Smart Compost Machine

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Abstract— ***The "Smart Compose System" is an innovative project designed for real-time environmental monitoring and alerting. Managing organic waste is a major environmental concern, especially with rising cases of urbanization and agriculture.[1]. Conventional composting processes involve manual monitoring without automation, leading to low efficiency in decomposition as well as the production of bad smells. This article outlines the design and implementation of an IoT-based smart composting system employing an ESP32 microcontroller. In this system, monitoring of major parameters involved in decomposition, such as temperature, humidity, water content, and gas production***
, is done with the help of DHT22 sensors, soil moisture sensors, and gas sensors, respectively. A 12V DC motor is employed in this project for automating the mixing process within an aerated double-layer stainless steel compost box with the aim of enhancing microbial growth. The system results in increased efficiency with shorter decomposition times.

Keywords—Kitchen Waste, Smart Composting, IoT, Sensors, Automation, Organic Waste

INTRODUCTION

Due to high rates of urbanization and agricultural activities, the amount of biodegradable waste has substantially increased. This poses a challenge for the waste management system. Conventional ways of composting waste are manual, time-consuming, and lack a controlled mechanism for processes such as temperature, moisture level, and gas release. Lack of monitoring of such processes might cause a slow decomposition process, bad smell, or the emission of detrimental gases.

Efficiency in composting is greatly reliant on optimal conditions being supported in order to facilitate microbial growth. Factors such as temperatures, humidity, water content, and aeration are very essential in ensuring that the resulting compost is optimal and that the composting process is faster. Recent technologies in Internet of Things (IoT) have facilitated the creation of smart technologies to enhance composting efficiency.

In this study, the design and implementation of Smart Composting System considering Real-time Analysis Using ESP32 Microcontroller are presented. The system consists of DHT22 sensor, temperature, and humidity measurement; soil

moisture measurement sensor for measuring moisture content; gas sensor for detecting production of generated gas; and 12V DC for mixing. These devices are installed in the Stainless Steel container, which provides strength, non-corrosiveness, and high temperature stability compared to regular containers used for higher temperature generation for efficient microbial action. The purpose of developing the proposed system is minimizing human intervention, increasing the efficiency level of composting processes, and maintaining the safety standards of the environment. The proposed system is cost-effective and can be applied for smart agriculture, household composting, or any type of waste management solution.

I. LITERATURE SURVEY

Recent studies highlight that improper management of organic waste has become a serious environmental issue due to rapid urbanization and increased household waste generation. Traditional composting methods mainly depend on manual supervision and lack real-time monitoring, which often results in inefficient decomposition, unpleasant odours, and harmful gas emissions. To overcome these limitations, researchers have proposed IoT-based smart waste management systems that focus on continuous monitoring and automation. Al Mamun et al. demonstrated that IoT-enabled waste systems significantly improve efficiency by integrating sensors and cloud platforms for real-time data access and control.

Several researchers have emphasized the importance of controlling composting parameters such as temperature, humidity, and moisture content to enhance microbial activity. Islam et al. presented an IoT-based smart composting system where sensors were used to measure environmental parameters, ensuring optimal conditions for decomposition. Their findings indicate that maintaining temperature ranges suitable for mesophilic and thermophilic bacteria accelerates the composting process. Automated monitoring reduces human effort while improving compost quality and decomposition speed.

Advancements in microcontroller technology, particularly the use of ESP32, have further strengthened smart composting solutions. ESP32 provides integrated Wi-Fi and Bluetooth capabilities, enabling seamless data transmission to cloud platforms such as ThingSpeak for analysis and visualization. The integration of gas sensors like MQ-4 allows early detection of harmful gases, enhancing environmental safety. Previous studies confirm that combining sensor-based monitoring with automated aeration using DC motors leads to uniform decomposition and reduced processing time. These studies form the foundation for developing a cost-effective, reliable, and scalable smart composting system as proposed in this work.

III METHODOLOGY & IMPLEMENTATION

STEP-1: Waste Collection: Organic waste material is collected and put inside the composting container made of stainless steel to begin the decomposition stage.

STEP-2: Sensor Placement: DHT22, soil moisture sensor, and gas sensor are placed inside the container to monitor temperature, humidity, soil moisture, and gas emissions continuously.

STEP-3: Data Acquisition: The data acquisition is performed by the ESP32 chip, which acquires real-time data from all sensors at fixed time intervals.

STEP-4: Data Processing the ESP32 performs the processing of the sensor readings and matches the readings with the defined threshold values for the ideal composting factors.

STEP-5: Motor Control: The 12V DC motor is turned on whenever necessary to achieve mixing and aeration, hence enhancing oxygenation and breakdown processes.

STEP-6: Environment Monitoring: It keeps checking for any toxic gas release by decomposition, maintaining the wholesomeness of the environment.

STEP-7: Continuous Process: The process is a continuous one, and it ensures efficient composting.

A. ***Block Diagram***

VI. RESULTS

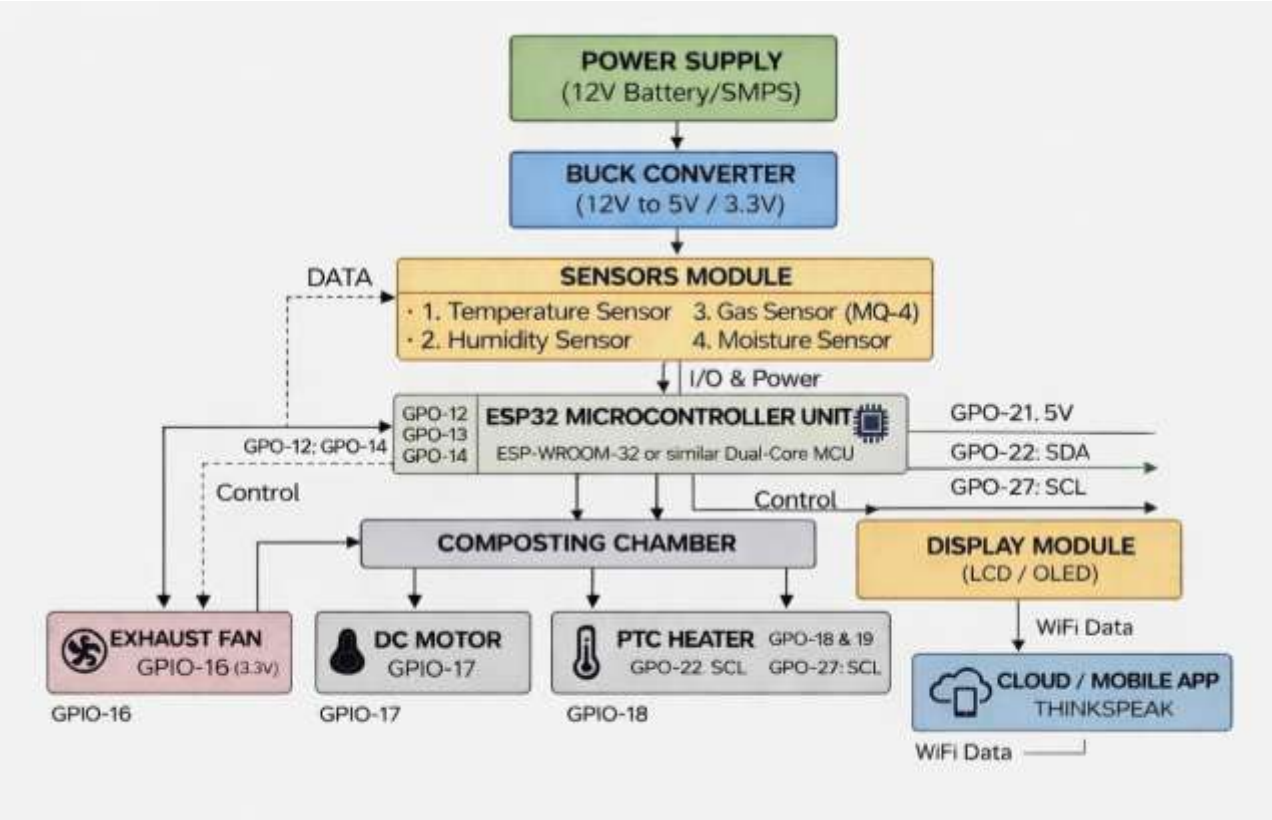

Fig1: Project Prototype

A. Composting Process from Day1 to Day7

Organic waste successfully converted into nutrient-rich compost within 7 days using the smart compost machine.

Fig2: Smart Compost Machine Prototype

B. ThingSpeak Data

The status will be going to update on thingSpeak with time and date.

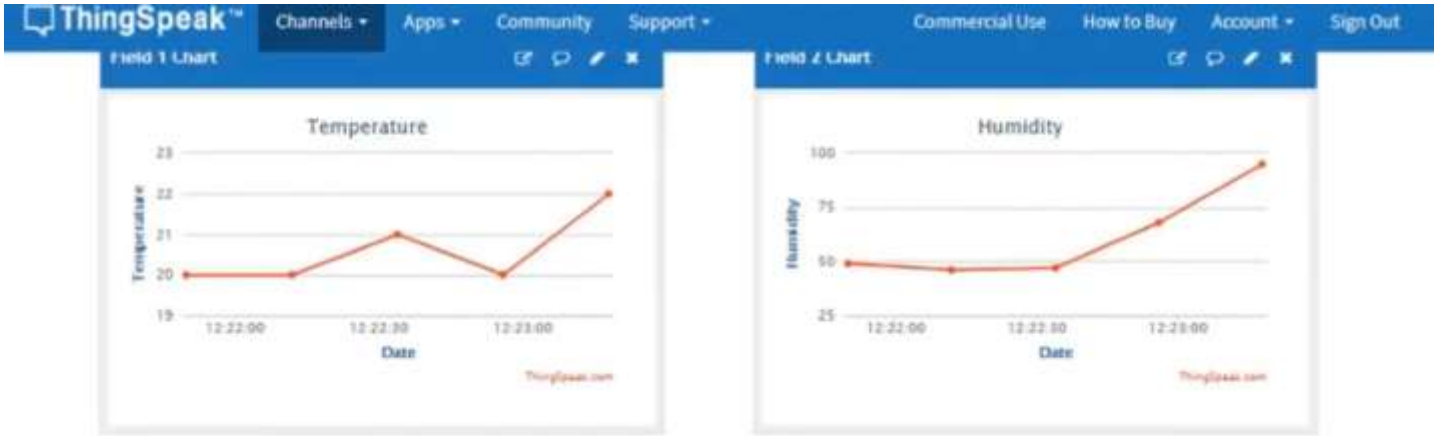

Fig3: Temperature and Humidity ranges in Thingspeak view

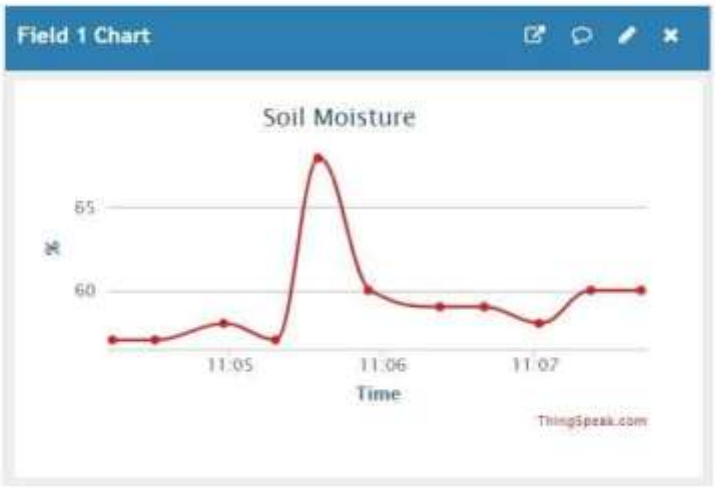

Fig4: Moisture ranges in Thingspeak view

Fig5: Moisture ranges in Thingspeak view

VI. CONCLUSION & FUTURE WORK

Design and development of an Internet of Things (IoT)-assistive Smart Composting System using an ESP32 microcontroller and various environment sensors. The proposed Smart Composting System efficiently addresses and regulates composting parameters such as temperature, humidity, moisture level, and gas production to achieve optimal composting. The inclusion of a 12V DC motor in the proposed composting system enhances microbial growth and facilitates faster composting. The proposed composting system is packed in an SSD stainless steel container that increases its durability and safety and reduces manual intervention. The proposed composting system is cost-effective and scalable

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