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Hand Gestures Remote Controlled Robotic Arm

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Abstract

In this paper author has explained the development of a robotic arm, prepared by him, which is operated & controlled wirelessly with the help of hand gestures. It's a CLASS – 5 Robot (Numerical Control Robot).The complete robotic assembly is made into 2 parts viz a transmitter assembly put on the gloves comprising of APC-220 Module, Arduino Board, Gyroscope, Accelerometer and a receiver(Robotic Arm) comprising of APC-220 Module, Arduino Board, Servo Motors and arms mounted on circular revolving base made of acrylic sheets.

Keywords: Components- Robotics, Gesture, Arduino, Gyroscope, Accelerometer, Servo Motor.

1. Introduction

Robotics is a current emerging technology in the field of science. A number of universities in world are working in this field. Robotics is the new emerging booming field, which will be of great use to society in the coming years. These days many types of wireless robots are being developed and are put to varied applications and uses. The author has developed a robotic arm, with his own learning and resources, which is operated & controlled wirelessly with the help of hand gestures which transmits signals to the robot through an auto device fixed on the gloves put on hands rather than controlling it manually through a conventional remote controller. The Robot moves and acts in the manner depending on the gestures made by the fingers and hand from a distance. The robot moves in up, down, left or right directions and picks up objects from one place and keeps at another desired place as directed by the movements of fingers and hand. It is a TYPE – C Robot, Programmable, servo controlled with continuous or point to point trajectories.

2. Methodology

2.1 Robotic glove:

Robotic glove houses the circuitry which controls the robotic arm. It consists of Arduino Mega 2560 which is programmed in such a way that it transfers the required data with the help of APC – 220 Module as well as it receives the data transmitted by the robotic arm.

The Gyroscope and Accelerometer installed takes the angles (alpha, beta and gamma) and acceleration in all three directions of the hand respectively, sends the signals to the Arduino Mega via wires where the values are combined and processed simultaneously. At the same time the Flex sensor is doing its job by sending the degree of movement of the finger to the Arduino Mega. The processed values are then transmitted from the Module (Trans-receiver) to the robotic arm. The module takes the feedback from the arm and sends the new processed signals to it.

2.2 Robotic arm:

It is the main instrument where implementation of the program from the robotic glove takes place. It consists of total of 6 nos. of Servos, connected in such a way that it provides 3 DOF's (Degrees of Freedom) to the system. A micro controller Arduino UNO which inputs the values from the module and sends the data accordingly to the servos. Both the circuitry and base are clipped upon the common base, made of acrylic to improve the stability. The whole chassis is made of Acrylic; the lowest point servo is attached in such a way that it moves the upper base horizontally from 0-180 degree depending upon the values from the APC-220 Module. 4 more servos are attached for controlling the direction of the robot in the vertical direction mounted on the base servo. At the apex, a mini servo is connected with the help of gears to control the Grabber of the robot.

As mentioned above, the robotic arm mimics the movement of glove worn by the user, when the glove is tilted in the forward direction or any such direction, the arm spontaneously follows suit.

The Grabber functions with the use of flex sensors attached to centre most finger, the degree of movement of the finger determines the angle of the mini servo which is attached to the gears controlling the movement of the grabber.

2.3 Constructional Details

The robotic arm developed by me consists of following parts:

TRANSMITTING END (Robotic Glove put on hands):

1. APC-220 module transmitter
2. Arduino Mega-2560
3. Gyroscope
4. Accelerometer
5. Gloves

RECEIVING END (Robotic Arm):

1. APC-220 module receiver
2. 6 nos. Servo Motors
3. Arduino UNO 328p
4. Chassis
5. Gears

The construction is explained in various steps as follows:

Step 1-Boards:

Two microcontroller boards were taken up as per the requirement for the project:

1. Arduino Duemilanove :

It contains Atmega AVR 328p micro controller. It has 14 digital Output/Input pins (of which 6 can be used as PWM signals), 6 analog inputs, a 16 MHz crystal oscillator. Operating voltage of the micro controller is 5V. Contains 32 KB of flash memory enough to store the data for this particular project.

2. Arduino Mega :

It contains Atmega AVR 2560 R3 micro controller. It has 54 digital Output/Input pins (of which 15 pins can be as PWM output) , 16 analog inputs, 4 UART (hardware serial port), a 16 MHz crystal oscillator. Operating voltage of the micro controller is 5V.

Step 2- Sensors:

In order to have proper mechanism and response from the robot , proper readings had to be taken for it. In this I have used 3 sensors:

ADXL335 :

It is a 3- axis accelerometer sensor, which can measures the forces applied on to the sensor in all the 3 directions X, Y and Z axis. Further the raw data from the sensors are converted into acceleration by using some complicated equations. The advantage of the accelerometer was that the values do not change unless there is a change in position. But the problem with the accelerometer was that it contained high level of noise which makes the values inaccurate. So, to make these values accurate Gyroscope sensor was used.

L3G4200D:

It is a 3- axis Gyroscope sensor which can measure the degree of rotation in all the 3 axis in form of alpha, beta and gamma. The values provided by the Gyroscope are very accurate but values do not remain static and tend to drift to the position Zero. To make the readings accurate as well as static both the values from the Accelerometer and Gyroscope were combined by using Kalman filters.

Flex Sensor :
Flex is basically a strip of carbon material having metal pads inside it. As the sensor is flexed, the resistance across the sensor increases. The resistance of the flex sensor changes when the metal pads are on the outside of the bend. Straight (un-flexed) resistance: 9000 ohm, 90 degree bend resistance : 14000 ohm and at 180 degree bend resistance 22000 ohms. This resistance was calibrated and converted into angles and further used for the for the grabbing purpose in the Robotic Arm.

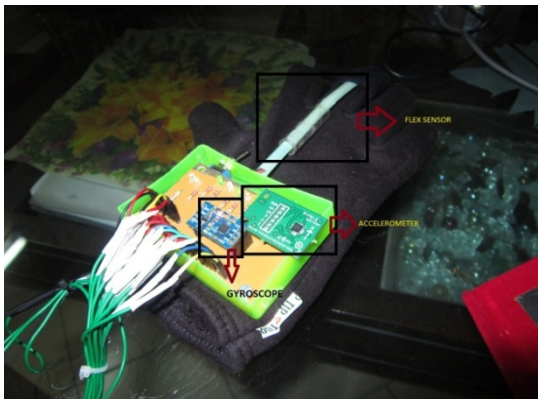

Figure 1: The figure shows flex sensor, accelerometer and Gyroscope as parts of the transmitter fixed on the hand glove.

Step 3- Communication:
To get the most out of the system, it was better to transfer the data wirelessly. This was done with the help of RF module communication between the Robotic Arm and glove. The APC-220 Module was used in the process, which is highly integrated semi-duplex low power transceiver module with high speed MCU and capability RF IC. It has high sensitivity and strong interference circumstance as well.

Characteristics:

- 1000 meter of communication distance (2400bps)
- Output power is 20 milli-watts.
- Frequency is from 418 MHZ to 455MHZ
- More than 100 channels
- UART/TTL interface
- Exceeds 256 bytes of data transfer

Step 4- Robotic Arm Mechanism:
It’s a basic robotic arm mounted on a surface Controlled with the help of arduino development board. Each joints of the robotic arm is connected to the servo motors. Robotic arm contains 2 joints , total of 6 servo motors were used, 4 servo motor were

used in order to control these joints,1 servo motor to control the rotation of the surface of the robotic arm and 1 more servo motor to control the lock of the grabber.

2.4 Functioning of robotic arm:

A small object of low weight is placed near the robotic arm at a distance within the approach of arm. The system is made on. The operator stands at a distance from the robot and moves the finger/hand up, down, left or right. The robotic arm follows the direction. The arm is brought over the object and then lowered. The grabber is fully opened to pick up the object. The robotic arm then is moved up and rotated to another desired position, then lowered. When the arm reaches the ground floor, the grabber is given a command to release the object, which places it at the desired location.

This way the robotic arm can be operated and controlled in any manner as deemed necessary by the operator from a distance, usually up to 200 meters.

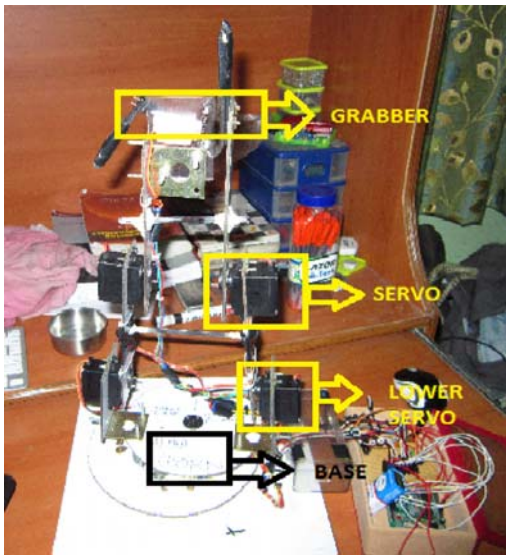

Figure-2: Shows assembly of Receiver end

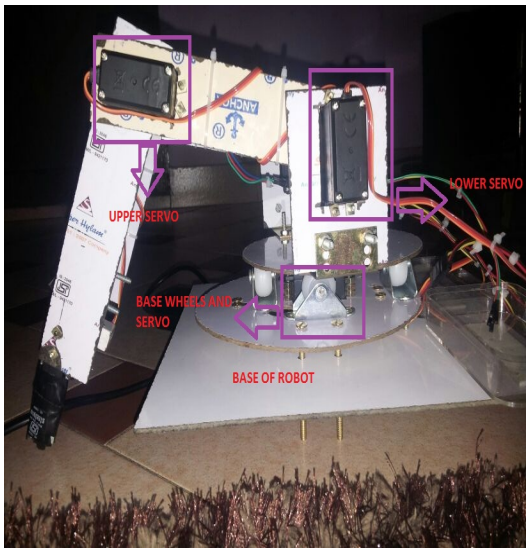

Figure-3: Complete assembly of Robotic Arm

3. Applications:

Such types of robotic arms can be put to use in various types of applications as follows:

i. Control of various functions of robots in arduous and dusty atmospheres industrial jobs as in painting shops, shot blasting chambers etc. The operator controls the robotic functions from outside the hazardous chambers looking through a glass door.

ii. Automatic picking of small objects (bottles, bags, tumblers etc) moving on a conveyor and placing at other desired location in industries manufacturing various types of cosmetics, food products, medicines etc.
iii. Automatic metal cutting machines in particular desire profiles, which are located in high temperature zones.
iv. Advanced robotic toys, operated with state-of-art hand operated control systems.
v. Robots controlled cranes, lifting forks etc operated from a distance with fingers/hands controlled remote system.

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