OBJECT DETECTION BASED MEDICAL WASTE DETECTION ROBOT FOR QUARANTINE CENTERS AND HOSPITALS

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ABSTRACT

The problem of infectious diseases is spreading in the world due to the contaminated solid waste from hospitals as humans who picks up these waste materials, come in contact of it and can became a victim of a disease and that is very dangerous. A robot that is able to detect and collect the contagious material such as plastic bottles automatically is feasible solution to the above problem. In view of this trash detection is done using a neural network algorithm which detects the contaminated product and an infrared sensor is provided to calculate the distance from the waste material. USB camera is provided to detect the waste and this camera sends the image to raspberry to classify it whether it is a trash or not. This robot is of low cost and 100% pollution free which makes this model a necessity in today's world.

KEYWORDS: waste detection and collection robot, Automatic, MobileNetSSD, Raspberry pi 4.

I.   INTRODUCTION

Managing the garbage is still one of the issues in India which are still pertaining. The Existing methods find it difficult to manage the solid waste like plastic bottles, surgical instrument in the hospitals etc. Meanwhile due to widespread of covid-19 in India, there has been a need of proper methodology by which the proper maintenance of hospitals, isolation centers can be done. Waste material such as bottles, plastic etc which become contaminated due to coming in contact of a patient in these places, so to involve a human in these kind of areas is very dangerous as it can lead to the spread of the disease if that person get infected. Human intervention is very critical in these kind of places, whereas a model which can automatically pick the waste material from these places is very useful and can solve a problem of spreading of the disease in it its own way. As we can regularly see that workers are being getting infected due to coming in contact with waste material. This shows that there is need of automation in trash collection which can prevent the spread of a disease till a certain level

II.   METHODOLOGY

2.1 Object Detection

The algorithm we are using to detect the garbage is SSD MobileNet, in the object detection algorithm we need to identify where the object is and then we obtain its bounding box.
Faster R-CNNs are one of the most used algorithm to detect the object but this is a complicated method difficult to learn and implement and dataset we need to train we large so to test and train data using this algorithm we also very difficult.
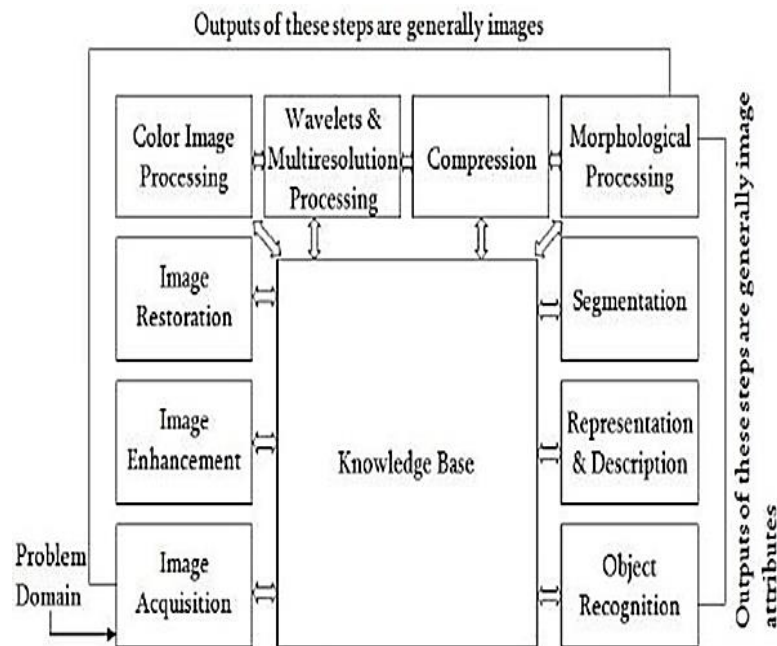
Figure 1: Fundamental of Image Processing

There is also one disadvantage using this algorithm it can be slow of the order 7 FPS (Frame per Second) even if it uses the word "FASTER". So if we want to achieve speed and to process data much better than Faster R-CNNs we can use you Only Look Once (YOLO) algorithm to detect object because it can process 40-90 FPS (Frame per Second) on a GPU. Its upgrade can process up to 155FPS.But the problem with YOLO is not its speed, its accuracy is the main problem so that's why we are not using this algorithm to detect the object. Single Shot Detector (SSD) it is one of most used algorithm to detect object and this project we are also using this algorithm for detection purpose and it is developed by Google and actually it is balance between the Faster R-CNNs and YOLO and it also processed faster at 22-46 FPS depending on the network we use. MobilenNets: Efficient (deep) neural networks. When we are building object detection network we use network architecture that already exist such as VGG and then use this architecture inside object detection pipeline. But the problem is that these network architecture can be very large in 200-500 MB.

The Idea behind depth wise separable convolution is to divide it into two stages:

1 .A 3×3 depth wise convolution.

2 .Followed by a 1×1 point wise convolution.

This helps us to decrease the number of parameters we are using in the network SSD (Single Shot Detector). It means that in a Single Shot, it can detect multiple object and it has two main parts to detect object:

1). It need to extract feature.

2). It Implement Convolution filter to detect object.

There are two models of SSD available:

1). SSD300:- This model takes input size 300*300. It is used for lower resolution image and its accuracy is lower than SSD512.

2). This model is used for high image resolution and its input size is 500*500. It is more accurate than SSD300. SSD is also faster than R-CNN because R-CNN needs two shot, one for creating region proposals and one for detecting object but SSD done it in a single shot. The MobileNet SSD algorithm first tested on coco dataset and then tested on PASCAL VOC and its precision is up to 72.7%. For example SSD300 has 79.6, SSD512 has 81.6% and R-CNN has 78.8% which is lower than both SSD300 and SSD512.

2.2 Distance and Robot movement estimation:

After detecting the garbage, the next step is to find out the distance between the garbage and the robot and which is most important function of this project and to finish this task first what we do is that this project is movind in a predefine path which programmed it into arduino and ont only this robot moves

in a predefine we also define some in the path where this robot stop scan that place using object detection algorithm. If we find any garbage during scanning we pick that garbage and store it in a drawer.So after detecting the garbage robot starts moving in a direction towards the garbage and then we use counter which is active after detecting the garbage. We use counter that after robot pick the garbage then it can return to its previous position using counter. As shown in the given figure 2 below we use this formula for calculating the distance between the garbage and the robot.
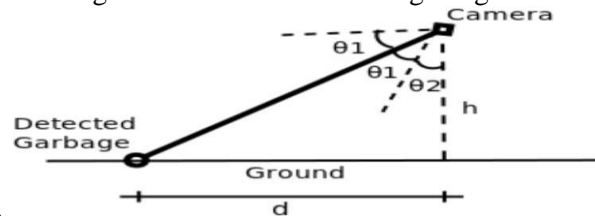

Figure 2: Calculation technique

$\theta 2$= Tilted angle of camera
$2(\theta 1)$ = View angle of camera
h= Height of the camera
d= distance of the garbage from the camera
d=h* tan($\theta 2$+ $\theta 1$)   (1)

From the above formula (1), the location of the garbage has found with the help of this formula. So the above algorithm we use to find out the distance between garbage and robot and also we programmed predefined path and location to Arduino Nano and then Arduino Nano gives signal to the motor driver to control all the movements of this robot.

III.   SYSTEM OVERVIEW

3.1 Block Diagram
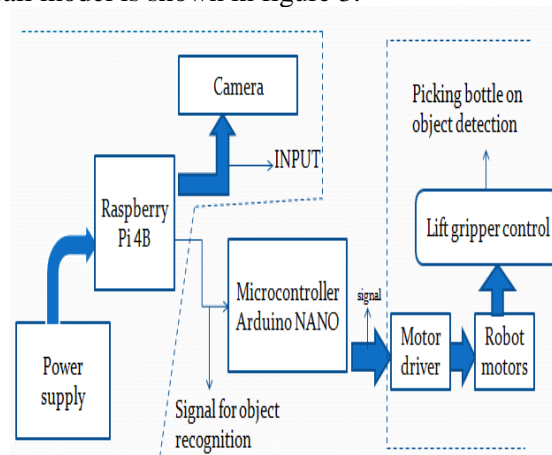Block diagram of our Overall model is shown in figure 3.

Figure 3: Block Diagram

So, first we capture the object by the camera then we use Raspberry pi for applying object detection algorithm on that captured picture. Then Raspberry pi give to Arduino Nano which controls the movement of the robot using motor driver IC and we pick up the garbage using robotic arm.

IV.   DESCRIPTION

4.1 Raspberry Pi-4B:

Raspberry Pi 4B is the controller we are using to for the detection algorithm and it is a fourth generation Raspberry Pi 4 Model B which is a size of credit card we use and it is very powerful microcontroller which can be used in variety of application and is faster than its previous model

which is a third generation controller and if we compare to the first generation its processor is more powerful and 10X faster than first generation pi controller and also it can connect to wireless LAN & Bluetooth that make it ideal solution for any type of connected designs.

4.2 Arduino Nano

The second controller which we are using in this project is Arduino Nano which helps us to control the movement of robot and about this controller it is similar to Arduino Uno but it is small, and more compact and it can also be programmed using Arduino Software IDE and this controller is based on ATmega328P, and offer same connectivity as Arduino uno and its program can run both offline and online.

4.3 Driver (L293D)

L294D is Motor driver we use for the motors and this IC drives the motor on either direction and this motor driver is very important component in our project and it can control two sets of DC motor on both direction and it is 16-pin IC which works on concept of H-bridge. H-bridge is a circuit which design for voltage to be flown in both direction. Voltage is needed to change its direction to rotate motor in clockwise and anticlockwise direction. In L293D IC there are two H-bridge which controls the flow of voltage for two motors independently. The voltage we needed to operate this is 5V which we can get from Arduino Nano and L293D IC not use this voltage to drive motor so for driving this motor we us separate external voltage supply VSS and maximum voltage supply we needed is 36 volts.

4.4 Trash Collector (Arm)

Now, the robot need to pick the garbage so to achieve this we use robotic arm.The design to collect garbage can be split into three major parts: Base of robot, Robotic arm and Drawer. The base drives the motor the garbage. The Robotic arm collects the garbage. The Drawer stores the garbage collected by the robotic arm.

4.5 Power Supply

For the power supply, we are using 12 V external supply, but we can also use solar panel to power our project. Solar panel which we can using can produce 12 volts 10 watts. The output of solar panel is given to solar charge through diode to avoid back current.
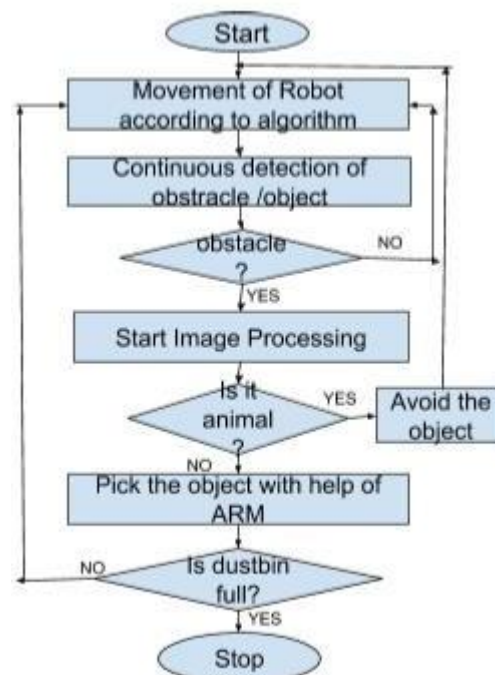
V.   FLOW CHART

Figure 4: Algorithm

The illustration of algorithm (Figure 4) is as follows:

The robot starts and move on a predefined which we programmed to Arduino and robot is continuously detecting garbage using object detection algorithm. If the garbage is detected it moves towards the object to pick the garbage by using the robotic arm and store it in the drawer. If the garbage is not detected then the movement of robot again take place according to the algorithm. This process is repeated every time it detects an object until the drawer is full. When the drawer is not full it repeats the process until the drawer is full.

VI.   RESULTS

The Purpose of the project was achieved to some extent. This project is actually work on two module, first the robot need to detect the garbage using object detection algorithm and the algorithm we are using for object detection is SSD MobileNet. After detecting the garbage our robot is move towards the garbage and pick the garbage and throw it in the drawer.
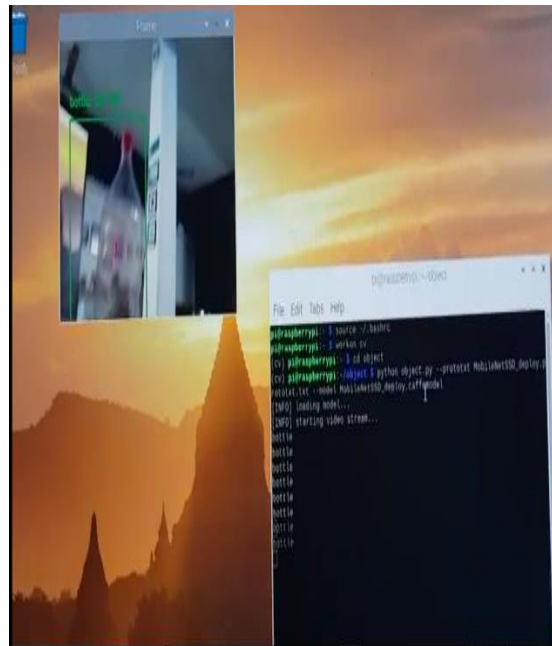

Figure 5: Object Detection

This robot is successfully implementing both the module. It can detect the garbage at the distance of 20 cm and it moves in a constant speed.

VII.   CONCLUSIONS

The Garbage pickup is exposing workers physically to many occupational hazards and this robot is saves life of worker from any type of harmful object in the garbage and waste management can be done smarter manner. This project fulfil its task of collecting garbage from places like hospitals and isolation centres'.

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