A Survey on Garbage Classification and Monitoring Using IOT

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ABSTRACT

With rapid rise in human population there has been significant increase in waste produced across the world.This paper is a survey on the multiple methods that have been devised in different cities to combat the increasing waste produced.Burning,classifying of wastes are been implemented in a large scale across nations.Classifying the waste before treating them will be very useful and will save both money and the environment.Mainly wastes have to be classified as plastic and non-plastic since all forms of plastic are non-biodegradable and other wastes generally decompose quite easily.

This venture focusses on smart waste management, but not quite factory-specific and can be accessible in every house, thereby every day-to-day waste could be segregated. This smart bin uses Internet of Things (IoT) and segregation-specific sensors as a medium for separating the wastes. The Internet of Things (IoT) is a concept in which surrounding objects are connected through wired and wireless networks without user intervention. A discrete state control system is also implemented to prevent over dumping of waste in bins. Once the bins are full, an alert is sent to the local garbage collector requesting for garbage collection.

INTRODUCTION

Waste Management has become the hot debate of today's world. Of which, segregation is the primary concern, after which how it is disposed or trying to look at the possibilities or reusing them. We can achieve it possibly using IoT (Internet of Things). Today all the major issues are cleared in an instant using IoT, therefore it has come forth into more prominence and reliability. While this is by no means an easy task, technology has stepped in to help us make everyday city management operations more sustainable. As IoT's impact on the waste management industry increases, the future of recycling looks promising. IoT applications in waste management are effectively improving municipal operations. Predefined routes and outdated methods of waste collection are increasingly being replaced with sensor-enabled bins and sophisticated waste management applications.

As sensor technology advances, a whole array of everyday objects are being connected to the internet

(and to each other) to exchange information interactively.

Sensor-enabled and internet-connected garbage bins can collect information on fill level, temperature, location, or whatever data types the sensors gather and the sanitation department finds useful. With a user interface revealing the locations and fill levels of all bins, waste collectors can get an automated route planned for them that has prioritized areas in urgent need of cleanup and avoided disposal units that still have room. Not only are these bins optimizing fleet logistics operations and reducing fuel consumption, but they're also recording the number of times they're emptied and how fast they fill up. Such data, when combined with statistics from other smart city systems, can facilitate more insightful, multi-pronged actions, such as planning the better distribution of garbage bins, zeroing on problems (*e.g.* incorrect disposal practices), or reducing waste going to the landfill.

The next step for "digital bins" lies in automating the categorization of waste content, a task at which most people make mistakes. The Bins then compress the waste and notify sanitation workers of fill levels for each waste category. Intelligent categorization and segregation is an upcoming trend. A growing collection of interlinked autonomous systems are managing everyday urban operations and improving both citizen experiences and our carbon footprint.Wastes generally fall into 2 categories,Bio-degradable wastes-Examples are food waste,paper wastemanure,hospital waste.Bio-degradable wastes are defined as anything which is organic or can be broken down into CO2 and methane.The second category is Non bio-degradable wastes –Examples are plastics(PET,HDPE,PVC,PP,Styrofoam), glasses, metals, toxic chemicals, toxins and inorganic waste.Hence it is important to classify waste based upon whether it is degradable or not.Wastes generally tend to be both wet and dry and hence classification among the same is also necessary.

System Architecture of Smart Bin

It is illustrated as, when the waste item, is kept on the plate, the respective sensors identifies whether the waste is wet or dry, and if it is dry, it further slides over to its respective bin area of metallic dry waste or non-metallic dry waste accordingly. The wet waste is collected and left out. From which we could identify further as plastic wastes that falls into the bin. And it is collected for further usage after segregation is done.

LITERATURE SURVEY

Meher Madhu Dharmana et al [1]proposed to segregate plastic using a machine that works based on analysis of audio signals.MFCC feature extraction is used for audio signal analysis and FFT is used to convert each segment of the audio signal from time domain to frequency domain.Mel filter banks are used to estimate the energy existing in the various frequency regions and MFCC feature algorithm is used to process the audio signal and give it as an input to the Multilayer Neural Network(MNN).The number of hidden layers was increased to achieve greater efficiency. A mechanical system consisting of motor drive system,conveyer belt and audio sensor is implemented to classify the waste. MFCC feature extraction was done in a simulation software where the audio signal from different objects was trained and then inputs were vectorized as MFCC vector frames for plastics and non-plastics. Based on the classification,the waste is segregated.The vector quantized MFCC features along with the classification system gave an accuracy of 85%.The difficulty to train the large number of layers was the main issue here.

Shamin.N et al [2] proposes IoT based totally clever waste segregation and administration machine which assessments the wastes in the dustbins through the usage of Sensor systems and as soon as it detected the waste substances in it will be segregated with the assist of sensors and right away,utilization of Microcontroller as a mediator between the sensor devices and IoT system is done. Ultra-sonic sensor is used to detect the presence of the waste material. The moisture sensor's work is to detect the moisture in the waste, and if there is moisture presence then the waste cannot be put in the dustbin. Image processing is used to identify the plastics and degradable items and is separated to other sections.The features of the image which is been captured by the camera are extracted using the SURF (Speeded Up Robust Features) algorithm.The accuracy from this method was 99 percentage.

Wesley Pereira et al [3] proposed a smart bin that focuses on sanitation,waste identification,reusability,recycling and waste optimization. The usage of 2 capacitive plates for identifying the type of waste based on capacitive value which is expressed in picoFarad(pF). Apart from this, ultrasound sensors for the bin to open when a person approaches the dustbin to throw garbage thus making it hands-free and evidently more hygienic is used and for segregation of plastic Spectroscopy is used which is measured via IR sensor.The procedure was to project an IR light towards the waste. Based on the absorptivity of the plastic, it can be identified and segregated. The absorptivity cannot be measured directly hence Reflectivity and Transmitivityismeasured by knowing the Incident Radiation,Absorbed Radiation and Reflected Radiation.It was seen that the threshold value for wastes were around 6.532pF and wet waste like banana peel had a significant reading of

25430pF while dry wastes like paper, cloth and pens ranged from 7.2 to 7.6 pF.

Nimisha S Gupta et al [4]proposed the use of a discrete state control system to prevent over dumping of waste in bins and to separate wastes automatically through conveyor belts. capacitive sensors which uses dielectric constant values for segregation of dry and wet wastes and apart from segregation they also added that monitoring of wastes is done via IOT module,IR sensor is also fixed at the end section of main conveyor for the purpose of waste arrival detection, it causes the segregation bin to rotate in 120° according to the program. With the help of IOT the amount of waste that falls on dry metal and wet categories are obtained.Banana peel, wet cloth, lemon, etc. is detected as wet waste. Keys, tin lid, aluminiumsheet pieces, etc. are detected as metallic waste. If a metal waste is detected it falls upon metal bin. If a wet waste is detected it falls upon wet bin and if the dry waste is detected it falls upon dry bin.

Rajkamal R et al [5] proposed the automation of segregation at source level with constraints that wet waste should be wrapped in paper and dropped, Dry waste should be dropped individually or wrapped in paper or plastics. For the purpose of segregation usage of capacitive based moisture sensor, inductive based metal sensor, methane sensor and odor sensor is done. Here the controller takes the decision based on dielectric constant reading. For glass it is observed to be 3.8. Thus based on the comparative analysis from the various sensor readings, the controller determines the category of waste. Instead of catering to an entire city, this system is initially proposed for apartments, colleges and schools where there is considerable quantity of waste generated. The GREENBIN has the following constraints: Dry waste and wet waste should not be mixed.Wet waste should be wrapped in paper and dropped.Dry waste should be dropped individually or wrapped in paper or plastics. This system can be implemented as a part of networked system to enable automated waste collection and Functional Flowmonitoring system is used forindividual households. Also the data from these households can be utilized for government schemes and policies. GREENBIN is such kind of waste management solution that aids in segregation of waste at source so that the individual components of waste can be identified early

Santhosh Kumar B R et al [6] proposed a effective and efficient methods of waste collection and segregation at domestic level based on their nature of composition i.e. metal, plastic and biodegradable.A microcontroller based embedded system was designed, which uses DC motor for conveyor belt and segregates wastes into three categories metal, dry and wet waste using simple techniques.This method proposes the use of sensors for segregation of waste and A recyclebot was designed which uses image processing technique to distinguish waste into recyclable and non-recyclable material. .The system has to be trained well to get efficient results. Hence if the system isn't

trained well before put into use its efficiency of working is very less. The speciality is that each segment of the dustbin can be detached separately in order to dispose the trash in an accomplished manner, so that the segregated waste can be recycled and utilized. Apart from this level detecting sensors monitor the level of wastes collected in each segment and continuously compare the values specified in the cloud and when it reaches a particular level, user receives an message as that particular segment is filled.

Ravi Kishore Kodali et al[7] proposes various type of classification and management of waste for effective solid waste management.Waste is classified into recyclable,compost,hazardous,landfill and methods have been given to manage the same in an eco-friendly manner.Various sensors such as ultrasonic sensor,moisture sensor and motion detection sensor coupled with GPS/RFID/GPRS technologies can be used to effectively manage waster in an smart manner.An integrated solid waste management like 3R is used to minimize and process the waste.Based on type of waste,they are sent to different processes like composting,landfill,recycling etc.Motion detection sensor is used for opening and closing of bin lid automatically so that user hygiene is maintained.

WisdomGenP.Dumpayan et al [8] proposed to solve increasing waste problem in Manila,Philippines by creating a vending machine that runs based on solar power.User should drop in waste bottles and in turn will be given credit points which can be used to purchase other products.Capacitive and Photoelectric sensor work in tandem to detect bottles(both PET and other types).An 100% accuracy was shown in input sensing and points adding and also machine charging.Full accuracy was also shown in RFID card recognition.The average over 5 trails for the bottle acceptance and dispersing process was found to be 45.38 sec average charging and discharge time was found to be 7.5 hours and 21.8 hours respectively.

Mohammed Rafeeq et al [9] proposed to segregate materials such as metals, plastic bottles, glass and bottles via different sensors suited for different purposes for level detection infrared sensors are used to indicate the bins are full.Waste is pushed onto conveyer belt, the presence of waste is first identified by use of Infra-red sensor at start end of the conveyor belt, the waste moves further for detection with inductive sensor to detect it is metal or nonmetal. If it is detected metal, conveyor motor rotates to in a direction to collect the metallic waste, for nonmetal it moves further with capacitive detection of plastic or glass. With detection of plastic it rotates in other direction or moved by pivot to collect in other bin. The system classified metals correctly for 90% input, glass for 93% and plastic almost 98% of the time.

L.MadanKumar et al[10] proposed to classify various types of plastics using Near-InfraRed Spectroscopy and Multivariate Analysis.They used Spectral Angle Mapping(SAM) for pattern recognition and NIR spectrometer for finding the spectral range of sample.NIR spectrometer works based on vibration of molecules using the harmonic oscillator model.MVA methodologies like Outlier

Detection, Baseline correction, Scatter correction and pattern recognition are used to classify the input objects. Once the type of plastic is determined using Spectral Angle Mapping. Air jet nozzles were used to send the sample into the correct collection bin.Computation was done with Raspberry Pi with code written in Python.They were able to classify plastics with high range of accuracy ranging from 95%(for PP and PVC) to 100% (for PET,HDPE,PS) for input samples around 300 to 400 for each type of plastic.

TITLE	AUTHORS	TECHNIQUES	RESULT	ISSUES
Plastic Segregation Using Audio Signal Analysis	Meher Madhu Dharmana, L.N.Usha Mahathi, Abhinav Indarapu, B.Hari Mohan Reddy	MFCC Feature Algorithm and Multilayer Neural Network	A mechanical system consisting of motor drive system,conveyer belt and audio sensor is implemented to classify the waste with the help of MFCC feature extraction. The vector quantized MFCC features along with the classification system gave an accuracy of 85%.	Difficult to train large number of layers
Smart Garbage Segregation & Management using Internet of Things(IoT) & Machine Learning(ML)	Shamin.N, P.Mohamed Fathimal, Raghavendran.R , Kamalesh Prakash	SURF(Speeded Up Robust Features) Algorithm	The features of the image which is been captured by the camera are extracted using the SURF (Speeded Up Robust Features) algorithm and the accuracy produced by thus method is about 99 %	Image should be captured in good light,Waste material may not be in dataset.
Smart Bin(WasteSegregation and Optimisation)	Wesley Pereira, Saurabh Parulekar, Sopan Phaltankar, Vijaya Kamble	Capacitive **plates** with IR,Ultrasonic sensors	Based on the absorptivity of the material which is measured in picofarad (pF), identification and segregation is implemented.	System fails if sensors give incorrect data
Automatic Waste Segregation	Nimisha S Gupta, Deepthi V, Mayakunnath, Rejeth Pal S, Badsha T S, Nikhil Binoy C	PIC Controller with IR Sensor	A discrete state control system to prevent over dumping of waste in bins With the help of IOT module and to separate wastes automatically through conveyor belts embedded with sensors	Waste not classified as biodegradable and non - biodegradable
Waste Segregation at Source Level For Effective Generation of Electricity GREENBIN	Rajkamal R, Anitha V, Gomathi Nayaki P, Ramya K, Kayalvizhi E	Capacitive based moisture sensor,inductive based metal sensor,methane and odor sensor	Green bin that aids in segregation of waste at source so that the individual components of waste can be identified early	Constraints on input such as dry waste should be wrapped in paper or plastic
Eco-friendly IOT based waste	Santhosh Kumar B R, Rohit K,	STM-32 microcontroller with various sensors	Microcontroller based embedded system was	System fails if sensors

segregation and management	Varalakshmi N, Manjunath, Soundarya S Lokeshwari, Sahana D N	such as Level Detection,Odor,Moisture Sensor	designed, which uses DC motor for conveyor belt and segregates wastes into three categories: metal, dry and wet waste based on their nature of composition	give incorrect data
Smart Solid Waste Management	Ravi Kishore Kodali, Venkata Sundeep Kumar Gorantla	Sensors combined with GPS/RFID/GPRS technologies	An integrated solid waste management is used to minimize and process the waste.Based on type of waste,they are sent to different processes like composting,landfill,recycling .For the purpose of maintaining hygienea motion detection sensor is used that opens and closes the bin lid automatically	No system has been created and hence no data is available
Two-way powered microcontroller-based plastic bottles 'drop-and-tap' reverse vending machine with stored value system using radio frequency identification (RFID) scanner technology	Wisdom Gen P.Dumpayan, Matthew Lawrence M.DeMesa, Nathalie Danielle F.Yucor, Eden T.Gabion, Jacqueline D. Reynoso, Gabriel Rodnei M. Geslani	Solar powered vending machine using RFID	A vending machine embedded with capacitive and Photoelectric sensor working tandem to detect bottles(PET and other types). An 100% accuracy is achieved	Occupies large space,users need to have card before hand
Automation of Plastic, Metal and Glass Waste Materials Segregation using Arduino in Scrap Industry	Mohammed Rafeeq, Ateequrahman, Sanjar Alam, Mikdad	Arduino Controller with various sensors like IR,Capacitive and Inductive Sensors	Arduino Controller system that segregate materials such as metals, plastic bottles, glass and bottles after the input from different sensors. With an accuracy of 90%for metals , 93% for glass and 98% for plastic	Accuracy is less (false detection is high), no image processing tchniques to improve the same

CONCLUSION AND FUTURE WORK

Smart waste management is very much a cause of concern considering the ever-increasing population in today's world. Classifying them into dry and wet wastes and then further segregating dry waste into plastic and non-plastic is becoming the need of the hour. Awareness among people for plastic disposal can also be taken up in the future. Also, the system can be made to work using eco-friendly power. The system takes input only that are completely dry or wet and then classifies them.Future work can be based on accepting semi-solid wastes and also multiple wastes at a same time for faster processing.

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