Voice Interfaced Arduino Robotic Arm for Object Detection and Classification

Vishnu Prabhu S and Dr. Soman K.P

Abstract— Nowadays Robotics has a tremendous improvement in day to day life. But in real life interaction between humans and robot in various applications done manually through keyboards and also it is difficult to send a person inside hazardous environment like in chemical plant, bomb detection, etc. To overcome such problem robots can control or interfaced through voice commands which will be given by the person to control it in such environments. This paper is mainly focus on to control or interfaces the robotic arm by human's voice commands to do a particular task that is to pick an object by detecting and classify it accordingly.

Index Terms— Robotic arm, Arduino, DC motors, H-Bridge, Pulse Width Modulatiion (PWM), Processing, Roborealm.

1 INTRODUCTION

Robotics is advancing rapidly in all areas. Presently various Industries is moving from automation to robotization to increase productivity and also to deliver uniform quality.

Currently, everyone find substitues for himself to carry out his orders and also to work in a hostile environment. Robot and robot like manipulators are now commonly used in hostile environment, such as at various places like atomic plant, chemical plant, bomb detection areas, etc. One type of commonly used manipulator in Industries for various applications is robotic arm also known as robotic manipulator.

In this paper, we focus on to control the robotic arm by voice commands which will be given by the user by Processing software where speech recognition system is been built. The commands passed through serial communication from Processing to Arduino and it sends it to Robotic arm to pick the object and object recognition taken place by Roborealm software for futher classification.

This paper is organized as follows. Section 2 gives a brief introduction about Robotic arm. Section 3 explains about Arduino role. Section 4 gives study of Processing. Section 5 explains about Roborealm Section 6 Implementation Section 7 Concludes the paper.

2 INTRODUCTION OF ROBOTIC ARM

2.1 OWI-535 Robotic Arm

A Robotic arm has similar functions to a human arm. Here OWI 535 Robotic arm is been used for the process. It is an open or closed kinematic chain of rigid links interconnected by movable joints. The mechanical structure of a robotic manipulator consists of rigid bars called links and the links of a robotic arm are connected together to form a mechanical structure through joints.

Fig: 1 OWI 535 Robotic Arm

It has five motions where each motion a DC motor is been used.Five motions are: Base Rotation, Base motion, Elbow Motion, Wrist motion, and Gripper or end effector.

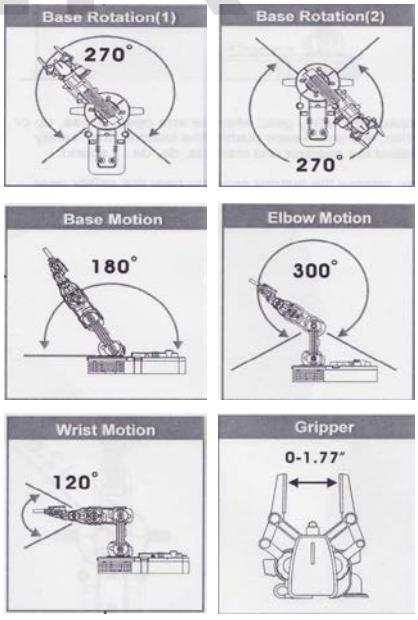

Fig: 2 Rotation Limits of each motion in Degrees

- *Vishnu Prabhu S student of masters of technology in Computational Engineering and Networking in Amrita University, Amrita School of Engineering-Coimbatore,Tamil Nadu. Email:vishnuprabhu272@gmail.com*
- *Dr. Soman K.P Head of Cmputational Engineering and Networking in Amrita University,Amrita School of Engineering-CoimbatoreTamil Nadu.*

2.2 DC Motor Control

As mentioned above all DC motors in robotic arm is controlled by H-bridges.It is an electronic device that allows the DC motor to run forward and backward.Here L293D dual H-bridge motor driver integrated circuit (IC) is used, (i.e) two DC motors can be driven simultaneously in both direction. So, totally three L293D IC's are used for robotic arm.

Fig: 3 L293D H-bridge (IC)

Fig 4 shows the Circuit diagram to control DC motors with an H-bridge (IC) is given below

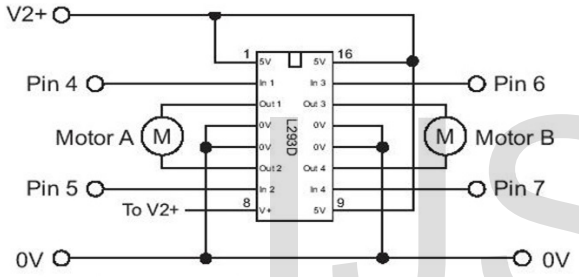

Fig: 4 Circuit diagram of L293D H-bridge (IC)

3 ROLE OF ARDUINO

Arduino is an open source platform it is based on a simple microcontroller board and also it has an environment for writing software for the board.

Major advantages of using Arduino are it is very inexpensive, clear programming, and it is an open source and extensible software and hardware.

In this paper, Arduino Mega2560 is used. Fig 5 gives the Specifications of Arduino Mega2560.

ARDUINO MEGA 2560	
Microcontroller	ATmega2560
Operating Voltage	5v
Input Voltage (recommended)	7-12V
Digital I/O pins	54 (of which 15 provide PWM output)
Analog Input pins	16
DC Current per I/O pin	40 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

Fig: 5 Arduino Mega2560 Specifications

Fig 6 is the circuit board used for the work which it contains Arduino Mega2560 and L293D H-bridge's

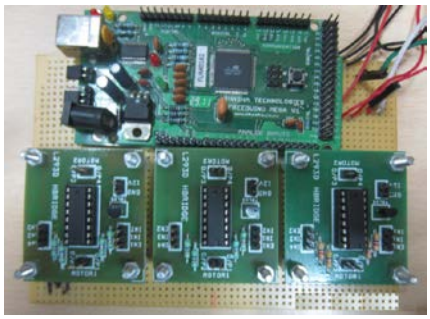

Fig: 6 Circuit Board

3.1 Pulse Width Modulation (PWM)

Pulse Width Modulation technique is been used, to control the speed of the DC motors and also to find the angle (i.e) how many rotations can a DC motor needs to reach a particular-point.

PWM gets analog results with digital means.Digital control are used to create a square wave, a signal switched between on and off. AnalogWrite () function which is used in the Arduino uses this technique to emulates an analog signal using digital pulses.PWM is on a scale of 0 – 255.

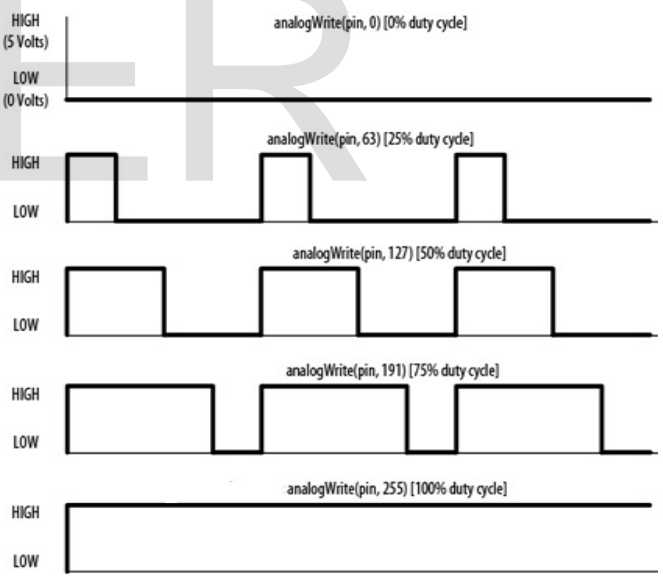

Fig: 7 Pulse Width Modulations

Fig 7 represents the Pulse width Modulation for four different scales (i.e) for 64, 127, 191, and 255 it gives rotation of DC motor they are as follows:

PWM is 0 → 0 degree of rotation.
PWM is 63 → 90 degree of rotation.
PWM is 127 → 180 degree of rotation.
PWM is 191 → 270 degree of rotation.
PWM is 255 → 360 degree of rotation.

4 PROCESSING

Processing is an open source programming language and it is useful in various environments like creating images, animationas and for interactions. It is useful to talk with the Arduino and for display or save some data collected by arduino. It also works best for communicating simple information.

Interaction or speech processing with Robotic arm from user is takes place by Processing; it sends the commands through Arduino by Serial communication to Robotic arm.

Voce is a speech synthesis and recognition Library used in Processing for Speeech Processing. It is a cross platform, accessible from JAVA and C++ .It uses CMU sphinx internally.

Sphinx4 and FreeTTS is the toolkit used to build the speech recognition system.

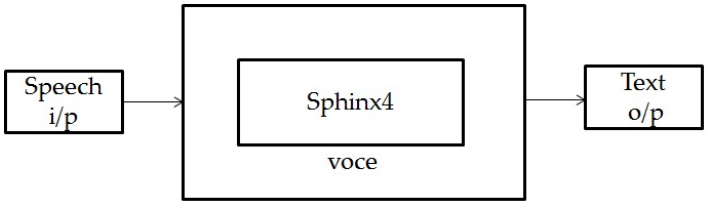

Fig: 8 Voce Architecture

Voce for speech recognition it uses sphinx4 microphone which it continuously listens for incoming audio data from the user's audio hardware. Grammer file is used to define what is been recognized during the time of speech recognition and also these files are application specific.

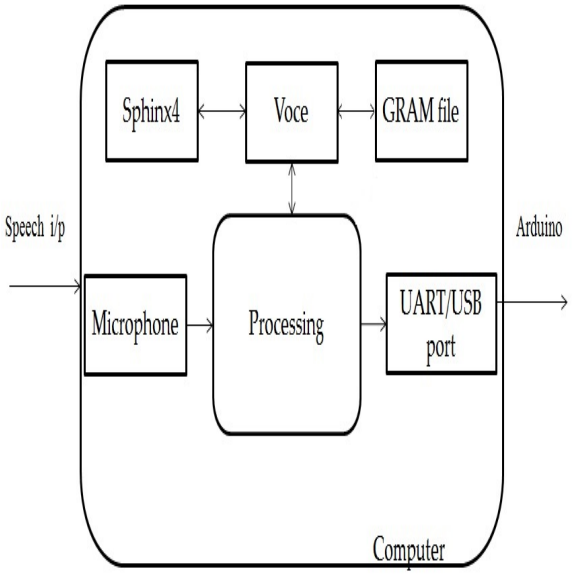

Fig: 9 Scematic representation of Processing

5 ROBOREALM

Roborealm is an application used for various sources like image analysis, computer vision, also for robotic vision system by using USB webcam and a PC.

Roborealm is used for robot's environment process for acquiring images and analyze what needs to be done and finally it sents the information through serial communication to robotic arm by interfacing with Arduino.

6 IMPLEMENTATION

6.1 Proposed Methodlogy

The Proposed Methodlogy of this paper is given below in form of a schematic diagram

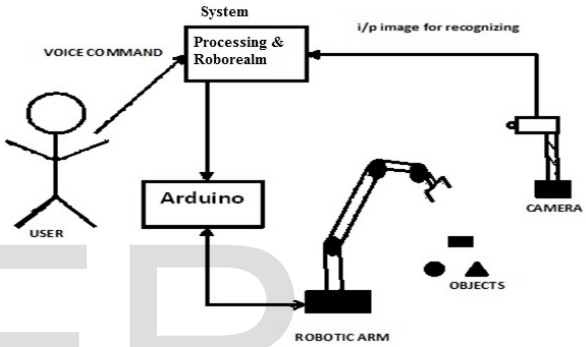

Fig: 10 Proposed Methodlogy

Step 1: Uploading the program in Arduino

Before uploading the program we need to set the Board and Serial port number correctly.

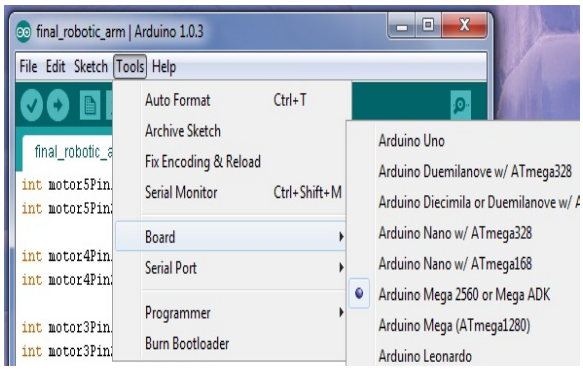

Fig: 11 Select the Arduino Board

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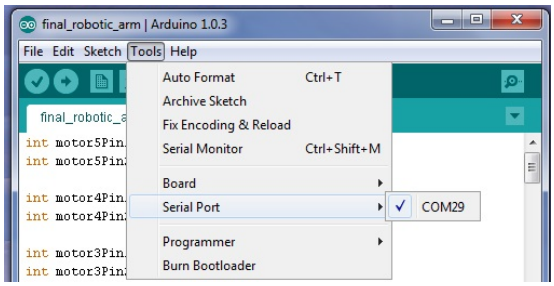

Fig: 12 Select the Serial Port

Step 2: Upload the Program to the Arduino Mega 2560 for the robotic arm to do the operations accordingly by the user's voice commands received by serial communication from Processing.

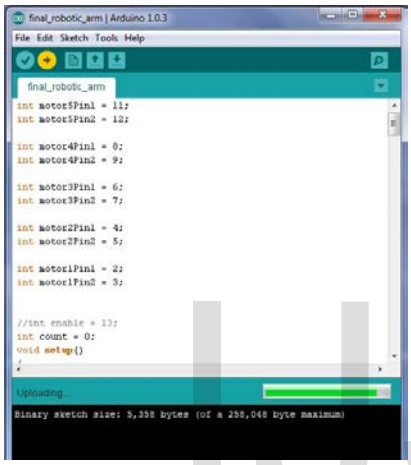

Fig: 13 Upload the Program

Step 3: Open Processing application for sending the voice commands to robotic arm. In this paper we used Isolated Speech recognition that is assigned numbers from one to ten to each DC motor to move forward and backward. For example for base motor if voice command is one, the motor will rotates forward and if command is two it rotates backward.

Fig: 14 Run the Program in Processing

Step 4: User gives the voice command that is from one to ten to move the motors of the robotic arm to pick the object and show it to the camera for the detection and classification purpose.

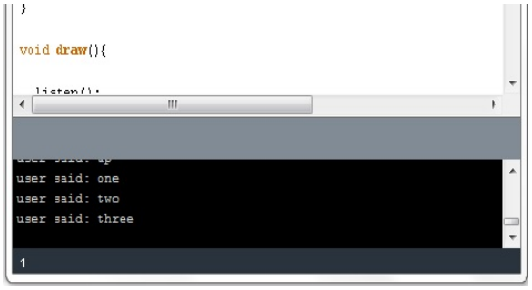

Fig: 15 Voice Commands given by User

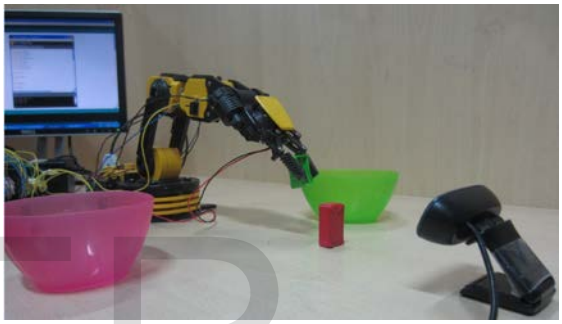

Fig: 16 Robotic arm picks the object

Step 5: Accordingly by the voice commands given by the user Robotic arm picks the object and shown it to the camera.In this paper we considering only the shapes of two different object that is square (green) and rectangle (red), color is for identifion The camera is interfaced with the Roborealm application and it detects the object which is picked by the robotic arm.

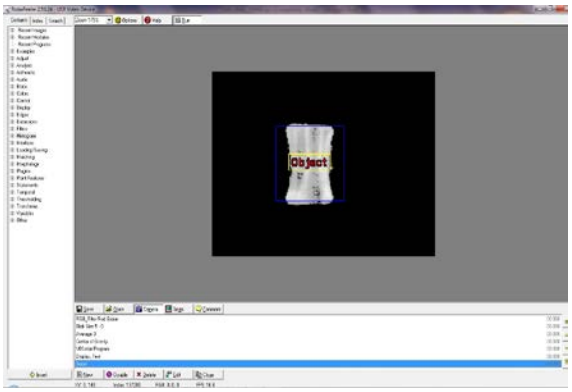

Fig: 17 Rectangular object detected

Step 6: Upload the program in Arduino for the object detected done by the Roborealm. Based on the Object's Center of Gravity Density, assign the threshold values for the object's COG_DENSITY value lies for classification.

Fig: 18 Arduino program for object Classification

Step 7: After uploading the program, we need to write VB_script code to get the COG_DENSITY value that is to be sent to the Arduino through Serial Communication by Roborealm.

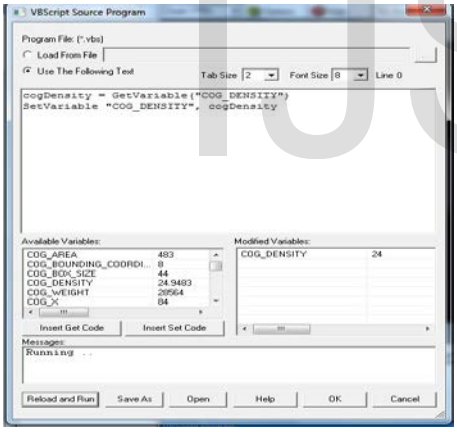

Fig: 19 VB_Script code to get COG_DENSITY

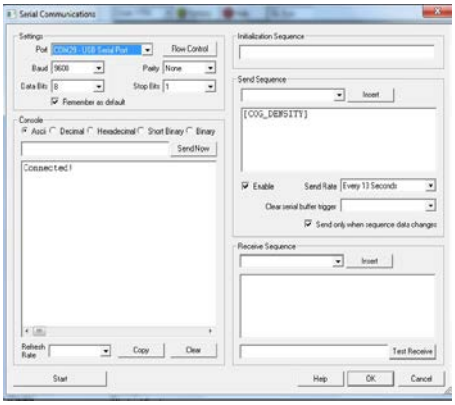

Fig: 20 Serial Communication from Roborealm to Arduino

Step 8: COG_DENSITY value varies based on the shape of rectangle and square objects and it has been sent to Arduino by Serial communication from Roborealm and finally, the robotic arm classify the objects accordingly.

Fig: 21 Robotic arm classify the object

4 CONCLUSION

Voice Interfaced Arduino Robotic arm for detecting the objects and also for classifying the objects is successfully implemented.In this paper we mainly focus on the shapes of the objects for detecting and classifying. In future, it can be further continued for detecting the objects based on the color, shape deformation.etc.

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