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AUTOMATED WASTE SEGREGATION:
PREREQUISITE FOR ECOLOGICAL FUTURE

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Abstract:

The purpose of this paper is to address high priority issue which is waste management. According to information published by world bank in 2018, Global waste will grow by 70% by 2050 unless strict and necessary action is taken. Mismanagement of waste is anticipated to detrimental to humans and local environment. While adding to the climate challenges resources needs to be used and then reused continuously so that they don't end up in landfills. When waste is segregated at primary level, the economic value will be realized at its best segregation of waste storage or waste disposal facilities, it is prolonged and intricate process which makes recycling inefficient. This paper explains variety of process which has been implemented in order to separate waste primarily in houses malls, public transportations etc. Making entire waste management process efficient.

Keywords-Waste Management, Climate challenges, Reuse, Primary level, Recycle.

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I. INTRODUCTION

One of the global problems that affect everyone and all living things is garbage. The world's population is anticipated to reach 8.5 billion by next decade. The rise in population will increase the amount of solid waste generated and is expected to increase by at least 169%. Due to rapid industrialization and urbanization causes an extraordinary increase in the origination of unwanted waste. From the beginning of the human civilization, people used various methods of waste disposal to get rid of unwanted material. Sometimes it was buried in the land, thrown in the sea. Getting rid of unwanted material is always a major concern for the modern society. Trash has played a tremendous role in history. The Bubonic Plague, cholera and typhoid fever, to mention a few, were diseases that altered the populations of Europe. They were preserved by filth that accommodated rats, and contaminated water supply. When wastes are not properly managed then it may cause serious hazard. Urban India generates 62 million tonnage of waste annually, out of which 43 million tonnage of municipal solid waste is collected, out of which 31 million dumped in landfills and just 11.9 million is treated. It has become matter of big concern if proper disposal system is not applied. Managing waste effectively and recycling efficiently, a nation can ahead one step forward. To achieve these goals, various methods like re-using, reducing, recycling, recovery,

treatment, and proper waste disposal are enacted, among other solid waste management practices. Proper segregation at source is the initial step with these methods. This is implemented to improve the volume of waste recycled and treated. With so much concern recently about being greener and economically friendly, waste management has become a very important topic. People and companies have started realizing that the things they use and the way they dispose of them can make a big impact on our world. That is why a waste sorting system is designed which can be used in houses, offices, industries as a part of smart waste management system. In this system Segregation of solid waste is done using sensors to distinguish wastes such as metals, glass, and wet waste as an object passes through its range.

What is Automated waste segregation?

An automated waste segregating system that will be able to classify the type of waste using a computer vision model and/or material sensors. The system will be able to mechanically segregate their respective waste receptacle, and will enable users to monitor and interact with data gathered. The classifications used in this system include metals, dry and wet waste etc.

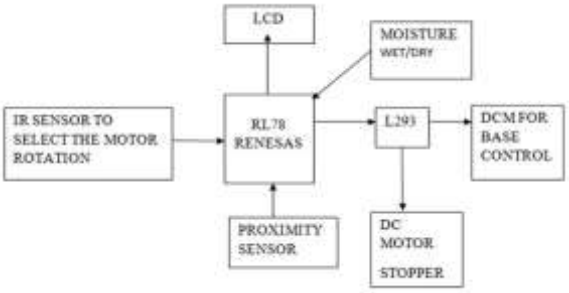
Since beginning of this century, waste segregation has been prime topic of discussion amongst all the environmentalist globally. This has emanated numerous automation techniques for waste management. In this paper we will be reviewing few important methods such as Automated waste segregator using microcontroller, which also uses Resistive sensing module, waste segregation using optical and material sensors with user communication capabilities, IOT based waste collection using IR sensor and waste segregation using proximity and humidity sensor, spot garbage. The main purpose of this study is to assess existing research presented studies around globe. This will enable to detect flaws, an algorithm used and method of those cited studies. This will also ascertain the most efficient methods to be used in future studies.

II. EXISTING STUDIES

To better understand the different studies published in paper and to be able to determine as to what kind of algorithm is to be used best the following are the different studies using different algorithms and studies where it applies. It also has the strength and weaknesses which can be used in deciding as to which algorithm is the right one. There are many systems that can separate waste into different categories. In this paper we have reviewed few of them, They are as following:

1. **Automated Waste Segregation using Microcontroller**:

The main purpose of this method is to design and develop a sorting system that sorts the waste automatically into three categories mainly metals, wet, and dry waste. The system mainly consists of Microcontroller, inductive proximity sensor, resistive plates, IR sensors and servo motors.



Waste is pushed through a flap into the inclined plane having the inductive proximity sensor. When the waste is dumped, the object slides over the incline to roll over the inductance coil which is used to sense any metal object. If the object is metallic a change in parallel resonant impedance of the metal detection system is detected. The object flow continues and it drops into the resistive sensing module. An IR and photodiode combination is placed here to check the presence of waste and when waste falls between resistive plates, a change in IR value is detected. That

change is used as the threshold to start the calibrations. Here, a decision is made if the waste is wet or dry based on its relative permittivity. After the identification of waste, a circular base which holds containers for dry, wet and metallic waste is rotated. The collapsible flap is lowered once the container corresponding to the type of garbage is positioned under it. The waste falls into the container and the flap is brought to its initial position. The waste in the containers now can be collected separately and sent for further processing.

ADVANTAGES:

- It can be successfully implemented at domestic level for segregation of waste into metallic, dry and wet waste.
- It is affordable as well as easy to use.

LIMITATIONS:

- The system can segregate only one type of waste at a time with an assigned priority for metal, wet and dry waste.
- Other objects like glass and wood have intermediate relative dielectric constant and thus are detected as dry waste so they cannot be separated.

RESULT:

Classification	***Accuracy***	***Time (seconds)***
Metal	1.00	5.13 ± 0.30
Dry	0.82	7.33 ± 0.51
Wet	0.93	6.94 ± 0.39
OVERALL	0.91	6.46 ± 0.47

The project has been tested for different categories of waste namely wet, dry and metal. Wet waste means organic wastes such as vegetable peel, garden wastes etc, dry waste includes paper wastes, plastic bottles etc, and metallic waste include safety pins, foil paper etc.

2. **Waste Segregation using Optical and Material Sensors**:

When waste is thrown into the receptacle, the IR proximity sensor module gets activated and in turn activates the camera and inductive sensor. The object slides down an inclined path and falls onto a flap where the inductive sensor and camera are used to classify the waste into one of the four classifications: metal, paper, plastic and other trash. Once a classification is made, data on the type of waste, time, and date of when the waste was thrown is sent to the database. Waste is dropped and segregated into its corresponding receptacles below via three servo motors. The first servo motor is used to drop the waste from the sensing area while the remaining two servo motors are used to move the waste into one of four receptacles at the bottom third of the receptacle. Once the waste has been segregated, sensor is used to measure the level of the trash in each receptacle

ADVANTAGES:

- Automated waste segregation system can successfully segregate waste at source.
- This system can be easily produced again because multiple waste bins will be able to use the same model that was trained.

LIMITAIONS:

- for the system to be accurate, the dataset needs to be quite large and continuously updated
- It can only segregate one object at a time and its accuracy can be improved.

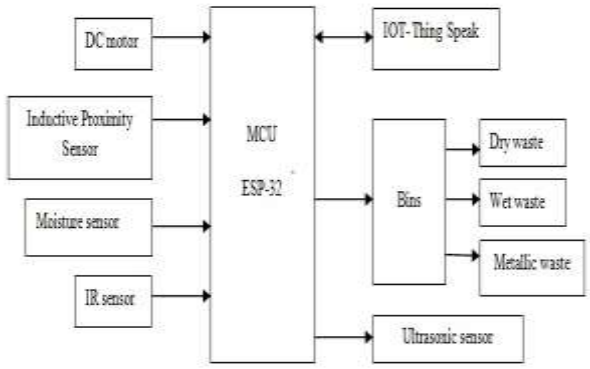
RESULT:

The model was tested with the system, throwing waste in the enclosure in random positions. Out of 100 tests, the system with the trained model achieved 89% accuracy overall. Individually, the class that was most accurate was metals with 100% accuracy.

Classification	*Accuracy*	*Time (seconds)*
Metal	1.00	8.13 ± 0.47
Paper	0.80	8.10 ± 0.41
Plastic	0.92	8.33 ± 0.51
Other Trash	0.84	7.94 ± 0.39
OVERALL	0.89	8.12 ± 0.47

3. IOT based waste collection using IR sensor:

The segregation model is designed to segregate dry, wet, plastic and waste water into their respective bins. It is an efficient and hygienic waste segregation and disposal system which helps in optimization of waste but an expensive system and consumes more space for household level. Therefore, designing of a cheaper and less space consumption system was done which gives accurate results and also checks the level of bins using IOT and cloud computing which displays the result on the LCD and notify the user with an email on their devices.



IR sensor senses whether the waste bin is filled or not. If the bin is filled, then the IR sensor gives information to the microcontroller. Then according to the coded program in the microcontroller, after a delay of 5 seconds servo motor rotates the waste bin in 120° and hence allows the wastes to fall onto the sub-conveyor. It starts to roll. Now the wastes are falling onto the main conveyor. Based on the time delay given in the microcontroller program, after some delay main conveyor starts to roll while sub conveyor stops working.

Waste is falling upon the segregation bin, where metallic, dry and wet sensors are placed. Metallic inductive proximity, moisture sensors are fixed and connected in the segregation bin. 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. Three Different collecting bins are connected upon the servo motor. The servo motor rotates in clockwise or counter-clockwise directions based on the type of waste and waste falls on to the particular waste collecting bin. Namely metal, wet, dry waste bins are placed. If a metal waste is detected it falls upon metal bin, if a wet waste is detected it falls upon wet bin else it falls upon dry bin.

ADVANTAGES:

- Dustbin levels can be monitored through smartphones using IOT.
- The entire procedure is maintained by implementing and utilizing GSM and GPS based on IOT.

LIMITATIONS:

- It works only for one kind of waste at a time.
- The System is unable to segregate plastics, glass, wood or toxic materials.

RESULT:

Based on some experiments paper, dry cloth, wood pieces, plastic wastes, cardboard pieces etc. are detected as dry waste. Banana peel, wet cloth, lemon, etc. are detected as wet waste. Keys, tin lid, aluminium sheet pieces, etc. are detected as metallic waste. IOT helped to count and monitor the type of waste and its quantity also uses think speak IOT to notify the 2 levels of bins as either empty or full using LAN Wi-Fi from ESP-32 to the connected mobile over cloud storage.

4. Spot Garbage

Spot garbage Is a smartphone-based application. It detects a pile of garbage and identifies the location where the garbage is present by using the location access of smartphones. The app uses the convolutional neural networks architecture for detecting wastes in images. A convolutional neural network is a class of deep neural networks, most commonly applied to analysing visual imagery. They are also known as shift invariant or space invariant artificial neural networks

ADVANTAGES:

- It can spot any type of garbage depending on image dataset.
- It uses deep learning algorithms.

LIMITATIONS:

- Sometimes garbage detection fails due to insufficient images data.
- When there is a similar garbage, it can misclassify the garbage or sometimes lose the distinct attributes when afar.

RESULT:

It relies on smartphone. The created app uses convolutional neural network architecture in identifying wastes which makes the study become more accurate and strong.

III. FUTURE SCOPE:

Wet waste can be further segregated into biodegradable and non-biodegradable. Metals can be specifically segregated using more variety of sensors. There should be easy availability of these systems in villages, hospitals, industries etc. Different types of waste segregator machines should be design for hospitals, pharmaceutical industries etc. Real time monitoring and controlling of waste management by using IOT should be easily accessible for controller. System should be modified to process more than one waste at a time. There should be a Prediction system that will analyse data for amount of waste generated in future and time taken for its management.

IV. CONCLUSION:

Waste management is finally getting the recognition it deserved. Governments are finally considering waste disposal and management as serious issue to be resolved. Multiple algorithms and methods of useful waste management and disposal have already been studied by many researchers. Many developments are taking place in this decade. more and more IOT based waste management projects are financed by numerous companies from different industries and countries.

But a crucial issue of these devices is its inability to separate multiple waste at a time. They aim to classify an only single object, in real-world scenario, it is very difficult to separate individual objects from a garbage pile and then classify them as the amount of garbage present will be in the magnitude of millions of tons and it will be very time consuming. Systems working on optical sensing needs more and more image dataset to be flexible enough for use in most efficient manner possible. The devices which are using sensors have constraints because of limited range of sensors.

Since the past decade, there is a huge increase in the use of electronic gadgets, which can be attributed to the explosive growth in computer and technology. The average life of an electronic gadget like a smartphone is around 2 years. In the next few decades, the number of electronic wastes generated will increase drastically. It will be very difficult to recycle these components as each part are made of made of different materials and each of these materials has to be recycled in different ways, therefore an efficient method to recycle electronic gadgets and their spare parts is needed. With this, a study to conduct new wastes segregation is a must.

The material and equipment which will be used for fabrication should have minimal cost possible, so that final appliance would be cost-efficient and affordable.

V. ACKNOWLEDGEMENT:

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