Voice Activated Robotic Vehicle for Multipurpose Applications

Syed Noman Mehmood[1],Muhammad Tayyab[1], Tahir Qadri[1] , M. Aamir Khan[1] , Irfan Anis[2]

Abstract- In today's world technology has made our lives easier and more enjoyable, in this continuity voice controlled robotics framework is exceptionally helpful for people in high hazard territories. The intention to use robots commercially and domiciliary is executing challenging work into more conveniently simple way. There are several robots designed for industries, commercial purpose, domestic purpose, for transportation etc… The main idea of this paper is to design a multipurpose robot vehicle with robotic arm which is controlled by voice commands. This multipurpose voice control robot operate on land, seas, rivers, ponds and ocean zone. This robot provide services from land to marine or vice versa. In the scenario, where the use of robots has move from industries to normal life, a healthy interface require between a human and robot. Speech recognition or speech to text recognition technique is an interface between human and robot. In this project, it is implemented to control the robot with voice commands by developing Voice Control Robot Android Application (VCRAA) which is installed in android mobile. This multipurpose robot is independent of speaker and work according to the voice commands. The voice command received by the controller through Bluetooth module in the form of text. This controller gives commanding signal to robot vehicle and robotic arm according to the command. The operation of the robot is that it can perform different movements, turns left, right, pick, place etc… As there are limitations in the robotic work, people are more focusing on more accuracy provided by the robots. The project is the model how to reduce the manual efforts being put by humans. The amphibious robot is the next step in order to achieve more accuracy and efficiency. A robotic arm is designed using the solid work to simulate a hand model action. The main aim of this project is to build a robot which can provide services to both land and sea areas where difficult for human to go. Applications of the developed system can be extended to service transportation, exploration of .hazardous environments and public safety to mention a few

***Keywords*:Robotic Arm, Buoyancy Force, Raspberry Pi Python, Voice Control Robot Android Application (VCRAA)**

INTRODUCTION

The growth of emerging technologies has been increased day by day in the modern world and we all benefit from this emerging technologies. Over the years, humans have evolved in investing new technologies for reducing human effort and saving human life. But research and development of technologies are still irreversibly fast and every day we can meet with new things that makes our life easier and comfortable. This progress is unstoppable in any industry. In this regard the surprising raise in the utilization of robotic technology offers various advantages and drawn the attention of both academic and commercial investigation. Robotic systems is a set of different units which can be used to perform diverse tasks in industrial and domestic areas. Robot is a package of system technologies that automatically operate and perform specific actions according to the command. All over the world Robot has been controlled remotely. With growing modernization in the field of Robotics, robots can be control with more natural interface with less human interference. The most widely used natural interface is speech. The voice controlled robotic vehicle is demonstrated in this paper which has the ability to follow voice command from user. Recently, the voice controlled robots have been widely used in different fields. New research also focuses on the controlling of Robot by using voice command system. In [1] develop the robotic arm which is controlled by voice command through android application by using raspberry Pi. Develop a voice controlled robotic arm by using voice recognition module and Raspberry Pi controller which has the ability to recognizing individual voices, object identification by using Machine Learning approach and after recognition particular object pick by it [2]. Designed a robot vehicle by using human voice command through Bluetooth module and Arduino controller. This voice control robot based on speech recognition, in which voice command given by android application [3-4]. In [5] designed the Voice Control Human Assistance Robot which move objects from one place to another, provided information to the user from internet, and also use machine learning algorithms for character recognition and ultrasonic sensors use for obstacle avoidance. The whole process control by the Raspberry Pi. In [6] designed a multifunctional assistive robot by using raspberry pi zero, which performed face detection with live streaming for home security, and also detection of events, PDF reading, newspapers, stories, articles and voice recognition. In [7] suggest using voice control in Medical robot for surgery. In [8] determines the most problematic voice commands and ideal voice commands for voice control of a collaborative robot by doing analysis which have main focused on various voice commands, their repeatability and reliability in robot-human cooperation. In [9-11] the proposed method of voice

[1]Sir Syed University, Pakistan
[2]IQRA University, Pakistan
Email:mtahir@hotmail.com

control robot by using android smart phone. In this method voice application use to give the command and speech recognition method used. In [12] designed the remote control robot which is control by both manual and voice. For this android application designed and ultrasonic sensor used to obstacle avoidance. In [13] present the remote controlled floating robot which is used to remove the waste from canals, ponds, rivers, or in oceans. It has the capability of working for four hours continuously without charging. In [14] designed a floating waste scooper robot to collect the large amount of dry waste like plastic bottles from water surface. In [15] design a Robotic Arm Assistant powered by machine vision and voice recognition to assist people with physical movement impairments by detect and deliver objects to the user using YOLO Algorithm. Develop a robot vehicle by using Arduino and RF module in which robot vehicle controlled by multi-way i.e. by voice command, by keypad buttons and by word command typing in GUI [16]. In [17] construct a robotic car which is controlled by human voice command by using android app and voice module. In [18] develop a robotic vehicle work as a fire fighting robot which controlled manually by android phone via Wi-Fi or Bluetooth who detect and extinguish the fire. In [19-20] is the implementation of the arduino based robotic vehicle controlled by voice command to aid disable people.

The rest of the script is organized as follows. The overall system model present in section2. The working of the system will explain in section 3. Section 4 briefly discuss the software applied in this design, section 5 results and discussion and section 6 will end this article with conclusion and future scope.

SYSTEM MODEL

The system model proposed here is the multipurpose assistive robot based on voice control using android application. This research aims to define and present the abilities to develop robot which not only operate on land but also within the ocean zone. We summarized our efforts to aim to design a robot who provide services from land to marine and vice versa. In this design robot balance itself on the sea level while performing the given task. The system model consist of two parts. In the first part develop an android application based on voice recognition system. In the second part control the motion of robot which is design with robotic arm control by the Raspberry pi controller.

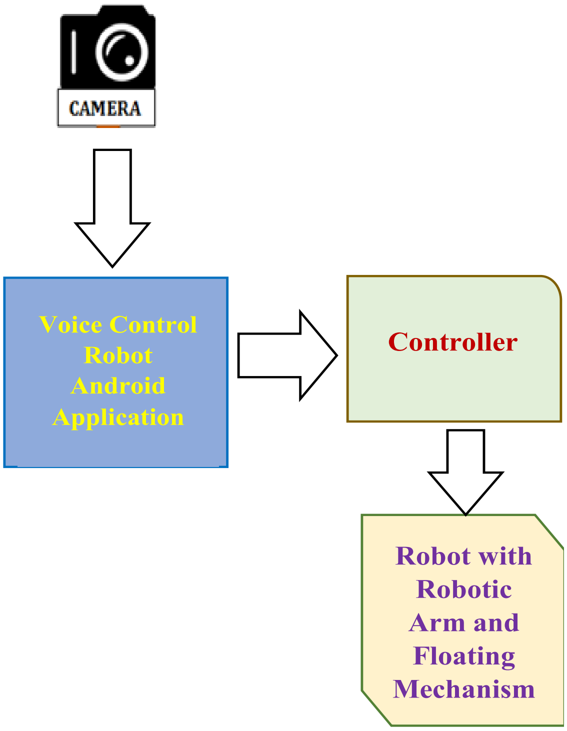

Figure1. System Model

Voice Controlling Mechanism using Android Application
Controlling the things with speech makes human life easier and comfortable. In this article the presented model is an implementation of this approach. The main reason to use this approach is, the speech is an important and easier interface to control many systems and communicate with computers. In the proposed model the movement of Robot vehicle with robotic arm control by voice command. In this multipurpose robot, a camera module is used to perceive its environment and provide an information about their surroundings through live streaming. This helps to direct the movement of robot and assign task perform by the robotic arm.

To direct the Robot remotely through voice commands develop a Voice Control Robot Android Application (VCRAA) using android software development kit. To develop application software for low power handheld devices like smart phones, tablets etc… used mobile application development process. VCRAA operate by using Android smart phone to give voice command. Android emulator used to develop and test the application without using physical device. To recognize the voice commands, automatic speech recognition or speech to text recognition technique is used. In this technique the voice command given by the user can be fetched using android application which will convert the voice command to the text. The text can be a numeric value or a word. In order to convert the voice commands into text android phone process the different voice commands by using android application and identify the voice command or speech by recognize its components. So when user give the command "STOP" the sound of this word generate the sound packets called Phonemes that is s, t, a, a, p. By using this real bits of sound the system recognize the command STOP and covert into its respective text. The voice commands transmit after conversion into text to the controller of the Robot wirelessly by using Bluetooth module.

The voice commands use in this proposed model to control the movement of Robot and perform the task by robotic arm are listed as:

Table 1: Voice Commands

S.No	Commands
1	Stop
2	Go Forward
3	Go Backward
4	Slow
5	Fast
6	Go Up
7	Go Down
8	Go Right
9	Go Left
10	Break
11	Pick
12	Place
13	Drop
14	OK
15	Clockwise
16	Anti-Clockwise
17	Open
18	Close

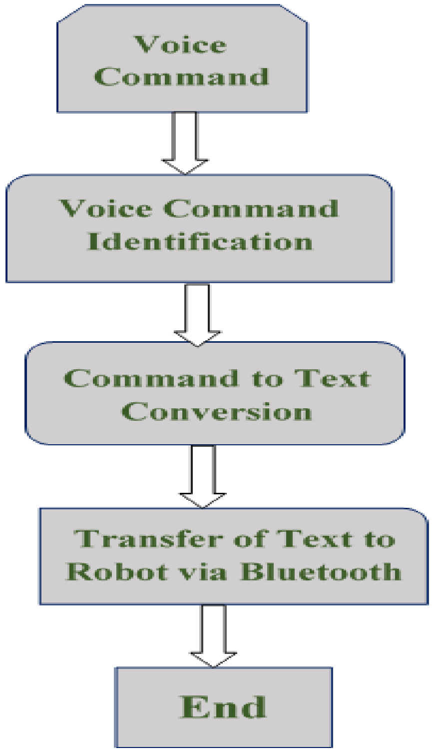

Figure2. Flow of Voice Control Mechanism

In the Android application also initialize the control button to control the movement of Robot by using button. After press the voice button for voice command the race speed is set 130 in the android application.

Robot Controlling Mechanism using Raspberry Pi

In proposed system, the operation of Robot vehicle and robotic arm is controlled by Raspberry Pi. Raspberry Pi is a single computer board act as a mini CPU which process all the voice commands and control the movement of robot vehicle and its robotic arm accordingly. It has inbuilt Bluetooth which provides the wireless transmission between the VCRAA which is installed in smart phone and the Robot vehicle. Bluetooth is a wireless protocol for short range communication from fixed or mobile devices. The user initiate the voice command from android smart phone using VCRAA. That command transmit wirelessly using Bluetooth which operates at 2.4GHz through ISM band in the form of text. The raspberry Pi receive the command using Bluetooth transceiver and process by comparing it with pre-programmed command such as go left, go right, go forward, go backward, pick, place etc… After read the command the Raspberry Pi gives the commanding signal to operate the Robot vehicle and Robotic Arm according to the command.

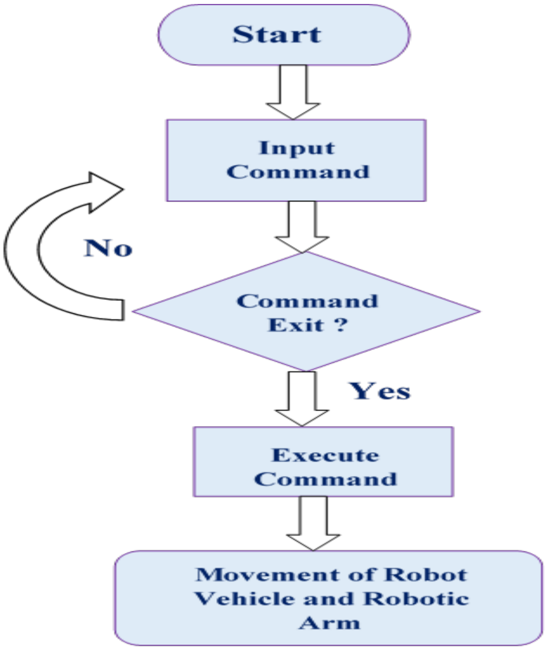

Figure 3. Flow of Robot Control Mechanism

Two DC motor with gripped tyre used to drive the robot. Because the high ampere motor the relay H-bridge motor controller (driver) use to control the speed and direction of rotation of motors. A wheel or tyre is a circular block of durable and hard material. The Robot vehicle move in different direction as per received voice command. When user gives command "go left" the motor driver stop the left wheel and right wheel will move then robot moves in left direction similarly for "go right" command it stops the right wheel and left wheel will move then robot moves in right direction. For sharp turn, one wheel move in clockwise direction and other wheel move in anticlockwise direction. The mechanism of the movement of Robot vehicle shown in fig 4.

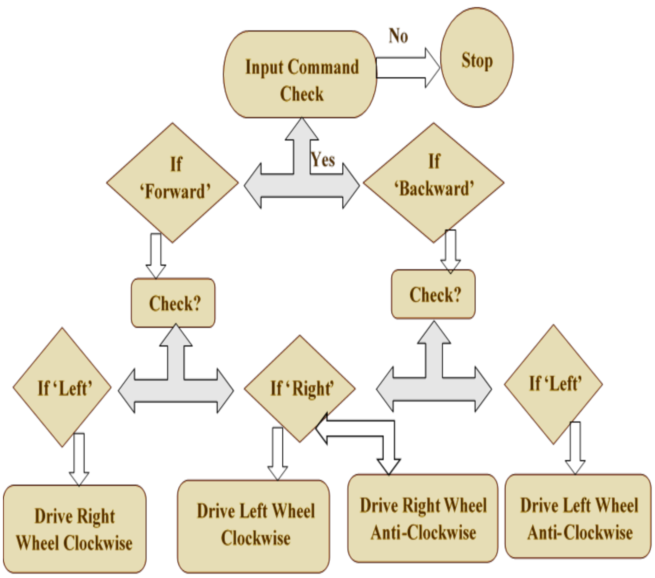

Figure 4.Flow of Robot Movement Mechanism

C. Robotic ARM Mechanism

Robotic arm is a programmable mechanical arm which has similar skills to a human arm. Working in hazardous areas or can be used where not possible for actual human to work or unavailability of a human at the desired location is the most significant advantage of robotic assistance with robotic arm. The robotic arm work on the same mechanism of that in the excavator. The front end of robotic arm connected with gripper. The arm of the robot lifts and expands the gripper to assists the gripping and moving of objects. The other end of arm connects the amphibious base with robotic arm occasionally called 'boom'. These two major ends combine with the turning point 'elbow'. Four window motors are used that are connected at the arm of the robot for movement. The motors are connected to the GPIO pins of the Raspberry Pi. The robotic arm also controlled by voice command. The raspberry Pi receive the command using Bluetooth transceiver and process by comparing it with pre-programmed command such as pick, drop, open etc… After read the command the Raspberry Pi gives the commanding signal to operate the Robotic Arm according to the command. Robotic arm has following characteristics. Motion of wrist is 120 to 140 degrees, Elbow range of 280 to 300 degrees, Base rotation of 250 to 280 degrees, Base motion of 180 degree, vertical reach of 18 inches, horizontal reach of 14 inches, lifting capacity of 100gm and gripper for holding object.

D. Floating Mechanism of Robot Vehicle

The solution to the problem of producing amphibious robot is to design a robot vehicle with the mechanism responsible for mobility in water. The designed robot vehicle floats on the same mechanism like boats which floats on the sea bed. The boats float on concept of force called buoyancy, which is the reason for boat floating. An object float or sink depend on the density of the object. If density of object is denser than water it will sink; if it is less dense than water it will float. Law of physics fundamental to fluid mechanics demonstrated by Archimedes' principle, which indicates that the upward buoyant force that is applied on a body immersed in a fluid, whether fully or partially underwater, is equal to the weight of the fluid that the body displaces. If the weight of the water displaced is less than the weight of the object, the object will sink, otherwise the object will float, with the weight of the water displaced equal to the weight of the object. The base of robotic vehicle consists of two propellers which are connected with two DC motors that are used for the movement of robot on sea bed while the robots turns by asymmetrical motor activity in base on the either side of the body. This robot vehicle use for waste collection in canals, rivers, ponds and oceans.

WORKING ALGORTHM

- Robot Vehicle with robotic arm waits for user's command.
- User gives voice command by using VCRAA from android phone.

- Voice command recognition or identification process initiated and convert it into respective Text.
- The command transmit via Bluetooth in the form of Text.
- By powering on the Raspberry Pi, the robot is at standby mode ready to receive the voice command. Raspberry Pi is the brain of the project controlling all the movements of the robot.
- Raspberry Pi process the command and compare with Pre-Programmed command and determine the action to be performed.
- If the command is matched, then the task defined by that particular command is executed by the robot.
- The execution of the task includes movement of the Robot vehicle and the robotic arm is used for picking up the desire objects form land or sea.
- The robot waits for next commands and is back on standby mode.
- If the command is not recognized or not matched, the robot stops.
- The robot then waits for further next commands.

SOFTWARE DESIGN

In this project, design implements two software modules. The first module is server side python code in Raspberry Pi controller. The second is client side Voice Control Robot Android Application (VCRAA) installed in the Android phone. The server side python code receive data from client side application. The python code combine with Bluetooth socket program to receive data from client side application wirelessly and also combine with driver code to drive the DC motors for movement of robot vehicle. Server waits for the connection with the client side application program. Once the connection is established, it receive the voice control command in the form of Text and process it for matching by using if else statements. After matching sends the signal to each motor according to the command. Depending on the input value, by using if else statements to switch to each movement of DC motors connected with the robot and robotic arm. Client side Voice Control Robot Android Application (VCRAA) develop using android software development kit. Automatic speech recognition or speech to text recognition technique is used to recognize the command and convert it into Text. After connection the Raspberry Pi with application via Bluetooth, then will be send voice command in the form of Text. The server side program is in the "Listening mode", the Robot vehicle and robotic arm acts accordingly.

RESULTS AND DISCUSSION

To evaluate the system prototype, we performed several experiments using different voice commands. The most important parameters for voice command based operated systems are accuracy and response time. Accuracy means how accurately system understand the voice command and response time means how fast the system reacts on voice command and perform the defined task. In testing phase performance of system model analyze by using these two parameters. Each programmed command test 50 times and their number of responses and accuracy showed in table2. Most of commands achieved accuracy more than 80% but few commands not accurately recognize and have accuracy less than 80%. Table 2 shows "Go Right" command has high accuracy which means system recognize this command easily but the "Ok" command has 60% accuracy which means system facing difficulty to recognize this command or may be speaker not pronounce this command correctly. Another interesting analysis is those commands who performed same tasks but have different accuracy. For example, "Go Forward" and "Go Up" perform same task but "Go Forward" has more accuracy than "Go Up". Similarly "Stop" and "Break" commands perform same tasks but have different accuracy which shows command recognition also depends on speaker pronunciation and the sound of command. Figure 5 shows the graphical analysis of table1, which explicitly shows that the average recognition rate of 85% achieved.

In the proposed model we used automatic speech recognition system so we can use any voice command and any number of commands without need to train the voice module and without any limitations of number of supported commands as compared to [2]. The proposed model is robotic vehicle with robotic arm as compared to [6] so the commands mentioned in table 2 are for both robotic vehicle and robotic arm. The overall accuracy about 96% as compare to [6] after1-2 sec the voice commands followed by vehicle only but with robotic arm the overall accuracy 85% after 1-2 sec the voice commands followed by vehicle and robotic arm together. The proposed model used automatic speech recognition system performed better with average accuracy of 85% as compared to [16] in which used Microsoft's speech recognition.

Table 2: Accuracy of Voice Commands

Voice Commands	Number of Test	Number of Response	Percentage of Accuracy
Go Forward	50	45	90%
Go Backward	50	42	84%
Go Up	50	35	70%
Go Down	50	38	76%
Go Right	50	50	100%
Go Left	50	49	98%
Slow	50	40	80%
Fast	50	40	80%
Stop	50	48	96%
Break	50	44	88%
Pick	50	47	94%
Ok	50	30	60%
Place	50	45	90%
Drop	50	43	86%

Open	50	45	90%
Close	50	45	90%
Clockwise	50	42	84%
Anti-Clockwise	50	38	76%

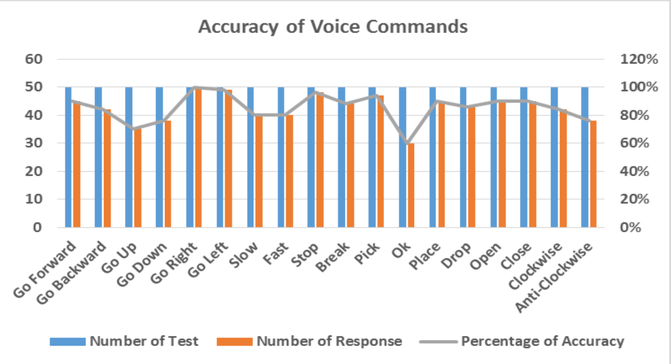

Figure 5: Accuracy of Voice Command

Table 3 shows the response time of each command. Some commands within 1 sec or 2 sec followed by the robotic system and system perform their task according to the command. But most of commands took more than 2 sec. The reason will be the same as discussed in table1 that command recognition depends on speaker pronunciation and the sound of command. Another interesting observation is some commands have high accuracy but response time is slow. For example, "Clockwise" command, "Open" command. Similarly those commands who performed same tasks but have different response time. For example, "Go Forward" and "Go Up" perform same task but "Go Forward" has less response time than "Go Up". The possible reason is the system response time vary according to the sound of command.

Table 3: Response Time of Robot on Voice Command

Voice Commands	Number of Test	Number of Response	Response Time
Go Forward	50	45	2sec
Go Backward	50	42	2sec
Go Up	50	35	4sec
Go Down	50	38	4sec
Go Right	50	50	1sec
Go Left	50	49	1sec
Slow	50	40	2sec
Fast	50	40	2sec
Stop	50	48	3sec
Break	50	44	3sec
Pick	50	47	2sec
Ok	50	30	4sec
Place	50	45	2sec
Drop	50	43	3sec
Open	50	45	3sec
Close	50	45	3sec
Clockwise	50	42	4sec
Anti-Clockwise	50	38	4sec

CONCLUSION AND FUTURE SCOPE

So now we've just about reached the end of this article, but this should not be the end of story. In the presented work designed the voice activated multipurpose robot with robotic arm who not only helpful for human to perform task in hazardous places but also work in difficult situations. This multipurpose robot not only operate on land but can also operate on ponds, seas and rivers. The specialty of the design is to balance itself on the sea level while performing the given task. It also consists of a robotic arm mounted on the base which is capable of picking/dropping different objects from one place to another and it is controlled by wireless communication. The developed robot are able to move in any direction according to the voice command received from user wirelessly. The accuracy of voice command recognition is 85% which can be improve further in future work.

Future work will focus on presenting the framework with increasingly complicated activities and sentences. After certain modification in this design, this robot can be used for military purposes, different industries, surveillances after adding image processing, medical purposes and many more. This Robot can be make it IoT for controlling purposes. This robot can be command without android application by using direct voice recognition hardware, Raspberry Pi library for voice recognition, prerecorded human voice with artificial intelligence and many more.

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