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Implementation of Smart Waste Sorter by Image Processing Using Robot

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Abstract: Automation has led to the growth of industries in recent years. For better performance of industrial process automated machines are used. Image processing has led to advancements in applications of robotics and embedded systems. Sorting of waste are usually done by humans which takes a lot of time and effort. Using Computer Vision techniques, a conveyor belt system is developed using stepper, servo motors and mechanical structures, which can identify and sort various objects. This reduces human effort, time consumption. Application of image processing in industries has gained a lot of scope. The research on automation and robotics has shown importance in industries, defence, surveillance and security using image processing. Sorting of waste is one of the challenges faced by the industries. The main objective is to build a system that is capable of identifying and sorting various waste materials by using image processing. Image processing is the key to the robot sorting system. General object detection method should be fast, accurate, and can be applied for wide variety of objects. Object Recognition is the most important task in the computer vision field. The increasing demand for real time image processing, has led to a great deal of research in Object Recognition algorithms. The goal of object recognition is to automatically detect the objects in the screen and classify them according to their properties. This process is repeated for all the frames of the captured images.

Keywords: Automation, Image processing, conveyor belt system is developed using stepper, servo motors and mechanical structures, identify and sort various objects, Object Recognition algorithms, properties, waste sorting and management. .

I. INTRODUCTION

Rapid increase in population has led to improper waste management in metro cities and urban areas which has resulted in spreading of diseases. The segregation, transport, handling and disposal of waste must be managed properly to minimize the risks to the public, and the environment. Modern collection and transportation of municipal solid waste involve many technical steps and emerging technologies in integrated waste management system. The overlapping of information technology with waste management system gives raise to many innovative technologies in the way of sustainable development. Also, Municipal solid waste workers (MSWWs) or refuse collectors, universally expose too many work-related health hazards and safety risks, notably allergic and other diseases of the respiratory system. Hence garbage has to be sorted and disposed properly to avoid all hazardous problems.

II. EXISTING WASTE DISPOSAL PROBLEMS

1. **Production of too much waste**: One of the major waste disposal problems is attributed to the generation of too much waste. It therefore means that every state and local authority suffer the problem of effective waste disposal due to the generation of too much waste.
2. **Most of the waste is toxic:** On a daily basis, the industries produce toxic products that end up getting thrown away after use. Most of the products contain hazardous and health-threatening chemicals.
3. **Landfills are a problem as well:** Most landfills lack proper on-site waste management thereby contributing to additional threats to the environment. In the long-term, landfills leak and pollute ground water and other neighboring environmental habitats making waste management very difficult. They also give off potentially unsafe gases.
4. **Reliance of dying technologies to reduce and recycle waste:** Waste disposal and management facilities as well as state resources have continued to rely on myopic and quickie solutions instead of developing effective recycling and waste reduction programs. Consequently, it has created continued reliance on the use of outdated technologies to deal with waste disposal. The problem is that most states are reluctant and less creative towards advancing novel technologies for reducing the toxicity and volume of waste or enhancing recycling, especially solid waste.

III. OBJECTIVES

1. The manpower needed can be significantly reduced by developing an autonomous robot which can locate, sort and separate the different garbage items.
2. This type of garbage segregation machine has a completely automatic system, which means the whole operation process just needs a few people to manage. In other words, it is conducive to reduce labor cost. Garbage sorting

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equipment is carefully designed. Therefore, it has good functions, such as a high sorting rate. The sorting rate can reach more than 90%.

3. Prevent direct contact of the garbage collectors with the hazardous wastes to overcome harmful consequences as the robot we are going to implement will be sorting different kinds of garbage.

IV. LITERATURE SURVEY

First. **Automated Garbage Collecting Robot: by Ruide (Ray) Chen, Scott Chu, Bao Nguyen Kevin Tan, 2010 EE464 Senior Design Project, Electrical and Computer.**

Automatic Garbage Collection Robot (AGCR) for household use that has more robust collecting abilities than currently available commercial cleaning robots. Designed a robot that was capable of targeting specific objects, collecting them with a robotic arm, and depositing them in a receptacle. The project consists of four main modules: robotic arm, navigation, image processing, and interfacing.

*Second.***Developing an Intelligent Waste Sorting System with Robotic Arm: by Sadia Zahin Diya, Rifat Ara Proma, Muhammad Nazrul Islam, Tasmiah Tamzid Anannya, Abdullah Al Mamun, Rizvi Arefeen, Saifullah Al Mamun, Ihtiaz Ishmam Rahman, Md Fazle Rabbi in IEEE-2018 international conference.**

In this paper, an intelligent system was proposed and developed for automatically sorting the waste. A light weighted experiment was carried out to evaluate the system performance. The experiment replicated with 11 objects (waste) of different size and types. The experimental results showed that the proposed system was reliable and achieved about 82% accuracy for the categorization of different kinds of waste

Third. **Object detection and robotic sorting system in complex industrial environment: by Liang Bin Yan, Wang YanBo, and Chen ZhiHong. Beijing Research Institute of Precise Mechatronics in IEEE-2017 international conference.**

This paper uses the CNN network to deal with the object image acquired by vision sensor. Designed two decupling regression layers to calculate position and posture separately that gets high performance on object detection in complex environment. Experimental result shows that it can achieve 91.6% precision on production data set.

Fourth. **An Automatic Classification Method for environment: by S.Sudha, M Vidhyalakshmi, K.Pavitra,2016 IEEE International Conference on Technological Innovations in ICT For Agriculture and Rural Development**

In this paper, they have proposed an automated recognition system using Deep learning algorithm in Artificial Intelligence to classify objects as biodegradable and non-biodegradable, where the system once trained with an initial dataset, can identify objects real-time and classify them almost accurately.

Fifth. **Object Sorting using Image Processing: by Rahul Vijay Soans, Pradyumna G.R., and Yohei Fukumizu, 2018 3rd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology.**

In this paper using Computer Vision techniques, a conveyor belt system is developed using stepper, servo motors and mechanical structures, which can identify and sort various objects. This reduces human effort; time consumed, and also improves the time to market the products

Sixth. **Object Detection Based Garbage Collection Robot (E-Swatch): by Shobhit Khandare, Sunil Badak, Yugandhara Sawant, Sadiya Solkar, 2018 International Research Journal Of Engineering And Technology**

This paper proposes the method where a robot can be used to clean the polluted areas such as garbage around the dustbin. A Robot is powered by Solar Panel, which again saves the electric power. Robot has the advantages of the powerful image processing and ultrasonic sensor to sense the surrounding area and accordingly action can be taken. An image processing has been used here to avoid interaction with the wild life.

V. MOTIVATION

Approximate 0.2 million tones' garbage generated per day only in India. Maximum garbage cannot be fixed to proper solution because separation mechanism is not present widely in India. Some garbage cannot be separated by hand as they are hazardous like chemical waste, medical waste, floating waste etc. so the separation of the garbage is needed which is safe, lenient and automatic. Hence the following:

- ✓ Proper disposal of waste can keep the environment fresh and clean.
- ✓ It reduces environmental pollution.
- ✓ Saves life of workers from any type of harmful or infected objects in the garbage.
- ✓ Waste can be sorted in a faster and in a smarter manner.

VI. DESIGN AND IMPLEMENTATION

It is Raspberry Pi 3 based garbage separation robot. Raspberry Pi 3 is root of the system. It controls the working and time period of all the sub-section. So as to separate the garbage into plastic, metal, glass, degradable and non-degradable there is a particular image processing algorithm.

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In this implementation we are using automatic mode of operation where waste will be segregated using image processing; camera is attached in front of robot. This will capture the image of waste and is given for image processing. Raspberry pi will give command to robot to start move forward and till any obstacle is detected using obstacle sensor it will continue to move forward. After detecting any obstacle robot will stop and camera will on to take garbage image. The image processing algorithm we are using will process it and according to garage detected, robotic arm will dump it in respective bin. Figure 1 shows the block diagram and figure 2 shows the flowchart.

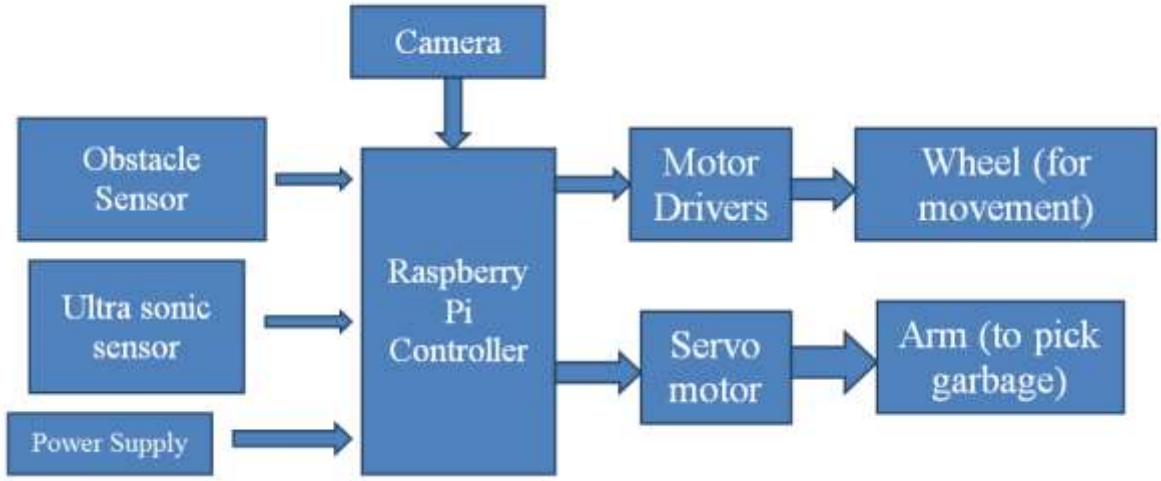

Figure 1 shows the block diagram of the assignment.

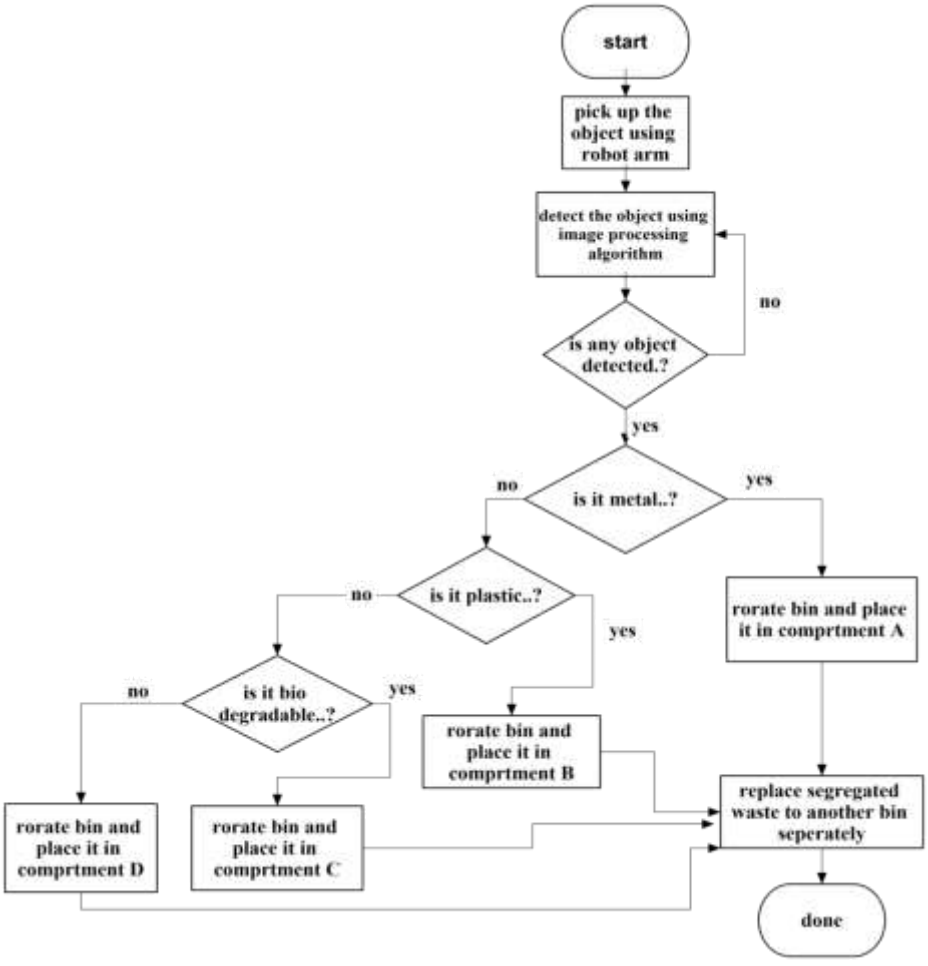

Figure 2 shows the flowchart of execution of the program.

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VII. REQUIREMENT SPECIFICATION

Processor

- Broadcom BCM2387 chipset.
- 1.2GHz Quad-Core ARM Cortex-A53(64Bit)
- IEEE 802.11 b / g / n Wi-Fi. Protocol: WEP, WPA WPA2, algorithms AES-CCMP (maximum key length of 256 bits), the maximum range of 100 meters.
- IEEE 802.15 Bluetooth, symmetric encryption algorithm Advanced Encryption Standard (AES) with 128-bit key, the maximum range of 50 meters.

GPU

- Dual Core Video Core IV® Multimedia Co-Processor. Provides Open GL ES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high-profile decode.
- Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure

Memory

- 1GB LPDDR2

Operating System

- Boots from Micro SD card, running a version of the Linux operating system or Windows 10 OS

Dimensions

- 85 x 56 x17mm

Power

- Micro USB socket 5V, 2.5A

Connectors:

Ethernet

- 10/100 Base T Ethernet socket

Video Output

- HDMI (rev 1.3 &1.4)
- Composite RCA (PAL and NTSC)

Audio Output

- Audio Output 3.5mm jack
- HDMI
- USB 4 x USB 2.0 Connector

GPIO Connector

- 40-pin 2.54 mm (100 mil) expansion header: 2x20strip
- Providing 27 GPIO pins as well as +3.3 V, +5 V and GND supply lines

Camera Connector

- 15-pin MIPI Camera Serial Interface(CSI-2)

Display Connector

- Display Serial Interface (DSI) 15 way flat flex cable connector with two data lanes and a clock lane

Memory Card Slot

- Push/pull Micro SD

VIII. IMAGE PROCESSING

In virtually all image processing applications, however, the goal is to extract information from the image data. Obtaining the information desired may require filtering, transforming, colouring, interactive analysis, or any number of other methods. To be somewhat more specific, one can generalize most image processing tasks to be characterized by one of the following categories:

1. Image Enhancement

Image enhancement techniques have been widely utilized in many applications of image processing where the subjective quality of images is consequential for human interpretation. Contrast is a paramount factor in any subjective evaluation of image quality. Contrast is engendered by the difference in luminance reflected from two adjacent surfaces. In other words, contrast is the difference in visual properties that makes an object distinguishable from other objects and the background. In visual perception, contrast is resolute by the difference in the color and effulgence of the object with other objects. Our visual system is more sensitive to contrast than absolute luminance; consequently, we can perceive the world similarly regardless of the considerable transmutations in illumination conditions. This simply means improvement of the image being viewed to the (machine or human) interpreter's visual system. Image enhancement types of operations include contrast adjustment, noise suppression filtering, application of pseudo color, edge enhancement, and many others.

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2. Image Restoration

The purpose of image restoration is to "compensate for" or "undo" defects which degrade an image. Degradation comes in many forms such as motion blur, noise, and camera miscues. In cases like motion blur, it is possible to come up with a very good estimate of the actual blurring function and "undo" the blur to restore the original image. In cases where the image is corrupted by noise, the best we may hope to do is to compensate for the degradation it caused.

3. Image Analysis

Image analysis is the extraction of meaningful information from images. Image analysis operations produce numerical or graphical information based on characteristics of the original image. They break into objects and then classify them. They depend on the image statistics. Common operations are extraction and description of scene and image features, automated measurements, and object classification. Image analyse are mainly used in machine vision applications.

4. Feature Extraction

Feature extraction involves simplifying the amount of resources required to describe a large set of data accurately. When performing analysis of complex data one of the major problems' stems from the number of variables involved. Analysis with a large number of variables generally requires a large amount of memory and computation power or a classification algorithm which over fits the training sample and generalizes poorly to new samples. Feature extraction is a general term for methods of constructing combinations of the variables to get around these problems while still describing the data with sufficient accuracy. All the pre-processing techniques on image processing are implemented through MATLAB.

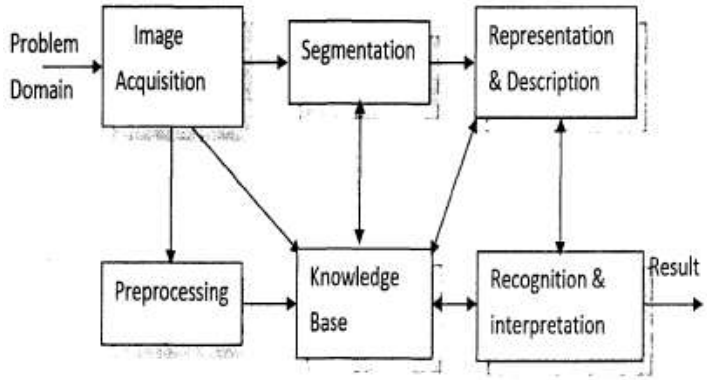

Figure 3 shows the process of Image Processing for waste segregation.

IX. CONCLUSIONS

Automated robot that sorts garbage into its respective categories is created which achieves high sorting rate without the involvement of manpower or any human intervention. Proper management of waste plays a vital role to control global warming. Automatic Sorter Machine for Smart Waste Management System is an excellent example of proper waste management. It will also ensure effective recycling system. This project proposal for the management of wastes is efficient and time saving than the currently employed method where the municipality employees perform. Though this system is simple in concept, it is very valuable and affordable. Hence to ensure being automated, a system which takes lots of dataset as input without human intervention and also has the capacity to think by itself offers the best solution.

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