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 Modulation (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 substitutes 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 further 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 Computational 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)](image)

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)](image)

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.

![Fig: 5 Arduino Mega2560 Specifications](image)

### Table: Arduino Mega2560 Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcontroller</td>
<td>ATmega2560</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>5v</td>
</tr>
<tr>
<td>Input Voltage (recommended)</td>
<td>7-12V</td>
</tr>
<tr>
<td>Digital I/O pins</td>
<td>54 (of which 15 provide PWM output)</td>
</tr>
<tr>
<td>Analog Input pins</td>
<td>16</td>
</tr>
<tr>
<td>DC Current per I/O pin</td>
<td>40 mA</td>
</tr>
<tr>
<td>Flash Memory</td>
<td>256 KB of which 8 KB used by bootloader</td>
</tr>
<tr>
<td>SRAM</td>
<td>8 KB</td>
</tr>
<tr>
<td>EEPROM</td>
<td>4 KB</td>
</tr>
<tr>
<td>Clock Speed</td>
<td>16 MHz</td>
</tr>
</tbody>
</table>

![Fig: 6 Circuit Board](image)

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](image)

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, animations 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 Speech 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. Grammar file is used to define what is been recognized during the time of speech recognition and also these files are application specific.

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 sends the information through serial communication to robotic arm by interfacing with Arduino.

6 IMPLEMENTATION

6.1 Proposed Methodology

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

Step 1: Uploading the program in Arduino
Before uploading the program we need to set the Board and Serial port number correctly.

Fig: 10 Proposed Methodology

Fig: 9 Schematic representation of Processing

Fig: 11 Select the Arduino Board
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.

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 rotate forward and if command is two it rotates backward.

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.

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 identification. The camera is interfaced with the Roborealm application and it detects the object which is picked by the robotic arm.
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.

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.

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.

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.

REFERENCES