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Development and Implementation of Smart-city using IoT

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Abstract: In the world of Modern era, metropolis is the place which requires constant advancement and maintenance due to its growing market. It is a place, which also requires proper planning for the infrastructure and livelihood of its residents and visitors. While there are already some metropolises of the world that are already struggling to cope with the massive influx of people, we need to create blueprint of cities in a way as to make these urban areas more live able and truly sustainable in design and also make sure that they solve the existing problems and also provide solutions to the problems that are expected to appear after its implementation. In this paper, we try to bring about a new perspective and approach for few of the key areas of the smart city and also try to solve few of the major problems, which affect the core workings of a smart city in a cost-effective, simple and efficient manner.

Index Terms **- Smart city, IoT, ICT, Industry 4.0, MQTT.**

I. INTRODUCTION

The concept of smart city has been introduced to highlight the importance of Information and Communication Technologies (ICTs) in the last 20 years. In literature the term smart city is used to specify a city's ability to respond as promptly as possible to the needs of citizens. Quality of life and city development are profoundly influenced by the core systems of a city: traffic, waste management, public safety and industries [1]. So, we must to start analyse and solve these issues in the development of smart city for these areas. For a smart city to be considered as a smart city it needs to cater to needs of its residents in an efficient, functional and feasible system, the idea proposed must also be cost effective and environmentally friendly. Taking all of the above conditions into account the difficulty in the implementation of smart city increases drastically and the previous solutions and proposals are deemed unsatisfactory when approached from multiple angles [2]. In short it must at least satisfy the requirement of efficiency and functionality for the proposed solution to be a viable option to be taken into consideration during the implementation of the smart city.

II. PROBLEM STATEMENT AND PROPOSAL

A. Implementation of smart monitoring systems in industries

Smart Industry stands for radical digitalization, connecting products, machines and people with the use of new production technology. The World of Industry is developing at a fast pace which is called by various names such as, Industrial Internet of Things, Industry 4.0 and by some many other terms which finally lead to smart and better manufacturing. It is bringing an elemental change in how factories and workplaces process, making them easy to use with high efficiency, with high flexibility and more environmentally friendly.

The new modern-Day Machines provide new interfaces that are more elegant, highly realistic and touchless interfaces for smoother and safer interactions [4]. Machines are also becoming connected inside the factory and to the cloud, enabling optimum planning and increased flexibility in manufacturing and maintenance.

In Smart Industry Monitoring System, the temperature sensor and the humidity sensor installed in the industry reads the surrounding temperature and pressure and sends it to the Industrial cloud [3].

The server or cloud performs the logic to check if the sensor values are within the limits, if not then sends the required data to the AC panel to automatically bring back the temperature and pressure to the desired limits required for the proper functioning of the industrial equipment. Also, there is a flame detector installed to check if there is any fire accident, if so, the flame detector sends the data to the server and the server turns on the relay that in turn starts the fire alarm.

Hence the smart Industry Monitoring System can be installed in the industries where extreme temperature and pressure conditions has to be maintained and where human beings are not permitted. Hence the smart Industry Monitoring System can be installed in the industries where extreme temperature and pressure conditions has to be maintained and where human beings are not permitted.

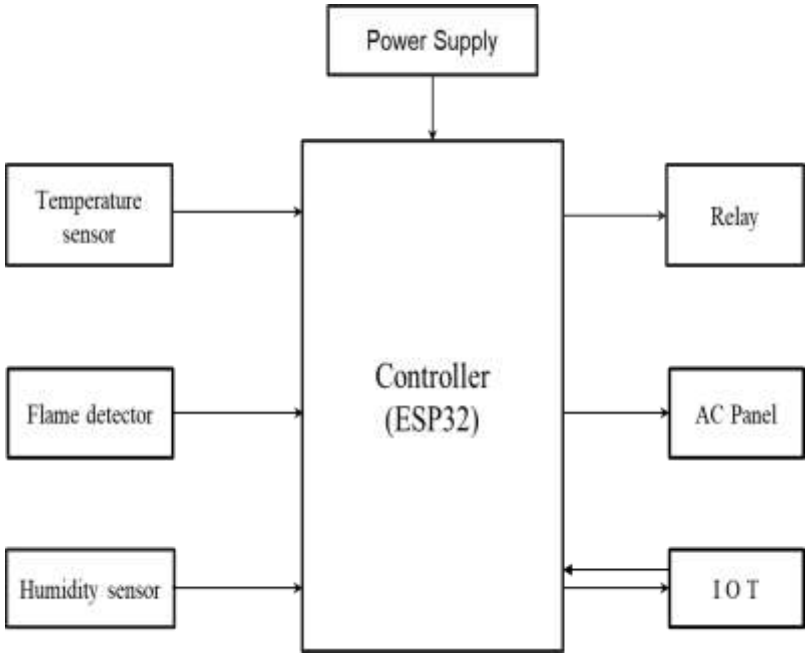
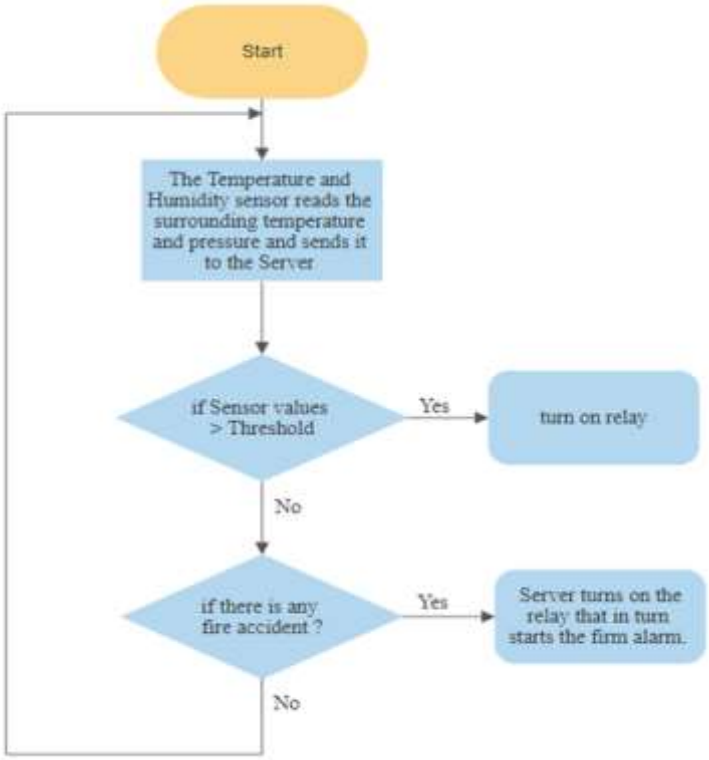


Figure 1: Block diagram Smart industry monitoring system

Figure 2: temperature sensor circuit (left), flame detection circuit (right)

Smart Industry monitoring Flowchart



Explanation:

Step1: start
Step2: sensor reads respective data and sends it to controller/server.
Step3: if sensor value greater than threshold value condition is true, turn on relay, else step4.
Step4: check if there is any fire accident? Condition true, go to step5.
Step5: server turns on the relay that in turns stars alarm, else step6.
Step 6: go to step2, procedure repeated.

B. Implementation of a smart home automation system

In this new age of smart technologies and people working late night shifts, it becomes impossible to take care of and monitor their residences by constantly returning to check up on them repeatedly. So it becomes important for the us to observe and take important measures in real time to monitor the occurrences in our home, hence the implementation of home automation systems becomes pivotal in the implementation of a smart city. The process of controlling or operating various equipment, machinery, industrial processes, and other applications [5] using various control systems and also with less or no human intervention is termed as automation. Home automation is a modern technology that modifies your home to perform different sets of tasks automatically. Today Automatic frameworks are being favored over manual frameworks due to the ease with which the system works [7].

In Smart home automation system, Temperature and Humidity sensor installed in the house, the sensor reads its respective data and sends it to the controller. Controller sends data to the server. The server performs the logic to check if the sensor values are within the limits, if not then, sends required data to controller, controller turns on the relay that in turn starts load.

Gas sensor installed in the house, the installed sensor reads its respective data and sends it to the controller. Controller sends data to the server. The server performs the logic to check if the sensor values are within the limits, if not then, sends required data to controller, controller turns on the relay that in turn starts the alarm.

Motion detect (ultrasonic) sensor installed to detect moving objects, particularly people. Sensor reads its respective data and sends it to the controller. Controller sends the sensor data to the server. The server performs the logic to check if the sensor values are within the limits, if not then, sends required data to controller, controller turns off the relay that in turn off electronic appliances.
All the sensors data of the system are sends to server via MQTT protocol (for transmissions of data in a secured manner), in order to control the operation of controller from remote station.

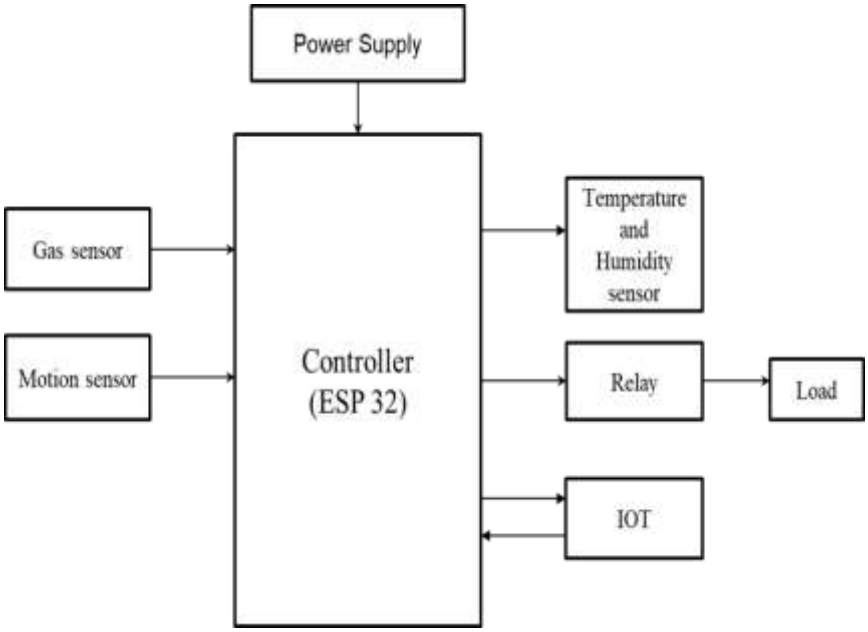


Figure 3: Block diagram of Smart home automation system

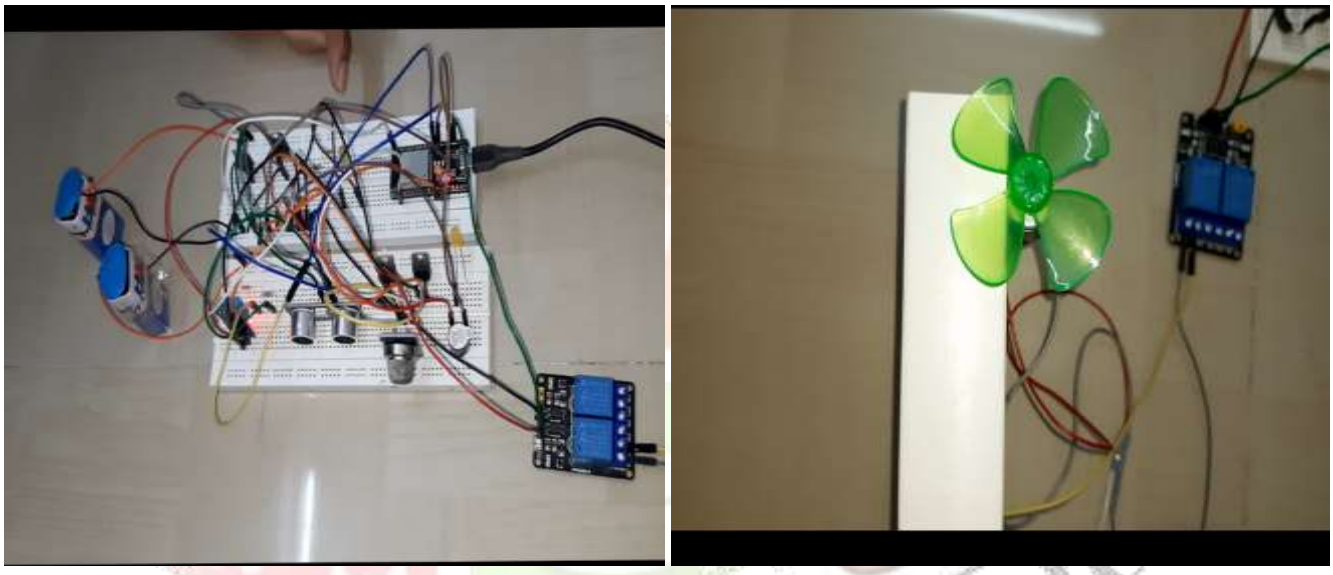


Figure 4: motion detector circuit (left), temperature and humidity detector (right)

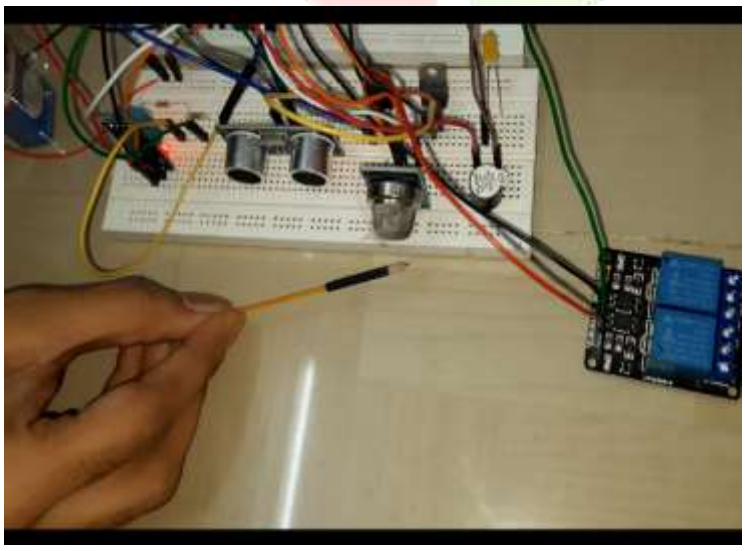
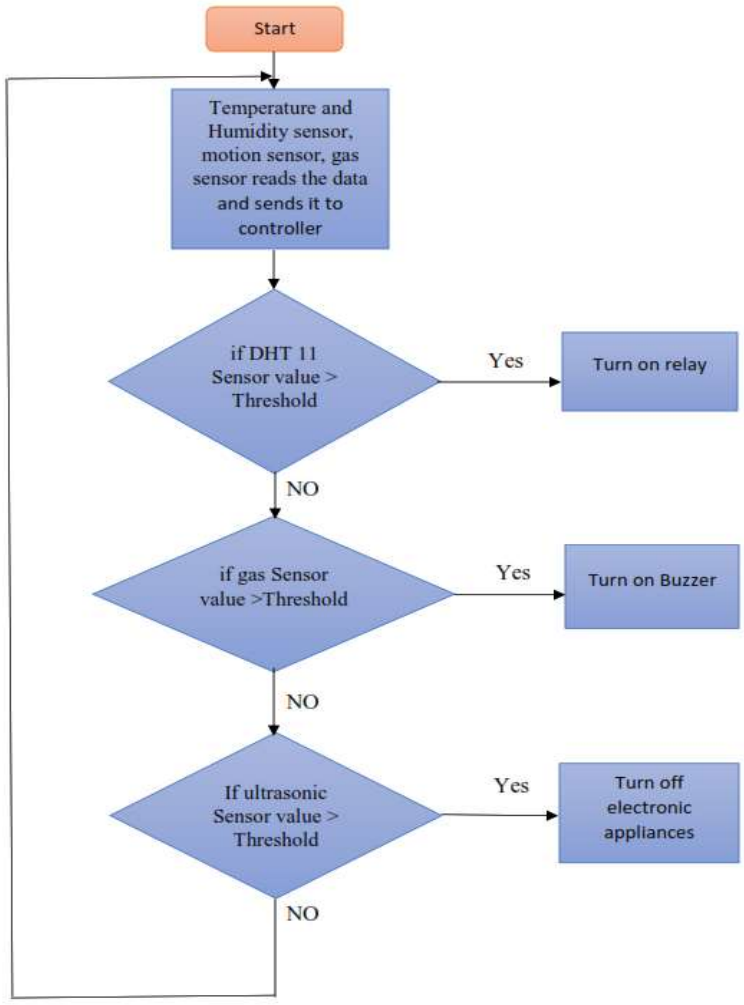


Figure 5: smoke detector circuit

Smart Home Automation System Flow chart



Explanation:

Step1: start
Step2: sensor reads respective data and sends it to controller/server.
Step3: if DHT sensor value greater than threshold value condition is true, turn on relay, else step4.
Step4: if gas sensor value greater than threshold value condition is true, turn on buzzer, else step5.
Step5: if ultrasonic sensor value greater than threshold value condition is true, turn off electronic appliances, else step6.
Step 6: go to step2, procedure repeated.

C.Implementation of smart traffic monitoring system

Traffic congestion leads to increase in air pollution, travel time, and economic losses. Governments increasingly try to monitor and resolve traffic congestion, but the task is difficult because of the complexity of the problem specifically, traffic congestion is difficult to predict and forecast [7].

Traffic density monitor is a unit, which calculates density of vehicle and sends calculated data to the Server that is the Raspberry Pi 3 via the MQTT protocol. The server performs the logic and sends command what operation should be performed to traffic signal unit. Further traffic signal unit displays the necessary signal using display unit.

Through the inputs from the traffic density monitor, we obtain the requisite time period for each traffic light as well as to control the flow of traffic based on the rate of traffic influx present during the various periods of time in a day. It can also be optimized to perform based on the real time information from the traffic density monitor.

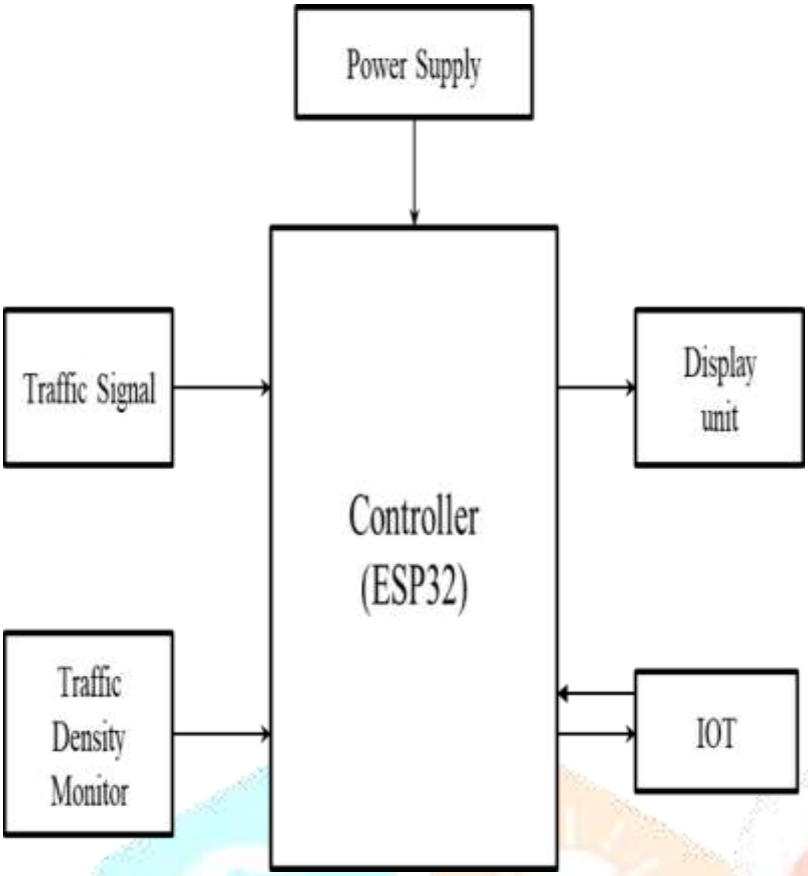


Figure 6: Block diagram of Smart traffic monitoring system

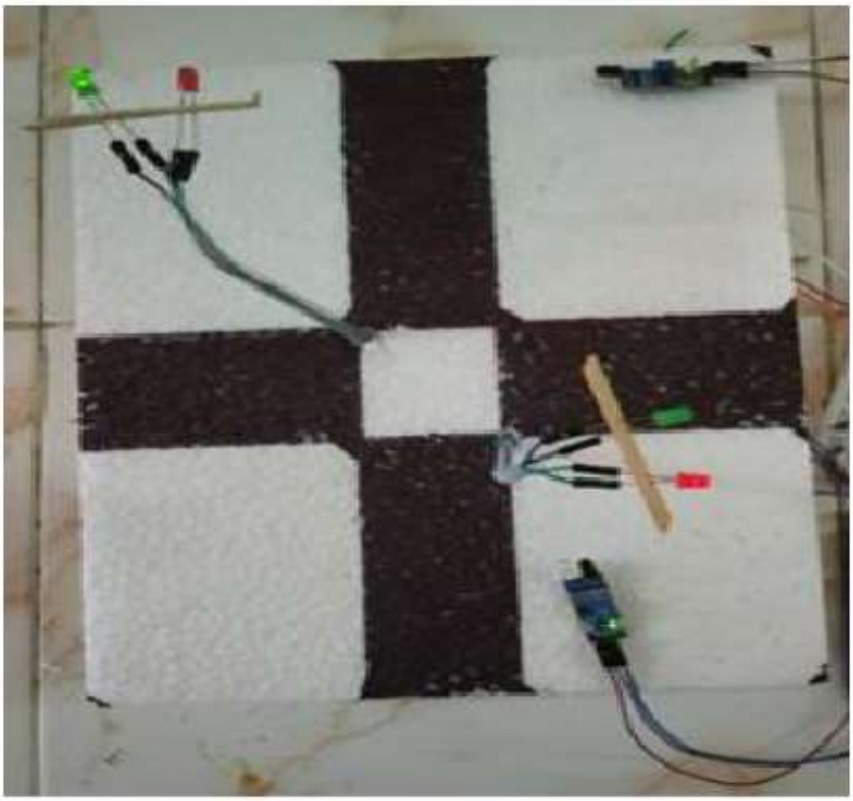
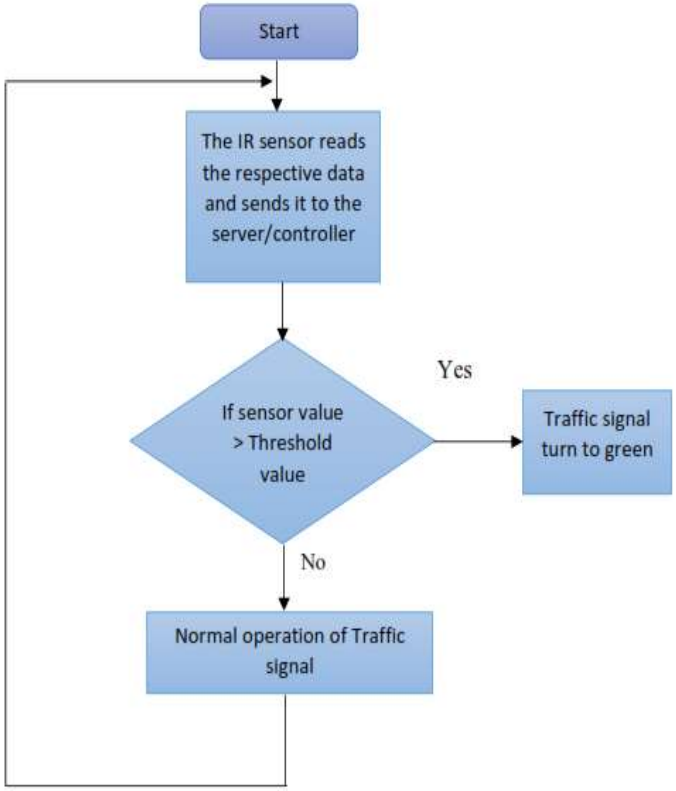


Figure 7: Traffic system circuit

Smart traffic monitoring system Flowchart



Explanation

Step1: start
Step2: sensors read the respective data and sends it to controller/server.
Step3: if sensor value greater than threshold value condition is true, traffic signal turns green, else step4.
Step4: Normal operation of traffic signal.
Step 5: go to step2, procedure repeated.

D. Implementation of solid waste management system

Waste management is a term given to a method of waste collection that counts its transport, disposal or recycling. The waste material created by a human operation that must be treated in order to prevent its adverse health and environmental effects. Solid waste disposal is a big problem in most countries around the world, especially developed cities. Therefore, an efficient system must be built which will solve or reduce this problem to a minimum level. In smart cities, IoT technologies play an important role in the implementation of new services and in the redesign of existing services. Currently, government and public authorities are stepping up their waste management initiatives to improve collection efficiently and intelligent disposal of waste generated by a city [11].

Solid waste management which impacts our society's health and environment has been one of the key concerns with our climate. Waste identification, tracking, and control is one of the present-day key issues. The conventional way in which waste bins are manually controlled is a tedious method, which uses more human energy, time and expense that can be easily avoided with our new technologies. That is our solution, a method for automating waste management. This is our IoT Garbage management system, a creative solution to support keep the cities safe and clean.

The project's basic concept is to track the amount of the local garbage bins in real-time. Once the entire system is installed, and the main processing unit is supplied with power, i.e. Raspberry pi, it runs the software and the ultrasonic sensor is enabled. Sensor detects the amount of garbage in the bins, and the result is provided to the server. This provides an administrator with a visual view of the amount of waste in all the garbage bins on the server dashboard and can track all levels of garbage bin from a single location. Many bins whose garbage rates are above the threshold value may also take the required steps. It helps to simplify the cycle and to reduce man-power wastage.

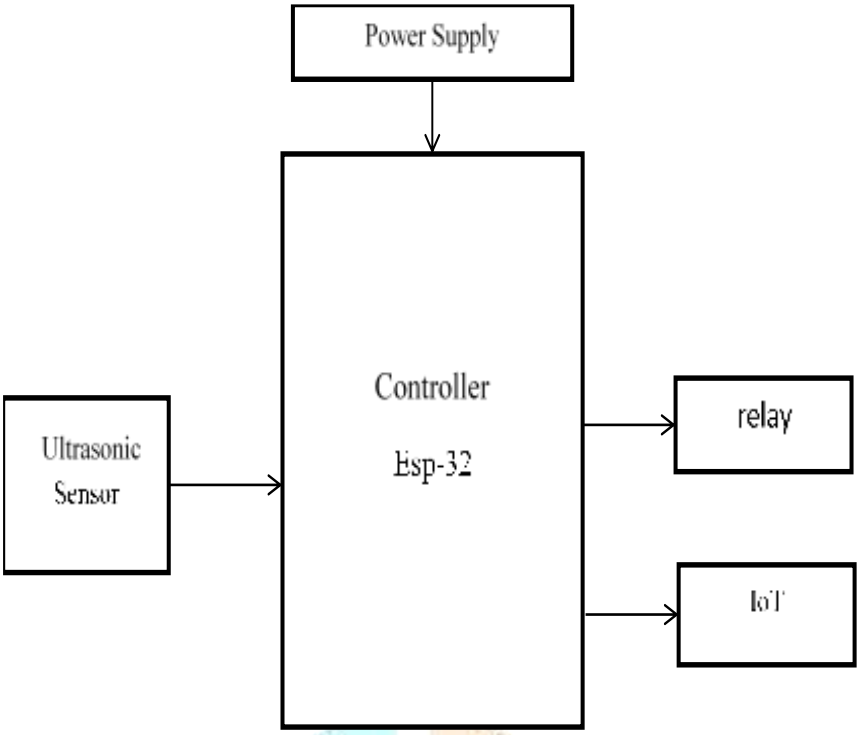


Figure 8: Block diagram of Solid waste management using IoT

Figure 9: Dustbin status detection circuit

Solid waste management Flowchart

Explanation:

Step 1: This is process flow algorithm for this proposed flow chart.
Step 2: At Initial stage, the level of the bin will be detected by the ultrasonic sensor.
Step 3: The ultrasonic sensor monitors the garbage level of the bin to reach the threshold value.
Step 4: When it reaches threshold value, a message will be sent to concern municipal authority.
Step 5: The authority will intimate the concern person to clean the garbage that is filled.
Step 6: Then truck reaches the particular location empty the bin.

III. GENERAL BLOCK DIAGRAM

The proposed smart city block diagram mainly contains two systems, one intends to "collect the information from the different sensors", act as a 'Client' and other one, "processing the information", act as a 'Server'. The sub-system(client) is responsible for collecting the information through different types of 'Embedded system' that have capabilities to receive data and processing it from analog world, for any instance, we can use any kind of sensors such as flame sensor, temperature & humidity sensor, gas sensor, ultrasonic sensor among others and all of them can be included in our architecture. Each system working in the principle of "Client/Server or Publish/Subscribe configuration". Then, we use a 'Standard Protocol' used in IoT for 'Telemetry Scope' (communication), to make transmissions of data in a secured manner.

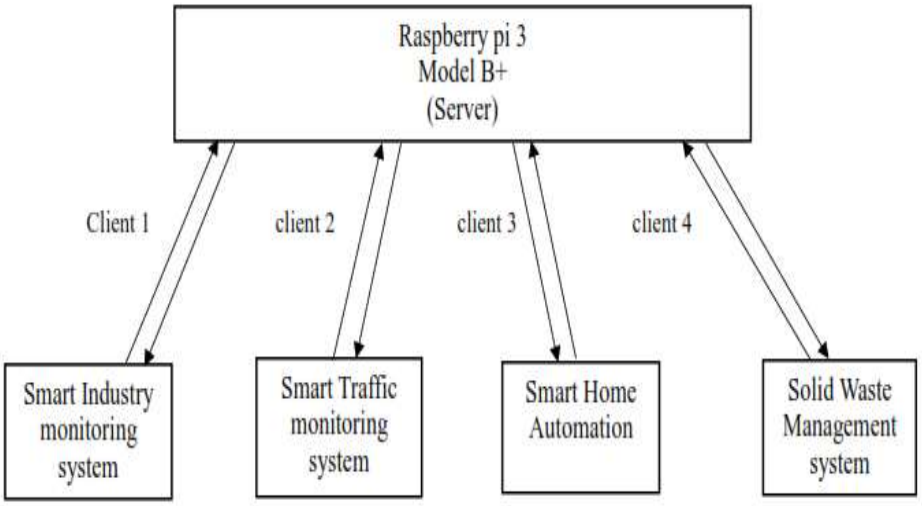


Figure 10: Block diagram of proposed model

System Architecture

We use a Standard protocol used in IoT for communication between server and client, as we explain in each system, we use 'MQTT' Protocol stands for, Message Queuing Telemetry Transport Protocol that uses the publish/subscribe messaging transport protocol.

The 'Publish/Subscribe configuration' is an alternative configuration to the Client-Server model, where a client communicate directly with an 'Endpoint'. However, publish/subscribe both will act as a client, "who is sending a particular message "called 'Publisher'. From a different client or more clients "who is receiving the messages" called 'Subscriber'. This means that the publisher and the subscriber do not know about the presence of each other. To complete the scenario in gathering the information by sub-system, there is a third component, called 'Broker'(Server), which is known by both the publisher and subscriber, which filters the all incoming messages/outgoing messages and distributes them accordingly depending on requirements [12].

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IV. RESULTS AND DISCUSSION

In this paper, we demonstrate the multiple sub-blocks of the smart city's infrastructure to ensure the proper functioning of the smart environments.

Smart industry monitoring system

The circuit depicts the flame detection module of the smart industry monitoring system. The electronic component, which is held in the arm, is the flame detector, in which there are two inbuilt LED's.

The first among the is permanently glowing due to supply voltage. Upon sensing the flame in the nearby vicinity then the other LED also starts to glow in the flame detector module.

The figure shown below is integrated with the raspberry pi module through the ESP32 module in the client server module protocol.

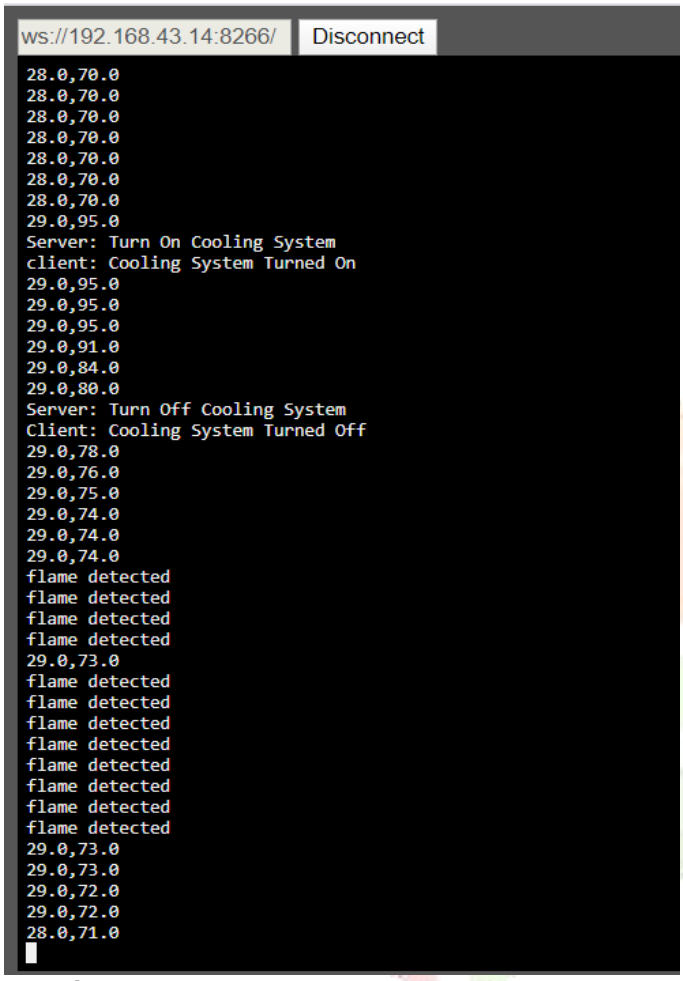
Figure 11: flame detection (left), temperature and humidity detection (right)

The temperature and humidity sensor as the name imply is used to detect the temperature and humidity of the ambient environment and show us the result. The electronic component used in our project records temperature and the humidity conditions of the environment, which is typically an important matter in many of the production sites of the industry.

In the above figure, we see the integration of the temperature sensor with the raspberry pi through the ESP32 module via a client server protocol.

In the above figure we are able to determine that after the temperature is increased above a set threshold value the sensor indicates a message in the display as well as automatically activates a cooling solution, which in this case is a rotor fan which is implemented together with the whole circuit

Output:



Smart home automation system

In the smart home automation system, we have an electronic component called as the smoke sensor MQ2, which is used, evaluate the air content in the residence and also issue an alarm in case if any of the dangerous gases are detected.

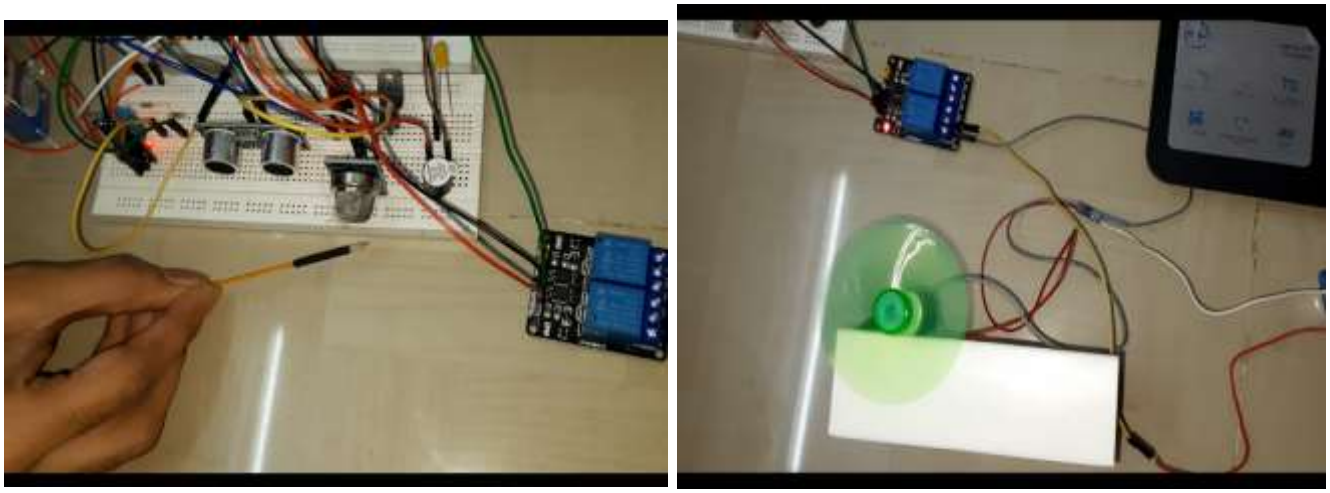


Figure 12: smoke detection (left), temperature and humidity sensor (right)

When the temperature and humidity of our residence increases, due to remote access from the server we can operate the fan or any other cooling device through the connected server.

We have implemented a motion sensor with the help of the ultrasonic sensor using which we can detect any movement in any of the rooms in our residence.

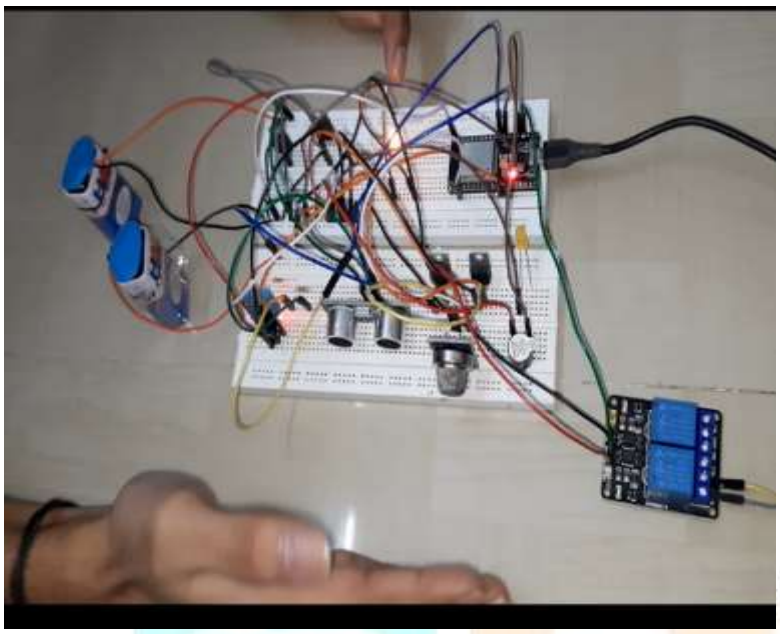
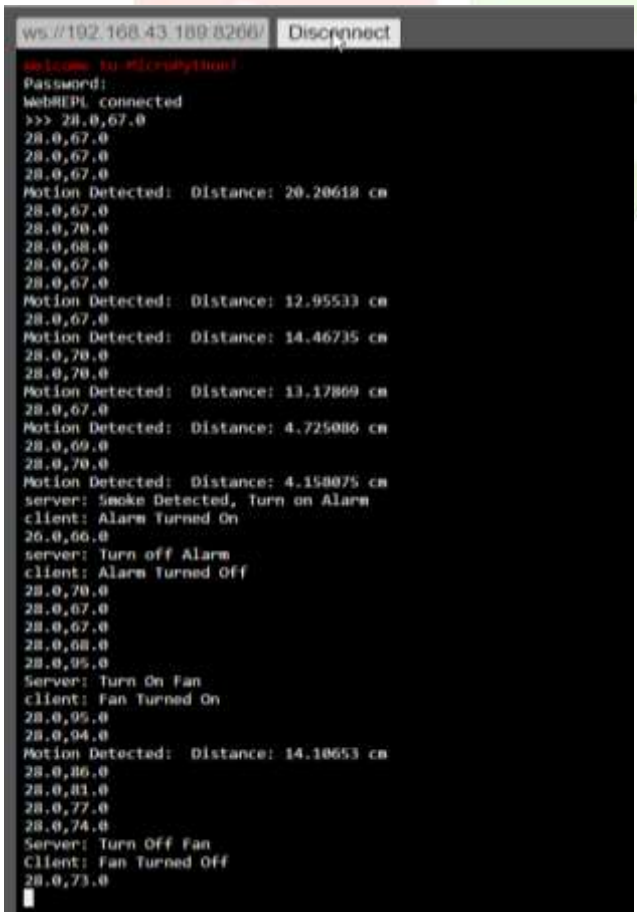


Figure 13: ultrasonic motion sensor

Output:



Smart traffic monitoring system

In the smart traffic monitoring system, we try to determine and notify whenever the traffic reaches maximum capacity so that the traffic system can efficiently control the traffic based on the notification provided.

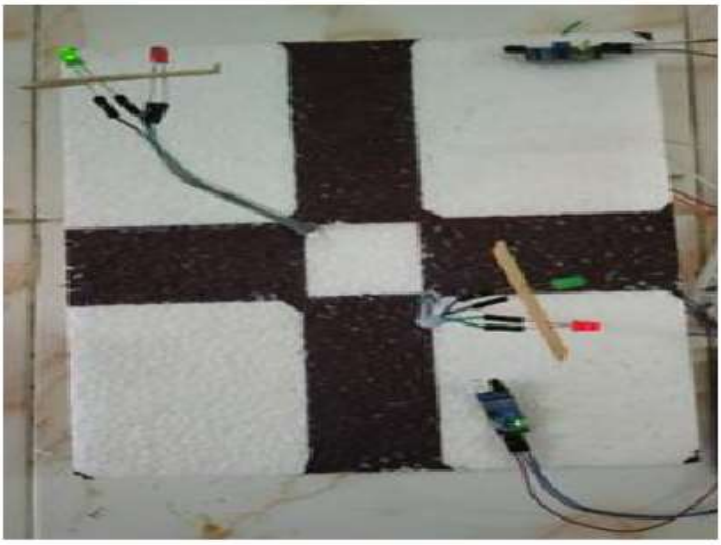


Figure 14: Overall Module with Lane1 having Green signal and Lane2 having red signal.

The above figure illustrates where, Lane 1 traffic signal is green signal, normal operation of traffic signal take place.

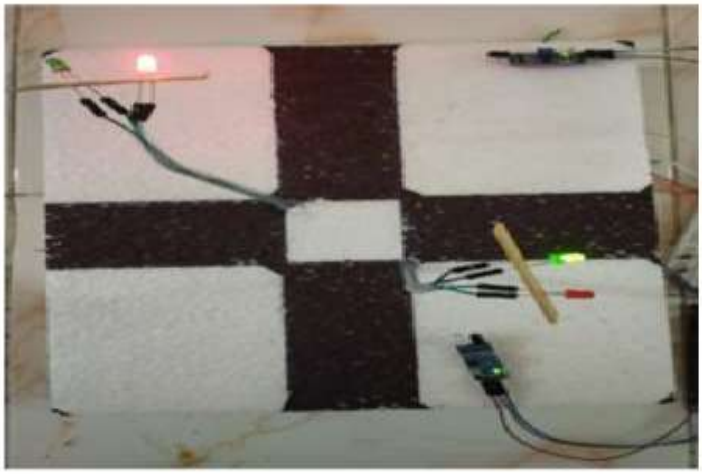


Figure 15: Overall Module with Lane2 having Green signal and Lane1 having Red signal.

The above figure illustrates, Lane 2 traffic signal is green signal where sensor value is greater than threshold so more vehicles are there in it, signal turns green.

Output:

```
AUTOMATIC TRAFFIC LIGHTS BASED ON TRAFFIC DENSITY
TRAFFIC DENSITY IS HIGH IN LANE 1
LANE 1 IS ACTIVE
TRAFFIC DENSITY IS HIGH IN LANE 2
LANE 2 IS ACTIVE
TRAFFIC DENSITY IS HIGH IN LANE 1
LANE 1 IS ACTIVE
TRAFFIC DENSITY IS HIGH IN LANE 1
LANE 1 IS ACTIVE
TRAFFIC DENSITY IS HIGH IN LANE 1
LANE 1 IS ACTIVE
TRAFFIC DENSITY IS HIGH IN LANE 2
LANE 2 IS ACTIVE
```

Solid waste management system

In the solid waste management, system implemented using IoT, we try to determine and notify whenever the dustbin reaches maximum capacity so that the waste collectors can efficiently collect the waste based on the notification provided.

To notify the full status of the dustbin in this circuit we have added an LED light connected to the circuit, which glows whenever the dustbin is full, and this result is also notified to the waste collectors via the network.

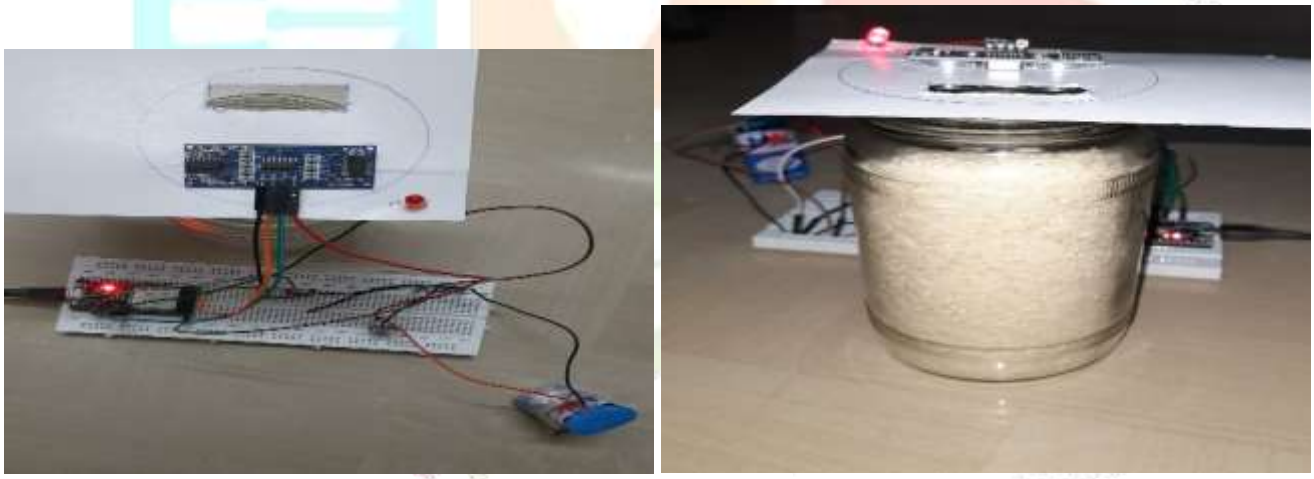
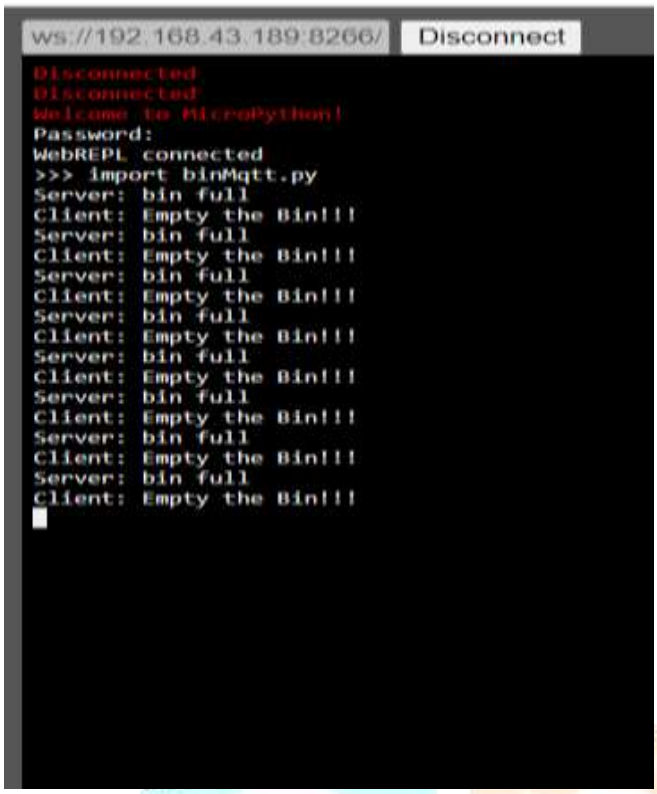


Fig: Dustbin is empty red light is off (left), Dustbin status-full red light is on (right)

Output:



Applications:

Through this paper, we would like to observe the following outcomes
• Efficient monitoring of industrial working conditions.
• Proper traffic monitoring which leads to shorter commute time and lower probability of traffic jams.
• Remote management of smart home devices.
• Efficient collection and effective disposal of solid wastes.

Conclusion:

In this digital era of emerging smart cities, we face multiple challenges in all forefronts for developing a visionary approach for the development and implementation. In this paper, we analyze the concepts that can be turn into the reality and focus on these concepts for the effective building of smart cities providing the best of our efforts in the most cost-effective, efficient and practical functionality.

IV. ACKNOWLEDGMENT

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