Development of A Smart Waste Management System with The Help of The Internet of Things

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Abstract – This text describes a solution to the problem of waste management. Waste management is a widely known issue that creates many negative effects, such as environmental pollution, health problems, reduced soil productivity, and visual pollution. To solve or minimize this problem, the authors have created an IoT sensor system and a web application. The system uses an ultrasonic sensor to detect the level of garbage in a trash can, and an MQ-135 sensor to detect negative odors. The data collected by the IoT sensors is transferred to a firebase database via an ESP32 MCU and displayed on a web application built with React JS. The application shows the garbage level and CO_2 level and indicates if they are over or under 80% with red or green colors, respectively. Additionally, the application has a scheduling system for garbage collection, providing a fast mechanism for future problems.

Keywords – Waste Management, IoT Sensor, Pollution, ESP32 MCU, Ultrasonic Sensor

I. INTRODUCTION

Waste is one of the biggest environmental problems in the world and in our country. Improper and unsystematic collection of waste leads to environmental pollution, affecting both rural and urban areas. In urban areas, unplanned urbanization and rapid population growth, along with inadequate waste management, can lead to environmental pollution due to poor planning and irregularities in waste management. This pollution affects not only human life but also all living things, causing various diseases [1]. These diseases both financially and mentally wear out people and make human life more difficult.

In today's systems, the waste collection vehicles going to and from empty trash cans cause unnecessary fuel costs, and it is also known that this fuel releases carbon dioxide into the environment and has negative effects on human health. To reduce these problems and protect human health, various IoT sensors have been used in the study to try to minimize environmental pollution. The fill rate of the trash is integrated into the system using an ultrasonic sensor, the harmful gases in the environment are detected using a gas sensor, and the location information is obtained using a GPS module, to eliminate the deficiencies in existing systems. In addition to all these efforts, a web application has been created. This web application allows you to see the data from the sensors and makes the system much more efficient. Also, a garbage collection system based on appointments has been created in the web application. For example, if a user has construction work to be done on certain days, it is estimated that a large amount of waste will be generated as a result. Since these wastes are expected to be an additional output apart from the normal waste, they

will fill the garbage bins instantly and cause various problems. To minimize these kinds of problems, the appointment-based waste management process has been integrated into the system. In this way, the waste management system has been made much more effective and environmental pollution has been reduced to a maximum extent. With the decrease in environmental pollution, the living standards of humans and other living beings will increase and be protected.

II. Materials and Method

In our study, this smart waste system has been developed by using IoT technologies, especially sensors. The development of IoT technology, especially the internet, has started to take place in every part of our lives. In short, it can be said that IoT objects are associated with each other [13]. The combination of IoT objects and the internet continues to affect us positively in all areas of life. In this study, cloud storage technology, especially IoT sensors, and React js library for web part were preferred as material. In our work, IoT sensors will undertake processes such as the filling rate of the garbage and the measurement of bad gases in the environment. Cloud storage technology will be used to store the measured data.

A. ESP32 Wi-Fi Bluetooth MCU

ESP32 gives confidence to its users by working in both hot and cold environments without any problems. It provides a guarantee by quickly adapting to any changing conditions. Designed for various clients, this microcontroller has the feature of providing low power consumption according to special situations. Its biggest feature is that it has integrated Wi-fi and Bluetooth connection [5]. Figure 1 shows the ESP32 Wi-Fi Bluetooth MCU.

Fig. 1 ESP32 Wi-Fi Bluetooth MCU

B. HC-SR04 Ultrasonic Sensor

It emits sound waves with high and low frequencies that the human ear cannot perceive, and by catching this wave back, it measures and measures the difference. It is known that it can easily measure the distance between 2 and 400 cm. It has a measurement accuracy of about 3mm [6]. Figure 2 shows the HC-SR04 sensor.

Fig. 2 HC-SR04 Ultrasonic Sensor

C. GY-NEO6MV2 GPS Module

This card is a product that we can use for location control and tracking. It is a module with high quality and precision. It is used when location information is required. It is known to have an accuracy of 5 meters [7]. Figure 3 shows the GY-NEO6MV2 module.

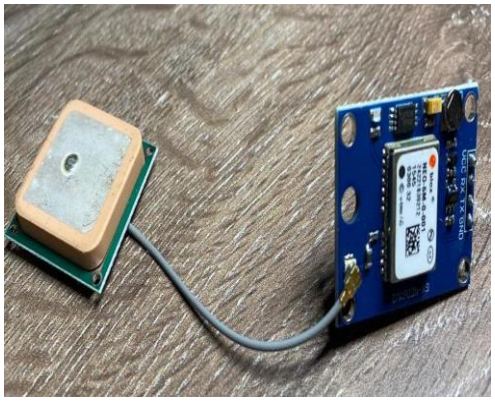

Fig. 3 HC-SR04 Ultrasonic Sensor

D. MQ 135 Sensor

It is a gas sensor that measures smoke, alcohol vapor, benzene and CO_2 gases. It works with 5V voltage. It can be easily used with Arduino or microcontrollers [8]. Figure 4 shows the GY-NEO6MV2 module.

Fig 4 MQ 135 Sensor

E. Firebase

Firebase, which is a NoSQL database, is used as a database in our system. Data is stored in documents. It keeps data in the form of key values. Firebase database, which is quite cheap, is often preferred by users. Figure 5 shows the collection in the firebase database.

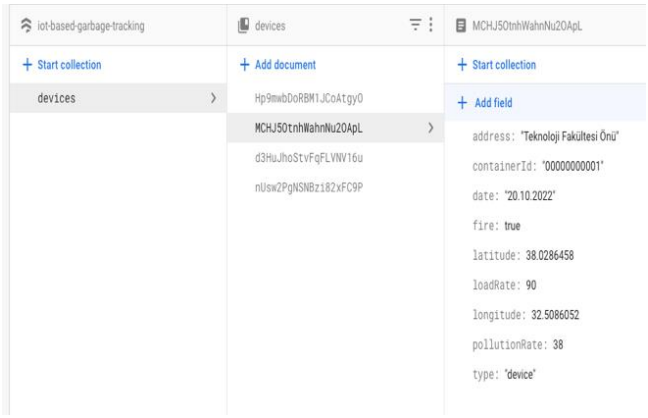

Figure 5. Firebase Database used in the project

III. RESULTS

The most important difference that distinguishes this study from other studies is the use of the ESP32 Wi-Fi Bluetooth MCU controller. The reason for choosing this microcontroller is that it is much better than Arduino both in terms of cost and usability. Another feature that distinguishes it from other works is that appointments can be created via the web application. For example, a user will make a home renovation process in a certain period and as a result of this renovation, excessive excavation will occur. Since so many excavations will instantly fill the trash can, we prevent any malfunctions that may occur in the system by instantly taking an excavation that has been specified for the day and time. Thus, the system has reached a sustainable level. System water etc. It was buried in a box, taking into account the spillage of things. This box was drawn using the Autodesk Inventor program. Figure 8 shows our box, that is, our system. Ultrasonic sensors, gas sensors, microcontrollers, and GPS modules are integrated into it.

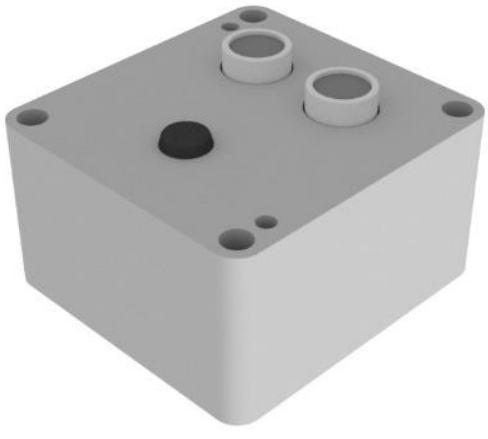

Fig. 8 An image of the system

The box is fixed on a table with a height of 15 cm. This value is taken into account when measuring with the ultrasonic sensor. Figures 9 and 10 show the system fixed to the table.

Fig. 9 The system with sensors inside

Fig. 10 While the system is measuring

The worker was carried out in a round trash can as seen in figures 9 and 10. In Figure 11, the percentage values corresponding to the occupancy rates of the garbage are shown. Our system works by means of these ratios. If the rate is 80 percent or more, our garbage icon in our web application turns red, and if it is 79 percent and below, it turns green.

Table 1. The occupancy rates of the garbage used in the study

Solidity ratio	**Volume (cm^3)**
25%	25.352,95
50%	70.685,84
80%	113.096,80

IV. CONCLUSION

In this study, waste management was tried to be systemized by using ESP32 (Bluetooth-wifi), HC-SR04, MQ-135, and GY-NEO6MV2 GPS Module. It was tried to show whether a bin is full by using an ultrasonic sensor, CO_2 ratio by using the MQ-135 sensor, and the location of the bin by using the GY-NEO6MV2 GPS module. In this study, the data obtained from the sensors are recorded in the Firebase database via Esp32. With the web application written in React js, this data was pulled from the database and integrated into the web application. Thus, through our application, we can see which trash can is full or which bin has a higher amount of CO_2. In addition to all these, events that may be unusual are considered. For example, any home, workplace, etc. The user enters the excavations that will occur as a result of events such as repairs and maintenance in places, by specifying the date and location 1-2 days in advance, so that quick action is taken against environmental pollution and possible diseases by getting a quick reaction by the system.

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