Gesture Controlled Mobile Robotic Arm Using Accelerometer

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ABSTRACT:
In this paper we have presented a model to control robotic arm through human gestures using accelerometer. A three axis accelerometer is mounted on human hand in order to perform the action of robotic arm according to the action of human hand. Accelerometer is connected to the LPC2148 Microcontroller which is programmed to take analog readings from accelerometer and transmit them using Bluetooth to the receiving unit at robotic arm. Movements of the robotic arm are achieved through Servo-Motor are a type of electromechanical actuators that do not rotate continuously like DC/AC or stepper motors; rather, they are used to position and hold some object.They are used where continuous rotation is not required so they are not used to drive wheels (unless a servo is modified). The arm is also equipped with a gripper to facilitate the pick and drop facility.The main aim is to control the robotic arm using human gestures wirelessly with smooth movement over a range.

KEYWORDS Bluetooth, MCU, Gesture, Accelerometer, Servo motor, Gripper

I. INTRODUCTION

Nowadays, robots are increasingly being integrated into working tasks to replace humans especially to perform the repetitive task. In general, robotics can be divided into two areas, industrial and service robotics these robots are currently used in many fields of applications including office, military tasks, hospital operations, dangerous environment and agriculture. Besides, it might be difficult or dangerous for humans to do some specific tasks like picking up explosive chemicals, defusing bombs or in worst case scenario to pick and place the bomb somewhere for containment and for repeated pick and place action in industries. Therefore a robot can replace human to do work [1]. There are certain techniques being implemented to control the movement of a robotic arms like Motion sensors & markers [2], vision systems [3] etc. Use of accelerometer as a gesture recognition device is becoming quite popular due to its small size and low moderate cost. A robotic arm is a robot manipulator, usually programmable, with similar functions to a human arm. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement. The end effectors can be designed to perform any desired task such as, gripping, spinning etc.,depending on the application. The robot arms can be autonomous or controlled manually and can be used to perform a variety of tasks with great accuracy.Currently, such robotic arm is controlled using joystick which is wired to arm. To make control of an arm more precise like human beings we designed an arm which is wirelessly synchronized to human arm and can emulate the movements of a human arm. Robotic arm whose objective is to imitate the movements of a human arm using accelerometers as sensors for the dataacquisition of the natural arm movements. This method of control allows greater flexibility in controlling the robotic arm rather than using a controller where each actuator is controlled separately. The processing unit takes care of each actuator's control signal according to the inputs from accelerometer, in order to replicate the movements of the human arm [1].

II. RELATED WORK

Gesture control is becoming a popular technique in many applications and various works has been implemented in this field. Industrial arms like MOTOMAN HP6 based on learning and Artificial Neural Networks is current related work on this technology [4]. Some researchers [5] used Kinect atHumanitarian Technology (HuT) Labs of Amritathat involves the building of a Robotic arm which mimics the motion of the human arm of the user. The system monitors the motion of the user's arm using a Kinect. The skeletal image of the arm obtained using the "Kinect Skeletal Image" project of Kinect SDK, consists of 3 joints and links connecting them. Coordinate Geometry is used to calculate the angles between the links connecting the joints. This gives us the angles for a 3D representation of the human arm. Also, some researchers implemented a Gesture Actuated Robotic Arm [6] using MEMS- accelerometer sensors placed on different joints of human hand. Researchers also worked on an Integrated Vision-based robotic arm interface for operators with upper limb mobility impairments[7] which was developed to operate a commercial wheelchair-mounted robotic manipulator (WMRM)

III. PROPOSED MODEL

The model consists of the transmitting and receiving units. The system can be understood with the help of flow chart as shown in figure-1.The transmitting unit, as shown in figure- 2 is at human end can be mounted on a glove which is worn by human hand. The unit contains an accelerometer, a microcontroller for processing the signals and analog values from accelerometer and a Bluetooth to transmit codes against different ADC values from MCU. The values are being transmitted wirelessly at receiving end, which consists of bluetooth as a receiver, & a microcontroller (LPC2148) for controlling servo motors. The whole arrangement is placed on a mobile platform with wheels to facilitate movement from one place to another. The mobile platform can be controlled using a wireless remote control.

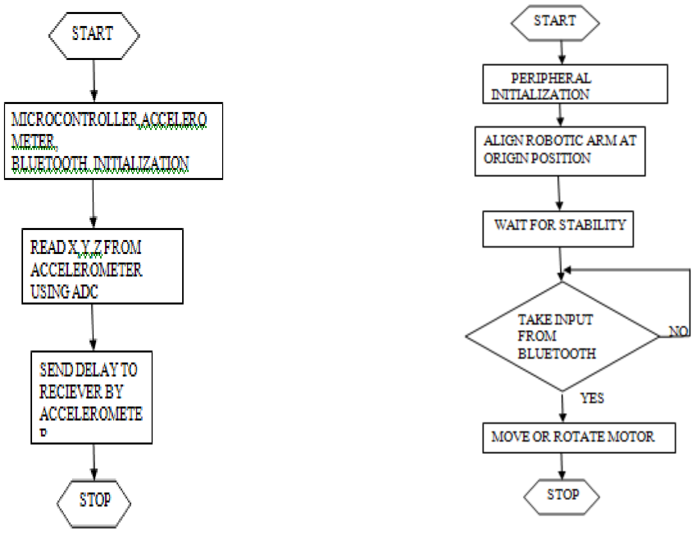

Figure 1: Flowchart

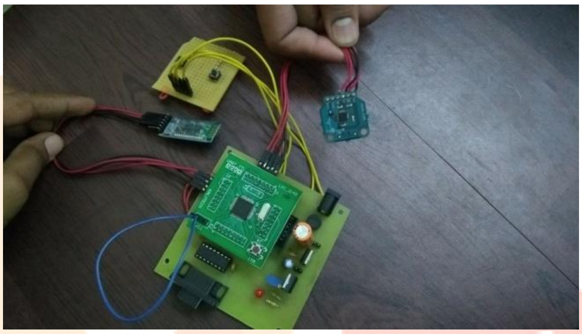

Figure 2:Transmitting End

A.DATA AQUISTITION WITH ACCELEROMETER

3-axis wireless accelerometer mounted on a glove is used to capture human hand behaviors, and a microcontroller acquired the values in analog form. The 3-axis accelerometers (ADXL330, Analog Device) is physically rated to measure accelerations over a range of at least +/- 3g, with a sensitivity of 300 mV/g and sensitivity accuracy of 10%. The analog readings from accelerometer can be displayed on a LCD and analyzed to create a mathematical relation with the PWM control of motors.The advantage ofthe accelerometer is that the values do not change unless there is a change inposition. But the problem with the accelerometer is that it contained high level of noise which makes the values inaccurate. So, to make these values accurate Gyroscopesensor can be used. Figure-2 shows the data acquisition from accelerometer and transmission from human hand.

B. COMMUNICATION

HC-05 embedded Bluetooth serial communication module (can be short for module) has two work modes: order-response work mode and automatic connection work mode. And there are three work roles (Master, Slave and Loopback) at theautomatic connection work mode. When the module is at the automatic connection work mode, it will follow the default way set lastly to transmit the data automatically.The range of Bluetooth is upto 10m. We use Bluetooth Tx And Rx for Communication purpose Between Transmitting And Receiving End.

C. PWM CONTROLOF SERVO MOTORS.

AVR Timer1 Module which is a 16bit timer and has two PWM channels (A and B). The CPU frequency is 8 MHz this frequency is the maximum frequency that most AVRs are capable of running. And so it is used in most development board like Low Cost AVR Development Boards

FAST PWM Mode
TOP Value = ICR1
ICR1=19999;
ICR1(Top value)
Period

So the timer will count from 0 to ICR1 (TOP Value) as shown in figure 4. Registers of MCU are set as:

TCCR1A |=1<<WGM11 | 1<<COM1A1 | 1<<COM1A0;
TCCR1B |= 1<<WGM12 | 1<<WGM13 | 1<<CS10;

Here top value is ICR1 which is 19999 so number of cycles will be 20000 each cycle of 20 millisecond and 50 cycles in one second. The default frequency of MCU we used is 1MHZ, i.e. it corresponds to 1 second. The servo needs a pulse every 20msec. which corresponds to 50Hz. Therefore, no. of cycles we get by dividing 1MHZ.

Cycles= 100000/50
Cycles=20,000 (1)

Hence, range of ICR1=0-19999
And, top value of ICR1=19999

D. Controlling of servo against the analog values from accelerometer.

By taking various observations and relating the analog values from accelerometer with PWM values for motor, following relation is obtained.

*P=b*6 (2)*

OCR1A=ICR1-P (3)

Here, b is the accelerometer reading. P is PWM value

However, an alternative can be used by manually taking readings over a wide range of angles, and defining those values in program.Different codes corresponding to different readings are transmitted and corresponding (Table 1)PWM value (p) for the angle is chosen to move servo. Figure 3 shows the circuitry used to drive servo motor wirelessly for the angle is chosen to move servo.

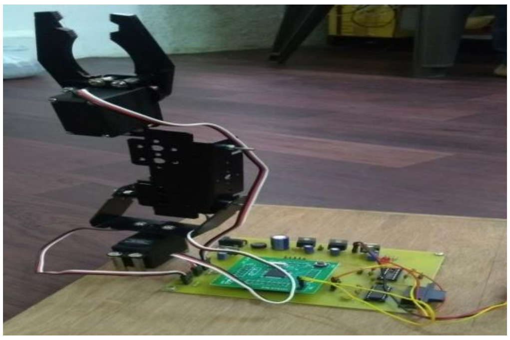

Figure 3: Receiving End

for the angle is chosen to move servo. Figure 3 shows the circuitry used to drive servo motor wirelessly

Analog Values (Accelerometer)		**PWM value(p)**
PWM value (p)		
X	Y	
360-370	290-300	600
320-330	300-310	800
300-310	320-330	1100
290-300	350-360	1560
300-310	380-390	1800
320-330	400-410	2100
360-370	420-430	2400

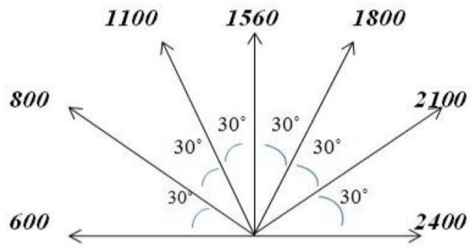

Figure 4: Angle Sepratuion Correspnding to PWM values

E. Robotic arm and Mobile Platform.

The arm consists of 2 servo motors which provide two degree of freedom to the arm. The servos are attached to the body of arm made of wooden plank and controlling circuitry is placed on a common base. One servo is used for the horizontal motion with angles from -180 to +180 degrees and other servo is for the wrist movement from -90 to +90 degrees. The gripper attached in front is controlled using the push button switch assembly on the glove.The whole arrangement is placed on a mobile platform with wheels for the movement from one place to another controlled using a wireless remote control.

F. Gripper Control.

The gripper is controlled using two push button switches also mounted on the glove. On pressing the buttons logic 0 is transmitted. Figure 5, shows the gripper mechanism which contributes to capture and release function with the help of gears and helical shaft connected to motor. One button is used for clockwise rotation of gripper motor (gear motor) providing a capture action and other button is used for anticlockwise rotation of gripper motor providing a release action to the gripper.

Push Button Transmitted code

1 0xfe

2 0xdf

To The Receiver

Code Check Movement

True Clockwise

True Anticlockwise

IV. APPLICATIONS

1. Scientific:

Gesture control mobile robotic arm can help the scientist performing hazardous experiment in safer way by using robotic arm to pick the Dangerous liquids. This can also help scientist to perform the liquids which are highly flammable.

2. Military:

Gesture controlled robotic arm can also be used for military purpose to perform operation on explosives as gesture controlled robotic arm can also help the bomb squad to detonate or defuse the bomb without involving risk to their life.

3. Space:

Gesture Controlled Robotic arm can also help the astronauts to repair or pick up objects in zero gravity without going in the space.

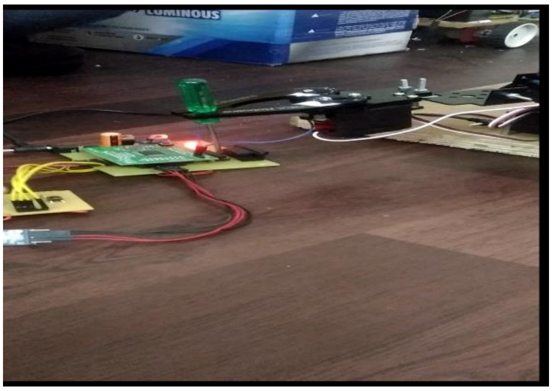

Figure 5 : Claw/ Gripper

V. RESULT

This control mechanism provides an easy movement & control of arm but doesn't facilitate the teaching and learning. Thus, a cheap and easy way of control using popular LPC microcontrollers and Bluetooth devices is implemented. The structure of arm and mobile platform as shown in figure 6, works efficiently replicating the gestures of human arm.

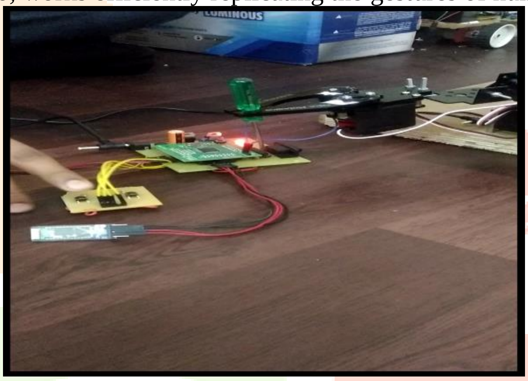

Figure 6: Object Pick And Place Robotic Arm

VI. CONCLUSION

It provides a better way to control a robotic arm using accelerometer which is more intuitive and easy to work, besidesoffering the possibility to control a robot by other wireless means. Using this system non Experience robotic armcontroller can easily control robotic arm quickly and in a natural way. Also, many applications which require precise control and work like human beings can be easily implemented using this approach. And it provides more flexible control mechanism.Accelerometer equipped with gyro sensors can help to make movement smoother. Although, the gesture control is achieved but problem of noise and jerks can be there which can be further removed by calibrating & taking more observations and using a much precise smoothing algorithm.

VII. REFERENCES

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