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Automatic Waste Segregator Using Image Classification

Sonali Preetha Nandagopalan, Silpa S, Prakriti Sharma K P
ISE Department, NHCE, Bangalore, Karnataka, India

ABSTRACT

Negligent and improper waste segregation has led to a lot of environmental issues like global warming and we and the upcoming generations are the victims to it. Improper segregation causes production of waste that cannot be reutilized which makes itself hazardous as the dumping of plastic. Hence Waste Segregation is of utmost necessity. A fully automated waste segregation system would be beneficial as it would enable us to implement a fully sealed garbage sorting space, so the chances of pollution of garbage reduces. As it is automated, the odour problem from waste can be handled. It would also mean that the workers' health in the waste management industry would be prone to lesser risks. Final products procured from the waste segregation process can be refined into useful resources or disposed without generation of any pollutant. This paper proposes an "Automatic Waste Segregator" (AWS) which can be used by organizations handling large number of people and hence dealing with a lot of day to day waste. The waste classifier is built using an Image Classification Algorithm, trained and tested on the Waste images dataset. The classifier segregates the waste into three categories namely, dry, wet and plastic waste. The classifier is then deployed on a Raspberry Pi board. The trash will be thrown into a dustbin which is internally divided into three bins. All three bins are covered by plates which form the common base where connected to it) will then detect the type of waste and the corresponding plate opens and the trash falls into the right bin. The AWS is connected to a network hence security is of utmost importance. We propose multi factor authentication to access any data or IOT device related to the AWS. In this paper we also deal with next generation firewall for protection of the network the project works on and also ensuring hardware outage doesn't result in insecure state of IOT device.

Keywords : Automatic waste segregator, Waste Management, Raspberry PI, Image Classification, Camera, IOT Security.

I. INTRODUCTION

Generating waste is as normal as breathing or bathing. It is a part of the drill. All the problems arise when this waste is not disposed or segregated properly. It can cause economic, environmental and health issues in multiple ways. Each kind of waste, after segregation is disposed in a different way. Waste can be recycled, used in landfills or even incinerated.

When waste is not segregated properly, it can contaminate soil and water bodies. When soil is contaminated: land fertility reduces, which leads to lesser produce and so more people go hungry to bed in the end. When water bodies get contaminated: the water quality reduces, marine/river life gets effected and as a result all the animals and human beings that sustain on food from the water bodies, suffer. Water contamination also leads to formation of pathogens like Cholera and Dysentery that were labelled as epidemic, once upon their time. When the wrong

kind of waste is used in landfills or incinerated, more greenhouse gasses are produced which leads to atmospheric pollution.

People who live near such waste dumping yards, or work in waste management are deeply affected by it. They are prone to infections and blood diseases. Over the years, improper waste management has been the even cause death.

Moreover, recent studies prove that often governments have to spend a lot of money (definitely more than the amount spent on waste management) to counter the threat and effects of improper waste segregation.

This is why accurate waste segregation is very important. It saves nature on a whole from getting in harm's way. It also saves us humans from a lot of vulnerabilities and definitely gives us a prettier version of the earth, to live in.

Now, the waste segregation is at the individual's discretion. Every individual is supposed to segregate the waste into dry, wet and plastic; and dispose it on days assigned to that particular type of waste. This system of waste management has rules and fines to ensure its implementation. The large organizations are the ones who fall prey to this system. Nobody takes responsibility for that, causing utmost of financial loss to the organization. Even at an individual level, urgent engagements and practically any other activity holds more importance that segregating waste in our society. Since all has been tried and tested, with not much output, we intend to make the entire segregation process automatic and real time.

II. RELATED WORK

The works related to our projects are as stated below:

A. Automated Recycling System Using Computer Vision - Desi Tomaselli (ECE-498: Capstone Design Project) [4]:

The author has designed a segregation system which comprises of an IR proximity sensor, a motor, 4 containers (glass, metal, paper, plastic) and the classification system used is KNN (k- nearest neighbor) algorithm deployed on a Raspberry Pi 3 Model B. Once the object enters the system, the classifier system classifies the object held in the waiting compartment. The images taken from the camera, are fed into the model and are classified (into glass, paper, metal, plastic) based moves in a certain direction depending on the classification done and the object falls into the respective container.

B. Trash Classifier using Image Processing [20]:

The author has used a conveyer belt, magnets, bins, raspberry pi processor for the waste segregation process. Raw garbage is loaded on the conveyer belt. In the initial stage, the magnet grabs all the metallic scraps and puts them in a separate bin. Next the garbage is queued in order to restrict the amount of trash entering the image acquisition module. The Raspberry Pi processor gets the image captured by the camera in image processing and acquisition module. The image is then sent to the unit which trained using an algorithm. The classification data is then sent back to Raspberry Pi, which guides the conveyor flap to tilt and direct the garbage into the respective bins (organic wastes, papers, plastics, and non-magnetic metals).

C. Intelligent Garbage Classifier [2]:

The author has built a system that possibly can visually classify and segregate different types of waste in an effective manner using various latest technologies like computer vision, robot control and others.

D. Intelligent Waste Separator [3]:

The author has designed a system which can segregate inorganic and other kinds of waste. The topics of main significance are image processing, computer vision, machine learning, pattern recognition, embedded systems, and circuit design. Although this system doesn't resolve the trash issue, it gives a solution for simplifying the waste segregation process and also reinforcing environmental culture.

E. Classification of Trash for Waste Classification Data

The author devised a classification scheme where trash could be classified into various categories using machine learning and computer vision algorithms. The report showed that in order to create a more accurate system, there is a requirement for a large and continuously growing dataset.

III. METHODOLOGY

A. Proposed system:

The proposed solution is an Automatic Waste Segregator, "The Autowastagator". The Automatic Waste Segregator will be built using an Image Classification model using the ResNet algorithm. The model will be built on a Waste Images Dataset procured from different resources in order to increase the accuracy and efficiency of the model. The following table comprises of the resources from which the data is collected and the three categories they are divided into:

Table 1: Dataset Collection

SL.NO.	CATEGORY	RESOURCES
1.	Wet	The train and test dataset of the Organic data of Kaggle Waste Classification Data, Google Images, other Images from the internet
2.	Dry	The train and test dataset of the Recyclable data of Kaggle Waste Classification Data (non-plastic component), train and test dataset of Gary Thung and Mindy Yang's waste dataset (cardboard, glass, metal, paper and trash components), Google Images, other Images from the internet
3.	Plastic	The train and test dataset of the Recyclable data of Kaggle (plastic component), train and test dataset of Gary Thung and Mindy Yang's waste dataset (plastic component), Google Images, other Images from the Internet

The data collected is then trained and tested and a model is created. The input to the model will be a video input where the video comprises of trash being thrown. As already mentioned as the target audience will be members of an organization, there is a high probability only one trash is thrown at a time which is then recorded by a webcam and then the waste category classification is done. At the end of the process a report is generated comprising of the details of the number of images (obtained from video stream) of each category of waste disposed.

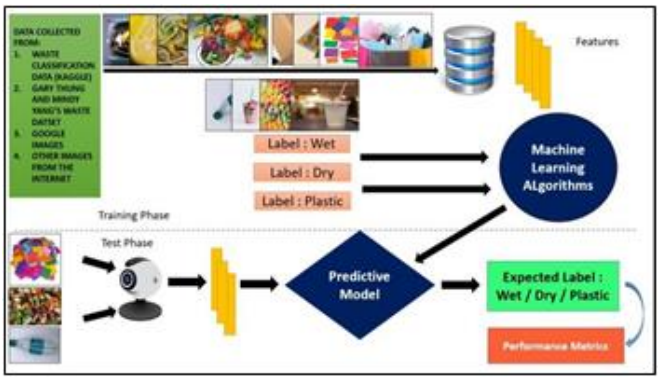

Figure 1: Architecture of Algorithm

Figure 2: Project Flow

Proposed System:

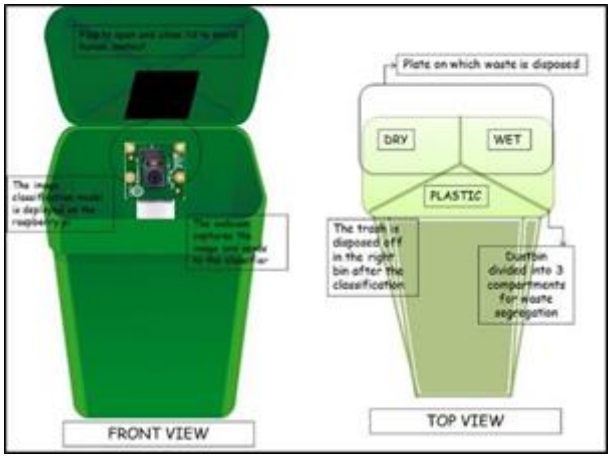

Figure 3: Proposed Design of Dustbin

The real-life implementation of the proposed system could include the classifier being deployed on a Raspberry Pi board. The dustbin is internally divided into three bins. All three bins are covered by plates which form the common base where the trash falls. The Raspberry Pi (with the camera connected to it) will then detect the category of waste thrown and the corresponding plate opens and the trash falls into the right bin

C. Multi Factor Authentication

Over the last few years Multi-factor authentication has gained a lot of traction. Other thanks the traditional password authentication there are six other different types of methods of application namely, retina scans, security tokens, fingerprint recognition, voice recognition, facial recognition and gesture-based authentication. This paper will also focus on how the combination of these authentication factors can be utilized to secure access to smart things.

The table 1 provides an overall view of the various authentication mechanisms. It also includes usability which depends on four factors namely, Speed, efficiency, learnability and memorability. Each authentication factor will be categorized based on the four factors. From a user's perspective, the speed and efficiency of facial recognition is medium and the learnability and memorability is categorized as easy. These values are assigned considering that the fact that the user doesn't have to remember any text in order to authenticate himself but the facial recognition system takes time to recognize and sometimes falters owing to next factor, password or pin authentication, this authentication takes place faster as the system would recognize them faster as it is already present in the database but the user will have to remember the same. As there are a number of restrictions imposed on password creation memorability factor further aggravates due to inability of many users to remember them over a time period. Thus, in conclusion the speed is categorized as fast and efficiency is termed as good but learnability and memorability are categorized as medium.

Moving onto fingerprint recognition, this form of authentication is found to be leading in all the usability factors owing to the facts that the user doesn't have to remember anything as well as the system can easily recognize the user with utmost speed and efficiency. Let us now take into consideration gesture recognition. The efficiency of the authentication process will be on the higher end. Both the system has to be configured and the user will have to learn the gesture and remember it for a certain time period. Thus, fingerprint recognition and gesture recognition are categorized as medium. Location based authentication comprises of a combination of multiple forms of authentication, that is, fingerprint and facial recognition. This is because the user first needs to be provided authenticated access to enter and then further location details are accessed to verify the identity of the user. Thus, taking into consideration all factors location-based authentication is termed as medium. Thus, as we have arrived at some reasonable conclusion with respect to these authentication factors, utilizing the measurements of speed, efficiency, learnability and memorability we can combine different factors of authentication to secure the IoT network of the AWS.

Table 2: Analysis of Authentication Methods

D. Next Generation Firewall

The matching criteria is based on execution of regular expression against IP packet headers in the currently used firewalls. From the monitored traffic, the network IDS and IPS have capability to extract insights. With the utilization of next-generation firewall, the advance machine learning techniques can be used to analyse packets and build predictive models which can be used to predict abnormal behaviours of unforeseen traffic. This technology can be designed to be a plug-in IDS/IPS. Enhancement and dynamic updating of firewall rules can be done using this system.

IV. RESULTS

The accuracy of the classification system has been improved by addition of dataset. The proposed solution is expected to have an accuracy rate of above 93%. At the end of the process a waste classification report is generated comprising of the details of the images (obtained from video stream) of each category of waste disposed. The waste classification report provides information regarding the quantity of waste, percentage of contaminants found and so on which will help us figure out ways to reduce the production of such waste and how to dispose them in a safe manner. The IoT network security has been improved with the utilization of multi factor authentication and next generation firewall, making the data secure and safe to use by the users.

V. CONCLUSIONS

The Automatic Waste Segregator has an improved efficiency and better accuracy. The components multi-factor authentication and next generation firewall further improves the security features of the IoT network. It is evident that the waste segregation process is done with very less human effort, in an effective and eco-friendly way, thereby reducing risks of pollution or emission of hazardous pollutants.

VI. CONCLUSION

- The tensile test showed very good load bearing capacity for the 0/90 ◦direction with a peak load 1600N.
- The peak load for +45°/-45° was around 2000N.
- The laminates showed good results in both the cases. Also, the strength of the fiber is higher in longitudinal direction than that of transverse.
- The results give scope for the application of these natural fibers in interior of automobiles.
- The addition of mango particles have given improved results in tensile strength compared to the results with only banana fibres.
- The work can be extended by increasing the number of layers and varying the percentage of fibres.

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