AUTOMATIC WASTE SORTING BASED ON IMAGE PROCESSING

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***Abstract* — Many studies have covered sorting technologies. Effective recycling based on effective sorting. Separating the different elements found in waste streams is essential for enabling the recovery of useful materials, minimizing the amount of material sent to landfill and allowing recyclable materials to find a new incarnation.**

In this paper we proposed waste sorting scheme based on Artificial Neural Network (ANN) with the accuracy of 92%. The aim is automate waste sorting by applying deep learning techniques to recognize the type of waste from their images. Deep learning with Back Propagation Network algorithm is used here. It separates waste into 3 main categories: Plastic, Paper and Metal using png image of the waste and implement it on a Raspberry Pi 3. The PI controls a mechanical system that guides the waste from its initial position into the corresponding container.

***Keywords*— ANN, Image Processing, Raspberry PI, Open CV, Raspbian OS.**

I. INTRODUCTION

In developing countries, waste sorting is becoming particularly important at all levels. If these wastes are not disposed properly, then they can have a many affect on the environment. This sorting of waste should be done as early as possible, so it reduce contamination possibility by other elements. Making the trash bin smarter helps in this matter by automatically sorting waste on both home and large scales. The current trend is to efficiently separate the waste in order to appropriately deal with it. Separating the different elements found in waste streams enables the recovery of useful materials hence, minimizes the large quantity of material sent to landfill and allows recyclable materials to reach its destination [1].

To make our environment sustainable handling of solid waste in household and industrial cleaning and ocean conservancy is a complicated task. Now a days it is required to reduce the human work in cleaning and sweeping, to develop an artificial intelligent machines in industries and to decrease the human effort and manpower in the cleaning, and there by separating the garbage into degradable and non-degradable wastes. The whole purpose of assigning machines to do a man's work is to reduce our work load and most importantly, do the job for us in environment that is too hostile for us. we are trying to design a machine that is capable of automatic cleaning with the help of its cleaning purpose mainly in industries and there by separating the waste into different types to avoid polluting environment. The concurrent effects of a fast national growth rate, of a large and dense residential area and a pressing demand for urban environmental protection create a challenging framework for waste management. It is necessary to design and develop an automatic garbage classification system. This paper presents a new method which obtains waste images from the refuse conveyor belt by high-speed camera system, extracts the texture features and separates the waste automatically.

II. LITERATURE REVIEW

In a further studies segregation of the waste materials has been a key huddle in recycling consumer waste. Sorting is a multi-stage process used to transport the waste materials to the appropriate collection facility. Separation of recyclable and non-recyclable waste is the first stage in sorting .The sites with this separation of waste materials at pre-collection time has seen a 30 percent increase in recycling rates. These can be easily carried to a centralized collection station using a segregated waste collection system. Encouraging consumers to recycle waste materials and use sorted trash bins that facilitate the first stage of segregating waste materials plays a great role in eliminating this hurdle. The Recyclebot operates around stadiums and other public places, collecting waste materials and separating recyclable materials from other non-recyclable wastes [2].

Intelligent solid waste bin is essential to develop an efficient and dynamic waste management system. This research presents the implementation and execution of an integrated sensing system and algorithm for solid waste bin to automate the solid waste management process. Several sensing methods have been integrated and have combined their verdicts that offer the detection of bin condition and its parameter measurement. A number of test runs have been conducted to assess the functioning of the prototype system. The outcomes are the sensing system with the algorithm is efficient and intelligent and can be simply used to automate any solid waste bin management process [3].

Another similar system is gray level co-occurrence matrix (glcm) has a good ability to express the characteristics of

texture, a waste identification method based on glcm and probabilistic neural network was proposed. The method obtains waste images from the refuse conveyor belt by high

speed camera system, after image preprocessing, extracts the texture features glcm, then trains the neural network with the glcm as samples, and waste intelligent identification was realized, lays the foundation for automatic classification of waste and provides a new harmless, reduction and resource way for the garbage disposal [4].

The main problem with the existing system is when human does the waste sorting, they take a lot of time, can be tiring sometimes and they cannot work more than 8-9 hours a day, but the proposed system can work for 24*7 hrs with low time maintenance. The second problem is the waste is highly contagious and harmful as it contains bacteria, viruses which may lead to bad health of people working in the waste sorting task. The third problem is safety of human personal; the garbage may contain explosive material which may explode and lead to the death of workers, hence to solve these problem we are proposing our solution. We are trying to design a machine that is capable of automatic cleaning with the help of its conveyor mechanism that can be able to reduce the man power for the cleaning purpose.

III. METHODOLOGY

A. Block Diagram

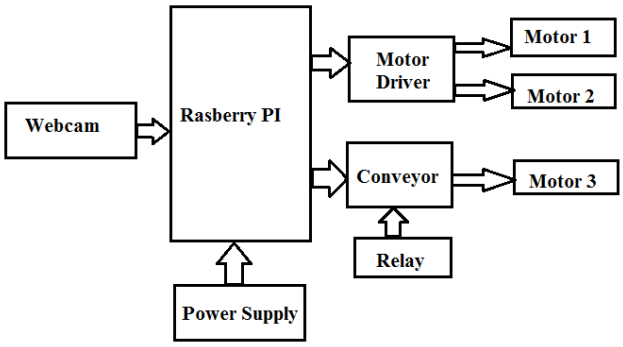

Fig.1 Block Diagram

B. Block Diagram Explanation

The main goal is to design an autonomous waste sorting method. We have used this method for sorting waste like metal, paper and plastic. We have used here Conveyor, Raspberry PI, web camera and motor driver. It is consist of two modes: training mode and operating mode. In training mode raspberry pi is a main controlling processor, web camera to take input image and give it to raspberry pi. We will be using SMPS as a power supply to the system which is of 12 Volt. We will convert 12 Volt into 5 Volt before giving it to raspberry pi, as its operating voltage is only 5 volt. The captured image is processed by image processing which is consisting of image segmentation. Segmentation is the process of partitioning a digital image into multiple segments based on pixels. The result of image segmentation is a collection of segments which combine to form the entire image. It involves feature extraction which defines as a function of one or more measurements, each of which specifies some quantifiable property of an object, and is computed such that it quantifies some significant characteristics of the object. Then it transferred to the neural network. Train the neural network for corresponding material type. In operating mode if we put the material in front of camera it is possible to identify waste with the trained network. To separate the waste and to move the conveyor we are using DC motor. Raspberry Pi uses IDLE software.

C. Algorithm

1. Input the process start button
2. Initiate the training mode
    a. Get camera snapshot
3. Image processing
    a. Image Segmentation
    b. Feature Extraction
    c. Feed to Neural Network
    d. Get the class
    e. Iterate through 2 to 3 for i=k times, where k is the number of training for the same material
4. Testing mode
    a. Put material in front of camera
    b. Get camera snapshot
    c. Input the image to the trained network
    d. Trained network sort the material
    e. Start the motor corresponding to the matched material
    f. Move the waste into desired container through conveyor
    g. After sorting is done, move the motor to its original position
5. Else Go to step 2

IV. ARTIFICIAL NEURAL NETWORK

An artificial neuron network (ANN) is a computational model based on the structure and functions of biological neural networks. ANN is also known as a neural network ANNs have three layers that are interconnected. The first layer consists of input neurons. Those neurons send data on to the second layer, which in turn sends the output neurons to the third layer. ANNs gather their knowledge by detecting the patterns and relationships in data and learn or are trained through experience, not from programming. An ANN is formed from hundreds of single units, artificial neurons or processing elements (PE), connected with coefficients (weights), which constitute the neural structure and are organized in layers. The behavior of a neural network is determined by the transfer functions of its neurons, by the learning rule, and by the architecture itself. During training, the inter-unit connections are optimized until the error in predictions is minimized and the network reaches the

specified level of accuracy. Once the network is trained and tested it can be given new input information to predict the output [5].

Back propagation is a training method used for a multi layer neural network. It is also called the generalized delta rule. It is a gradient descent method which minimizes the total squared error of the output computed by the net. Any neural network is expected to respond correctly to the input patterns that are used for training which is termed as memorization and it should respond reasonably to input but not the same as the samples used for training. The training of a neural network by back propagation takes place in three stages are first Feed input pattern, Calculation and Back propagation of the associated error and Adjustments of the weights. BPN is used here because weight is different for different materials so it is necessary to adjust the weight function according to materials. The output units and the hidden units can have biases. The signals flow in the forward direction i.e. from input unit to hidden unit and finally to the output unit. During back propagation phase of learning, the signals flow in the reverse direction. In the forward stage, each input unit receives an input signal and sends this signal to each of the hidden units. Each hidden unit computes its activation and sends its signal to each output unit. Each output unit computes its activation to compute the output or the response of the neural net for the given input pattern. During training, each output unit compares its computed activation with its target value to determine the associated error for the particular pattern. Based on this error the factor for all values is computed. This computed value is used to propagate the error. At a later stage it is also used for updating of weights between the output and the hidden layer. Once all the factors are known, the weights for all layers are changed simultaneously. The adjustment to all weights is based on the factor and the activation of the hidden unit [6].

V. RESULT AND DISCUSSION

Hence the designed system is capable of sorting the waste and collecting it into three containers. The training of neural network has been done for different types of material and the system is capable of distinguishing between the different types of waste in order to reduce the power consumption, the system will not start processing (including the start of conveyor belt motor) until we put waste into it.

This paper contains three types of waste. The material size used in this study is 100. Usually, a high material size results in better accuracy and better convergence. However, the material size is limited by the amount of memory available on the GPU. So 100 was the maximum number of images that we can use here before running out of GPU memory. Every weight is updated by a small portion proportional to the error. The results show that the highest accuracy achieved during training is 95% on the validation set. Finally the best model is tested on the testing set and an accuracy of 92% is achieved with 93% detection of paper, 92% detection of plastic and 93% detection of metal.

VI. CONCLUSION AND FUTURE WORK

On a high level, more research should have been done regarding the interfacing between modules so that a specific implementation plan could have been created. This would have allowed avoiding on-the-fly creation of code with limited functionality and debugging. In addition, more time should have been spent researching mechanical design of our conveyor system. Overall the design prototype looks satisfactory with optimization point of view and our system will be in future will be capable of sorting into more type of waste and complex algorithm will be implemented. Also in future the number of objects that the camera recognizes may be increased by adding more objects to the image database.This process may be automated, and a user friendly GUI-based application may be created to achieve this functionality.

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REFERENCES

[1] George E. Sakr **"**Comparing Deep Learning And Support Vector Machines for Autonomous Waste Sorting" in IEEE International Multidisciplinary Conference on Engineering Technology (IMCET) vol. A247, pp. 529-551, 2016.

[2] Balaji Masanamuthu Chinnathurai "Design and Implementation of a Semi-Autonomous Waste Segregation Robot" in IEEE conference 3rd ed., vol. 2, pp.68-73, 2016.

[3] Md. Abdulla Al Mamun "Integrated Sensing Systems and Algorithms for Solid Waste Bin State Management Automation" in IEEE Conference vol. III, pp. 271-350, 2014.

[4] WangKun**"**Identification Method of Waste Based on Gray Level Co-occurrence Matrix and Neural Network**"** in IEEE conference Sep, vol. 2, pp. 740-741, 2011.

[5] Sumit Rathi, Shivam Pande, Harshad Lokhande "Smart Garbage Collection System" in International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 5 Issue IV, April 2011.

[6] Aishwarya Ghongane, Aniket Piralkar, Vaishnavi Pawar, "Automatic Garbage tracking and Collection system" in International conference on recent trends in Engineering, Science and Management vol. 7, pp. 978-993, 2011.