help our citizens to communicate with the services like hospitals or police, in emergency situations like thefts, accidents etc. Live streaming camera to provide surveillance of the surroundings gives security.

This will be monitored by the authorities for providing the responses through the control room. Display board provides information of the environmental conditions and conveys messages to the public. Loud speaker system is used to alert the public in case of emergency and dissemination of information regarding pollution level, traffic etc.

A. Internet of Things (IoT)

The Internet of Things is the network of physical devices, vehicles, home appliances, and other items embedded with electronics. IoT finds various applications in industries. The Internet of Things, or "IoT" is about extending the power of the internet beyond computers and smartphones to a whole range of other things, processes, and environments. Advancements in medicine, power, gene therapies, agriculture, smart cities, and smart homes are just a very few of the categorical examples where IoT is strongly established.

B. ESP8266 WiFi module

The ESP8266 is a complete and self-contained WiFi network solution. In it's original form it is a simple serial to WiFi converter that can be used to interact with the serial ports of micro-controllers over WiFi. The ESP8266 Arduino compatible module has a Micro Controller Unit which gives the possibility to control I/O digital pins via simple code like programming language

C. Solar Charger

Solar charger used in the solar power system to control the multi-channel solar cell array to charge the battery, and also control the battery to supply power to the solar inverter load. It regulates the charging and discharging conditions of the battery. In solar charger, the input power was at six Watts and for the wall phone charger; the input power was at 6.5 Watts.

D. Arduino IDE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards.
The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.
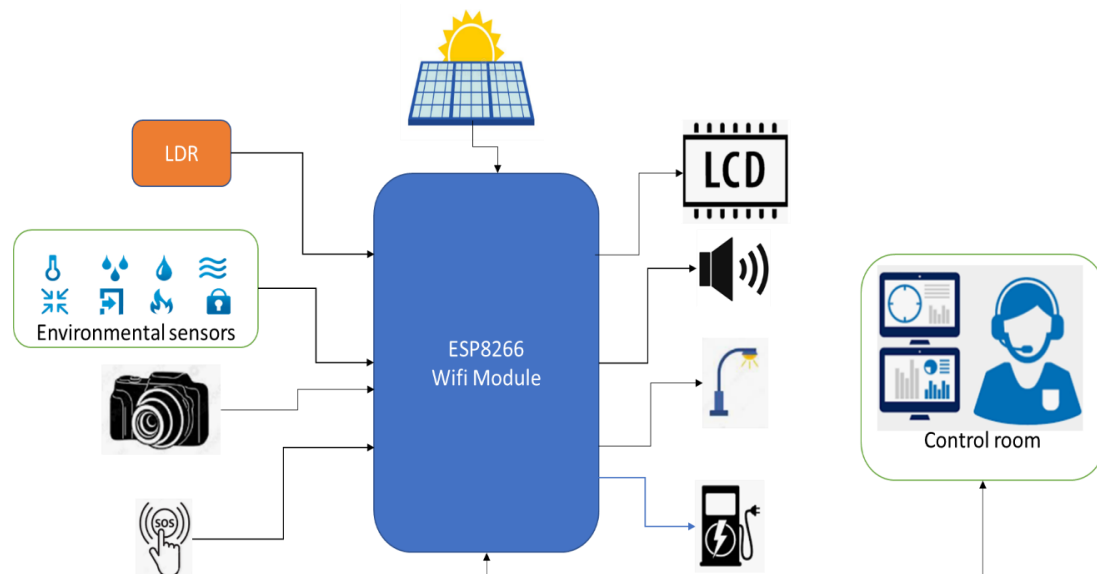The program or code written in the Arduino IDE is often called as sketching.

Fig. 2 Block diagram of Integrated Smart Pole

The proposed system also integrates the vehicle charging system which charges the battery using solar power and helps to charge the battery-operated vehicles as shown in Fig. 2. The charging system is self-sustained which uses renewable energy to charge the batteries. The main component is the ESP8266 WiFi module which analyses the sensor's data and acts according to it. The system is equipped with multiple sensors such as light sensor, gas sensor, temperature and humidity sensor. The light sensor is used to automatically control the street light based on the ambient light.

The gas sensor is used to monitor the poisonous gas present in the environment. If the amount of poisonous gas is higher than the threshold, then a message is sent to the authority notifying about the rise in gas level. Temperature and humidity sensors are used to monitor the temperature and humidity present in the environment, if there are any abnormalities in temperature, then a message will be sent to the authority. In addition to this emergency SOS button is also provided, on pressing this button an emergency message notification will be sent to the authority. When it comes to emergencies, be it medical or crime-related, time is of the essence. With IoT connectivity and smart pole technology, emergency services and first responders have a powerful smart detection tool that can help them close the emergency response gap. For example, microphones embedded within the smart pole can be equipped with pattern recognition technology to detect incidents such as cries for help, car alarms, breaking glass, gunshots, or other indicators of potential crimes or emergencies. When a smart pole detects such an event, it can brighten its light automatically, record audio, and alert emergency services. The interfacing flowcharts are shown in Fig. 3.

E. Algorithm

The algorithm for the working of the model is as follows:
1. Initialization
   a. Wi-fi is connected and display will be initiated.
   b. DHT 11 is connected, if not error message will be displayed.
   c. Web camera is turned on.
2. After initialization, system will check for the condition, if methane gas is more than threshold level YES message is displayed in the gas level otherwise NO message will be displayed.
3. Next system will read the values of Temperature and humidity level in the surrounding and display it on the LED.
4. A condition for LDR is checked, if value is less than threshold LED will turn ON, else it will remain OFF.
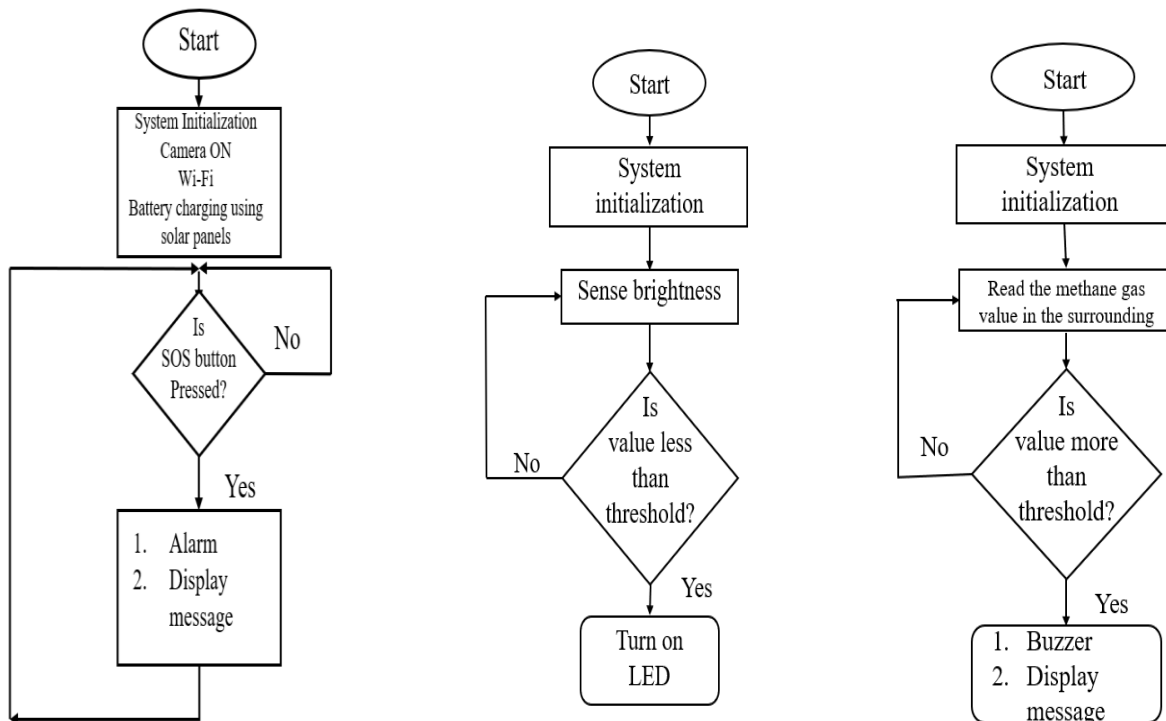

Fig. 3 Flowcharts of Button and Buzzer interface, LDR and LED interface and Gas sensor interface

5. If button 1 is pressed, buzzer turns ON and mail is sent to the given ID and the surrounding will be monitored in the control room. To turn off the buzzer button has to be pressed again.
6. If button 2 is pressed Helpline numbers will be displayed in the display.
7. These conditions will be monitored till the system is turned OFF.
8. STOP.

F. Results and Discussions

This system can harvest solar energy for functioning of the integrated smart pole that becomes a major component of a developing village/city, intelligent street light control, monitoring of environmental parameters, electric charging point for electric vehicles, assistance during emergencies and surveillance system. Relevant to society, the smart poles provide multi-utility functions and are potential building blocks of a developing village / city. Smart pole can be implemented on DBOOT model (Design, Build, Own, Operate, Transfer) providing a win-win situation for the citizen, government and business.
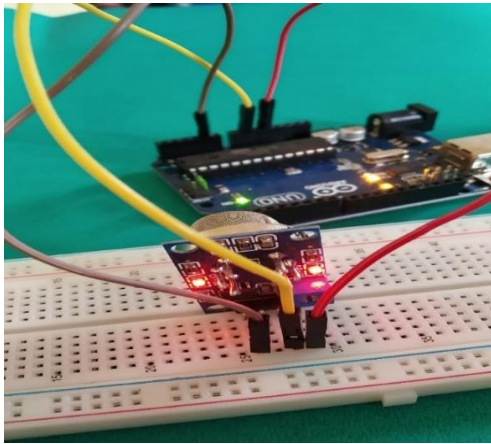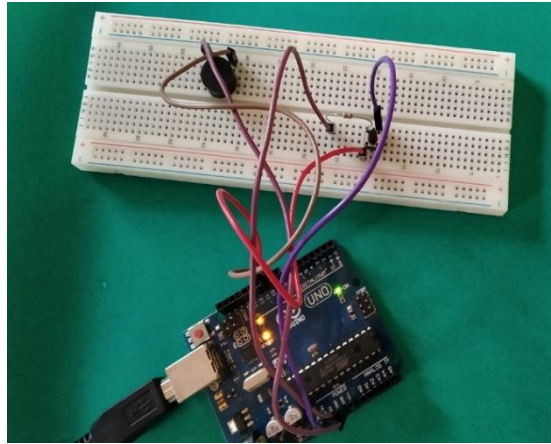
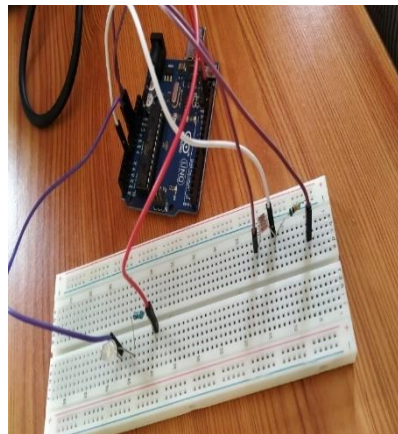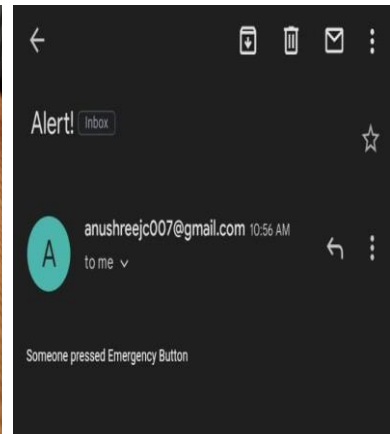(a)   (b)

(c)   (d)   (e)

Fig. 4 (a) Buzzer (b) LDR & LED (c) OLED (d)Gas Sensor (e) email interfacing

IV. CONCLUSION

An integrated smart pole provides automatic street light control with environmental parameter monitoring and surveillance system. It also provides electrical charging point for electric vehicles and disseminates messages during emergency. As it depends on solar panel for power, it would be burden during monsoon season. As it is installed in remote places maintenance would be difficult and as the microcontroller used is ESP 8266, only minimum number of components can be mounted on the microcontroller. The ESP 8266 Wi-Fi code takes a lot of CPU power. However, Smart pole provides the street light control, efficient monitoring of environmental parameters using sensors. It will also regulate the brightness and dimming of street light on the time of day and ambient conditions which contribute to energy saving and protect the environment. The electric charging point are incorporated as electric vehicles are increasing day by day. It will be helpful in case of any emergency situation as live streaming is available.

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