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Smart Waste Management System

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ABSTRACT

Waste management is a problem that we are thriving worldwide. Still, a majority of the world is trying to figure out a way to administrate and monitor waste in an efficient way to minimize the outburst of environmental perils. Even though various methodologies and technologies have been used to find a solution still none of them has reached their full potential level. This paper proposes an approach to provide a solution for waste management at its starting point with cost-effective benefits and a higher rate of practicality. With the help of the Internet of things (IoT) and Machine Learning (ML) based Image processing we have developed a handheld device with an integrated app to find a solution for this problem. The device will have the application to monitor the bin's environment sending data to the admin to make further actions if necessary, regarding the maintenance of the bin. Furthermore, the bin will be able to communicate with the user when requested. To make the user more involved in using the bin properly the app will provide a rewarding system to encourage the user to keep using the bin properly. With the joined eco-system of all these technologies, waste management and segregation can be done more effectively with less manpower and more awareness and encouragement among the users creating a new era of a clean eco-system.

Keywords— Internet of Things, Machine Learning, Smart Bin, Waste Management

I. INTRODUCTION

Waste is a significant uprising issue. According to estimates from the World Bank, 2.10 billion tons of solid garbage are produced year on a worldwide scale [1]. Even with that exceedingly cautious estimate, at least 33% of the garbage is not treated in an eco-friendly way. We can no longer afford to undervalue the significance of waste management and segregation.

Filtering and segregating different waste kinds to make recycling and proper disposal easier is known as waste segregation. When garbage is properly sorted, our eco-system can be saved and significant resources may be saved. If garbage is not adequately segregated, it will wind up jumbled in landfills just as it was in your trash bins. Food scraps, paper, and liquid waste can combine and decay, releasing toxic gas into the sky and runoff into the soil.

Even though various methodologies and technologies have been used to find a solution still none of them has reached their full potential level. The main reason for its hardness to reach its practicality is that most of the solutions are something that must be designed and developed stand-alone, and it cannot integrate with the current system. To implement the innovative technology the old pathways should be fully terminated to implement these which will consume a lot of resources and time.

The Internet of Things is a system of interconnected gadgets that communicate with one another through data transmission. The implementation of such innovation enables the linking of component identifiers and automates the processes. Sensing devices, actuators, and telecommunication networks are indeed the main IoT functioning entities that oversee all interactions. Sensors are used to sense and collect data from their environment. The collected data is dealt with by the controllers. The microprocessor receives the data collected by the sensors, processes it, and then sends it via internet access to the virtualized environment. Data transmission is the reporting system that sends emails or push alerts to mobile devices to notify the relevant people. The administration can keep an eye on the information which is transmitted to the virtualized environment.

Our proposed solution is a “Bin-Bot” a small device, and a smart application that is integrated with IoT (Internet of Things), which will be the size of our arm. Rather than designing dust bins with many features and functions which is cost-consuming and hard to implement, this device will be a solution for all of those. It will have most of the functions that smart dustbins have. The location and state of the Bin-Bot can indeed be provided as notice to the appropriate authority. The lid automatically opens and closes whenever a user's existence is recognized. Waste management that is also effective and wise is crucial to preserve prospects for fresh, environmental protection. An inventive method that should assist in preserving the hygiene and wellness of societies would be an IoT-based Smart Waste management system.

The remainder of this essay is structured as follows. The existing system is described in Section 2 along with literature background. The last section contains a summary and information on upcoming work.

II. BACKGROUND STUDY

Waste can be defined in a variety of ways and take on a wide range of forms. Some common characteristics used in the classification of garbage include physical states, physical attributes, reusable potentials, biodegradable potentials, source of creation, and degree of environmental impact (Demibras, 2011; Dixon & Jones, 2005; White et al., 1995).Waste can be loosely divided into three types depending on their physical conditions, according to White et al. (1995): liquid, solid, and gaseous waste. Despite the fact that it is evident that different countries have different classes. Examples of the most popular classes are provided below.

1. Physical state
   - Solid waste
   - Liquid waste
   - Gaseous waste
2. Source
   - Household/Domestic waste
   - Industrial waste
   - Agricultural waste
   - Commercial waste
   - Demolition and construction waste
   - Mining waste
3. Environmental impact
   - Hazardous waste
   - Non-hazardous waste

Liquid wastes, which can be disposed in groundwater or wastewater networks, as well as hazardous wastes, which need more stringent environmental regulations due to their potential to harm the environment, are omitted due to the research study's constrained scope. Only solid waste, excluding harmful solid waste, will be covered in detail.

III. LITERATURE REVIEW

A. IOT-Based Intelligent Bin for Smart

Cities For the management of waste in India, Keerthana B et al. (2017) designed the intent of bins. When the garbage level reaches its peak, the smart trash management system, which uses a sensor, microcontroller, and other modules, guarantees that the trash cans are properly emptied. If the waste amount exceeds one of the two thresholds established for the bins, an alert message is delivered to the van that picks up the trash. The technology additionally permits users to place trash bags into the bins until they reach the threshold level. It waits for the van to acknowledge it before emptying the bin, and if it doesn't, it sends another message when it approaches the threshold limit and the bin locks. The notification "Overloaded" appears when the bin locks. When the trash bin is not empty after a certain amount of time, a notice is sent to a higher authority so that they can take the necessary action. [4].

According to Insung Hong et al [9], shifting to an SGS (Smart Garbage Sensor) garbage collection system instead of an RFID system can improve energy efficiency by up to 16% and reduce food waste. SGBs (Smart Garbage Bins) have been installed within the SGS to regulate the system's efficiency. It is built upon a dynamic federation smart city platform, which according to Dario Bonino et al [8] provides end-to-end security and privacy. Its advantages include good reliability and resilience to system failure over the course of a particular month. The achievement of the ontology technique and the collecting of wastes are its main points.

A truck should be used to collect the filled trash cans, according to Alvaro Lozano Murciegoet.al [10]. The key benefit is that route optimization makes it simpler and simpler to go to the waste bin rather than making the vehicles drive a long distance, that would require more fuel.

Theodoros Anagnostopoulos et al. [11] have suggested that it should be assumed that the IoT base must be a part of the smart city at the start. The scheduling is dynamic. It is predicated on the idea that trash will only be picked up once it has exceeded its full capacity or the dustbins have reached their maximum capacity. According to Rachael E. Marshall et al. [12], both developed and high-income countries have smart waste management systems.

Many technologies, particularly the smart trashcan, have been suggested for garbage management. The garbage cans have been given silent sensors that can detect how full they are with trash. The instrumentation is divided into three levels, with rubbish being collected at each level. The sensors acquire information about the level of fill if the trash crosses a grade. This information is additionally supplied by instant messaging using a GSM module to the waste instrument. The placement of three inaudible sensors at three completely different instrumentation levels has the drawback of raising the cost of the garbage can due to the sensing components while also increasing the risk of sensor scan failure due to users' harsh behavior. There are plans to reduce the amount of trash with an IoT-based good garbage system (SGS) [1].

B. Smart Dustbin

They created a framework where a camera is mounted on a load cell detector at the base of each trash can for the purpose of recording garbage collection. Shots of the trash can be taken continuously by the camera. An ability to contrast the results of the cargo detector and camera is ready [3]. proposed a method for collecting and removing too much trash from the trash can. The electric Arduino UNO circuit was utilized to create a smart trash can. They created that trash can in such a way that when the level of waste inside reaches the mark, all LEDs blink and a signal is sent to the central hub, stopping the use of materials with anti-corrosive characteristics, extending the life of the trash can.

C. Internet of Bins Trash Mangement

To enhance the amount of recyclable material and manage unintended degradation that could lead to the emission of dangerous gases, an IoT-based automatic trash segregator was proposed. For the appropriate action to be performed, the smart bin can be set up to convey information about the rubbish being dumped [2].

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D. Garbage Collection and Monitoring System for Smart cities using IOT

Although there are numerous research projects on smart waste management systems and smart bins, we have rigorously reviewed and compiled about some of them here. Most contemporary works, it has been noted, employ the Arduino Uno as their base. The IoT-based systems used by most projects all use ultrasonic sensors to continuously check the amount of trash in the trashcan. The PIC controller sends the data to the central server after receiving the detected information via RF signals from the PIC controller. The webpage in the receiver's LCD that is connected to the server can be used to view the data that was recorded. When the dustbin's waste level reaches the maximum, a buzzer alarm is employed for waste collection. As a result, the appropriate authorities are alerted, the dump truck driver receives a notification, and other actions are performed. Due to the little amount of equipment and resources needed, the complete system is cost-effective.

IoT-based sensor systems are used in different applications to measure waste volume. The location of these smart bins is determined by the GPS (Global Positioning Technology) system. The trash management department receives this locational information via GSM (Global System for Mobile Communications) on smartphones. One can find the location of the trash can using Google Maps. [5].

E. IOT Based Intelligent Bin for Smart Cities

Several social, environmental, and health issues are being exacerbated by the municipal corporation's community trash cans. Numerous things, including poor planning, could be at blame for this. Both the placement of dustbins across the city and the collection process are problematic trash generated by the municipal corporation as well as by residents who are unsure of how to use dustbins. A user is given the option to dispose of waste while being made aware of several important issues, including unhealthy lifestyles, polluted air, and dirty environments. The desktop is connected to the sensor bin through a microcontroller board and program. Furthermore, how much food waste is produced overall affects the plot. User identification and the proportion of organic waste are displayed on an LCD panel [6].

IV. METHODOLOGY

This paper which is a survey of writing depended strongly on optional information just like with most work area study where existing data are utilized for investigation and to make required determinations. A portion of the origin of information for the review incorporates books, diary articles, unpublished papers, government reports, hierarchical and confidential pages. This kind of exploration approach is utilized when a significant measure of work has been finished on an examination subject and when the goal of the review is to respond to explicit inquiries based on past works. Our proposed system, with the Cluster MCU is linked to the GPS module, servo motor, and ultrasonic sensors. The microprocessor connects to the Bin Bot server through Wi-Fi only with aid of an integrated Wi-Fi adapter. Sensing data is gathered by the Mobile application server out from microprocessor, and when limits are reached, notifications are sent to the client's side via notifications through the B Bot App. Also, the ultrasonic sensor aids in the detection of an impending garbage disposal person. With the help of a servo motor mounted to the bin lid, the lid of the bin automatically opens when the person is detected. The servo motor would be configured to revolve when the ultrasonic sensor senses someone nearing the trash can, which aids in the lid being opened. The lid will remain open for a certain length of time, after which the servo motor will cause the lid to close on its own. Monitoring and tracking the direction of the dustbin is made easier by the GPS module. As a result, the location and volume of the trash are included in the alert sent to the user via B Bot mobile application. This enables the administration to locate the precise trash-can before it overflows.

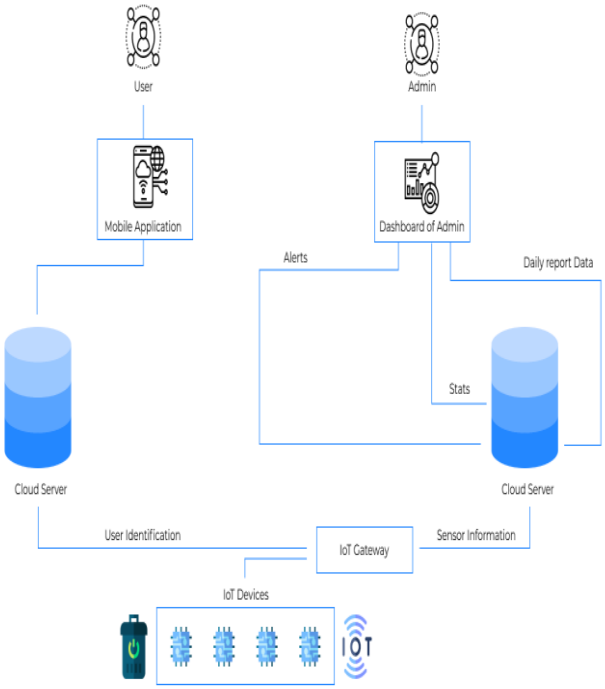

Figure 1: System Diagram

Monitoring to see if the trashcan is full in the first step in the procedure. Until the state is filled, the device keeps checking the state. The notification to empty the bin is transmitted to the trash collection unit whenever it reaches 90% capacity. After being notified, the staff can go to the container to gather the trash, unload it, and then clear it. Once the trash has been emptied, the server verifies to see if it is overflowing or not before moving on to the next step. The notification to clear the container is sent out to the garbage collection service once again if it is not done. As a result, this mechanism assures that now the trash can is cleared and, until it becomes, sends a frequent notification to the appropriate authorities.

A. Administration of the Trash Bin

The proposed device will have a circuit integrated into it with many combinations of sensors and transmitters. The device will have the capability to fit into any type of trash cans not respective to its design, with various attachments available to fit into its bin. Once the device is fitted inside the bin it will calibrate itself to the environment of the bin, the ultrasonic sensor will 1st measure the depth of the bin calibrating itself to send information regarding the filled percentage of the bin in the future, due to the different variation in bin's depth. As soon as the depth calibration has been done will move on to its function phase seeking the geo-location data to the server which is received through the neo-6m chip installed in the device. The geolocation data will be used by both the admin and the user, for the admin, it will serve the purpose by sending the location data to send the relevant cleaners to clean when the necessity arises, as for the use when they demand to find a bin near him to his

Figure 2: Waste Bin prototype.

B. Administration of bin through the app (admin)

The admin will be given an app, in which he can view and manage the different functions of the bin as well as the user. The bin can be managed by the admin in various ways, first one will be monitoring the level of the bin (Filled capacity). Between small time intervals, the Ultrasonic sensor in the bin will automatically turn on itself and will monitor the bin level in which the garbage has been filled. The data collected will be sent to the server for further analysis, after the calculation has been made the data will be sent to the admin's dashboard, if the dustbin has reached its maximum capacity, it will be notified in the dashboard as Filled and Inactive bin so that the admin can review that by assigning relevant worker for the cleaning of the bin.

Common dustbins is emitting bad odors. It mentioned that more than 40% of the users are refusing to use the dustbins because of their bad smell and untidy look, so as a precautionary measure for this we have added an MQ-135 sensor which will monitor the Ammonia and Carbon dioxide gases which are being emitted from the bin. When the bin starts to emit the above gases above a certain limit the device will send a warning to the admin to send relevant workers to clean it.

Initially Process starting on one particular come to our smart dustbin first motion sensor detect the human Presence after that Raspberry pi camera take a picture of his/her face then it will uniquely Recognize the face which person and other personal information easily identified and it will save as CSV file mean time our servo motor start working and help of the Linear Accelerator horizontally open our dustbin box then the person get a information which garbage throw our dustbin get some notification of his/her profile and get rewards based on their garbage.

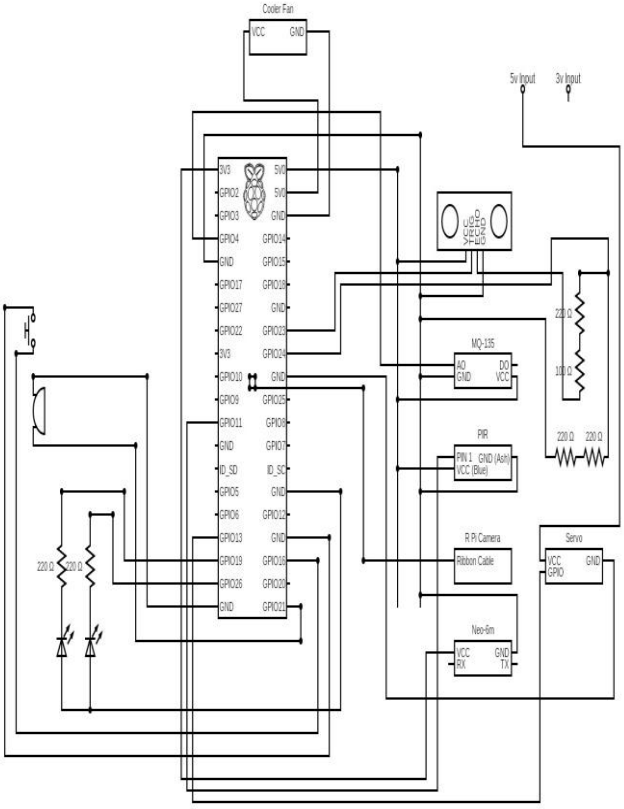

Figure 3: Circuit Diagram

C. Users interaction through the app

No matter how efficient the garbage management system or the segregation process is, still without proper self-disciple of everyone a clean environment cannot be maintained. Still based on human psychology when you are rewarded for a good habit you have done it will make you more involved in keeping than habit continuously. So based on the above psychology we developed a rewarding system for the user. Once the user comes near the bin with the help of the Ultrasonic sensor and servo motor and linear accelerator, the device will trigger itself and open its PI camera to scan the face of the user coming near the bin it will visible who is throwing the garbage inside our smart dustbin. Here we use feature extraction to check their eye length to identify each person uniquely. Once the face has been detected it will trigger its next pi camera inside the bin

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to scan the rubbish which has been thrown inside the bin. Once the camera has scanned the trash inside the bin with the use of image processing it will make sure whether the user has thrown the garbage in the right bin (paper, plastic, organic). Once the device has confirmed that the user has used the bin properly it sends a reward point to the user's profile. Depending on the number of rewards points the user has gained he can collect his gifts at a selected place.

Figure 4: Reward System

In addition to the reward points, there will be another reward system called badges will is also based on points, but it provides rewards on points.

V. RESULTS

The simulation results of the suggested smart waste management are covered in this section.

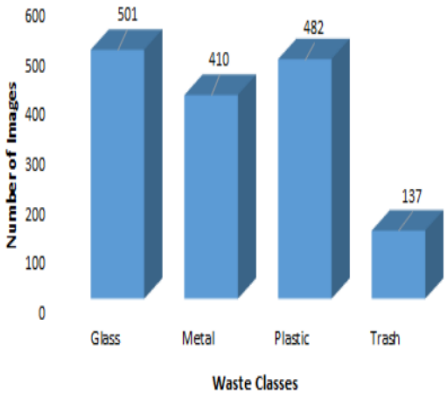

Figure 5: Sample Results

By calculating the system's accuracy, the performance of the system may be evaluated. The ratio of actual positive predictions for the original dataset is known as the system accuracy (AC). Finally, we received an accuracy of 82 percent. As shown in Figure 5, our categories are in the order of (glass, metal, plastic, unknown) after the test predictions were executed in a real-time environment.

VI. CONCLUSION

The project's design has implications for how waste management might be improved in confined spaces, such as premises. All of the technical components were carefully designed while paying attention to all of the limitations. The issue revolves around whether the project will be able to satisfy users' future needs. Customers have the option to change the hardware and software specifications of an IoT-based project in accordance with changing requirements. Future needs are already taken into consideration when designing IoT-based initiatives, and demand for our project will continue to rise in a developing economy like Sri Lanka where the concept of smart cities is unique. This project's implementation has been subdivided into several sections. Later tiers will also include large settlements after moving away from the campus grounds and toward the concept of smart cities. We're here right now to show how the model is actually working and to illustrate the actual implications..

In this project, an integrated system using an ultrasonic sensor and raspberry pi camera is used to collect trash in an affordable and efficient manner. For users and waste generated during garbage collection, the advanced system provides a progressed database at all times. By putting this initiative into action, we can prevent the trash can from overflowing. It has the ability to send data to the mobile app and automatically screen the level of trash. The technologies that can be incorporated into the suggested machine are adequate to guarantee a steady and optimal method for tracking and controlling waste series for a green atmosphere.

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