Android Application Based Robotic Arm Control Using Raspberry Pi

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Abstract— This work is intended to build up a pick and place robotic arm vehicle which could be controlled using an android application. The android phone and Raspberry PI board is associated with one another so that the developments can be controlled. The robotic arm is structured out in such a way that it plays out similar action as that of a human hand. Signal is being produced from the Android application to control the robotic arm vehicle either to move ahead, reverse, left or right, which will be further obtained by the Raspberry PI used. The robotic arm works as indicated by the preset program with the assistance of motors. The motors are the ones which drives the arm part as well the body (chassis). The android application is the main command sector of the robotic arm vehicle. The programming in Raspberry Pi is being developed in Python language and various information given will control the movement.

Index Terms— Raspberry Pi, Robotic Arm, Chassis, Android Application

1 INTRODUCTION

Robots are progressively being coordinated into working errand to supplant people particularly to take a shot at replicated activities. Robots can be characterized based on variety of field. They are industrial robots and service robotics. The service robots are the ones which perform in partially or fully autonomous manner to carry out benefits conveniently for prosperity of people and materials. Simultaneously, internet and WI-FI are turning out to be most normal asset for all.

The base part is being built using wheels and motors, whereas the arm part is being built using clamps, grippers and servo motors. Motors plays the major role in the movement of the robotic arm. All of these motors will be connected to the Raspberry Pi. The raspberry pi is a small sized single board PC which performs most of the similar properties as that of a normal computer. It is created by UK based Raspberry Pi Foundation. The Raspberry Pi consists of GPIO pins with the assistance of which we could control the developments.

Basically, robots controlled through internet will have wired connections, which leads to the issue of space limitations. In order to avoid this disadvantage, connections can be made wireless using Wi-Fi facility. Wireless could also mean the use of Bluetooth but here we are making use of Wi-Fi which has got higher range length than Bluetooth. In order to get a constant visual of the robot movement, a camera source can be used so as to get the real time video transmission feedback through the Wi-Fi. Whole control of the system is done using an application built in Android platform. Android application is created in Android studio. Since, the Android application being the center of command of the arm, all of the instructions regarding moving or grabbing specific things is done using JAVA language. This Android application will consist of certain buttons for the movement control. Hence, a signal is being generated from any of the button pressed in the application, which in turn runs the predefined programming done in the Raspberry Pi, on the basis of which the motors works along.

2 LITERATURE REVIEW

Robotics deals with the robotics program, their production and their applications. Robots has gained more prominence in today's technology because it demands a much lower fee to operate than a human work to do the same job, and once programmed robots perform better than an experienced human work. Industries switch to laptops nowadays mainly on job monitoring.

Since many years human beings try to substitute human work with machines. Machines referred to as robots are quicker and more high quality than people. The time period robotics is virtually described as the study, sketch and use of robotic structures for manufacturing. Robots are usually used to operate unsafe, hazardous, pretty repetitive, and unpleasant tasks. They have many one of a kind functions such as fabric handling, assembly, arc welding, resistance welding and computer device load and sell off functions, painting, spraying, etc. Many elements of robots are built with concept from the nature.

Construction of the manipulator as the arm of the robot is based totally on human arm. The robot has the potential to manipulate objects such as pick and location operations. It is also capable to function with the aid of itself. The improvement of digital industry robotic device science has been improved increasingly. As one such application, the service robotic with computer imaginative and prescient functionality has been developed recently.

Time and man power are crucial constraints for completing commitments in massive levels in this surprisingly growing world. In most common and often held works, the automation plays the required role to store manual effort. Selecting and putting jobs from origin to destination is amongst the most significant and most commonly done tasks.

Modern time business has become a growing number of turning closer to computer-based processing usually due to the use of compounded efficiency and standardized quality delivery of end goods. The inconsistency and typically excessive fees of tough automation systems used in the past for automated manufacturing tasks have resulted in a wide-ranging, fully pastime-based use of robot arm designed to perform a multitude of product enhancement in a versatile setting at reduced costs.

In automating the production cycle, use of such Industrial mechanical arm characterizes some of the modern-day traits. Present day mechanical manufacturing arm, furthermore, also demonstrates a mechanical framework and confined-system device design. They focus on basic repetitive work, which appear not to require high precision. The mechanical pick-and - place arm is an user-managed tool that collects subject from the provision and positions at the preferred location that should be operated entirely by human.

Android managed robotic automation developed by Jorge Kazacos Winter. The prime purpose of his work was the wireless transfer of data between a smartphone and the robot, and the development of the robot and its communication system under a good limit and open source philosophy. He does use Arduino micro-controller and Wi-Fi technology within that robotic equipment.[4]

In his paper, M.Selvam has intended to upgrade a mechanical machine with a wireless camera connected to it for monitoring. In his mission of providing communication between robot and smartphone, Bluetooth had once been taken out. Digital camera was used for wireless nightly vision to impart far ranged observation.

Vito M Guardi created the Bluetooth technology technique by creating an android app for a robot that is powered by a microcontroller. The core concept of his research is just to demonstrate that it is possible to operate one android app using completely distinctive digital devices. Vito M Guardi devised android phone and industrial robot interface communication protocol over a Bluetooth.[4]

In the current systems, pick and place robotic arm are managed using Arduino microcontroller .It usually includes Arduino mega micro controller, Bluetooth module, DC motors, voltage controller in this framework. The Microcontroller is interfaced with the Bluetooth unit, driver IC, and voltage regulator. Once the user gives the microcontroller a instruction, it is tested with the associated with different character and if they are identical, the robot performs the exact operation that it can transfer to any direction forward, backward , left, right, arm up, arm down, collect object and position it.[5]

There will be 4 motors which are used, series wheels are used for the vehicle movement and one for arm and wrist and the ultimate one for the gripper movement. Through the mechanical push button type switches, the maximum up and down motion of the arm and closing and opening of the jaw is constrained. The Blue regulate app is used to transfer control system instructions. Blue management is a primary Universal Remote Control for habitual devices enabled by Bluetooth, such as a control system related Bluetooth modules. Upon pressing a button the corresponding ASCII code is sent to the controller.[5]

The Bluetooth communication is facilitated on the system upon power. Once the pairing occurs between the 2 components, the control system will pause for the user 's instructions. Whenever the consumer presses a button the corresponding ASCII code is sent to the control system on the Bluetooth controlled app. This is verified by the operator with prestored value, if they really are

equal then the subsequent operation is completed. The machine is an automobile with a robotic arm. This will collect and position object from supply to destination location according to the command of the user. For this purpose, a connection is achieved via Bluetooth from person smartphone to system. Whenever the customer support the command, the prestored value is compared and consequent moves are made, for example, this can go forward, backward, left, or right. Besides this, the arm may go high or low and the gripper may move away or close down for the application of pick - and - place.[2]

The risks of the contemporary system is that, Arduino is a microcontroller that is used in digital and robotic application. Working of which is based on the code furnished to it. But it may needs to run just one program at a time which needs extra hardware to access the network and use code to properly handle this hardware. And next is the Bluetooth control used in this, the Bluetooth is indeed a feature in wireless technology used to trade information throughout small areas (only about 30 feet away). So the device could only be operated inside certain restricted area. Delay and sever issues are higher in this system Keeping all of this disadvantages in mind, a system can be designed in such a way which is a pick and place robotic arm vehicle using Raspberry PI and controlled by an Android Application. In this, the robotic arm is attached to chassis which is moving vehicle. So it is not fixed at one point, it could run around and do the necessary operations.

3 SYSTEM IMPLEMENTATION

All components of the robot model consists of mainly of two parts : Hardware and Software. Creating a platform is the most important and basic stage, consisting of system equipment and system software.

Creating a hardware of a robotic arm vehicle is the major step in the functioning of the system. Major components of the system's hardware platform is Raspberry PI and Robotic arm and chassis part. The basic motion control is achieved by turning on the Wi-Fi facility to control the free movement of the system and also gets the real time video transmission.

3.1 Raspberry Pi

The Raspberry Pi is a low-cost, small - sized device that is connected into a PC screen, and uses a general mouse and keyboard. It really is a small object which enables individuals of different ages to discover computer technology as well as gain knowledge how to program in languages such as Scratch and Python. An SD card inserted in the board slot acts as the Raspberry Pi hard drive. This is operated by USB and you can connect the video output to a standard Amplifier TV box, an extra contemporary display, or perhaps a Pc to use the HDMI port.

The Pi consists of various versions and here the version used is Raspberry 4 Model B. It consists of 40 vertical GPIO pins. Devices can be connected to these GPIO pins Based on the high and low command of the user, the particular device moves.

Figure 1 : Raspberry Pi

GPIO pins being General Purpose Input / Output connector no longer intended to be connected with any direct analysis feature on the Raspberry Pi board.

Instead, the GPIO pins are there explicitly for the end user to have access to the board for the functions of attaching other hardware boards, peripherals, LCD display screens, and other hardware devices to the Pi immediately on the board. For instance, if you'd like to buy an old console controller as well as cord it to your Raspberry Pi at once to give your arcade an extra real feel, you might want to use the GPIO functionality to do so.

3.2 Robotic Arm and Chassis Part

System is made up into two sections comprising of arm section and chassis part. The arm part is for the pick and place purpose and the chassis part is for the movement of the system. The robotic arm is made up using servo motors, L brackets, U brackets etc. It has

a 180 degrees rotation angle and can provide 6 degrees of freedom. It includes a parallel gripper with a maximum opening span of 55mm. They are quicker and can get the work done in seconds in contrast to their human counterparts.

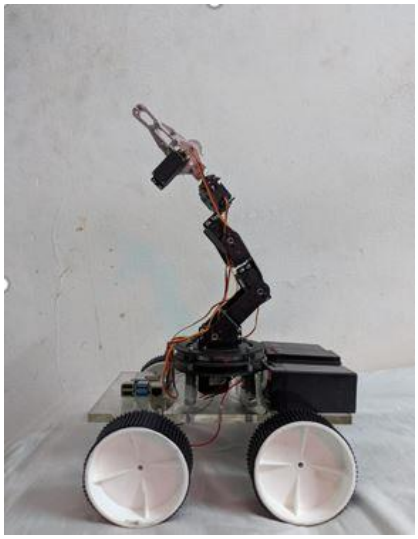

Figure 2 : Robotic arm and Chassis

• They are flexible and have the suitable design.

• They are accurate.

• They amplify the safety of the working surroundings and definitely never get tired.

The chassis part is similar to that of a 4 wheeler movement. It comprises of wheels, torque motors and a platform. It could freely in the direction specified the user that are forward, backward , left and right .Motors are the ones that plays a major role in the system. All of it is connected to the specified GPIO pins in Raspberry Pi . Based on the predefined commands the motors work which are connected to the GPIO pins and hence the system does the works.

3.3 Servo Motors

A servo motor is an equipment capable of moving or spinning an object with superb efficiency. If you'd like to turn and subject at a certain direction or distance, then you are using servo motor. This is completely fabricated of a basic motor running through the mechanism of the servo. When the motor being used being DC driven, it is related to as the DC servo motor, and if the motor is AC driven, it is pointed to as the AC servo engine. In small and moderate weight packages, we can get a really excess torque servo motor. Does these apps are used in many applications such as toy cars, helicopters and aircraft RC, Robots, Engine, etc.

Figure 3 : Servo Motor

The servo motor is driven by the use of PWM (Pulse with Modulation), that is also supplied with the help of the prime aim. There is indeed a minimal pulse, an optimum pulse and a rate of repeat. On either hand, servo motor can turn ninety degrees to form its neutrality location. This same servo motor aims to have seen a pulse every 20 milliseconds (ms), and also the pulse length will dictate which fast the engine turns.For example, a 1.5ms pulse would cause the motor to change to the location of 90 °, of that kind that even if the pulse is smaller than 1.5ms shaft shifts to 0 ° or if it is greater than 1.5ms then turning the servo to 180 °.

3.4 Torque Motor

Figure 4 : Torque Motor

The torque motor is one of a classification of rotary electric motors which directly converts direct current into mechanical energy. Another most common kinds focus upon this force generated by the magnetic fields. Most other forms of DC motors have had some internal system, either electro-mechanical or electronic, to swap the cutting-edge course with in motor process regularly.

Torque motors were the very first widely used motor construction, as they should be driven from current direct-current illumination distribution networks. The pace of a DC motor can be handled across a wide range, either by using a varying controlled by changing the current level of its field windings. Greatest power engines are used in devices, toys and gadgets.

3.5 Android Application

Android application is a built-in android platform application. Many smart phones use the android application(apps) quite extensively, and are designed in JAVA language. A signal is created by tapping on a particular key on the android software that further allows the arms move as per the preset program with in raspberry pi. Here Android application is the robotic arm's command center, since it offers moving or scoop up commands. That guidance is transmitted by android java as well as Raspberry Pi via the mechanical system. A software development kit (SDK) is usually a collection of software system enhancement tools which really authorize product implementation for even a particular software package, software program framework, hardware platform, computer system, video sport console, operating system, or comparable improvement platform. It may even be even something simplistic as implementing yet another or even more application programming interfaces (APIs) in the configuration of several libraries to communicate with a specific programming language or embedded complex analytics. For a smartphone or for a tablet Computer operating on the Android Kernel, a standard Android app is built. Android apps are implemented in java language including using Java core libraries.

4 SYSTEM ARCHITECTURE

Robotic arm is being controlled using an application build in the Android platform. The major systems used in this are the Android application in the smart phone, Wi-Fi, Raspberry PI, robotic arm and chassis part and the camera for real time video transmission. The Android application consists of buttons which includes the direction in which it needs to be moved and also real time video can be seen in the application through the RPi camera connected.

An application is being developed in Android Studio in such a way that , it consists of specific buttons for which movement n a button is being pressed in the application, corresponding signal is being given to the Raspberry PI through the Wi-Fi. The Raspberry PI is the main controller of the system.

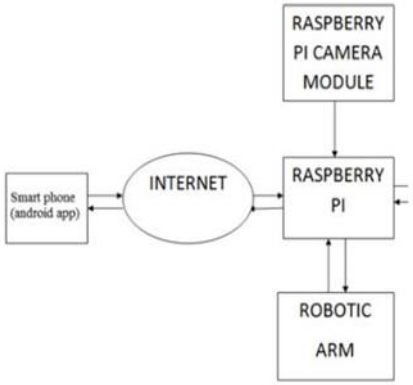

Figure 5 : Block Diagram

It is being coded with necessary movement for corresponding signals. The coding is being done in Python language in the Rasbian software and is being stored upon an SD card. Raspberry PI consists of GPIO (General Purpose Input/Output) pins which can be commanded to turn high or low in the program. The Raspberry Pi is being powered on by direct connection or to a Power Bank which could give an output of minimum 3 Ampere.

Motors are the major factor which helps in the functioning of the robotic arm. Two kinds of motors are being used in this system, Torque motor and Servo motors. The servo motors are being used for the functioning of the arm whereas the Torque motor is being used for the chassis movement. Six servo motors are being used for arm and 4 torque motors for chassis. Both of the motors are being powered up using a power supply board. Torque motors is being connected to L2D93 motor driver. These controllers are then being connected to the subsequent GPIO pins. Servo motors are being connected to the GPIO pins 2,3,4,5,6,7. And the torque motors are being connected to the pins 12,13,10,11. High and low command of pins constitute to subsequent movement of the motors.

The Raspberry PI cam is being used here, which is directly connected to the Raspberry Pi port. Hence all of the movement can be figured out through the video streamed on to the Android application using Web View content in Android Studio. Hence,

system works based on the command given the user. The whole system works based on Wi-Fi. The Raspberry Pi accepts the commands from the Android Application through internet connection. The Wi-fi can be enabled in the raspberry pi and need to be connected with the same network as that of which phone is connected.

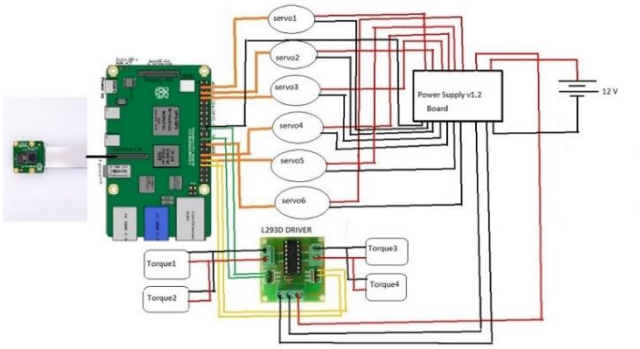

Figure 6 : Circuit Diagram

Figure 6 shows the circuit connection of the system. It consists of Raspberry PI 4 Model B, six servo motors,four torque motors, L2D93 motor driver ,power supply board, 12V Battery and a RPi Camera.GPIO pins 2,3,4,5,6,7 are being used for the servo motor control ,whereas pins 12,13,10 and 11 are used for chassis movement.

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The servo motor consists of three wires which are control pin,ground and Vcc. The control pin of servo motor is being connected to the Raspberrry Pi, Vcc and ground are being connected to the power supply board. Hence, each of the servo motor connections are being done in this structure. The control pins of the six servo motors subsequently gets connected to the GPIO pins 2,3,4,5,6,7 of the Raspberry Pi.

The torque motor needs to be driven using a motor driver L293D.The L293D motor driver could be fed with two motors at a time. The torque motors is being connected to this motor driver , and the driver is being connected to the power supply board as well as the GPIO pins 12,13,10,11 of the Raspberry Pi. RPi camera is being connected directly to the port in Raspberry Pi.

5. RASPBERRY PI CODING

The coding in Raspberry Pi is being done in Python language.

The powering up of Raspberry Pi is being done using a power bank having 3 Ampere as the output. Codes are being saved on to a SD card, which is being inserted into the Raspberry Pi. The connection between Raspberry Pi and Android Application is being done by using Wi-Fi connection. The motors are being connected onto to the GPIO pins for its functioning. For servo motor, the GPIO pins 2,3,4,5,6 and 7 are being used. Torque motors are being connected onto the GPIO pins 12,13,10 and 11 .First of all, of the required GPIO pins need to be declared as output pins. So that based on the program the output of the GPIO pins can be made high or low and in turn the motor moves. Then connection need to be made with the Android application. When a button is being pressed in the Android application, the corresponding program is being executed in the Raspberry Pi. For the movement of each of the servo motor, the duty cycle value need to be adjusted so that the required rotation is obtained. Whereas for each torque corresponding to the wheel, 0 or 1 needs to be specified. For the vehicle to be moving forward, every motor needs to be rotated in particular direction vice versa for it to move backward. Hence all of this functioning can be done using these programming code.

6. ROBOT SETUP AND FUNCTIONING

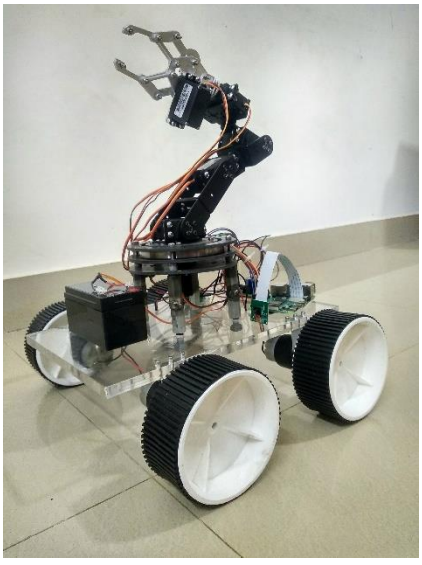

Figure 7 : Robot Set Up

The assembly of the system is being completed using motors, brackets and tyres. Other internal connections are also completed similar as that of the circuit diagram in Figure.6. The robot moves by 6 axis and performs this movements using motors. The six servo motors are being used for the arm movement and chassis movement is being done using the four torque motors connection need to be done with.

The robotic arm is being mounted on to the moving chassis, so that it could move around rather than remaining fixed at one position. The first axis movement is being done by one of the servo motor , which is the rotation of the arm in 180 degree angle. Rest of the axis is being controlled by each of these similar servo motors. And one is for the gripper opening and closing. In the chassis part, four of the tyres is being connected to the torque motor, so that when high signal is given to the motor , the subsequent wheel also rotates, in turn making it to move. Figure 7 shows the fully completed pick and place robotic arm vehicle.

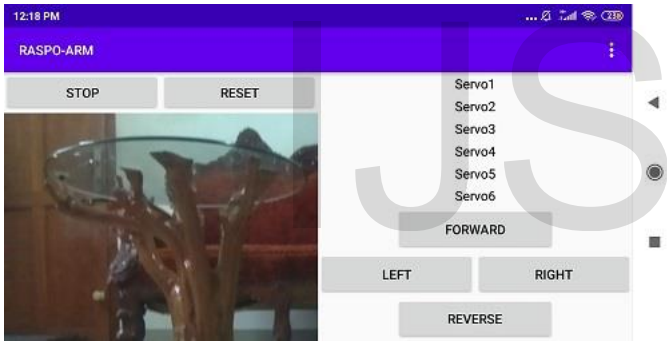

Figure 8 : Android Application

The Figure 8 shows the Android Application developed for this system. The application is being built in Android Studio using Java language. Each of these buttons are being specified with certain features. First of all, the connection is being established with the Raspberry Pi using Wi-Fi facility. The IP address of the Raspberry Pi need to be entered in the settings section for the establishment of connection.

The Real time video can be obtained on the screen so that we could get to know the current position of the system. The servo 1, servo2...etc buttons are being used for the movement of subsequent motors. The servo 1 button is used for the opening of the gripper, servo2 for the closing of the gripper, others for the subsequent movement of each. The forward , reverse , left and right buttons are being used for the movement of the base part. The stop button is being used to pause any of the current working step, And reset button is for the bringing up of it to its standard position.

Hence system has the capability to move around and pick items and drop to another desired point. It can be used in various industries when made in a larger scale. This system could also be used by people who has the disability to move around. Therefore, it could make a greater difference than that of the current scenarios.

5 CONCLUSION

The Raspberry Pi can now be used from a remote location to regulate a Robotic Arm with a Smartphone. There are a lot of critical facets to the current internet maintained robot scenario including such wired constraints as well as server difficulties. The latency and server issues are minimized with just this mobile system because the Wi-Fi has been used and is now the Internet's fastest access. The majority of the population globally use the mobile device. The robotic arm can undertake almost equivalent motions using motors with an accurate smartphone control. The future scope of this system can be, including gesture-controlled arm movement. Also, this current system can be developed in a much larger scale to pick and place items that are more difficult for the man type.

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