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DESIGN AND DEVELOPMENT OF SOLAR POWERED FULLY AUTOMATIC BIODEGRADABLE WASTE SORTER AND COMPOSTER

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Abstract: India is well known for its populations and then obviously, the side effects of increasing population. One of the major side effects of increasing population is the kitchen waste creation from individual homes or hotels. The major concern is regarding inclusion of non-degradable waste in the overall waste created. The researchers contributed a lot to define the categories of wastes but segregation of waste is a trending and vital issue now. Not only in India but in all developing countries, more emphasis has been done on awareness of keeping degradable waste from non-degradable one and this motivates to an engineer to design a machine/technology which will sort degradable waste from the non-degradable one. The waste sorter is designed to identify the type of waste based on image processing technique and the sort it in to two containers names green waste and non-degradable waste. The robotic arms are designed to operate based on instruction given by controller which takes inputs from high resolution camera. This machine is able to identify type of waste based on percentage of degradable waste included in one set of identification. The percentage level can be manually set as per user's demand. The waste so sorted will definitely be called as degradable waste and can be used for several applications like compost. The machine described above will be completely operated on Solar Energy and hence charge controllers and battery systems are employed in it. This makes this machine as a form of green technology which can be placed anywhere in outside places and waste can be placed in its containers to get sorted. The waste which is sorted by sorter will be provided to the composter bin for composting. The main aim of this paper is to present the technology to the researchers so that they can extend this prototype work to the larger scale. All the key components and specifications of the system are provided in this paper.

Keywords: - Solar, degradable waste, image processing, robotic arm

I INTRODUCTION

India is a country of farmers and farmers need compost for better soil fertility. The no cost fuel the farmers can get is the waste from household tasks and kitchen waste which can be utilized for the composting purpose.

Being unaware of the process of compost and busy in the farming work, they are unable to create compost on their own. The compost is also required to the small gardens and trees in society. This increases the need compost in city areas as well. The sorting of dry and wet waste is also an unresolved issue to the municipal corporations and hence the model to be designed will be beneficial to the various societies and apartments to collect their waste and segregate it. Hence, there must be confirm solution to this problem which can offer farmers or any individual a device to generate compost.

To generate compost, we need to segregate biodegradable waste from the non-degradable waste like plastic, glass, metal, and paper. The proposed model will provide a complete automatic process which can offer compost simply by placing waste as input. The sorting technology is described in this paper. The image processing technique is incorporated by using convolutional neural networks (CNN) and hence it is observed that the images captured are detecting the category of the object. The images were supposed to be taken by camera and should be assessed by raspberry pi to detect its category and based on that we can route the waste in the destination bin of degradable or non-degradable. To sort these objects from the trash can be done by using image processing technique. image processing is a very handful tool to solve these objects which can recognize the shape color and pattern of these materials to be sorted out. By using image processing, we can detect the objects like metal plastic bottles cardboard

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paper materials by detecting their shapes by using high-definition camera. When a camera takes a picture of a trash it will send image to the raspberry Pi. Tensor flow code is very useful to convert these images into multidimensional arrays or Matrix because every color image is a set of three-dimensional matrices. A CNN means convolutional neural network technique is employed for identifying the images this technique runs a a sliding window program by using which we can reduce the output data matrix smaller will be the size of window higher will be the accuracy of the detection.

Every image has its own unique pattern and when the sliding window program runs over that image it detects that pattern and identifies the image to be fit in any one of the categories.

The module provided by tensor flow and ReLU which is rectified linear function is used as a filter to categories this image large number of images are taken from the library and trained to the module so that the accuracy of module can be enhanced.

As the sorting technique is completely based on image processing it can be said that it works as a heart of the system this image processing technique is presented in this paper. The codes of tensor flow and training module are also described in this paper. This arrangement now needs to be interfaced with the hardware design. For this, the work has been carried out related to the design and selectin of components. The whole description is provided in this paper.

II. System description

The width of base is 3000mm and height is 1500mm. The width provided is 500mm. Based on these dimensions, the design of conveyor belt and its bearing is decided. These bearings and conveyor belts are yet to be dispatched. Once the belt and bearings delivered, next task will be to start installation of robotic arm and hopper on the conveyor belt. The arm is to be trained to recognize difference between degradable and non-degradable waste. The library of number of photos is prepared to train the robotic arm to detect the material based on shape and colour of the material. Image processing technique will be used to perform this task.

In general, any digital image processing algorithm consists of three stages: input, processor, and output. In the input stage image is captured by a camera. It sent to a particular system to focus on a pixel of image that's gives, its output as a processed image.

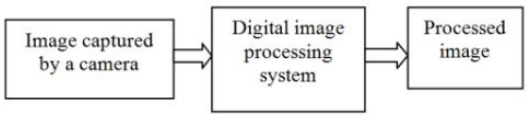

Figure: - Image processing process flow

The images from the library will be loaded via raspberry and then these will be recognized based on their shape and colour and moisture contain as it is degradable or non-degradable. This process will be done on multiple images of same material so that the sorting technique may identify the material more efficiently.

Redesigning of the Crusher and power calculations: -

Solar energy is required in proposed system for various applications listed below:

1) Sorter circuitry
2) Robotic arms
3) Crusher
4) Composter

The tentative energy requirement can be calculated for above sections of proposed system. The major part as per energy consumption is crusher as high torque will be required to it. This energy requirement can be calculated by assuming temporary dimensions of crusher.

1) Sorter Circuitry:

This section is a circuit consists of power electronics switches and less energy consuming parts whose voltage level is fixed at 5V and 12V DC and current carrying capacity is not more than 3- 4 Amps. The approximate

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power rating of this circuitry will be upto 20W.

2) Robotic arms: -

Electrically, these are nothing but stepper or servo motors.

Most popular stepper motor is Nema bipolar stepper motor which has 36N.cm holding torque and has rating of 2.8V, 1.68 Amps. Power consumption will be approximately 6W per motor.

For initial stage, assume 5 such motors will require for different processes. This means, power rating of robotic arms will not exceed 30W.

3) Crusher

Assume,

Radius of motor blades = 20cm = 0.2m

Total waste handling at a time = 10 kg

Total Degradable waste at a time = 6-7kg

For 3 cycles of operation in a day, waste handling in crusher = 2kg

Torque (T) = Force * radius

= Weight * gravity * radius

= 2* 9.81*0.2

= 3.924 Nm

Output Power = (Speed*Torque) / 9.55

= (100*3.924) / 9.55

= 41 W

Input Power = Output Power / efficiency

= 41/ 0.8

=50W (approx)

4) Composter: -

Composter will require periodically rotation action for movement of heap inside the tumbler. This can be done by DC motor as like in crusher. But, power usage of composter need not to be considered, because, crusher and composter working can be avoided at the same time.

RESULTS

The model is developed and examined. The system works fine with the detection algorithm and it is able to detect the percentage of waste available in image captured by camera. The level of waste to be declared as degradable or non-degradable is decided by algorithm. Currently the system is trained to detect the waste as degradable if the is 85 percent of waste is degradable and maximum of 15 percentage is non-degradable waste. If the amount of degradable waste is more than 15 percent, then the whole waste in the image will be described as non-degradable. About 15 kg of kitchen waste is tested with this model and the efficiency of detection is about 94 percent as 2109 samples are expected to be degradable and the 1982 samples were recognized as degradable.

Conclusion: -

The system is tested for various samples and all individual samples are being correctly identified. The major concern is with segregation of waste from one sample as degradable and non-degradable is little complex and pick up arrangement can be implemented for the same. There is a vast scope in working on this area. But multiple identification of same waste in different percentage levels can be done to achieve higher efficiency.

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References

1) A. N. Kokoulin, A. A. Uzhakov and A. I. Tur, "The Automated Sorting Methods Modernization of Municipal Solid Waste Processing System," *2020 International Russian Automation Conference (RusAutoCon)*, 2020, pp. 1074-1078, doi: 10.1109/RusAutoCon49822.2020.9208039.
2) 3)R. V. Soans, G. R. Pradyumna and Y. Fukumizu, "Object Sorting using Image Processing," 2018 3rd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT), 2018, pp. 814-818, doi: 10.1109/RTEICT42901.2018.9012110.
3) S. N. Kulkarni and S. Kumar Singh, "Object Sorting Automated System using Raspberry Pi," 2018 3rd International Conference on Communication and Electronics Systems (ICCES), 2018, pp. 217-220, doi: 10.1109/CESYS.2018.8724056.
4) P. Yadav, M. Uikey, P. Lonkar, S. Kayande and A. Maurya, "Sorting of Objects Using Image Processing," 2020 IEEE International Conference for Innovation in Technology (INOCON), 2020, pp. 1-6, doi: 10.1109/INOCON50539.2020.9298360.
5) J. Huang, T. Pretz and Z. Bian, "Intelligent solid waste processing using optical sensor based sorting technology," 2010 3rd International Congress on Image and Signal Processing, 2010, pp. 1657-1661, doi: 10.1109/CISP.2010.5647729.
6) F. Shaikh, N. Kazi, F. Khan and Z. Thakur, "Waste Profiling and Analysis using Machine Learning," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), 2020, pp. 488-492, doi: 10.1109/ICIRCA48905.2020.9183035.
7) T. H. Rocky, M. Islam and U. K. Saha, "Resource recovery potential from kitchen waste," 2nd International Conference on Green Energy and Technology, Dhaka, 2014, pp. 18-21. doi: 10.1109/ICGET.2014.6966654
8) S. Wang, J. Guo and D. Xu, "Non-Contact Low-Power Proximity Switch Based on Kitchen Garbage Crusher," 2018 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS), Xiamen, 2018, pp. 101-104. doi: 10.1109/ICITBS.2018.00034
9) X. Li, C. Li, M. Huang and H. Jing, "The Fault Diagnosis of Garbage Crusher Based on Ant Colony Algorithm and Neural Network," 2009 Third International Conference on Genetic and Evolutionary Computing, Guilin, 2009, pp. 515-519. doi: 10.1109/WGEC.2009.165
10) M. Huang, Z. Li and B. Kuang, "An Improving Design of Solid Garbage Crusher for Garbage Coal Production Line," 2010 Asia-Pacific Power and Energy Engineering Conference, Chengdu, 2010, pp. 1-4. doi: 10.1109/APPEEC.2010.5449102
11) U. Sharma, B. Singh and S. Kumar, "Intelligent grid interfaced solar water pumping system," in IET Renewable Power Generation, vol. 11, no. 5, pp. 614-624, 12 4 2017. doi: 10.1049/iet-rpg.2016.0597

ISSN: 2366-1313

12) Sivaprasad A, Kumaravel S and Ashok S., "Integration of solar PV/batteryhybrid system using dual input DC-DC converter," 2016 Biennial International Conference on Power and Energy Systems: Towards Sustainable Energy (PESTSE), Bangalore, 2016, pp. 1-5. doi: 10.1109/PESTSE.2016.7516473

13) Rim Toumi, “Design of a composting bin to convert AUI’s biomass to an organic feltilizer”

14) Borole, A.S., Phadke, A.R. (2022). A Review on the Development of Solar Power Automatic Biodegradable Waste Sorter and Composter. In: Kolhe, M.L., Jaju, S.B., Diagavane, P.M. (eds) Smart Technologies for Energy, Environment and Sustainable Development, Vol 2. Springer Proceedings in Energy. Springer, Singapore. https://doi.org/10.1007/978-981-16-6879-1_69

15) Borole, A.S., Phadke, A.R.,Shah, P.J.,(2022). Image Processing Techniques for Solar Powered Automatic Biodegradable Waste Sorter, International conference on Tech Trends in science and engineering, ICTTSE,26-02-2022