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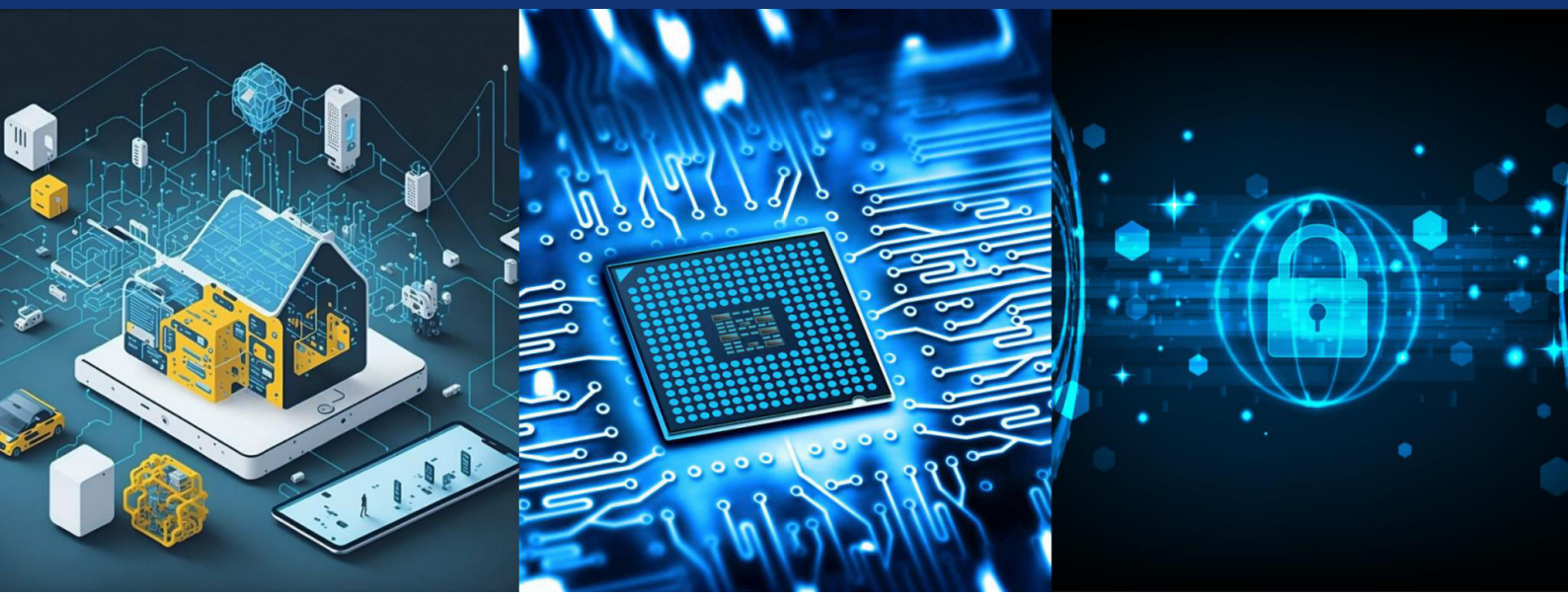

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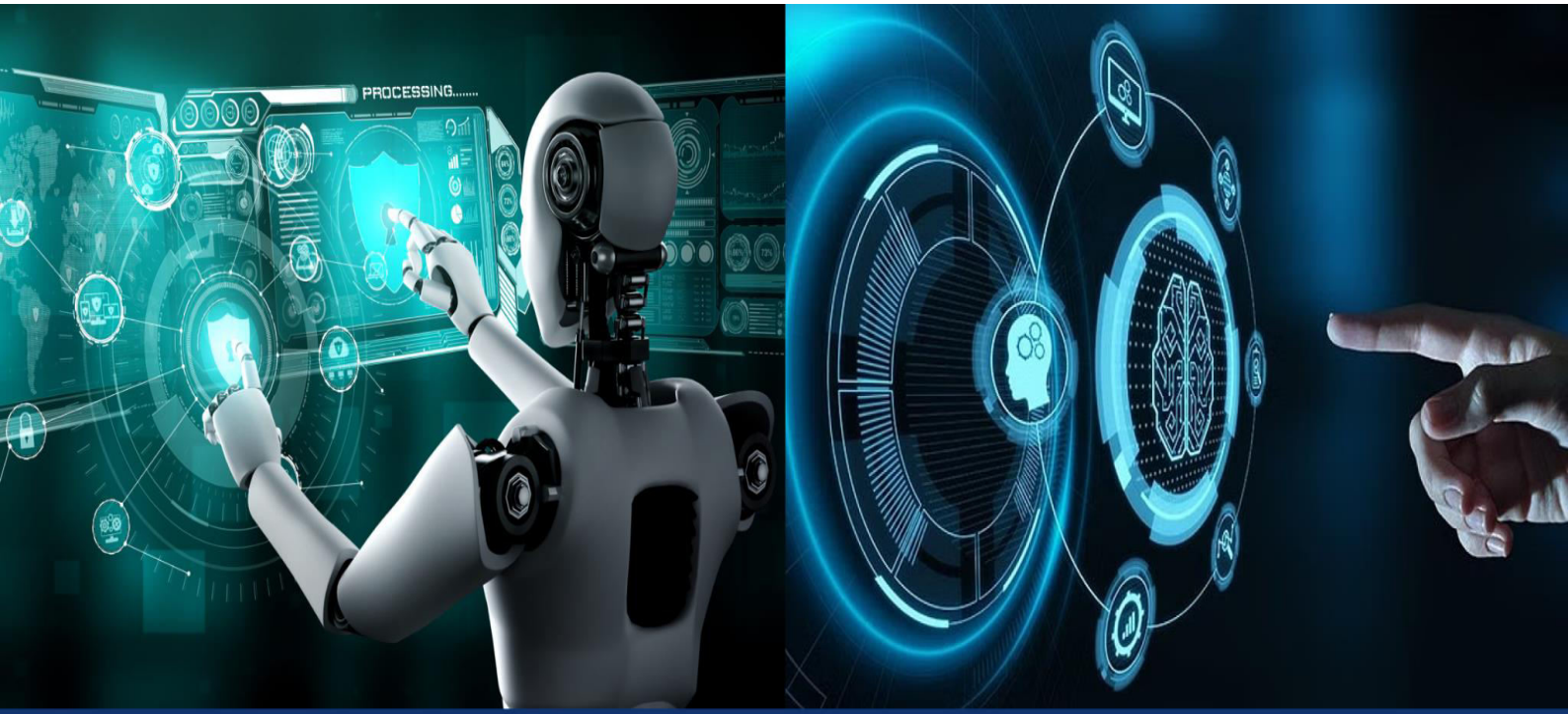

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NodeMCU based IOT Waste Monitoring System

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ABSTRACT: IoT referred to the change in industries with data real-time communication across different devices. For this project, we conceived an IoT-based system by monitoring garbage with the help of a microcontroller from NodeMCU, ultrasonic sensors, and a GSM module. This system would automatically send parameters on waste levels inside the bins to optimize routes for collecting wastes along with increasing the level of sanitation in cities.

KEYWORDS: IoT, NodeMCU, Ultrasonic Sensor, GSM, Waste Management, Smart City, Real-Time Monitoring.

I. INTRODUCTION

In this age of technology, which advances the world further into infrastructural developments of cities in a progressive way, the Internet of Things emerges as a giant enabler of effective and smart systems. It enables effective communication between a variety of devices and systems for the accomplishment of tasks that were formerly time-consuming and were accomplished by human workers. An application of the IoT is waste management. Large-scale collection of wastes in an urban setting is needed for hygienic and environmental sustainability purposes.

The increase in population has augmented the volume of wastes that need to be held in store lest they cause health problems. In this traditional manner of waste collection, the methods depend on human observation and collection which is inefficient and very laborious and costly. Our proposed solution, an IoT-based garbage monitoring system, automates the monitoring process and gives real time information about the status of the garbage bin.

This is a system, which makes use of ultrasonic sensors and GSM modules, to enable smart waste collection by alerting the concerned authorities whenever the garbage bin fills up

II. SYSTEM ARCHITECTURE AND DESIGN

This is an IoT-based garbage monitoring system; it uses the NodeMCU Uno microcontroller at its core. Several peripherals are hooked within the system; these comprise the HC-SR04 ultrasonic sensor and GSM module, as well as the DHT11 sensor. The ultrasonic sensor reads the distance continuously between the top of the garbage and the sensor, and the GSM module sends SMS alert signals when the bins are full.

2.1 Hardware Devices

NodeMCU : Here is where the processing unit core of the microcontroller takes place. In this instance, inputs from the sensors are processed and GSM modules are instantiated for further communication. The microcontroller boasts having 16 MHz as well as numerous input/output pins for reading external sensors and modules.

HC-SR04 Ultrasonic Sensor: Used to measure the distance between the sensor and the depth of garbage in the waste bin. The sensor has a frequency of 40 kHz and is known to deliver very high-accuracy distance reading.

GSM Module: The SIM900 or equivalent GSM module has been used for wireless communication. Real-time alert messages reach the waste management authority whenever the garbage bin fills up to a predetermined threshold.

DHT11 Sensor : These measure the environmental conditions of the garbage bin, which include temperature and humidity levels. With these added parameters, one can derive other data useful for analysis of organic waste decomposition [4].

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2.2. Software Design

It is developed with an Arduino IDE. Source code is written in C/C++. The code is merged with the real-time monitoring loop processing data from the sensors which sends GSM modules for alerting the bin when the threshold reach of the capacity reaches [3]. Microcontrollers and sensors communicate over standard I/O pins, while UART communicates with the GSM module.

III. IMPLEMENTATION

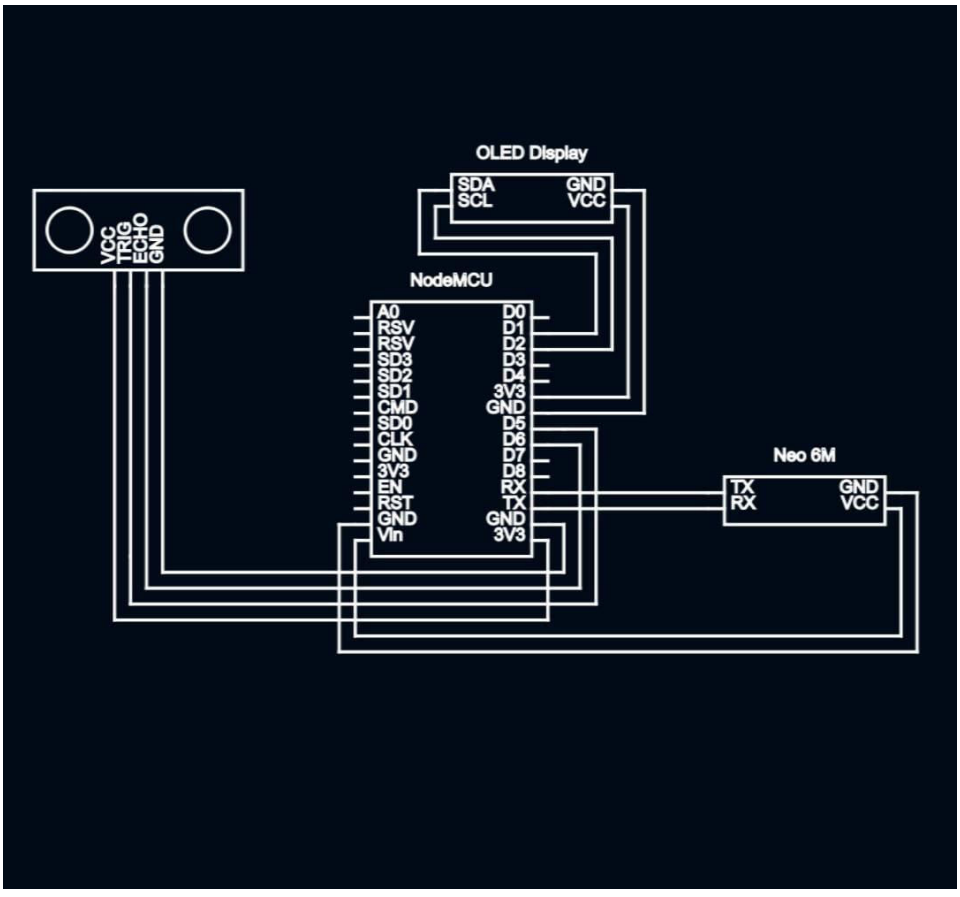
3.1. System Integration

An ultrasonic sensor is mounted at the top of the garbage bin and can be used to measure the fill level. If the distance between the surface of the garbage and the sensor goes above or below a set threshold, then the NodeMCU will engage the GSM module to send an SMS message to the garbage collection team. The system also captures environmental data from the DHT11 sensor that can be further analyzed in waste management studies. The entire design operates on 5V DC, and the GSM module requires another 12V separately, but the overall design is energized to run for long duration on low power consumption.

3.2 Data Communication

It utilizes the GSM module through AT commands to send SMS alert [2]. The message contains time-to-time information giving details about the status of the bin in terms of the fill level and ambient conditions. This ability allows the system to function anywhere cellular coverage is present, thus making it applicable within an urban and semi-urban environment.

3.3 Circuit Diagram



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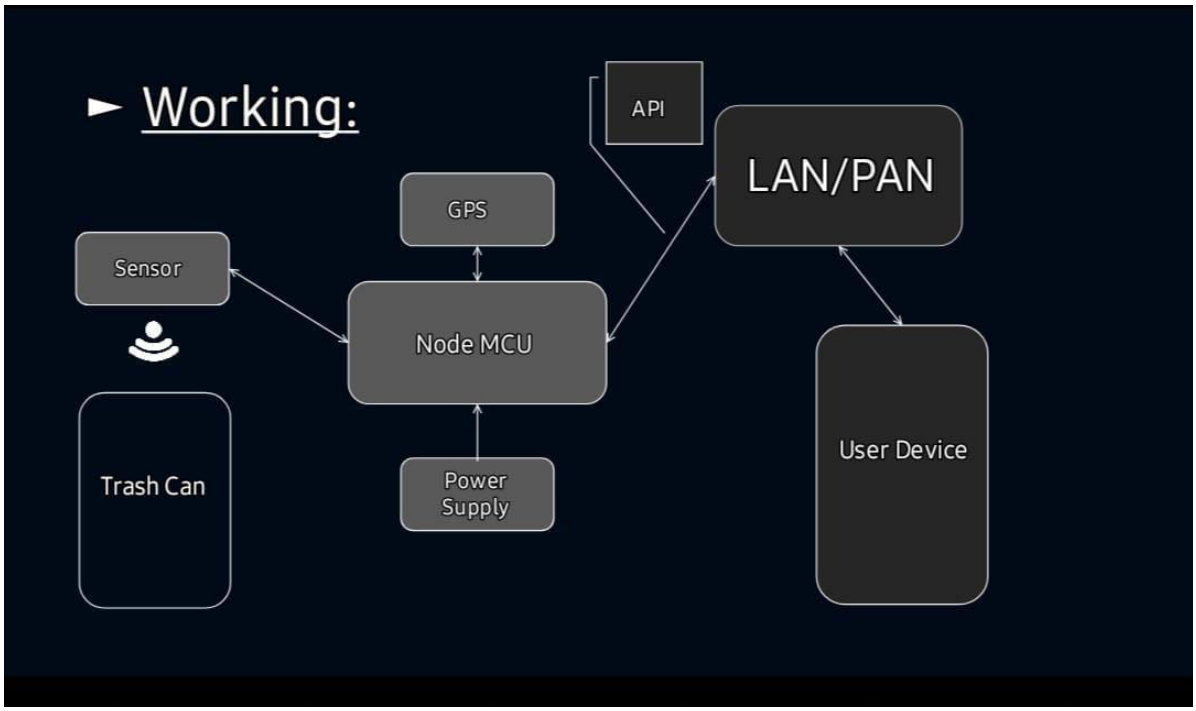
3.4 Block diagram



IV. RESULT AND DISCUSSION

Several test cases were implemented, like varying bin sizes and varied types of environmental conditions. From all sides, regardless of the scenario, it showed pointable measurements of the garbage filled; the GSM module, irrespective of any crossing threshold, provided adequate warnings. This system, therefore, highly reduced the need for frequent, in-person monitoring of the bins and improved collection of routes, thereby improving fuel consumption and the labor force [5]. Because of the trends detected in the temperature and humidity-affecting decomposition rates of wastes, which are all components of environmental data, the DHT11 sensor can help further complement waste management strategies. The type of additional information from this sensor will therefore be useful for further processing and disposal of wastes [4].

V. CONCLUSION

This project proves the feasibility and effectiveness of an IoT-based waste monitoring system using NodeMCU. Real-time monitoring and alert systems, besides lowering labor costs and thus cost, enhance procedures significantly on waste collection processes. Future work will see integration of this system with cloud-based analytics platforms to enable even more complex data analysis and predictive maintenance.

Gratitude We take this opportunity to thank [supervisor's name] for the excellent guidance that has been provided throughout the conduct of the project. Lastly, but not lastly, we are thankful to the department for all the resources and support necessary to complete this work effectively.

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