Mobile 6-Axis Robotic Manipulator Arm Using Raspberry Pi

Ramachandrapurapu S K NithyaAashitha[1], Nagamalla Vijay Sundar[2],YagniVeeranjanaya Reddy[3]
GIET Engineering College, Rajamahendravaram

Abstract- *In this research, a 6-axis robot manipulator arm is designed and constructed for industrial applications. Then, the robot arm motion is controlled in a position mode by users' specified angular motion of each joint with high accuracy even with load variation and repeatability. A motion control has been developed within Raspberry Pi to control individual or combined joints' position, velocity, acceleration. The purposes of this robot-arm motion-control implementation are to accelerate users' learning process and to interact with the industrial robot in a user-friendly environment.*

Keywords- Industrial Manipulator Arm, Motion Control Software, Accuracy and Repeatability.

I. INTRODUCTION

Automation and hazard reduction in the workplace are two important factors of driving the use of robotics, specially articulated arm robots, in order for decreasing human deaths and injuries, economically affordable production plus saving time. Therefore, high precision control is the basic and primary step of using these robots.

In brief, six degrees of freedom, three of which are used for posing the gripper at a specified position and the other three for orientation adjustment, is an essential dexterity characteristic of a space robot manipulator. Hence, the focusof this paper is on controlling a six degree-of-freedom arm robot with a particular series of links and joints.

II. DESCRIPTION

With a servo controller and the power of a Raspberry Pi, there will be no problem to write the python program and to control the 6-axis robotic arm. The robotic arm has six servo motors. The wires to connect the servo motors lead out at the back of the robotic arm. We will use the base to mount the Raspberry Pi ZERO W together with the PCA9685 servo controller on. We will use a sheet of cardboard to attach everything on.

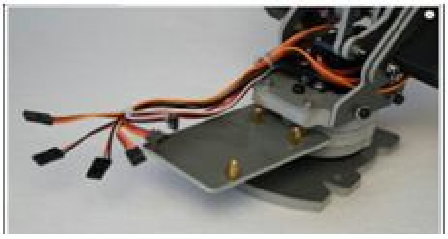

Fig.1Base on which Raspberry Pi is mounted

2.1. Robotic Arm:

The following picture shows the three servo motors which are attached next to the base. The one in the middle turns the base and is located in the center of the base. The picture only shows the two screws with which the servo motor is fasten. On the left and right side you see an additional servo motor. They are used to turn the lower and upper part of the robotic arm. The servo motors are looking very good. The next step is to connect the servo motors with the servo controller.

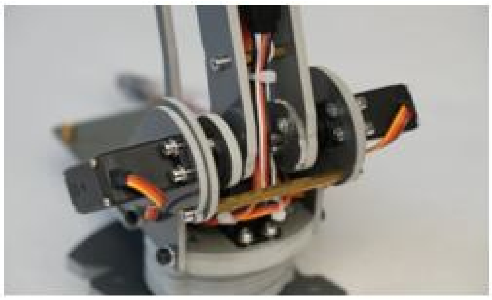

Fig.2 Three servo meters attached next to base

The head of the robotic arm has two servo motors. They are used to turn and pan the head. The head is mounted on a white Aluminum frame. A servo motor located in the bottom of the frame helps to turn the end effecter .

Fig.3 Head of the robotic arm

2.2. Raspberry PI Zero W:

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated selling outside its target market for uses such as robotics. It does not include peripherals (such as keyboards, mice and cases). However, some accessories have been included in several official and unofficial bundles

Fig.4 Raspberry Pi Zero W

2.3. Servo Controller (PCA9685) :

The PCA9685 is a 16-channel I2C-bus controlled LED controller optimized for Red/Green/Blue/Amber (RGBA) color backlighting applications. Each LED output has individual 12-bit resolution (4096 steps) PWM controller with a fixed frequency. The controller operates at a programmable frequency from a typical 24 Hz to 1526 Hz with a duty cycle that is adjustable from 0% to 100% so the LED can be set to output a specific brightness. All outputs are set to the same PWM frequency.

With the PCA9685 as the master chip, the 16-channel 12-bit PWM Servo Driver only needs 2 pins to control 16 servos, thus greatly reducing the occupant I/Os. Moreover, it can be connected to 62 driver boards at most in a cascade way, which means it will be able to control 992 servos in total.

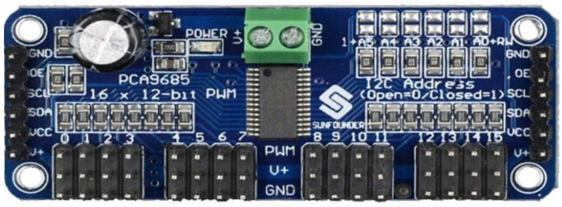

Fig.5 PCA9685 Servo Controller

III. CONSTRUCTION

The following pictures shows that I used a Raspberry Pi ZERO W and a PCA9685 servo controller.

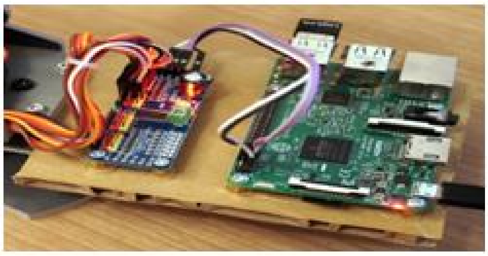

Fig. 6 Raspberry Pi connected with a PCA9685 Servo controller

To connect the servo controller with the Raspberry Pi is easy. You only need four wires to connect the PCA9685 with the Raspberry Pi computer. With this four wires the connection is establish between the Raspberry Pi and the servo controller which enables the Python program to control the robotic arm. The PCA9685 servo controller uses the I2C bus for communication. The I2C bus is available on the Raspberry Pi with the pins SDA/SCL.

The next table shows which pins are used on Raspberry Pi side and which pins are used on the servo controller side.

Table 1 : Pin Connection Table

Raspberry Pi	Servo controller
3.3 V	5V
SCL	SCL
SDA	SDA
GND	GND

The following picture shows how the power supply is connected to the servo controller, how one servo motor is connected to the PCA9685 controller and how the servo controller itself is connected via the I2C bus to the Raspberry Pi computer (3.3 V).

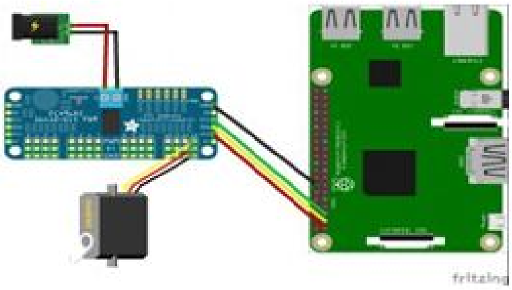

Fig. 7 Figure showing how the power supply is connected to the servomotor, how servomotor connected to the PCA9685 and how servomotor is connected to the Raspberry Pi

IV. WIRING OF THE POWER SUPPLY

The six robotic arm servo motors need 5 V for operation. But as explained above it is very important to connect only electronic components to the Raspberry Pi which are using 3.3 V. The terminal in the middle of the servo controller is connected to a power supply with 5 V to supply sufficient voltage to the 5 V servo motors. This high voltage part of the servo controller is separated from the logic part which works with 3.3 V as well. The Raspberry Pi is only connected to this logic part with 3.3 V.

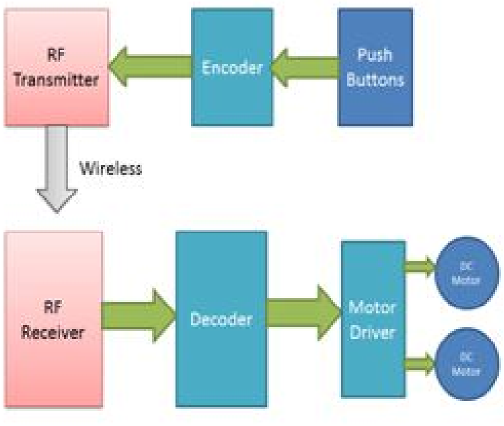

Fig.8 Block diagram of the RF controlled robot

V. CONSTRUCTION& WORKING OF THE ROBOT CHASSIS AT THE BASE

Interesting thing in this project is that it will run without using any microcontroller. Here we will run it directly by RF Decoder and Motor Driver.

RF controlled robot is controlled by using Four push button placed at transmitter side. Here we only need to push the buttons to control the robot. A transmitting device is used in your hand which also contains a RF Transmitter and a RF Encoder. This transmitter part will transmit command to robot so that it can do the required task like moving forward, reverse, turning left, turning right and stop. All these tasks will perform by using four push buttons that are placed on RF transmitter. The range of transmitter is about 100 meters at maximum supply voltage and for 5 volt the range of transmitter is about 50-60 meter with using a simple wire of single code 17cm length antenna.

VI. SUMMARY

If you are carefully with the different voltages of 3.3 V and 5 V the wiring is very easy. Here we used a power bank to supply 5 V to the servo motors via a USB cable I which we cut of the micro-USB connecter. The Raspberry Pi is also connected to the power bank via micro-USB cable. The PCA9685 servo controller is ideal for this robotic arm. The Raspberry Pi in this combination has enough power to control the robotic arm and to do some more stuff like live video streaming.

VII. CONCLUSION

In this way, we have designed a 6-axis robotic arm using a Raspberry Pi Zero W, which can be used for a wide range of industrial applications. The entire body of this system is also made to move from one place to a desired place using an RF controller.

REFERENCES

[1] Mikell P Groover, Mitchel Weiss, Roger N Nagel, Nicholas G Odrey, AshishDutta --"Industrial Robotics" – Vol-2

[2] SitiNurmaini, Anggina P., "Modeling of Mobile Robot System with Control Strategy Based on Type-2 Fuzzy Logic", International Journal of Information and Communication Technology Research. Vo. 2 No. 3, 2012.

[3] JebliTarek, Zaoui C., Aref M. , "Design and Control of A Dual-Arm Robot", International Journal of Latest Research in Science and Technology. Vol 4. Issue 6; p. 110-116, November –December 2015.

[4] RavikumarMourya, Amit S., Sourabh S., Sushant K. Manoj B., "Design and Implementation of Pick and Place Robotic Arm", International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME). Vol. 2 Issue 1, pp: 232-240, AprilSeptember 2015.

AUTHOR

Ramachandrapurapu S K NithyaAashitha, B.Tech Scholar, GIET Engineering College.

Nagamalla Vijay Sundar, B.Tech Scholar, GIET Engineering College

YagnamVeeranjaneya Reddy, B.Tech Scholar, GIET Engineering College

M. MadhuManikya Kumar, Asst Professor, ECE, GIET Engineering College