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GYRO-ACCELEROMETER BASED CONTROL OF A ROBOTIC ARM WITH METALLIC DETECTOR

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ABSTRACT

This paper is proposed a gesture recognition based 3DOF robotic arm controller using gyro-meter with accelerometer to improve the stability and to detect the rotational gesture of human arm and force sensor to grab the object . The arm also has the capability to grab only metallic object only. To find out the angular position of an object, it is easiest way to fuse 3axis accelerometer and 3axis gyro-meter sensor. A low cost MEMs chip (integrated 3-axis accelerometer and 3-axis gyro-meter)is used to detect human arm gesture as well as its angular position and there is an attached metallic detector at the end effector .Here gyro gives gesture orientation data to determine dynamic gesture behavior. The communication between human hand and robotic arm interaction has been established wirelessly over IEEE standard Xbee protocol interface. The result is that the arm's movement is synchronous with human arm gesture. The control strategy is easier than other systems like joystick control and this system applicable for industrial purposes. This robotic arm has been developed in Arduino IDE platform and it is also applicable in different platform like embedded, intelligent peripheral and so on.

Keywords: gesture; accelerometer; gyrometer; motors; arduinouno; interface; MEMs; arm; DOF; sensor etc.

I. INTRODUCTION

Control a robotic arm is still pester and time consuming in many industrial section. Many universities and researchers works in this field to make its simple and smarter (or skilled). The unique phase is human-robot interaction. This interaction mode varies in different purposes. Potential application range from the pure athletic application of Real Steel or the sci-fi television channels Robot Combat League to augmenting traditional robotic surgery (Da Vinci system) etc. In this field many research works for recognizing human gestures, recurring to vision based system motion capturing sensors or using finger gesture recognition systems based on active tracking mechanisms . Also many user interface available such as icon-based programming, color touch screens, 3D joystick, 3D or 6D mouse or wireless artificial neural network system. Motion capturing system is very popular because of simple way to control a robotic arm with accurately and efficiently. Accelerometer and gyro-meter sensor chip makes this operation very accurate and efficient. MEMs gyros make motion analysis of a human movement directly programmable into an embedded robotic control system very easily.

II. PROPOSED DESIGN

2.1 System Review

The whole system is divided into two sections :one is data transmitting section and other is data receiving section. And the two sections are interfaced with wireless xbee protocol. In transmitting section we have used MPU6050 IMU board . It's detects hand gesture and send data to main board for processing. With the help of complex geometry we calculate the proper angle of movement of hand gesture in main board. Then these data aresends to receiving section by xbee module. Transmitted data received by receiving xbee module and processed by receiving sections main board. Then warm gear motor with main board instruction which is received from transmitter section. The main board for processing unit used Arduino Uno (contains ATmega microcontroller).

Transmitting Section: The transmitting section comprises of MPU6050, force sensor and xbee transmitter.

Receiver Section: In receiver section the robotic hand consist of metal detector at the robotic hand section connected with two finger end effector. Here warm gear motor is used for the rotation of hand.

2.2 Block Diagram

At first sensor read data from hand gesture then it sends to main board for calculation. Then it sends over xbee module to receiving end. Receiver module's receive data and then transfer it to main board. The main board utilizes these data for movement of warm gear motor. This whole system can express as follows:

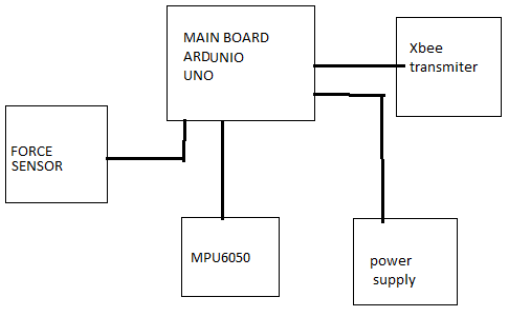

Fig 1 block diagram of transmitter section

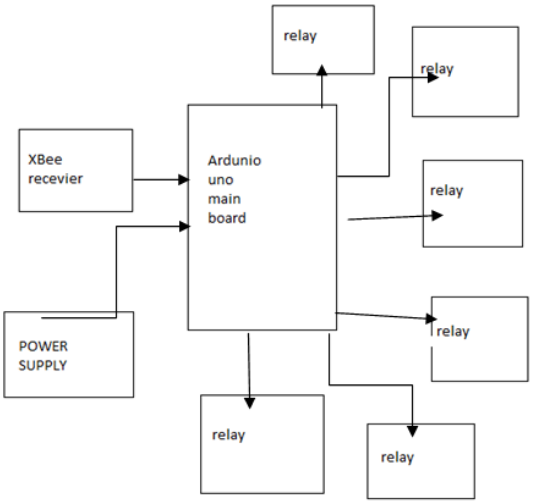

Fig 2 block diagram for receiver section

III. METHODOLOGY

The sensor board i.e. MPU-6050 placed horizontally on top of a hand glove and force sensor used for the grabing the object. When hand moved in different angle than sensor detect its acceleration as a raw value and time sensor detects gyros raw value. Then these values are fed by main board. Next is the time to process raw data into its meaningful angle. For processing purpose arduino-uno board is used which has Atmega328P microcontroller and 16MHz crystal oscillator. Different library function and geometrical calculations are used to find out exact angle of gesture and behavior. By combining accelerometer data and gyro data we calculate proper angle along a specific axis. Normal calculation angle is little bit deviated with world frame and time. To solve this problem we use most popular Kalman filter. This filter re-calculate angle each time to get real time exact angle and compare with world frame. Basically this calculated angle range is 0-360 degree. Our motor movement range is 0-180 degrees, that's why to maintain synchronous movement 0-360 degrees scaled down as 0-180 degree by movement mapping in algorithm section. Now it's a challenge sending calculated data wirelessly. In this system we use IEEE standard series2 xbee module. We selects AT mode and high baud rate for better performance. We prefer AT mode because we transfer data in serially to avoid more complexity also.

At receiving section transmitted data received by another xbee module. Then data sends to sends signal to the infrared sensor and then to the microcontroller, which provide movement to the robotic arm and the deflection is obtained by the help of encoder displayed on the lcd.At the end effector there is an attached metallic detector which is used to detect and pick the metallic object on its work space.

IV. DESIGNED HARDWARE AND RESULT

4.1 A proper hardware and software for the operation of this robotic arm has been designed and given below.

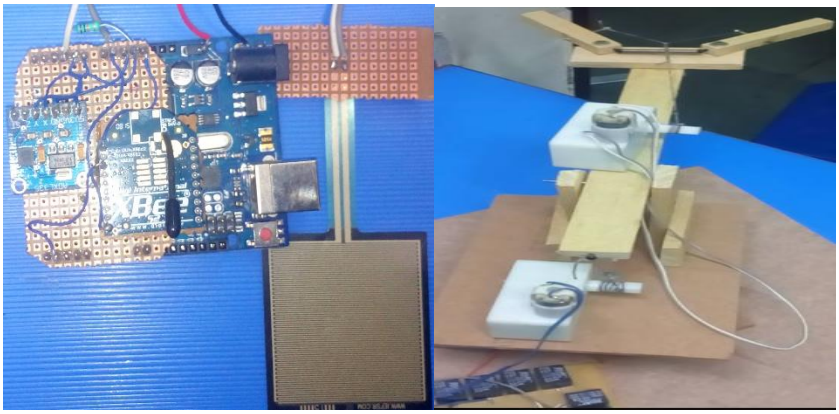

Fig 3. Total hardware of transmitter and receiver section of proposed design.

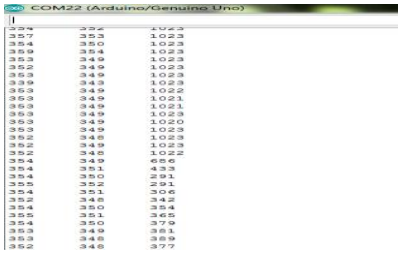

Fig 4 output result of gyro accelerometer sensor

4.2 Result:

Observation No.	Along x-axis (deg.) sensor	Along x-axis (deg.) Robotic hand	Along y-axis (deg.) sensor	Along y-axis (deg.) Robotic hand
Human1	16	15.4	17	16.4
Human2	18.4	17.8	15.7	15.1

V. CONCLUSION

Above experimental design is prototype. Here we try to improve its stability and first response also for the metallic detection. The control strategy is synchronous with sensor movement that means with human arm gesture.In this system we used just a 3-axis gyro-meter which helps to find out Z-axis rotational angle and makes the control system easier and the force sensor is used to grab the metallic object. Gyro system makes this system more stable and synchronous response. By applying this prototype methodology we can control industrial robotic arm easily. Using wireless camera module and powerful protocol then its may be controllable from far distance away also without face to face presence of human user.

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