A MQTT PRACTICE BASED SHREWD BINS FOR SHREWD WASTE MANAGEMENT USING IOT

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ABSTRACT:
A system using Message Queuing Telemetry **Transport (MQTT) is being designed in order to manage the waste collection. The growing amount of wastage day by day needs to be handled efficiently in order to properly recycle it The waste can be best handled at the point of collection or locally than at the dump yard. The dustbin uses ultrasonic sensor, infrared sensor and a camera module connected to it. The android mobile can be used to check the status of dustbins. A wireless ESP32 module board is used to send commands to the sensors. It also sends and receives data from mqtt server. The raspberry pi zero w module effectively takes the place of server and handles the system. The camera module used here helps in identifying the person and assign "cleanliness points" to him based on the amount of waste dumped by him. The usage of these sensors and proper design a well effective waste management system can be developed. A smart dustbin and well designed system effectively tackles the waste management problem.**

KEYWORDS: Monitoring, ESP32, Telemetry, MQTT broker, face recognition

INTRODUCTION

The biggest problem faced by any nation of the world is the ever growing amount of waste. Large amount of waste is generated by urban societies, industries and factories. Due to the absence of care and consideration by the people and the sanitation workers the dustbins generally appear to be flooding. Generally, garbage is collected by corporation by weekly once or twice. The garbage in the bin stinks and overflows and spread over the roads and pollutes the environment. The smell will be heavy and produces air pollution and spreads disease. The street dogs and animals eats the waste food and spreads the waste all over the area and creates a dirty environment. The IOT technology helps in building a smart solution for handling of waste in the smart cities. The Internet of things (IOT) is the internetworking of physical devices. This system depends on IOT(Internet of things). The MQTT protocol makes the work more easy and fast for communication between IOT connected devices.These sensors help in easy realisation of the system. The infrared sensor senses the presence of human near the bin and after that servo motor accordingly will open the lid of the bin. Ultrasonic sensor is used to know the status of the garbage filled or not and based on it, accordingly the microcontroller will update the garbage collection management about the bin status. The MQTT server handles the communication between the sensors. IOT Based Smart Waste Collection System is created to defeat the circumstance of rubbish flooding the receptacles in the diverse urban communities.Thesystem developed solves the issues with accuracy of update and collection of garbage in time.This system is simulated in a realistic scenario in the city, and utilizing openly accessible geographic area information of the municipality owned dustbins.

BACKGROUND: The Internet of Things(IOT), as expected infrastructure for envisioned concept of smart building, brings new possibilities for the building management. IOT vision introduces promising and

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economical solutions for massive data collection and its analysis which can be applied in many domains and so make them operating more efficiently.

LITERATURE REVIEW

"IN[1] ABEESH A, PRAKASH A P, MOHAN P, POORNIMA AND DHANYA M (2018), IOT BASED WASTE MANAGEMENT, MONITORING & TRACKING – SMART BIN" In the recent decades, Urbanization has increased tremendously. At the same phase there is an increase in waste production. Waste management has been a crucial issue to be considered. This paper is a way to achieve this good cause. In this paper, smart bin is built on a microcontroller-based platform Arduino Mega board which is interfaced with GSM modem and Ultrasonic sensor. Now a day's Automatic systems are being preferred over manual system to make life simpler and easier in all aspects. The number of users of internet has grown so rapidly that it has become a necessary part of our daily life. Dust bins placed across cities set at open placesare flooding because of increment in the waste each day andmaking unhygienic condition for the citizens, we have proposedwaste management system for smart cities whichallows municipal corporations to monitor status of dustbinsremotely over web server and keep cities clean very efficiently byoptimizing cost and time required for it. As soon as dustbin hasreached its maximum level, waste management department getsalert via SMS via GSM module placed at dustbin, so department cansend waste collector vehicle to respective location to collectgarbage.

IN [2] "AGARWAL P, SHARMA S, GUPTA L AND MANIDEEP B (2017), SMART ELECTRONIC GARBAGE MANAGEMENT SYSTEM BASED IOT" This paper aims to provide an overview of the voluntary approaches towards enhancing the design of a smart dustbin for the implementation of advanced waste management systems. In most of the places, the Municipal garbage bins are overflowing and they are not cleaned at proper time. As a result of which the consequences are severe. It includes overflow of garbage which results in land pollution, spread of diseases, also it creates unhygienic conditions for people, and ugliness to that place. There needs to be system that gives prior information of the filling of the bin that alerts the municipality so that they can clean the bin on time and safeguard the environment. To avoid all such situations we intend to propose a solution for this problem "Smart Garbage Bin", which will alarm and inform the authorized person by buzzer and alert system when the garbage bin is about to fill. To avoid all such unhygienic circumstances we are going to implement a project based on iot called smart trash management by interfacing an trash bin with infrared sensors, lcd, buzzer, wifi modules via an arduinoatmega .The current status of trash bin is depicted by sensors and automatically updates garbage level on html page with the help of a wifimodule . The main objective of this paper is to propose a plan to reduce human effort and resources along with the enhancement of smart city vision and to maintain a pollution free environment around our homes and specially in public places

IN [3] "AKSHATHA G, SNEHA K AND PRASAD B G (2016), MONITORING AND SMART PLANNING OF URBAN SOLID WASTE MANAGEMENT BASED ON IOT" Solid waste generated is a ever growing problem at local regions or at global levels. There is proper disposal of solid wastes pollute all the components of the green environment (i.e., air, land and water) at regional and global levels. Since there is rapid increase in producing or consumptions, quantity of wastes generated by the urban society has increased. The problem is more faced in the developing countries than in developed countries, as the economic growth as well as urbanization is more rapid. The continuous flow of garbage in all places where public people move around creates the unhygienic situations. It may invoke several injurious diseases among the nearby people. To avoid such a situation and to improve the cleaning, 'smart waste management system' is proposed. In the proposed system, the completeness of waste in the dustbins is checked with the help of Sensors used in the system, and information is sent to the required control room through GSM/GPRS system. Renesas Microcontroller is used to communicate the sensor system with GSM system. An android application is been designed to monitor the information related to the waste for different selected locations. Through this the collection of garbage can be made efficiently

IN [4] "ALI N, AWAIS M, MUZAMMUL M AND ZAFARA (2018), INTELLIGENT SYSTEM FOR GARBAGE COLLECTION: IOT TECHNOLOGY WITH ULTRASONIC SENSOR AND ARDUINO MEGA" Piles of rubbish are one of the major problems faced by most people in our country. Many times, in our city we see that the garbage bins or dustbins placed at public places are overloaded. It creates unhygienic conditions for people as well as ugliness to that place leaving bad smell which may lead to sanitary issues and disease. To avoid all such situations we are going to implement a project called IoT Based Smart Garbage System. The proposed system is consisted by the ultrasonic sensor to measure the waste level, and an Arduino Mega which Control the system operations. It can be also generate warning message to the municipality via SMS when the garbage bin is full or almost full, so the garbage can be collected immediately. The main aim of this project is to reduce human resources and efforts along with the enhancement of a smart city vision. Furthermore, it is expected to contribute to improving the efficiency of the solid waste disposal management

IN [5] "ANWAR, M. A. (2018). IOT BASED GARBAGE MONITORING USING ARDUINO (DOCTORAL DISSERTATION, WEST BENGAL UNIVERSITY OF TECHNOLOGY)" -As people are getting smarter so are the things. While the thought comes up for Smart cities there is a requirement for Smart waste management. The idea of Smart Dustbin is for the Smart buildings, Colleges, Hospitals and Bus stands. The Smart Dustbin thus thought is an improvement of normal dustbin by elevating it to be smart using sensors and logics. Smart dustbins is a new idea of implementation which makes a normal dustbin smart using sensors for garbage level detection and sending message to the user using MQTT protocol.

METHODOLOGYAND DISCUSSION: In this paper, we are discussing one of the most challenging issues-waste-collection, waste is not collected in the correct time and which leads to the environment damage and more health issues.

PROBLEMS OF WASTE Waste is a huge problem not only of India but the entire world. A few of these problems are discussed here. Unhandled waste causes lot of problems like environmental pollution of land, water and air; loss of ecology; animal deaths; numerous health issues in humans. a) Environmental Pollution b) Ecological loss c) Animal deaths d) Health problems in humans

EXISTING SYSTEM

In the existing system garbage is collected by corporation by weekly once or by 2 days once. Though the garbage strinks and overflows the garbage bin and spread over the roads and pollutes the environment. The smell will be heavy and produces air pollution and spreads disease. The street dogs and animals eats the waste food and speads over the area and creates dirty environment and The existing system of waste management is not very effective in handling the waste that is generated. In the current existing system the waste from household comprising of food waste, grocery waste, polythene covers, vegetable waste are put in a single dustbin. This waste is collected by the municipality workers twice a week into a loading truck. The other process of collection of waste existing is the waste is dumped into a larger dustbin at the colony or at the end of the street. This dustbin is often overloaded and overflowing with waste. The waste is then collected once a week by the garbage truck and then replaced with another. The problem of this waste collection is that garbage is not handled properly often mixed up and stashed. This system causes many problems not only for health and environment but also for separation. The waste collected by this process has no separate dry waste and wet waste; bio-degradable and non biodegradable; recyclable and non- recyclable waste concept. That's the reason why waste is deemed to be an ever growing and unsolvable problem. This can be only solved by a well maintained and procedure oriented system of waste management

PROPOSED SYSTEM

This system proposes an effective and efficient solution in collection of waste from households or factories. To achieve this "smart bins" are used for "smart waste management" are used. The system also employs a smart waste management system. The "smart bins" equipped with sensors that detect the person on arrival, open the lid and calculate the amount of waste deposited by the person. The person's photograph is captured by using a camera to

assign him points accordingly. The dust bin intimates the central system when the dustbin is short of being full. A microcontroller effectively communicates with the sensors and sends the data to a MQTT broker running on central device through internet. The central device collects the information various client dustbins connected to it through IoT. The central device subscribes to the data from broker and processes it and runs a dashboard that shows the visual status of the bin connected it. The camera module interfaced to the dustbin can be accessed remotely adding a security value to the system. The system using such smart bins help in avoidance of overflow of bins, seepage of water into bins during rain, they can be used for collection of separate wet and dry waste, recyclable and non recyclable waste…etc The main differentiating point here is the rewarding system that detects the person and allocates him "cleanliness points" that can be monetized or added to reward points of the person. This method of reward motivates people to dump waste properly into the dustbin. This system helps in effective processing of waste as it can be monitored by recycling companies that take up a colony or society for waste management. Here the system uses an IR sensor – to detect nearby object, an ultrasonic sensor – to detect height of waste in the dust bin, a servo motor – to handle the opening and closing of lid, a green LED – to indicate empty status of the bin, a red LED – to indicate full status of the bin, an ESP32 microcontroller with WIFI module to handle the dustbin sensors and communicate with the MQTT broker, an ESP32 camera module to stream data to the network and capture the person. The Raspberry pi zero w microprocessor board acts like the MQTT broker and runs visual display tool of grafana by subscribing to the data of MQTT broker. Thus, an effective smart bin waste collection, monitoring and management system is developed. This system uses IoT, artificial intelligence and machine learning to implement the management system.

BLOCK DIAGRAM OF ESP32, CAMERA MODULE OV2640 AND CP2102

Fig: Block Diagram of ESP32,camera module OV2640 and CP2102

- This block diagram explains the connections between CP2102 – a USB to TTL serial converter that is used to supply power of 5volts to the ESP 32 module and it also helps in programming of the ESP32 cam module.
- The ESP32 camera module is connected to the camera OV2640 by a JTAG connector that is used to take pictures of quality 2 Mega pixels maximum.
- This camera captures the pictures of the person and sends it to ESP32 cam module to process it.

BLOCK DIAGRAM OF ESP32 AND SENSORS

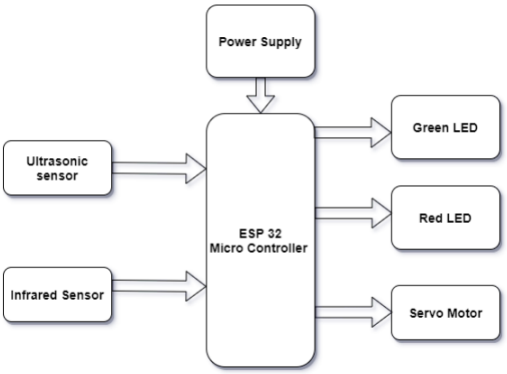

Fig: Block diagram of ESP32 with sensors of smart bin

• This block diagram describes the various sensors interfaced to the smart bin module.

• The USB cable supplies power to ESP32 module and also acts as a serial for loading of image into the module and also to print the logs.

• The Ultrasonic sensor is connected to the ESP32 to give the inputs of height of the bin.

• The InfraRed (IR) sensor detects a person and intimates the ESP32 module. The module then performs the required actions The servo motor is connected to the ESP32 to take instructions to open the lid of the dustbin and close it.

• The Red LED takes input from the ESP32 on when to indicate the status "DUSTBIN FULL".

• The Green LED similarly takes the input from ESP32 and indicates the status "NOT FULL" of the dustbin.

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• The ESP32 wirelessly relays all this information to the Raspberry Pi Module

BLOCK DIAGRAM OF SMART BINS FOR SMART WASTE MANAGEMENT SYSTEM

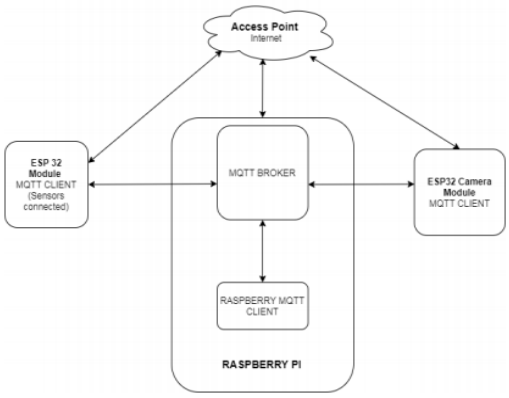

Fig: Block diagram of Smart Bins for Smart Waste Management

• This block diagram represents the connection of Raspberry Pi Zero W, ESP32 sensors module and ESP32 cam over Internet of Things.

• This is the block diagram of Smart Bins for Smart Waste Management.

• The modules are individually connected to a Access Point that connects them to the internet.

• The Access Point assigns each module a IP address and this helps them communicate with each other and share data.

• The MQTT protocol is implemented here with Raspberry Pi acting as MQTT broker while ESP32 sensor module, ESP32 cam and Raspberry Pi itself acting as MQTT clients.

• The Influxdb database runs on the Raspberry Pi and Grafana Visualization tool also runs on the Raspberry Pi.

• The Face Recognition algorithm also runs on the Raspberry Pi module.

• The ESP32 interfaces with sensors and publishes data accordingly while ESP32 cam stream live video.

• Thus, the system is connected.

IMPLEMENTATION

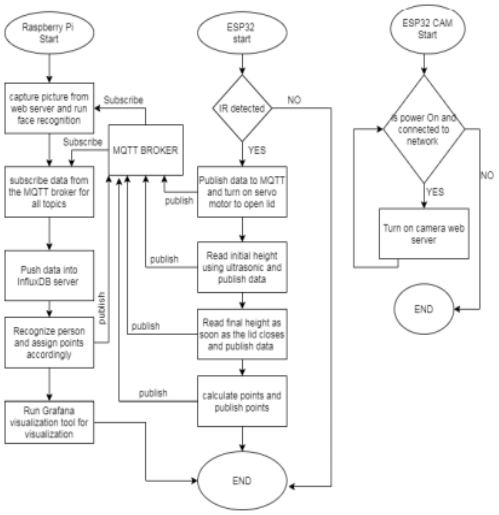

Fig: Smart Bins Flow Chart

The working of the Smart Bins for Smart Waste Management is as follows. The Smart Bin contains an ESP32 module with sensors and an ESP32 camera module. The

Raspberry Pi runs the MQTT broker for handling data from different MQTT clients and processes it. This data is visualized using Grafana tool.

• A person approaches the smart bin with waste. As the person gets close to the bin the IR sensor attached to the ESP32 detects him.

• Now, the ESP32 publishes the MQTT broker that a person is detected and then turns the servo motor ON.

• The ESP32 cam keeps the data live streaming on a IP address of the network.

• The MQTT Client of Raspberry Pi subscribes to the topic of IR sensor and on detection of person it captures the picture of person through the ESP32cam's web server stream.

• The Raspberry Pi runs face recognition on the picture captured by it by comparing it with its database.

• Meanwhile the ESP32 turns the servo motor ON and the ultrasonic sensor calculates the 'initial height' of the bin and publishes it to the MQTT broker.

• The person puts in the waste in the bin.

• The servo motor closes the lid and the amount of waste in the bin is calculated. The height calculated by ultrasonic sensor 'final height' of the bin and this is published to the MQTT broker.

• The "cleanliness points" are calculated by Cleanliness Points = Initial Height – Final Height.

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• These points are then published to the MQTT broker.
• The Raspberry Pi client meanwhile subscribes to all these topics and publishes them to the "Influx DB" database. This data is visualized by the "Grafana" visualization tool.
• The face recognition algorithm that has run on the pi recognizes the person and the
points are assigned to him. If the person is not recognized by the algorithm the points are assigned under the name of 'UNKNOWN'
• The 'Red LED' on ESP32 glows when the bin is full and "DUSTBIN IS FULL" message is published to broker. This is triggered when the height from the ultrasonic sensor is less than 5 cm.
• The 'Green LED' on ESP32 glows as long as the bin is not full.
• If a same person visits again to put the waste then the points get added to the already previous points he has got.
• The recycling agencies or the government can award the citizens based on the points achieved by them.
• This can also solve the problem of awarding waste collection workers based on the amount of waste they have collected.
• This way people are motivated to be responsible and put waste in the bin.
• The dustbin also can be continuously monitored by connecting to the network and opening the grafana tool.
• The dustbin live stream can also be monitored by opening a link in the grafana tool.
• The below image shows the kit implementation.

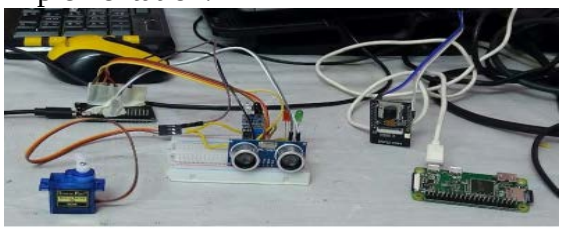

Fig: Prototype of Smart Bin for Smart Waste Management Kit

RESULTS

The below are the results of implementation of "A MQTT Protocol based smart bins for smart waste management system using IoT".

1.The first picture shows the smart bin kit that is interfaced to the dustbin along with Raspberry pi zero w board that acts as server.

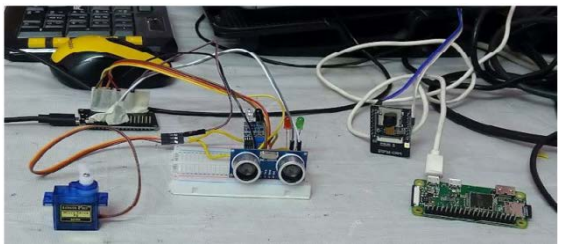

Fig: Smart Bin Kit

2.The second picture shows "Glowing Green LED" indicating the dustbin is not full.

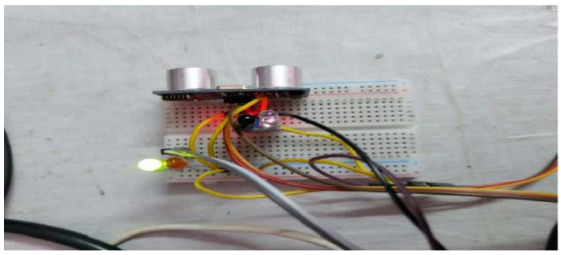

Fig: Glowing Green LED

3.The picture below shows "Glowing Red LED" indicating that the Dustbin is full. The green LED remains OFF. The serial log of arduino also tells the status that bin is full

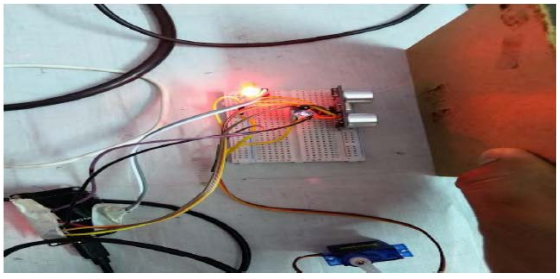

fig: Glowing RED LED

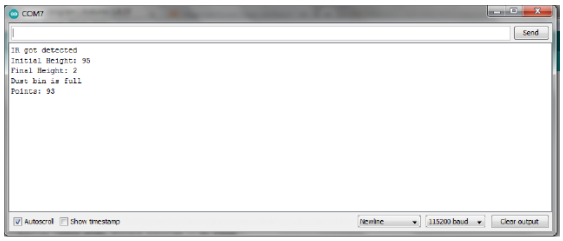

fig: Dust Bin is Full Log

4.The figures next show the details of Dust Bin in Arduino Serial and in Raspberry Pi MQTT Broker logs.

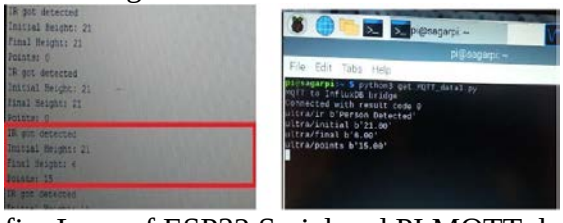

fig: Logs of ESP32 Serial and PI MQTT details

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5.The next pictures show the results of face recognition and points allocation.
6.The picture below shows the live stream of the person by ESP32 cam on an IP Address 192.168.43.71:81

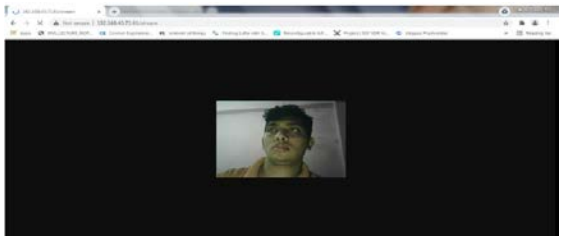

fig: Live stream of a person by ESP32 camera

6.The next picture below shows the picture in the database of Raspberry PI that is used as reference for recognition.

Fig: Picture saved in Database of Raspberry Pi

7.The next pictures show the output of face recognition algorithm. The data from this algorithm is published to MQTT server that assigns the points accordingly to him.
8.Then the Influx DB pushes these values into Database “Smart Bins” that is represented in “Grafana” dashboard.

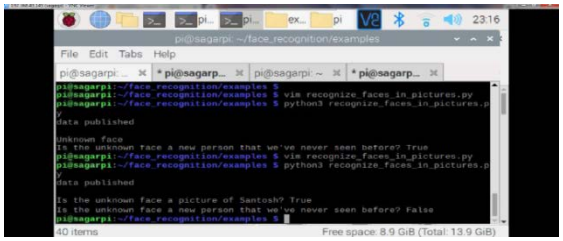

Fig: Face Recognition algorithm detecting “Santosh”

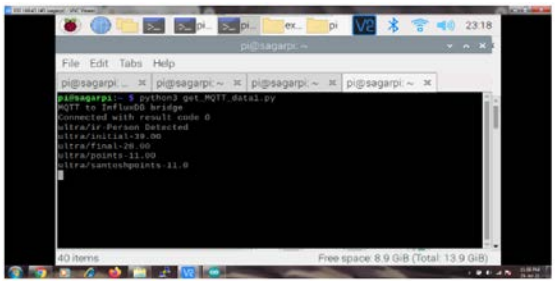

Fig: Points of “Santosh” being updated.

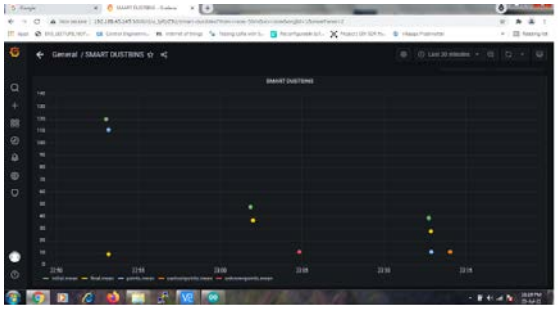

Fig: Points of “Santosh” being represented on Grafana.

9.It can be seen in the grafana tool that all the details like initial height of bin, final height of the bin, points are updated. The previous values are also shown.
10.The picture next shows how points are updated when the same person dumps waste again.

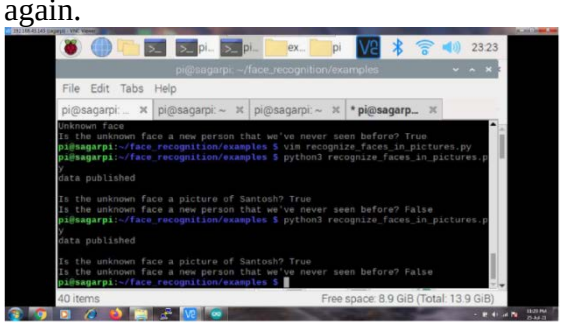

Fig: Face recognition software detecting same person again

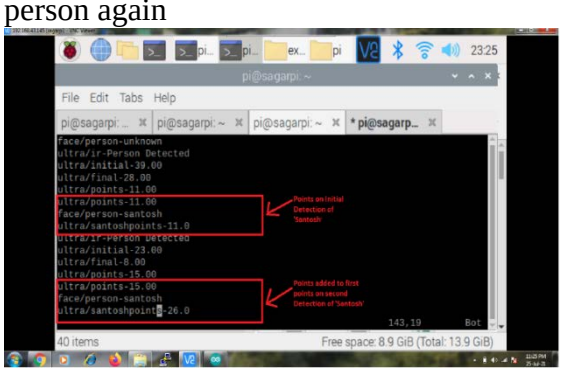

Fig: Points being summed up to initially obtained points of ‘Santosh’

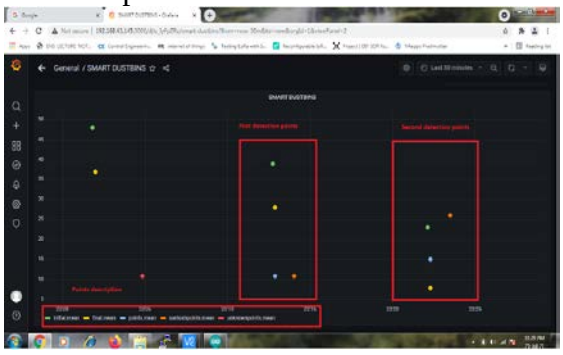

Fig: Visual Representation in Grafana Tool

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11.The next pictures show points assigned when waste is dumped by an “unknown person” i.e. a person whose picture is not in the database

Fig: Picture of “Unknown Person” captured by ESP32 camera

12.Detection by the Face Recognition algorithm that the person is “Unknown” to database.

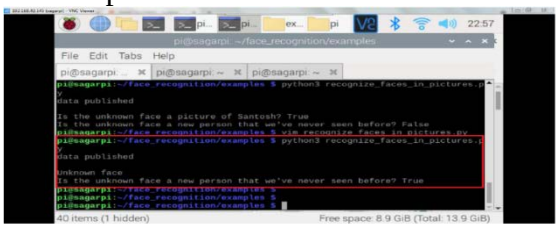

Fig: “Unknown” person face recognition output by the algorithm

13.The points obtained by the “Unknown” person by dumping waste into the bin.

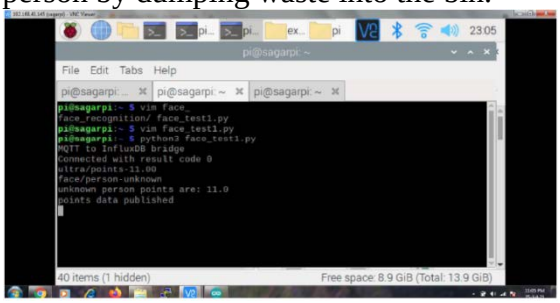

Fig: Points obtained by “Unknown” person

13.The points obtained by unknown person are reset to zero. They are not summed up to the previous values.

14.The below image shows the points obtained by “Unknown” person on grafana

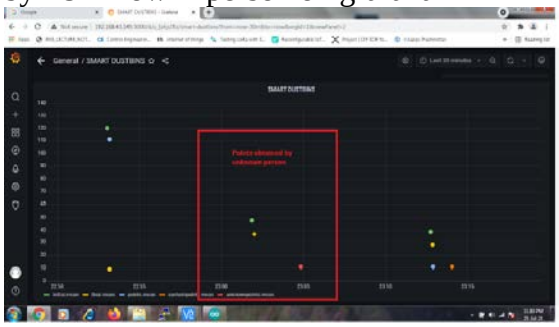

Fig: Points obtained by “Unknown” person on Grafana

Hence, these are the results of this project “A MQTT Protocol based smart bins for smart waste management using IoT”.

CONCLUSION: The IoT technology is spreading rapidly into the market. The use of it into all fields and domains has already begun. The use of this technology to develop smart bins offers an effective solution to the problem of ever-growing waste. The face recognition employed in this system to identify a person and assign points helps a lot in motivating people to work for the betterment of society. Many startups that are willing to recycle the waste may find this mechanism helpful as they can tune these bins accordingly to collect only required materials of a type and recycle them. They can also reward the person either in terms of money or other methods based on his points of “cleanliness”. This system can be scaled easily from a small colony to a huge city. Thus an efficient and effective mechanism to handle the solid waste at the point of generation is developed by this project

ADVANTAGES

• Better and effective management of waste.
• Continuous tracking of bins and people dumping the waste from anywhere.
• This system uses low cost and low power, sensors and microcontrollers.
• A motivating system of reward to dump waste properly in bins.
• The bins can easily be doubled up as security system or a security system can be effectively used to reward persons for dumping waste.
• Can be easily scaled from a small society to huge city.
• It provides a chance for generating money from this waste industry which is untapped.
• Helps a lot in contribution to the environment.

FUTURE SCOPE: This project can be further developed by using machine learning to identify the types of waste before dumping them into the bin by allowing camera to detect the items of waste bin. A segregation mechanism at the bin level can also be developed to recycle waste at the site itself. The companies looking to invest into this field may enhance the process of collection based on this system or reward and tracking. The bins are mostly in secluded areas so their cameras can be used to track any unusual movements. The dustbins can be further designed to segregate bio waste or edible food into a separate chamber that can be used as food for stray animals. Thus, by the use of IoT, Artificial Intelligence and Machine

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learning coupled with embedded systems can help us realize a better management system with more smarter bins.

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