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IOT BASED SMART SYSTEM FOR MONITORING WASTE

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Abstract: **Due to the rise in population, large number of waste is getting piled up at different places. This kind of unhygienic environment creates a path for the easy spread of diseases to nearby people. It also deteriorates the beauty of nature. This project involves the technology-based solution to resolve the wastes which are increasing day by day. This system proposes a web-based, cost-effective. Recycling is usually done manually by sorting the waste by the human interface. To reduce human interference and to make systems smarter. This project creates a system for gathering and separating garbage into dry and wet. The system is designed with inbuilt sensors to detect and segregate the waste , and place the waste into separate bins designed for dry and wet waste. Bills deduction by RFDL and camera sensor for sending image notification to concerned authority if the trash is disposed elsewhere. An efficient solution for smart and effective trash management using deep learning with Internet of Things (IoT).**

Index Terms **- IoT, Raspberry Pi, Dry and Wet Sensors, RFID Reader, Twilio, Things Speak**

I. INTRODUCTION

A waste operation system is the strategy an association uses to dispose, reduce, exercise, and help waste. Possible waste disposal styles are recovering, composting, incineration, tips, bioremediation, waste to energy, and waste minimization. There are multiple waste operation strategies and styles available. These strategies can be combined or rearranged to form a waste operation system that fits an association. ultramodern waste operation strategies are geared towards sustainability. Other druthers for waste operation is to reduce, exercise and reclaim waste. Also known as physical reclaiming, recovering is ideal for the disposal of inorganic waste similar as plastic, glass, and substance. Though organic waste similar as paper and food can also be reclaimed, composting would be a better waste disposal system as it converts organic waste into nutrient-rich bane.

Waste to energy on the other hand, is the conversion of non- recyclable waste into heat, electricity, or energy using renewable energy sources similar as anaerobic digestion and tube gasification. Resource effectiveness reflects the understanding that global profitable growth and development can not be sustained at current product and consumption patterns. Encyclopedically, humanity excerpts more coffers to produce goods than the earth can replenish. Resource effectiveness is the reduction of the environmental impact from the product and consumption of these goods, from final raw material birth to the last use and disposal. Waste collection styles vary vastly among different countries and regions. Domestic waste collection services are constantly handed by original government authorities, or by private companies for artificial and marketable waste. Some areas, especially those in less developed countries, don't have formal waste- collection systems. insulated waste is also constantly cheaper to dispose of because it doesn't bear as important homemade sorting as mixed waste. There are a number of important reasons why waste segregation is important similar as legal scores, cost savings and protection of mortal health and the terrain. This covers waste collection, transportation, treatment, and disposal as well as the oversight and control of the waste operation procedure and any legislation, technology, or profitable mechanisms that are related to trash. Reducing the dangerous consequences of similar scrap on the terrain and mortal health is the thing of waste operation. External solid waste, which is produced by artificial, marketable, and home exertion, makes up a significant portion of waste operation. In India, trash collection, transportation, and disposal are viewed as chaotic and unscientific. Overflowing tips and the disposal of rubbish outside of megalopolises and megalopolises have put people's health at trouble.

Existing System

Using image processing, artificial intelligence (AI), and mechanical sorting, scrap can be separated at the source. A prototype is created that uses image processing and AI to further separate the waste after the original isolation medium. The prototype exemplifies the separation suggested in the laboratory setting. This can be expanded upon to serve marketable waste operation needs.[1]. IoT (Internet of Things) and deep learning are the two main technologies that have been developed for eliminating the difficulties in the field of waste management. .Along with handling and sorting the rubbish, another crucial responsibility is garbage pickup. The health of the local population is impacted when rubbish isn't picked up at regular periods of time. Both technologies have done a tremendous job closing this communication gap and ensuring that waste is properly segregated with no effort spared [2][6]. Before being treated, the garbage that is discharged all at once needs to be divided into categories so that the system can determine whether it is dry waste or wet waste based merely on the image of the waste that was captured. With an emphasis on simplicity, it is proposed to present an application that will just require the local government entities to upload the screenshots of the trash cans and send them to the system to determine if the trash is wet, dry, or mixed. Machine learning will be used to identify the garbage's contents, which is a key task.[3]. Smart Waste Bin Segregation utilising Image Processing and help waste segregation through waste detection and built on machine learning capable of traversing the one-time path established by the user. These divisions—biodegradable, non-biodegradable, and unspecified—are meant to separate [4]. Dustbin with Automatic Waste Segregation and Self-Sanitization. It operates on the fundamental principles of sensing. focuses on waste separation and sanitization without human involvement. Additionally, it will aid in reducing the release of dangerous gases from decomposing trash. When the bin is full, the system can also identify garbage and send the receiver an automatic notification [5][8]. Small and medium businesses or industries that are transported immediately for processing can use a segregation system using a smart dustbin, which is also extremely affordable. Through the design, the trash is divided into metallic and non-metallic components. The circuit is managed by the microcontroller [7].

Proposed System

The proposed system uses machine learning and IoT to provide a solution to manage waste that is created at the household level and waste material gathered in open space to provide a way better hygenic environment. Here, we have suggested a method in which individuals must separate their waste at home, transport it to the truck, and scan their respective IDs using RFID scanners. After doing so, an LED will indicate where the individual should dump the waste and, upon detection, will also indicate whether it is dry or wet waste.Then load the waste into the appropriate bins, such as the dry bin and the wet bin, where the sensors will detect it. If the waste is placed correctly, the placer will receive points, and the servo motor will then place the waste into the appropriate bin. If not, the waste will not be taken, and the placer points will be subtracted. This message will be transmitted via SMS. The camera will be used to take pictures of the trash that has been gathered in the open area, which will subsequently be mailed to the appropriate authority.

II. REQUIREMENT SPECIFICATION

Hardware Requirements

1) Raspberry Pi model B+
2) LCD Display
3) Servo Motor
4) LED
5) Buzzer
6) Rain Sensor (Wet/Dry Sensor)
7) Camera
8) RFID Reader and Card

Raspberry Pi:-

The Raspberry Pi 3 Model B+ contains a wide range of improvements and features that will benefit the designers, developers, and even engineers who are looking to integrate Pi systems into their products. The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT. Here are some of the new Pi's specs:

- Quad core 64-bit processor clocked at 1.4GHz
- 1GB LPDDR2 SRAM
- Dual-band 2.4GHz and 5GHz wireless LAN

- Bluetooth 4.2 / BLE
- Higher speed Ethernet up to 300Mbps
- Power-over-Ethernet capability (via a separate Poe HAT)

Fig.1. Raspberry Pi

LCD Display:-

This is LCD 1602 Parallel LCD Display that provides a simple and cost-effective solution for adding a 16×2 display to the project. LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters. The values shown on the display can be either a simple text or numerical values read by the sensors, such as temperature or pressure and other text.

- Black text on the Green background
- Single LED backlight included can be dimmed easily with a resistor or PWM.
- Interface: I2C
- Interface Address: 0x27
- Character Color: Black
- Backlight: Green
- Supply voltage: 5V

Servo Motor:-

The servo motors are used for control applications which require precision control like robot arm positioning, tool position in machining equipment. The servo motors usually provide control over 180° range. This angular position control is performed by PWM technique.

- Operating Voltage: 3V to 7.2V
- Stall torque @4.8V:1.2 kg-cm
- Stall torque @6.6V:1.6 kg-cm
- Gear Type Plastic
- Weight of Motor 9gms

LED:-

A light-emitting diode (LED) is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor.

Buzzer:-

This is a small 12mm round Passive buzzer that operates around the audible 2kHz range and rated at 5V 42 Ohms.

- Rated Voltage: 3 ~ 5V
- Sound Output at 10cm with 2048Hz Square Wave: ≥85 dB
- Frequency Range: 50 ~ 14,000 Hz
- Resonant Frequency: 2048 Hz
- Operating Temperature: -20 to 60°C
- Pin Pitch:6mm
- External Material: Plastic
- Color: Black

Rain Sensor (Wet/Dry Sensor):-

The Raindrop Detection sensor module is used for rain detection or the detection of wet area when something is placed on the sensor.

- Operating Voltage (VDC) : 3.3 ~ 5
- Voltage Comparator: LM393

Camera:-
Up & down 30 degrees rotatable, you can adjust the angle as you like. High definition and true color images, manual focus. Built-in sound absorption Microphone, your voice can be heard clearly in 30 feet. You can directly use the video chat software features and then can see the picture.

RFID Reader and Card:-

RFID Reader is used to read information which is stored in RFID tag. This reader operated on 125 KHz which contain on-chip antenna which can be powered with 5V power supply. This Reader is attach to computer or any microcontroller but in our system.

- Operating Current:13-26mA / DC 3.3V
- Idle Current:10-13mA / DC 3.3V
- Sleep Current: < 80uA
- Peak Current: < 30mA
- Operating Frequency: 13.56MHz

Software Requirements

1) Raspberry Pi OS
2) Python
3) Open CV
4) Twillio
5) Thing Speak

Raspberry Pi OS:-
Based on Debian, Raspbian is a free operating system designed specifically for the Raspberry Pi device. The collection of fundamental applications and tools that run on your Raspberry Pi is known as an operating system. Raspbian, on the other hand, offers more than just an OS; it also includes over 35,000 packages, which are collections of pre-compiled software that are nicely packaged for quick installation on your Raspberry Pi. The recommended operating system for regular use of a Raspberry Pi is Raspbian.

Python:-

The building of websites, data analysis, artificial intelligence, and scientific computing are all common uses for Python, a high-level, interpreted programming language. The adaptability of Python is also well recognised. It may be applied to a variety of tasks, including creating web applications using frameworks like Django and Flask and conducting data analysis and machine learning with tools like NumPy, Pandas, and Tensor Flow. Its popularity is on the rise, making it a useful talent for both developers and data scientists.

OpenCV:-
OpenCV, also known as the Open Source Computer Vision Library, is a free and open-source software library for computer vision and machine learning. It is used for a variety of tasks, such as object detection, facial recognition, robotics, and more. OpenCV's adaptability is one of its key benefits. It is accessible to developers with various backgrounds and tastes because it is available in a variety of programming languages, such as C++, Python, and Java. It also has a sizable library of pre-built functions and algorithms, making it simple to put sophisticated computer vision tasks into practice. Overall, the OpenCV library for computer vision and machine learning is strong and flexible. Developers may perform a variety of complicated tasks using its tools and algorithms, and its robust community assures that it is always available.

Twillio:-

Sending large numbers of messages domestically and internationally quickly becomes complicated. As the messaging application becomes complex, it's helpful to use Twilio Programmable Messaging to organize the account and message into separate messaging services. A messaging service can be thought of as a high-level "bundle" of messaging functionality for a common set of senders, capabilities, and configurations.
The same settings and feature configurations apply to all senders (long codes, short codes, toll-free numbers, etc.) within the messaging service's pool. The functionality of the messaging service can be managed and configured directly from the console as well as the REST API. For each messaging service that you add from the console, first configure incoming message handling and status callback URLs. These can be configured in the integration section of the messaging service settings. Also, to send messages, you must assign at least one phone number or short code

to the service. Additional messaging capabilities (described below) can be added to your application using the newly configured messaging service.

Thing Speak(Cloud Server):-
ThingSpeak is an IoT analytics platform service that allows you to aggregate, visualize, and analyze live data streams in the cloud. Devices or applications can communicate with ThingSpeak via RESTful APIs, and data can be private or public. We also use ThingSpeak to analyze data and act on it. ThingSpeak provides an online text editor for data analysis and visualization in MATLAB. You can also perform actions such as For example, periodically run scheduled MATLAB code or send a tweet when data crosses a defined threshold. ThingSpeak is used for everything from collecting and analyzing weather data to synchronizing the colors of lights around the world. ThingSpeak stores time series data and how MATLAB analysis integrates with ThingSpeak. ThingSpeak is commonly used for prototyping and proof-of-concept IoT systems that require analytics.

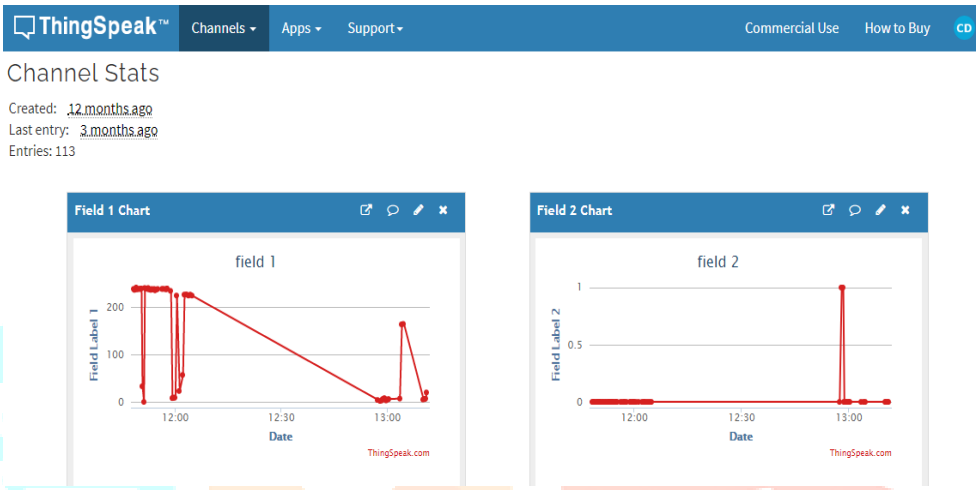

Fig.2. Things Speak

III. METHODOLOGY

The Raspberry Pi is a very cheap computer that runs Linux, but it also provides a set of GPIO (general purpose input/output) pins, allowing you to control electronic components for physical computing and explore the Internet of Things (IoT). RFID Reader is mounted on the vehicle side for person identification. Wet sensor is used to identify wet waste and dry sensor is used to identify dry waste. After proper waste disposal the respective person is rewarded with points. These reward points can be used for redeeming discounts on other organizations counter. Buzzer and LED are used for system related indications. Using Twilio services, messaging to people about informing their rewards points is done. Thing Speak IOT cloud is being integrated for uploading data like people id, waste disposed and reward points allocated. Servo motors are used to move waste to the bins. Camera is used to take images of the waste to identify the scraps using python script. Taken image is then sent through an Email.

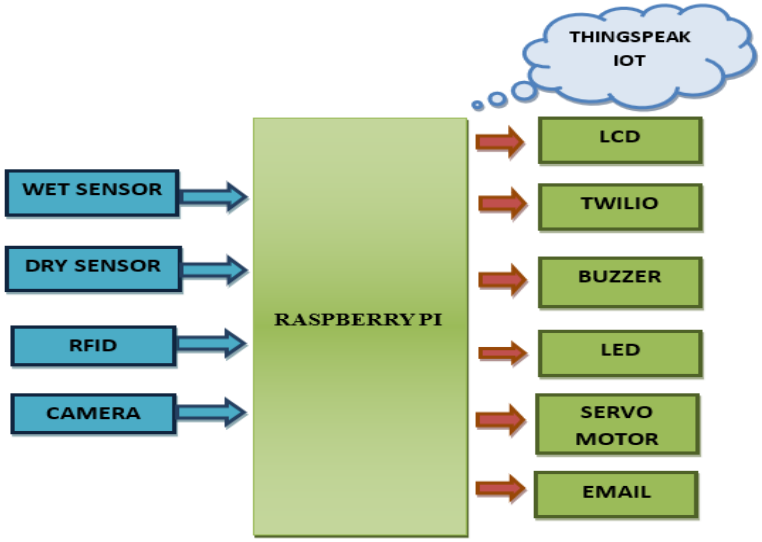

Fig.3. Block Diagram of system

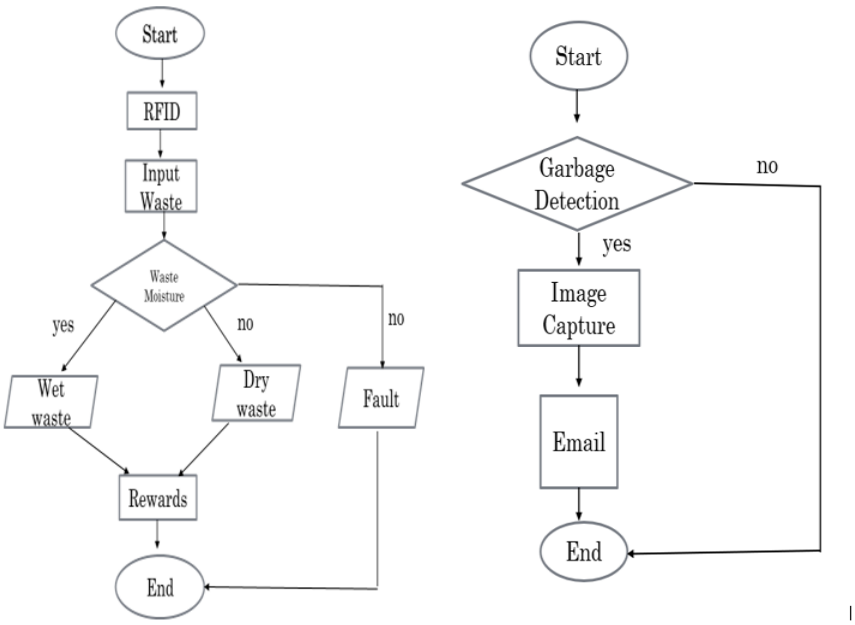

Fig.4. Flow Chart Of The System.

IV. WORKING

Detection of wet waste and dry waste is done by sensors. Wastes are separated by people and correspondingly they are rewarded with reward points if they have actively segregated the dry and wet waste in a proper way. A better option for the safe management and also it is of low cost. For urban household, college and offices it tends to be a compact, low cost, and user-friendly separation system through this system to utilize the waste management process. The camera sends the captured image of the garbage thrown in unwanted places to the concerned authorities which can also avoid the disposal of garbage by people in an uncertain way. Since the collection of waste is always a big task in day-to-day life, it is very important for a mere benefit and a two-way interaction for the people to adapt the garbage disposal process and follow it thoroughly. In this way, the reward points can help the people to focus on the task better.

V. RESULTS

Waste segregation system:-

Displaying the name of the waste segregation system in the LED display.

Fig.5. Waste segregation system

Scan your ID:-
This instructs the person to scan the ID so that the RFID reader can read and get the details of the person placing the waste.

Fig.6. Scan Your ID

Place your waste:-
Here, it instructs the people to place their trash in the appropriate bins.

Fig.7. Place your waste

Dry waste detected:-
The waste is placed in the dry bin here, where the fitted dry sensors detect it and, if positioned it correctly, they it will show “dry waste detected”.

Fig.8. Dry waste detected

Wet waste detected:-
The waste is deposited in this wet bin, where the dry sensors that were installed detect it and, if they were properly positioned, it will display “wet waste detected.”

Fig.9. Wet waste detected

Penalty Rewards:-
If the waste is not disposed in the appropriate bins means , there will be a penalty that lowers the points gained.

Fig.10. Penalty Rewards

Mail :-
The camera will be installed in its designated location and will detect waste that has been dumped in an open area. It will then take a picture of the waste and email it to the appropriate authority along with the camera number so that they can quickly determine where the waste has been dumped.

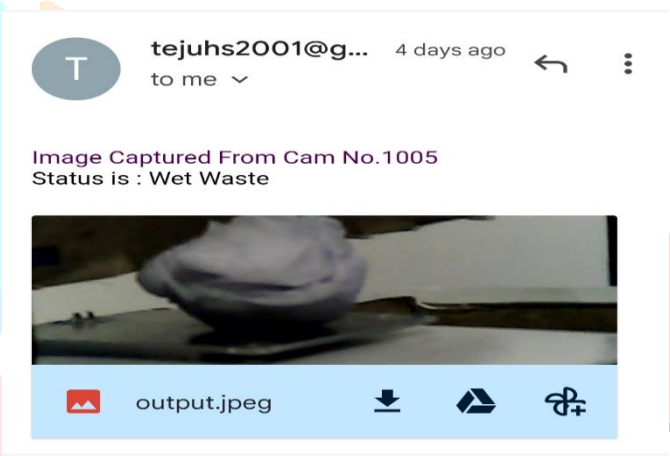

Fig.11. Mail

SMS:-
Assuming that the individuals will scan their ID and deposit their trash in the appropriate bins, they will be rewarded with points, and the information of those points will be communicated to them by SMS.

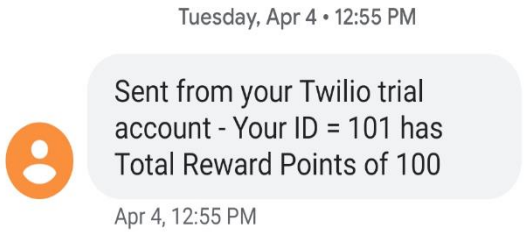

Fig.12. SMS

VI. CONCLUSION

Detection of wet waste and dry waste is done by sensors. These wastes are separated by people and correspondingly rewarded with points. It is the better option for the safe management and also it is of low cost. For urban household, college and offices a compact, low cost, and user-friendly separation system through this system to utilize the waste management process. Identification of waste objects is performed using python script. Camera's are installed at roadsides and given a number, if people are seen dumping garbage at roadside, the installed camera captures the image of Garbage dumped and sends it to the concerned authority via mail along with camera number so the authorities can locate road easily by using camera number.

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