Design of a voice control 6DoF grasping Robotic Arm

[1]Geetha R, [2]Amitha V, [3]Pooja K, [4] Prof. Manjula B B

[1][2][3] Student, [4] Associate Professor

[1][2][3][4] Department of Electronics and Communication

East West Institute of Technology, Bangalore, India

Abstract: This paper presents the design a 6-DoF robotic arm which can pick up objects in random positions on a 2D surface based on Raspberry pi, ultrasonic sensors and pi camera. The robotic arm is able to recognize objects based on computer vision foe shape detection. The ultrasonic sensor measures the distance between the objects and the robotic arm, and the position of the objects in the real world will be detected by its mass centre in the image to improve accuracy of the pick-up movement. The movement of the robotic arm also can be controlled by a voice bot assistance device. The experiment of applying the convolution neural network to control the robotic arm pick-up movement is achieved. The convolutional neural network can manipulate the position of the robotic arm to pick up objects after training the robot.

Index Terms - **Robotic arm, computer vision, object detection, voice bot assistance and raspberry pi.**

I. INTRODUCTION

Robot concepts have been introduced from science friction. As the development of mechanical, electronics, computer, sensor and communication technologies, robots have already extensively applied in industrial manufacture and even human's daily life. The robotic arms are one of the earliest programmable automated machines utilized in the industrial production and helped humans to finish some work faster, easier with more accuracy. It is able to move objects, tools, heavy stuff and pick and place objects in automation and complete some hazardous work which human cannot do. Robotic arms have been used for a variety of application in Industry, such as welding, gripping, lifting and even automotive assembling. Because of development of sensors, camera, micro-controller and computer, robotic arms are able to 'feel' outside world by sensor and 'think' using the computer, and then decide what they should do. Robotic arms have become very intelligent. Especially when cameras and image processing have applied into robotic arms, they can capture images by cameras and analysis images to take useful information and then process commands and take actions. Furthermore, the artificial neural network is the most modern technology in robot control. Robots are able to learn many things using the convolution neural network, such as robot movement and image recognition.

In this paper, a robotic arm is intended to pick up, move and place the objects. The location of the objects is unknown. The robotic arm can detect the desired objects and find the location of the objects by Pi camera and ultrasonic sensor. The convolution neural network is applied to the robotic arm control to decide the position to grasp the objects. The movement of the robotic arm also can be controlled by voice command by using a voice Bot assistant device.

II. SYSTEM DESCRIPTION

The system consists of 4 sections, the robotic arm which contains the pi camera and the ultrasonic sensors, Raspberry pi, and motor driver shield and voice Bot. The schematic representation of the robotic arm control system is shown in below Fig 1.

The robot moves in a trajectory line, covering its locality or zone which it is responsible for cleaning. The camera, mounted on the chassis of the robot, remains inactive until an object is detected by the ultrasonic sensor. When an object is detected, the camera captures a single image and send it to the server for image processing classification to detect it as garbage or non-garbage.

1. Robotic arm

The robotic arm is driven by dc motors and each dc motor has a potentiometer attached to the gear axis so that the potentiometer resolves as the motor rotates, the potentiometer gives a certain value of voltage as a feedback which is used to detect the position of that particular motor

2. Raspberry pi

The raspberry pi is a small single board computer. That connects to a computer monitor or tv and uses input devices like keyboard and mouse. These features are able to deal with complex computer vision algorithms and access public web service to accomplish voice control.

3. Ultrasonic sensor

This sensor is used to measuring distance or sensing objects are required. Ultrasound can also be used to make point to point distance measurements by transmitting and receiving discrete bursts of ultrasound between transducer.

4. Pi camera

It is a portable light weight camera that supports raspberry pi. It is commonly used in surveillance drones since the payload of camera is very less. Apart from these modules pi can also use normal USB webcams that are used along with computer.
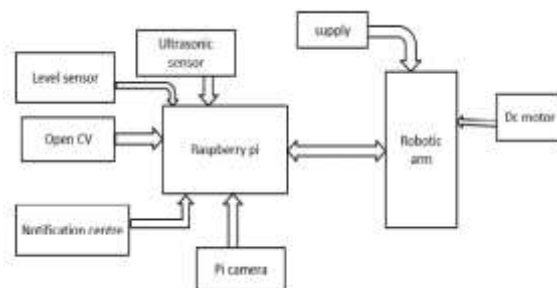
Fig:1 Block diagram of implementation of robotic arm.
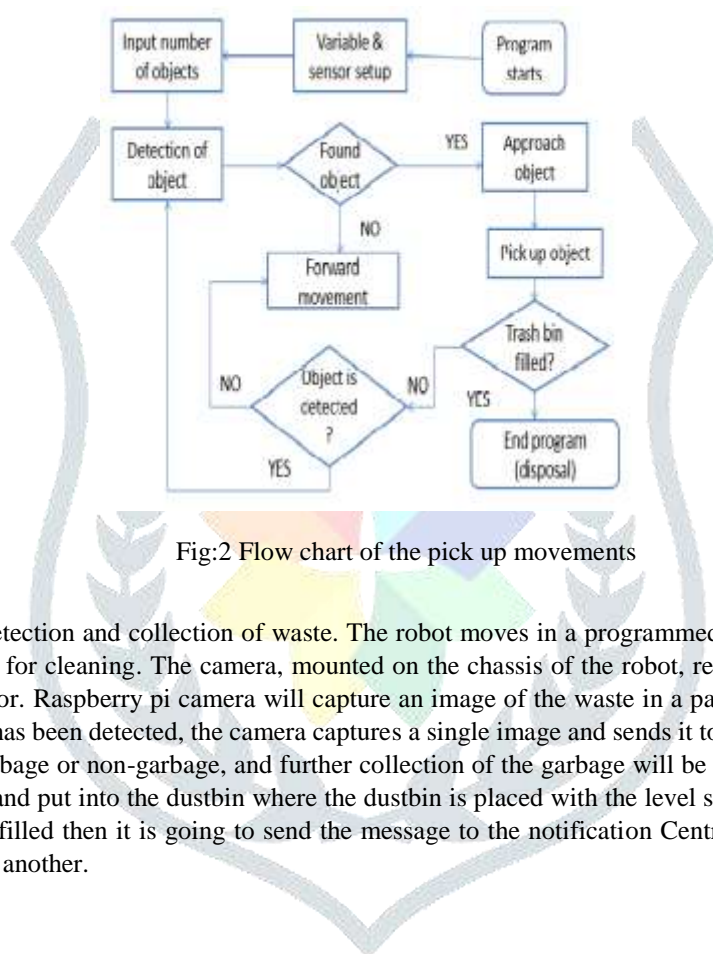
III. METHODOLOGY

Fig:2 Flow chart of the pick up movements

This paper is about detection and collection of waste. The robot moves in a programmed trajectory, covering its locality or zone which it is responsible for cleaning. The camera, mounted on the chassis of the robot, remains inactive until an object is detected by the ultrasonic sensor. Raspberry pi camera will capture an image of the waste in a particular area, and will store it as default image. Once an object has been detected, the camera captures a single image and sends it to the server for image processing classification to detect it as garbage or non-garbage, and further collection of the garbage will be done by using Robotic Arm and the Collected trash are picked and put into the dustbin where the dustbin is placed with the level sensor which detects whether the dustbin is filled or not. If it is filled then it is going to send the message to the notification Centre so they can identify the filled dustbin and they can change to another.

IV. COMPUTER VISION

Since the distance sensors send out the ultrasonic wave in a cone, sometimes the sensor cannot precisely detect the location of an object or find the center of an object. So the pi camera can be used for compensation of the disadvantages of the distance sensor to find the precise location of an object. In another word, the camera is used to detect an object and tell the robotic arm to face the object straight and the gripper points at the center of the object in order to improve the accuracy of the pickup movement

Open CV is a programming function library for dealing with image processing and real-time computer vision. The functionality of the library includes video/ image input and output, processing, display and facial recognition, object identification. It also includes the machine learning library which contains convolutional neural network, decision tree learning, deep neural networks.

The robotic arm need face the object straight and the gripper must point at the center of the object when it picks up the object. In addition, the camera is installed in the middle of the gripper. So the center of the object should be in the middle of x-coordinate the video. The center of the objects can be calculated by using the image moment. The Fig 3 below shows the results of object detection and the location of the center of the objects.

Fig:3 The object detection and the center of the objects in the image

V. VOICE CONTROL

In this paper, the robotic arm can be controlled by voice commands. The voice commands are collected by voice bot application and then recognize. After voice recognition, the voice commands are transferred to plain text commands to a public web service. So, the raspberry pi does not need to be on the local network with voice bot to access the web service and gets the text commands. Then, the raspberry pi gives commands to raspberry pi by changing its pin status. After raspberry pi successfully reads the pin, it will control the robotic arm to do a specific movement.
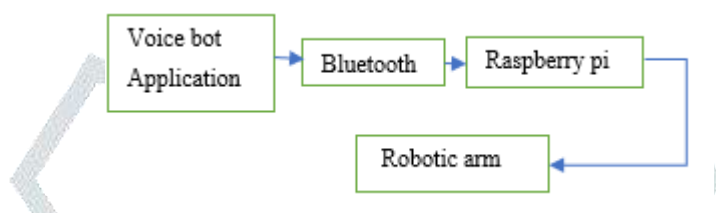

Fig 4. The schematic of the voice control of the robotic arm

The voice bot which creates a secure connection from a public endpoint to a locally running web service. It allows the raspberry pi to collect the text commands from voice bot through Bluetooth from any network. There are three voice commands have been designed for controlling the movement of the robotic arm.

The table III shows the Movements corresponding the voice command.

TABLE I THE MOVEMENT OF THE ROBOTIC ARM CONTROLLED BY VOICE COMMAND

Voice command	Movement
Robotic arm to scan	The basement of the robotic arm starts to rotate from 0° to 180°
Robotic arm to pick up an object	The robotic arm finds an object and picks it up, then place the object at a specific place.
To stop	The robotic arm stops the present movement and stops where it is.

VI. CONVOLUTIONAL NEURAL NETWORK

It is one of the most popular machine learning /Deep learning architectures due to its immense popularity and effectiveness of convents, there is a search in interest for deep learning. In a matter of three years, there has been huge progress.
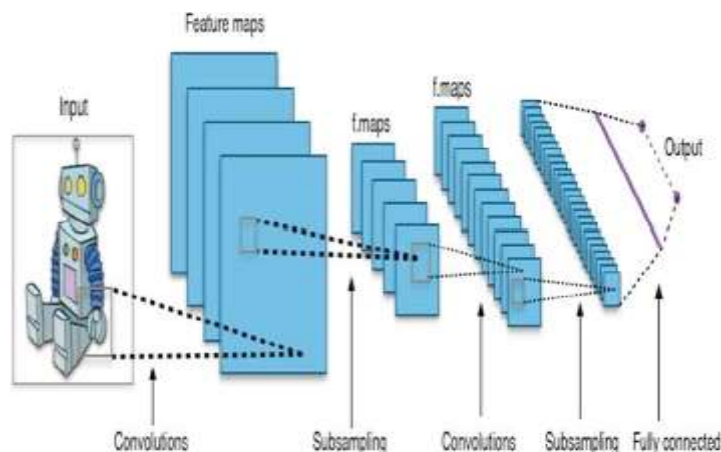.

Fig: 5 Convolutional neural network

In today's time, CNN is the model for image processing. Its accuracy and precision is what that makes it stand out from the rest of the machine learning algorithm.

An image can be represented in pixels which are arrays in its unique way and it depends on the image resolution used for the training set.

CNN is used by deep learning to train and test the model. It will make sure that the model passes through a series of convolutional layers with filters (Kernels), Pooling, fully connected layers (FC) and apply reLU function to classify an object with probabilistic values between 0 and 1.
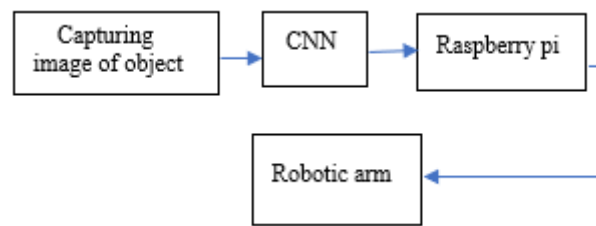

Fig: 6 process flow

In the implementation, CNN is trained by using 100 images of bottle and 40 images of apple. To train neural network, we applied 10 epochs and achieved up to 99.22% of accuracy. In the execution of proposed model following steps will take place:

Step 1: First of all, the image will be captured for detecting the object. In this project, the web cam is used to capture the image and that image will be taken as input using OpenCV (OpenCV is an open-source C++ library for image processing and computer vision) in python.

Step 2: After getting an image, CNN model is used to detect fruit from the image.

Step 3: Once the fruit is identified, a particular signal will be generated for a particular fruit. In our case, we generate signal as first letter of name of fruit (A for Apple and O for Orange). Then using the concept of serial function the signal will be sent to the Raspberry pi board.

Step 4: Now the dc motor start functioning. The h-bridge which acts as a driver is used to control the dc motors of the robotic arm. The robotic arm will move for a fixed time (defined in code) to reach at the dustbin and will place it.

VII. RESULTS AND DISCUSSION

1. The pi camera has detected and capture the image. The captured image is compared with the default image that is the image which the robot is trained. The three detected objects which are 71%, 60%, 53% in match with the default Image. In the black window the Robot has detected the objects has dry waste.
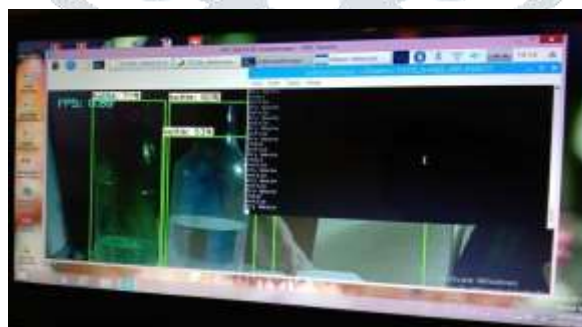
2. Giving the commands for the robot to move forward, reverse, stop, open, left from the voice bot application.
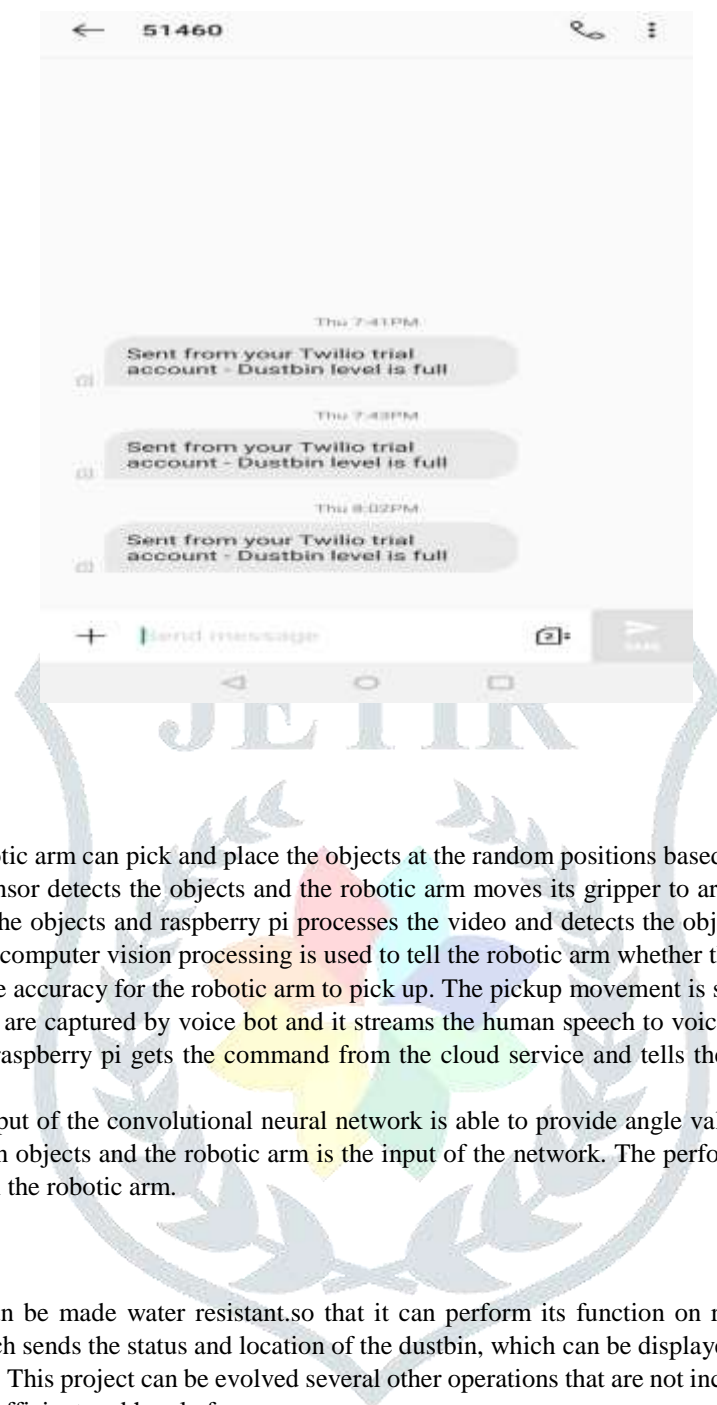

4. Using various commands through voice bot giving command to pick the bottle the image shows robot has picked the bottle.

4. The robot is going to dump the bottle in dustbin here, the paper box can be seen here used as dustbin.

5. Once the dustbin is full the message (dustbin level is full) will be delivered to the person whose in charge of emptying the dustbin.

VIII. CONCLUSION

In this paper, the robotic arm can pick and place the objects at the random positions based on raspberry pi, simple sensors and camera. The ultrasonic sensor detects the objects and the robotic arm moves its gripper to arrive at the desired location. The camera captures the video of the objects and raspberry pi processes the video and detects the objects and find the centroid of the objects, the information of the computer vision processing is used to tell the robotic arm whether the objects are at the center of its gripper, in order to improve the accuracy for the robotic arm to pick up. The pickup movement is successful and accurate.

The voice commands are captured by voice bot and it streams the human speech to voice service to analyse. It produces the plain text command, and raspberry pi gets the command from the cloud service and tells the raspberry pi which movement should be executed.

After training the output of the convolutional neural network is able to provide angle value for every joint in the robotic arm when the distance between objects and the robotic arm is the input of the network. The performance of the neural network is accurate and reliable to control the robotic arm.

IX. FUTURE SCOPE

The whole system can be made water resistant.so that it can perform its function on rainy days. GPS module can be interfaced to each dustbin which sends the status and location of the dustbin, which can be displayed on the GUI maintained by the respective authority of the city. This project can be evolved several other operations that are not included in this project. Expanding the system will result in more efficient and hassle free
Operations.

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