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IMPLEMENTATION OF IOT BASED SMART CITY SYSTEM

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Abstract: By 2050, there will be 20 billion people on the planet, and it is predicted that they will use 71% more natural resources, which will increase power consumption and make sustainable development more difficult. Smart cities will therefore be required to address these issues and foster economic development. Although there are many various energy sources, including thermal energy, wind, solar, and tidal energy, that can be utilised to generate electricity, the current generation has trouble lowering the quantity of power used. An efficient solution that seeks to maximise the use of energy resources and has objectives for sustainable energy is provided by smart cities (renewable energy and energy-efficient technologies). This paper demonstrates the implementation of a smart city through the Internet of Things using the Node-MCU device. The major objective of this project's goal is to improve living standards by developing smart home automation systems, smart street light controllers, and smart irrigation systems that conserve water. People's quality of life is improved as a result of the smart city deployment utilising Node-MCU because it enhances the economic infrastructure in a way that is both cost-effective and produces successful smart outcomes.

Index Terms **- Home automation, Smart irrigation, Street light controller, IoT, Node MCU.**

I. Introduction

IoT (Internet of Things) is a concept that allows physical objects to communicate with one another and connects them to the internet network so that they can be remotely controlled by websites and mobile applications. In order to help its residents and address their problems, a smart city uses a variety of IoT devices. IoT is used to gather and process data from numerous actuators and sensors [4], after which it is wirelessly transmitted to smartphones or computers. IoT offers a variety of applications and has the ability to meet customer requests for services and products. The conventional switch systems will make a good transition to this technology. IoT can communicate without the need for a human. Some preliminary IoT applications have been already developed in healthcare, transportation, and automotive industries [4]. Although Internet of Things (IoT) technologies are still in their infancy, there have been several recent advances in the connection of physical things to online sensors. Many concerns, including infrastructure, communications, interfaces, protocols, and standards, are involved in the Internet of Things advancement. This article discusses three major sectors: smart home automation, smart irrigation, and automatic streetlight controller.

There are countless uses for automation systems in all spheres of life. The house appliances may be readily tracked, monitored, and controlled with a home automation system [1]. Everyone can interact with the system thanks to a user-friendly networking. Every person can live a better, easier life thanks to residence automation. The evolution of automatic and programmable control systems can solve the issue of most home appliances still employing a basic manual control system. When a human has to link with other things, a sophisticated IoT network is created. The internet of things (IoT) technology is utilized to create cutting-edge concepts and significant growth for smart homes to raise living standards [5]. The ability to connect from any remote location and find rapid solutions to numerous problems thanks to the internet helps to lower overall costs and energy usage.

Agriculture uses the Internet of Things (IoT) technologies a lot these days. IoT is transforming the agricultural industry and giving farmers the tools, they need to combat the enormous challenges they confront. Agriculture must address growing water shortages, a lack of available land, and the rising consumption demands of a growing global population. These problems are being addressed by new cutting-edge IoT applications, which are also improving the quantity, quality, sustainability, and cost-effectiveness of agricultural produce. The foundation of the Indian economy is agriculture. As the world's population is expanding quickly today, agriculture is becoming more crucial to supplying the demands of the human race. Agriculture does, however, require irrigation, and since we use more water each year than we do for precipitation, growers must develop ways to do so while still getting the best output possible. However, in the modern period, farmers have been adopting irrigation techniques with human controls, irrigating the ground at regular intervals. With the aim of reducing water use in the agricultural sector, this article concentrates on that sector. A few sensors are used in the system's implementation, including a soil moisture sensor (REES52) for measuring soil moisture levels and a humidity and temperature sensor (DHT-11) for monitoring temperature fluctuations.

Street lights are one of the main energy consumers in any city. Even during the day, when street lights are not necessary, it is regularly observed that these lights are left on, in violation of the law requiring energy saving. This constant lighting increases the cost of electricity while also polluting the environment. A straightforward yet effective idea is the Automatic Street Light Control System, which automatically turns on and off-street lights using an LDR module. Utilizing this method can reduce human labor requirements and energy usage.

II. METHODOLOGY

The application of an Internet of Things-based Smart Home Automation System employing Node MCU is displayed in Fig.1.

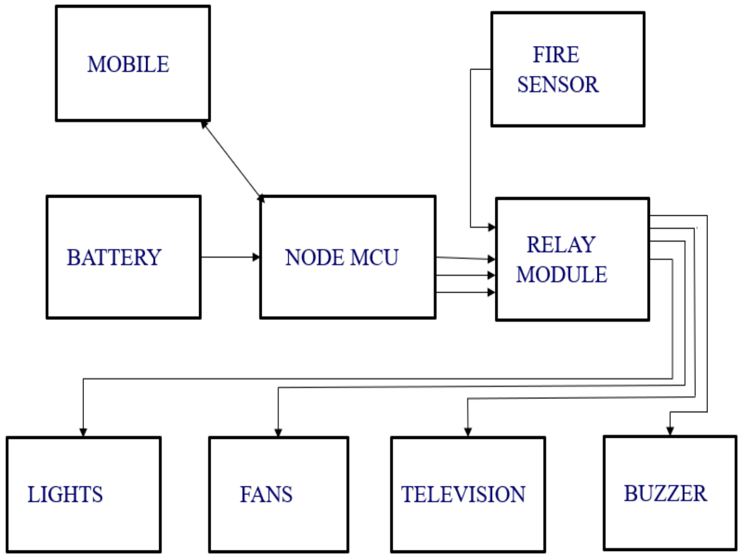

Fig.1

The main heart of this project is Node MCU, which is a Microcontroller board having inbuilt Wi-Fi connectivity. In the above block diagram, the mobile phone is interfaced with Node MCU and everything is connected to microcontroller board except fire sensor. The fire sensor is directly connected to relay which is used to reduce fire accidents in home. The operating voltage of Node MCU is 3.3v and gives the output with 5v which is not sufficient for the home appliances, so it is given to relay module which produces 230v which is required to control the home appliances. The commands can be given with the mobile phone. So that we can control home appliances with our mobile phones.

The Smart Irrigation System's block diagram:

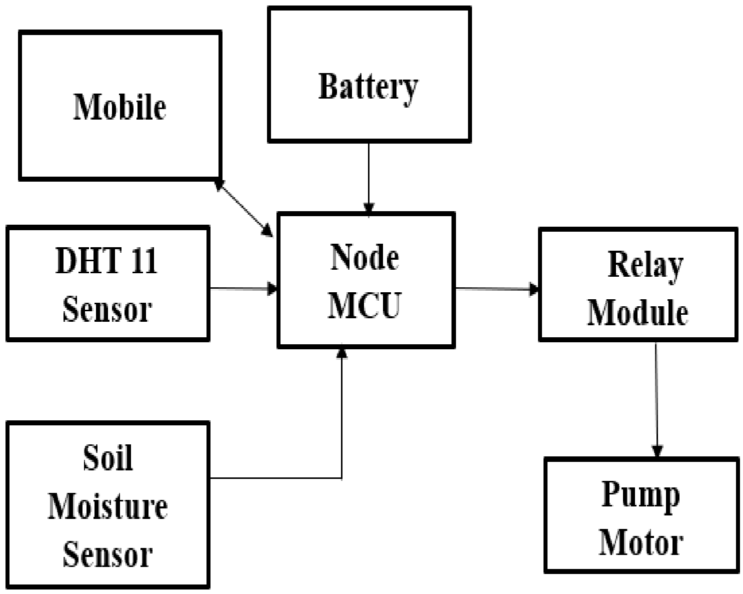

Fig.2

The above block diagram displays the implementation of Smart Irrigation System. In this also the main component is Node MCU. The mobile phone is interfaced with the microcontroller board. This implementation includes a soil moisture sensor, which measures the soil's moisture content, and a DHT 11 sensor, which gauges the environment's humidity and temperature. The Node MCU's microcontroller processes the sensor data and transmits it to the phone. The engine can be turned on and off using a mobile phone in accordance with the amount of soil moisture.

Block diagram for The Automatic Street Light Controller:

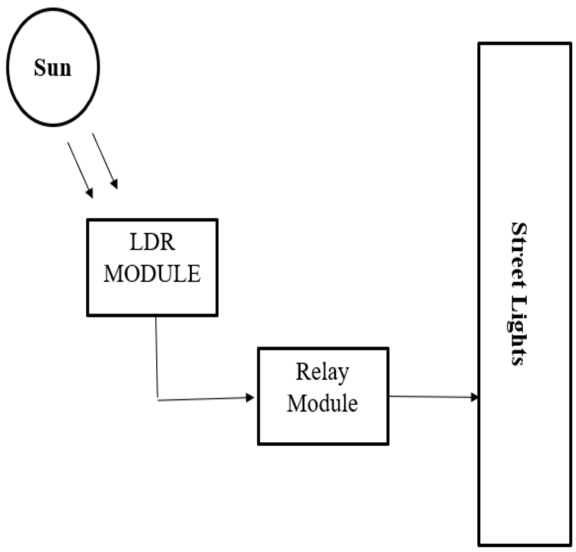

Fig.3

The above block diagram shows the implementation of Automatic Street Light Controller. The main component of this block diagram is LDR module. LDR stands for Light Dependent Resistor which is used to measure the intensity of light. In this there is no need of Node MCU for the operation. The LDR is directly connected to relay which is given to light. Whenever, the intensity of light is low the street light turns on automatically and turns off automatically when the light intensity is more. This is the operation of the above block diagram.

A. Node MCU

The esp8266 is a self-contained Wi-Fi networking device that can run standalone programs and serves as a bridge from an existing microcontroller to Wi-Fi. This module includes a built-in USB connector and a wide range of pin-outs. Node MCU can be connected to the PC with a micro-USB cable like Arduino. Furthermore, it is now breadboard friendly. Node MCU is an esp8266-based open-source platform that can connect devices and allow data transfer using the wi-fi protocol. Additionally, by providing some of the most important microcontroller features, like as gpio, pwm, adc, and others, it is able to meet the needs of the many missions on its own. The module features a wireless Wi-Fi transceiver that operates in the unlicensed 2400–2484 MHz frequency band.

Fig.4: Node MCU

B. Relay Module

Relay Module operates on the idea of an electromagnetic appeal. The electromagnetic region that creates the transient magnetic location is energized at the same time that the relay circuit detects the fault current. The relay armature is moved by this magnetic position during setup or very last connection. The excessive power relay has two contacts for turning on the switch, whereas the little energy relay has one superb contact. The relay's internal portion is demonstrated inside the figure below. It is wound through a control coil and has an iron core. Through the connections of the load and the control switch, the coil receives its power supply. The magnetic field around the coil is created because the current flows through it. To make it simple to incorporate relays into a project powered by a microcontroller, the dual-channel relay module incorporates switching relays and the necessary power circuitry. Terminal blocks are located on the left and can be used to connect power cables to the module without soldering. Next, proceed to the 2 relays. The relay's coil is rated for 5 volts direct current, while the contacts are rated for 10 amps at 250 volts direct current, or 30 volts, or 125 volts direct current. The signal from the inputs is expanded by the switching transistors to the point where it presses the relay. The freewheeling diodes protect switching transistors from voltage spikes. When the relay is active, the fame leds illuminate to signal switching. Optocouplers are utilized to further isolate the input from the relays. The vcc/jdvcc jumper can be used to determine isolation. The input jumper can easily be connected to jumper wires, other microcontrollers, and sensors because it includes entry and power pins.

Fig.5: Relay Module

C. Blynk smartphone app

The blynk platform's main goal is to make the development of mobile phone applications incredibly smooth. The development of a mobile app that might represent your Arduino is as simple as dragging a widget and setting up a pin, as you'll discover in this course. With blynk, you can control a motor or led from your smartphone with essentially no programming. However, don't let this ease of use fool you into thinking that blynk is only suitable for simple projects. Blynk is a powerful and adaptable tool that is used by both professionals and hobbyists. You may use your phone to activate the water, check the soil humidity in your vegetable garden, and unlock the storage door. Additionally, you may use it to control intelligent furniture that learns from your exercises, integrate IoT and AI into boilers and other common corporate items, and enhance the integrity and safety of oilfields. Blynk is free to use for individual use and prototyping. They make money with their enterprise edition by selling subscriptions to companies that need to post Blynk-powered apps for their hardware services.

III. SENSORS USED

i. Soil Moisture Sensor

Both the irrigation industry and plant gardens depend heavily on the soil's moisture. In the same way that soil nutrients provide plants the sustenance they need to develop, in order to adjust the plants' temperature, water must be provided to them. Utilizing a process similar to transpiration, water can be used to modify a plant's temperature. In addition, moist soil promotes the efficient growth of plant root systems. Extreme soil moisture may produce anaerobic conditions that may favor the growth of soil pathogens and plants.

One type of sensor used to determine the volumetric content of water in the soil is the soil moisture sensor. As the soil moisture straight, gravimetric dimension needs to be removed, dried, as well as sample weighting. These sensors measure the volumetric water content indirectly using the electrical resistance, neutron interaction, dielectric constant, and other soil laws as well as replacement of the moisture content. It is necessary to modify the link between the computed property and soil moisture since it may change in response to changes in temperature, soil type, or electric conductivity. The moisture of the soil can have an impact on the reflected microwave emission, which is mostly used in hydrology and agriculture.

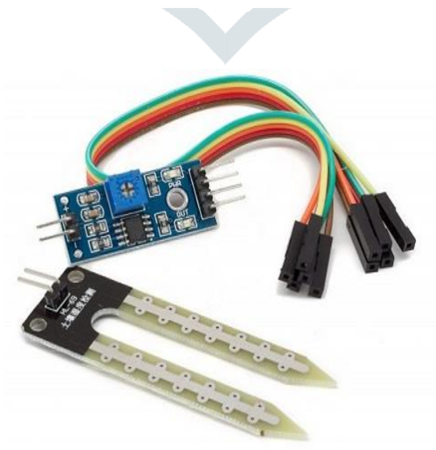

Fig.6: Soil Moisture Sensor

Working Principle: This sensor primarily use capacitance to gauge the moisture content of the soil (dielectric permittivity). This sensor can work by being put into the ground, and it can report the percentage of soil moisture present. This sensor's use makes it perfect for experiments in scientific classes covering subjects including biology, agriculture, soil science, horticulture, and more.

Specifications:

5V is the necessary voltage for operation.
Working requires a current of 20 mA.
Analog interface is the type.
This sensor needs to operate between 10°C and 30°C.

ii. DHT11 Sensor

The amount of water vapor in the air is measured as humidity. The amount of humidity in the air has an impact on a number of chemical, biological, and physical processes. Humidity can have an impact on staff health and safety, business costs associated with the products, and employee safety. So, measuring humidity is crucial in the semiconductor and control system industries. The amount of moisture in a gas—which could be a mixture of water vapor, nitrogen, argon, or pure gas, for example—is determined by its relative humidity. Based on their measuring units, humidity sensors can be divided into two categories. They are what they are: a relative humidity sensor and an absolute humidity sensor. The DHT11 is a digital temperature and humidity sensor.

The DHT11 is a low-cost digital sensor that measures temperature and humidity. This sensor may be readily interfaced with any micro-controller, such as Arduino, Node MCU, Raspberry Pi, etc., to rapidly measure humidity and temperature. For the DHT11 humidity and temperature sensor, there are both a sensor and a module available. This sensor can be distinguished from the module by a pull-up resistor and a power-on LED. The DHT11 is a relative humidity sensor. The ambient air is measured by this sensor using a thermistor and a capacitive humidity sensor.

Fig.7: DHT11 Sensor

Working Principle: The DHT11 sensor comprises of a thermistor for measuring temperature and a capacitive humidity sensing device. A substrate that can store moisture as a dielectric between two electrodes makes up the humidity-detecting capacitor. As the humidity levels change, so does the capacitance value. The changing resistance values are computed, decoded, and converted into digital form by the IC. This sensor measures temperature using a thermistor with a negative temperature coefficient, which causes the resistance value to drop as temperature increases. For this sensor to have higher resistance values even for the smallest temperature change, semiconductor ceramics or polymers are often used in its construction. With a 2-degree accuracy, the DHT11 offers a temperature range of 0 to 50 degrees Celsius. This sensor offers a humidity range of 20 to 80% with a 5% accuracy. The sampling rate of this sensor is 1Hz. It offers one reading each second, in other words. The DHT11 is a small gadget with an operating voltage range of 3 to 5 volts. The highest current that can be used for measurement is 2.5mA. The DHT11 sensor has four pins: VCC, GND, Data, and a Not Connected Pin. A pull-up resistor between 5k and 10k ohms is provided to enable communication between the sensor and microprocessor.

Specifications:

DC 3.3 to 5 operating voltage; 15 mA: Operating Current Digital Output: 0 to 5V; Analog Output: 0 to 5V;
Adjustable Trigger Level: Based on Light Falling on LDR LEDs; From Preset Output and Power PCB Indicators Dimensions: 3.2 by 1.4 cm, LM393-based design.

iii. LDR Module

A low-cost digital and analogue sensor module called an LDR sensor module may measure and detect light intensity. The Photoresistor Sensor is another name for this sensor. An internal LDR (Light Dependent Resistor) on this sensor aids in the detection of light. This sensor module comes with 4 connections. where "AO" is an analogue output pin and "DO" is a digital output pin. In the absence of light, the module's output increases, and in the presence of light, it decreases. The integrated potentiometer on the sensor allows the sensitivity to be changed.

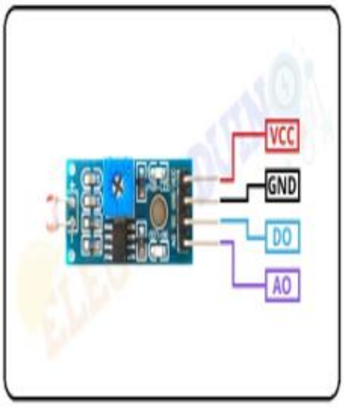

Fig.8: LDR Module

A potential divider is a circuit that consists of two resistors connected in series. While a constant voltage is applied across both resistors, the output voltage from the lower resistor will be measured. In this case, the lower resistor will be an LDR, and the constant voltage will be +5V.

Specifications:

DC 3.3 to 5 operating voltage; 15 mA: Operating Current Digital Output: 0 to 5V; Analog Output: 0 to 5V; Adjustable Trigger Level: Based on Light Falling on LDR LEDs; From Preset Output and Power PCB Indicators Dimensions: 3.2 by 1.4 cm, LM393-based design.

IV. RESULTS

Following are the experimental design and results for the smart city project:

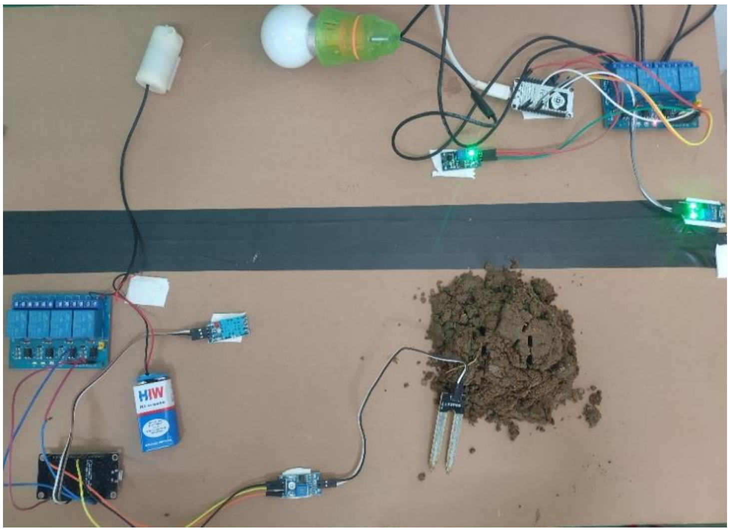

Fig.9: Implementation of Smart City System

Figure9 illustrates how the smart city system was implemented with the help of Node MCU. The smart home automation system, smart irrigation system, and automatic street controller are the three components of the aforementioned diagram. Two four-input relays are employed in this project, one for the smart irrigation system and another for the home automation system and street light control. Node MCU serves as the implementation's primary building block.

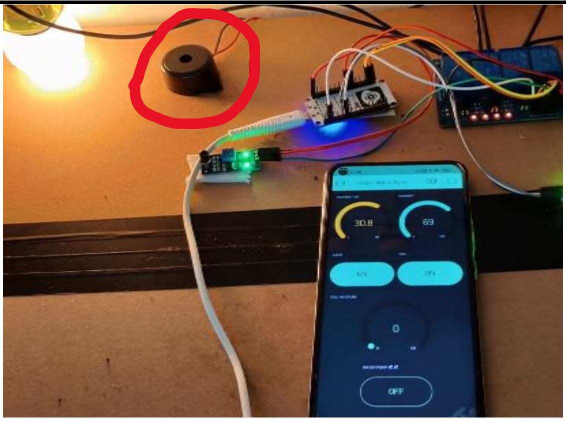

Fig.10.a Fig.10.b

(a) Home Automation System; (b)Values of temperature & humidity in blynk app

The above figure shows the implementation of home automation system. The home appliances can be easily controlled with our smart phone using blynk application. From the above figure it is clearly observed that the appliances (light, fan…) can be controlled with our phone. This can be done from any location inside the house or from the outside. We are able to manage a variety of appliances, but this project only uses a four-input relay, allowing us to control four. In addition to these functions, a new feature has been added: employing a fire sensor to detect fires inside the home and a buzzer (which is encircled in fig.10.a) is provided for signaling purposes.

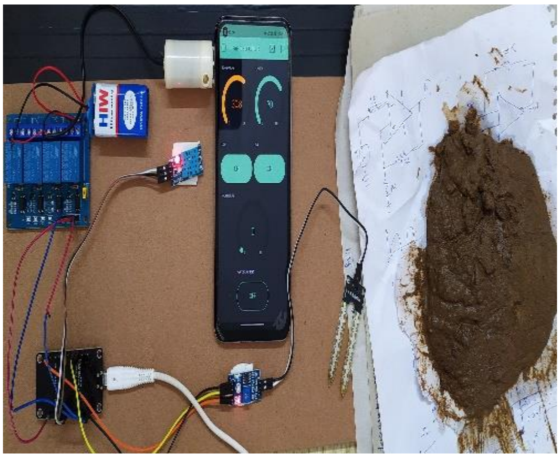

Fig.11.a Fig.11.b

(a) Smart Irrigation System; (b) with zero moisture levels

The implementation of a smart irrigation system is shown in fig.11.a DHT 11 and a soil moisture sensor are both utilized in this. To determine the soil's moisture content, a soil moisture sensor is used, and a DHT 11 sensor is used to determine the temperature and humidity levels. We may view the current temperature and humidity levels on our phone. The temperature and humidity values can change once we step outside. In fig.12.b, the pump motor is off. The motor can be turned on whenever the soil's moisture content is low. The moisture percentages can differ from crop to crop. Vegetables, for instance, may fall between 60 and 70%. The moisture measurement in Fig. 11 is plainly zero since the moisture sensor is not buried in the soil.

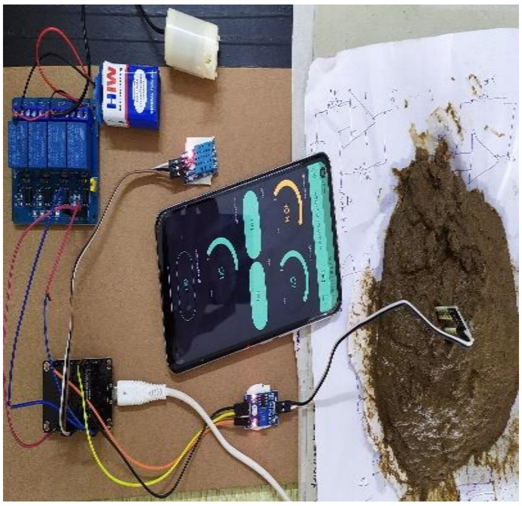

Fig.12.a Fig.12.b

(a) Smart Irrigation System; (b) with moisture levels

The moisture sensor is buried in the ground in the figure above. Therefore, it is evident that the soil has a 50% moisture content.

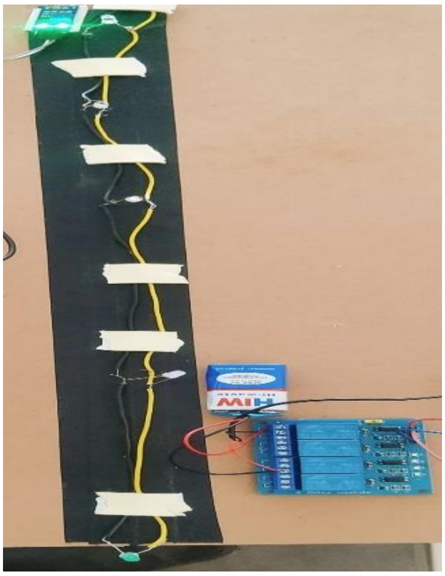

Fig.13.a

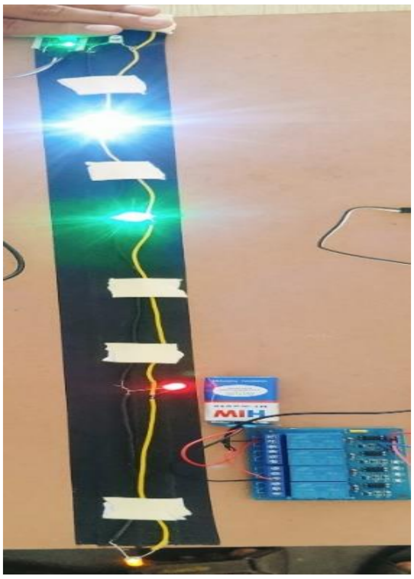

Fig.13.b

(a)Street lights are turned off during day time (b) Street lights are turned on during night time

The implementation of an automatic street light controller is shown in Fig. 13.a. Since the ldr module is exposed to sunlight, it is obvious that the street lights in fig.13. a. is off because it is daytime. The ldr module measures light intensity; as it is higher during the day, street lights are automatically turned off. The ldr module in Fig.13.b is not exposed to sunlight; hence the light intensity is modest. Street lights automatically come on at night since the intensity is lower.

V. CONCLUSION

In this research, we proposed and implemented the Node MCU-based IoT-based smart city system, which is adaptable, affordable, and secure and will function well over long distances. The usability and thorough development and testing of the proposed Smart city system have validated the research goal. One may control the light, fan switches, humidity, moisture sensor, and alarms in this proposed system, which is excellent enough to demonstrate its usefulness. The most crucial aspect of this system's execution is that it is secure and affordable, making it the ideal illustration of a social innovation.

VI. FUTURE WORK

The future work of the proposed work is to include smart traffic system by introducing cloud in the hospital management system and connecting to the traffic system so that every people patient can reach hospital with in less time which saves people life. Future work may focus on smart buildings with integrated sensors that reduce complexity.

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