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# Microcontroller Controlled Sensor based Wireless Robotic Arm

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**Abstract**: In last few decades robotics and gesture based controlling of equipment has improved a great deal, previously analog remotes were used for controlling of equipment. In this paper presented the development of a versatile and low cost robotic arm which can be utilized in any industry. This robotic arm can be used in number of applications by changing the program of controller and the structure is designed in such a way that it is capable to lift light and medium loads. The idea here is to control the robotic arm by using hand gestures. Here two different sensors are used, accelerometer and flex sensor to control robotic arm by the movement of fingers and hand positioning. The robotic arm moves in real time according to the position of accelerometer and its tongs moves according to flex sensor. By installing efficient and user friendly industrial electronics systems for manufacturing machinery or processors, one can obtain a precise, reliable and prolific means for generating quality products. In this model, the user is allowed to control the arm to a whole new level so that it can reach places which were almost impossible in previous cases it allows the operator to take full advantage of the flexibility of the arm.

**Keywords**: Servo motors, Accelerometer, Flex sensors, Microcontroller, Robotic Arm.

## I. INTRODUCTION

As the robotic industry is developing at fast pace there is a high necessity of designing a robot which could be controlled wirelessly. The controlling action used to control is totally gesture based. The main objective is to track human hand movement and execute a similar action with the robot placed at certain longer distance. The model developed aims to show how to control the robotic arm assembly using wireless controller based on flex sensor and MPU sensor (accelerometer and gyroscope) which can be used in various industrial applications for increased safety of human beings working in harsh environment [1].

The robotic arm contains various servo motors which move from $0^0$ to$180^0$, the movement of these servo motors is controlled with the controlling signal generated with the help of flex and MPU sensor [2]. The human hand movement is tracked with the help of MPU and then the data is sent to the microcontroller at the transmitter side and then the data is transferred wirelessly with the help of wireless module to the receiver side where another microcontroller receives the data and generates the controlling signal for the servo motors. Thus the servo motors rotate and execute the tracked hand movement. Now for the pinching action the controlling signal is generated with the help of flex sensor at the receiver side [5].

## II. METHODOLOGY

This model has two basic components, they are TRANSMITTER and RECEIVER the transmitter is the controller which is mounted on the hand glove of the operator and the receiver side is fixed on the robotic arm assembly.The hand glove has total of two sensors, one flex sensor and one three dimensional MPU sensor (accelerometer and gyroscope) the accelerometer is mounted on the palm of the operator so as soon as the operator moves his hand the accelerometer will sense its position ofthe hand in 3d space and generate a signalposition of the index finger and it generates a signal for the microcontroller [3].

These signals from both sensors are transferred through RF transceiver (nRF24L01). The microcontroller will receive all signals from the sensors and it will process them according to the program. The program will be written in such a way that the change of resistance will be proportional to the angle created by servo motor number -five. This will enable the operator to hold the object of various size and shape with great precisions. In this way the pinching gesture made with by fingers is used for holding action of the mechanical assembly [4]. The signal generated by the accelerometer will directly tell the microcontroller about the position of the hand of operator in 3d space this signal is processed or ran under program and is used to generate a corresponding signal to rotate servo motor (no1, no2, no3,

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no4) all these servo motors will rotate simultaneously for the location the targeted objected according to hand movement [2]. The receiver module has a microcontroller (Nano Arduino) to which all the servo motor are interfaced when the data is received by the receiver module it fed to the microcontroller which generates output signals for all the servo motors present in the mechanical assembly. All of above process is carried out in real time from the input signals generated from the fingers for pinching gesture and the movement of hand for the location of the target.The input in this whole process is the signals from the hand and finger of the operator and the output can be observed as mechanical arm moves or rotational movement of the servos accordingly for the microcontroller. The flex sensors are mounted on the index finger of the operator. When the operator makes pinching gesture with index finger and thumb to hold object, the flex sensors resistance is change according to the bending.

## III.EQUATION OF MOTOR RATING

In this arm there are multiple points. To determine the torque around each joint and to select the appropriate motor, the following described method is used.

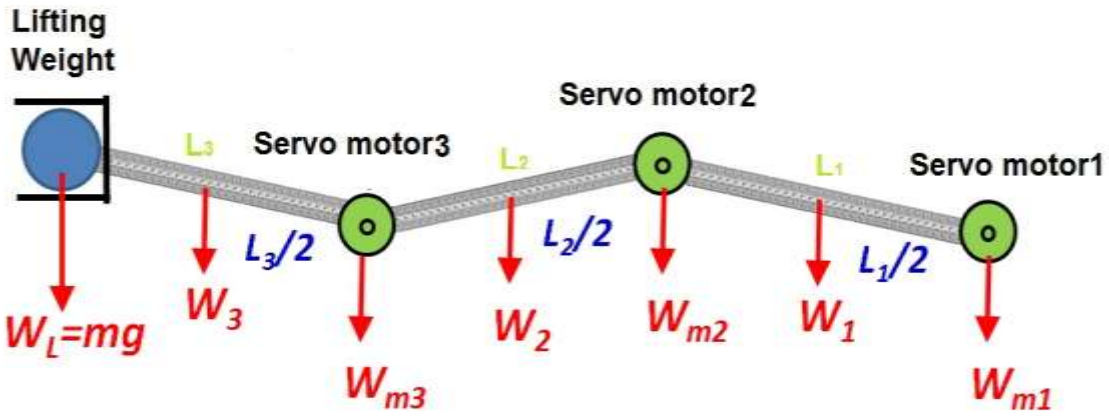


Fig 1. Torque Calculation for motors

Calculation of torque around each motor can be obtained by equation:

$$\tau_3 = (mg \times L_3) + (W_3 \times L_3 / 2)$$

$$\tau_2 = [mg \times (L_3 + L_2)] + [W_3 \times (L_2 + {}^{L_3}\!/_2)] + (W_{m3} \times L_2) + (W_2 \times {}^{L_2}\!/_2)$$

$$\tau_1 = [mg \times (L_3 + L_2 + L_1)] + [W_3 \times (L_1 + L_2 + {}^{L_3}\!/_2)] + [W_{m3} \times (L_1 + L_2)] + [W_2 \times (L_1 + {}^{L_2}\!/_2)] + (W_{m2} \times L_1) + (W_1 \times {}^{L_1}\!/_2)$$

## IV.BLOCK DIAGRAM

### 4.1 TRANSMITTER SIDE

The transmitter is used to send the data generated by the sensors i.e. the movement of the hand. For this two sensors are used, MPU and flex sensors which are mounted on the hand glove. The location of the hand is tracked by the MPU sensor, the MPU gives the output with respect to x,y,z axis in the 3-D plane. The MPU is mounted on the hand glove and as we move our hand in space the MPU gives output regarding the x,y,z coordinates [1]. For pinching gesture the flex sensor is mounted on the index finger of hand glove which is used to sense the bending action and thus generate output which is used to create the pinching action at receiver side [5].

So total of four variables are stored in the microcontroller which are x,y,z axis coordinates values and Rv the output of the flex sensor for picking gesture. All these values are transferred from the transmitter with the help of a communication module, in this case used NRF module. The data is sent in the form of packets each packet consisting x,y,z,Rv values the data transfer in the microcontroller is based on FIFO the first in first out mode [3]. In this module as there is no data transfer from receiver to transmitter used only one way communication i.e. from transmitter to receiver. In this way the hand gestures and movements are converted in to signals and transferred.

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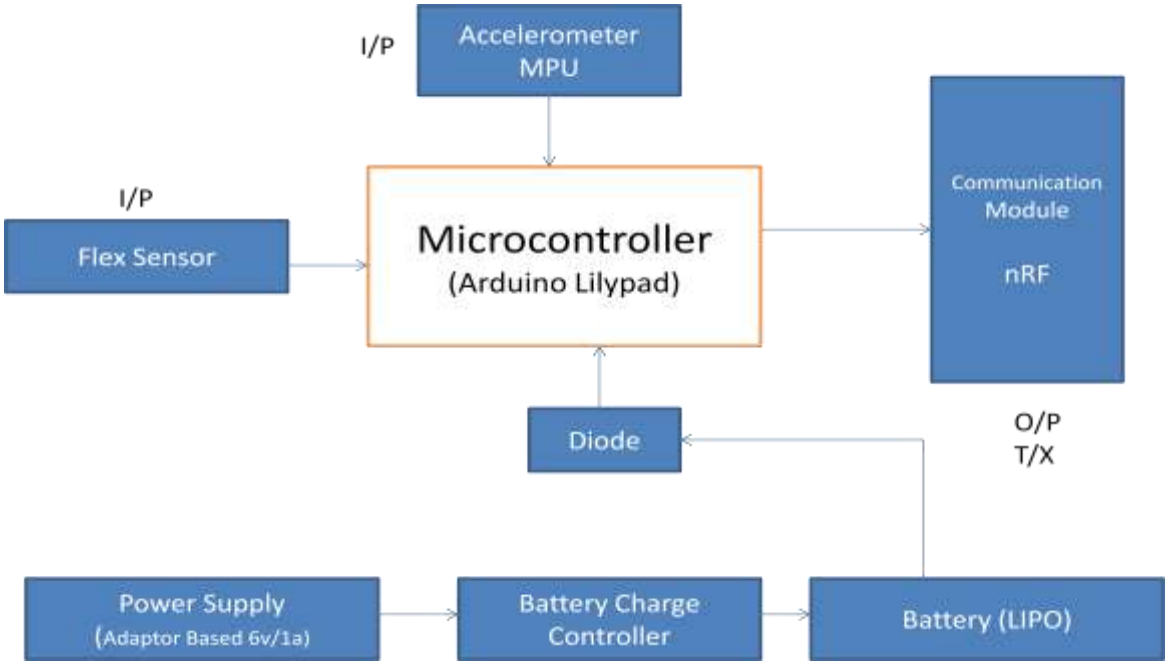


Fig2. Transmitter Block diagram

**4.2RECEIVER SIDE**

At the receiver side the robotic arm assembly consists of servo motors, a microcontroller and receiving module. The receiving module receives the data sent by the transmitter this data sent to the microcontroller which decodes the data and generates the controlling signals for the servo motors accordingly and thus the robotic arm is able to carry out moves like up, down, rotating and pinching action.

The block diagram describing the receiver side is shown in Fig. 3.

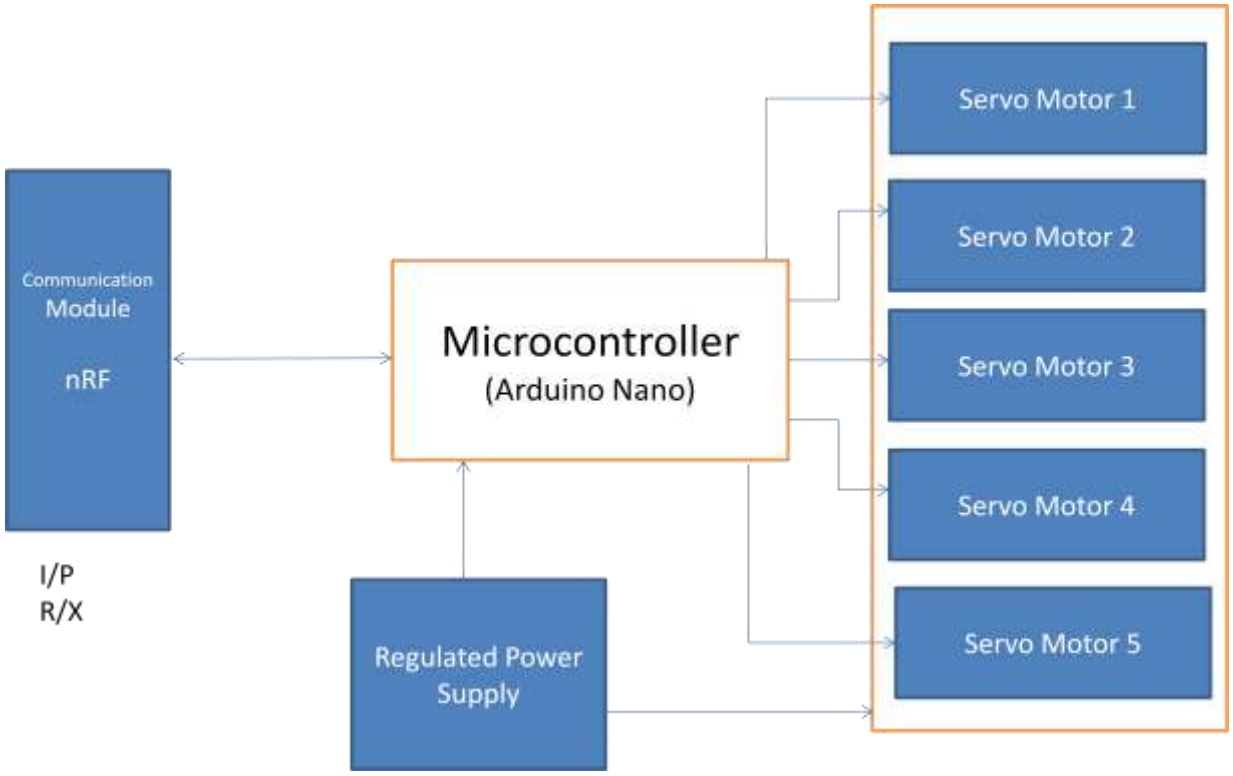


Fig 3. Receiver Block diagram


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## V. CIRCUIT DIAGRAM

### 5.1 TRANSMITTER SIDE

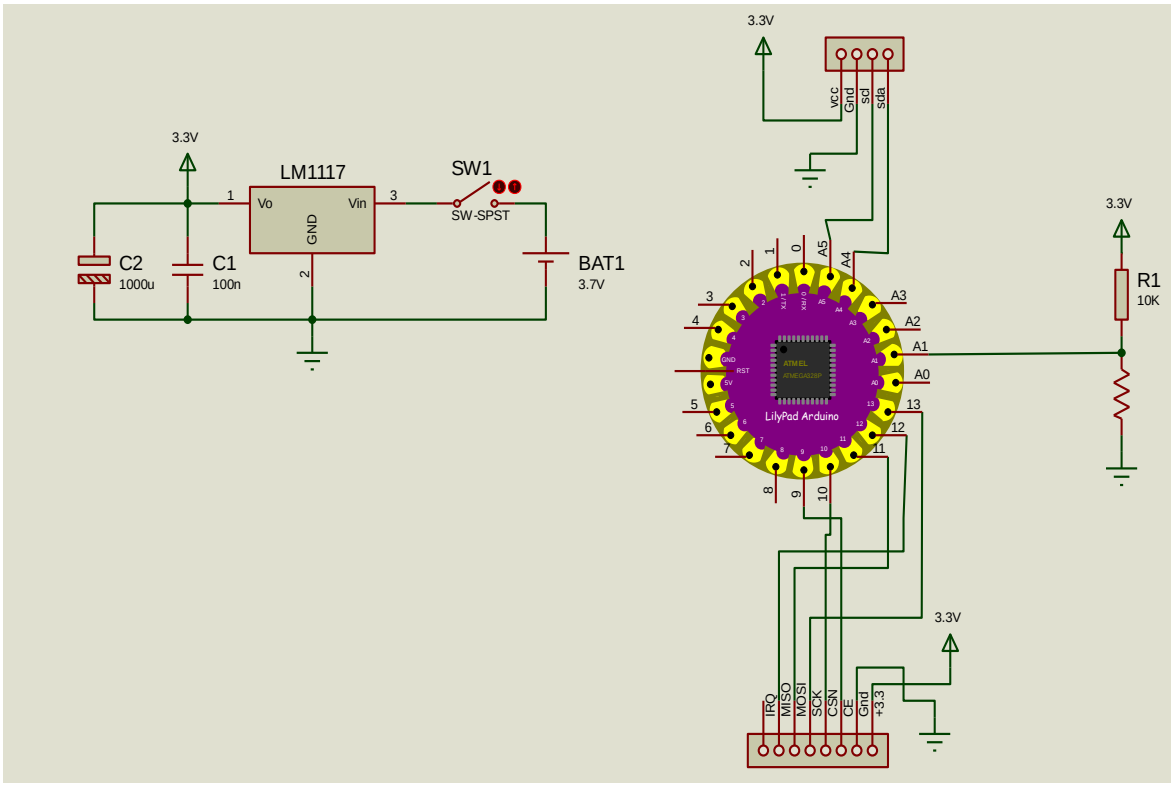


Fig 4. Transmitter Circuit diagram

### 5.2RECEIVER SIDE

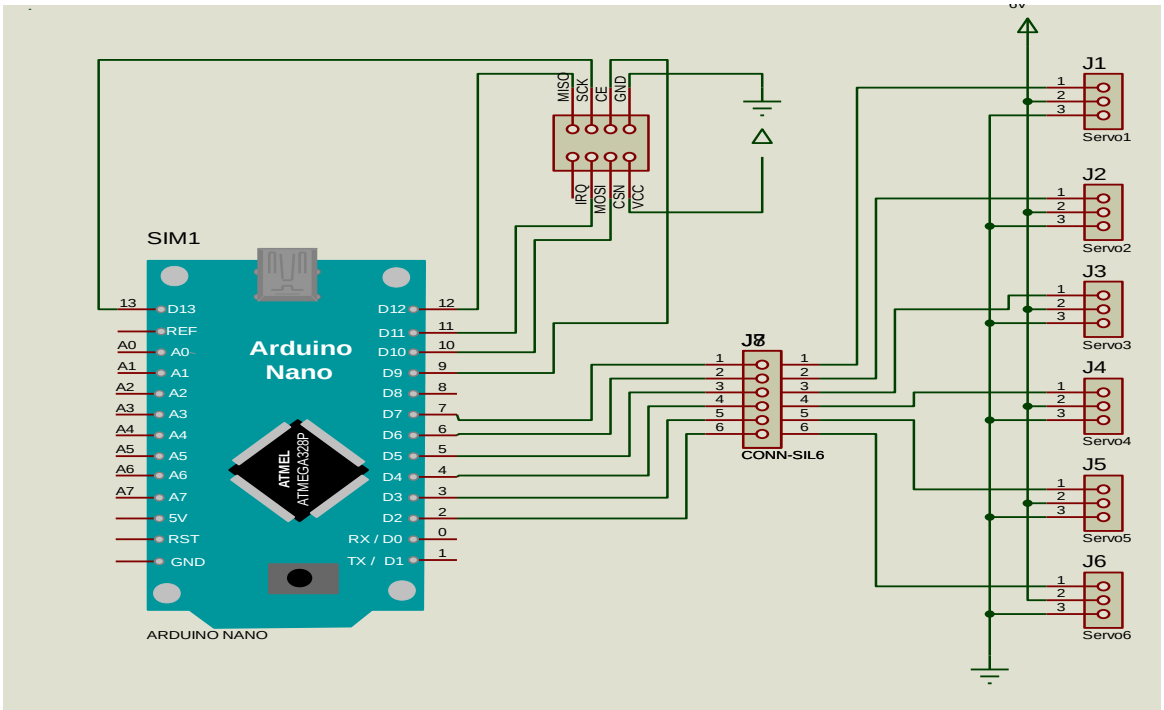


Fig 5. Receiver Circuit diagram


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## VI. ADVANTAGES AND LIMITATIONS

### 6.1 Advantages:

1. Ease of operation as motion sensors.
2. The complicated analog switches use is avoided.
3. The moves carried out with motion sensors are of high precision.
4. The moves carried out with motion sensors have high repeatability and consistency.
5. The speed of controlling the robot is increased.
6. As wireless mode of communication is used work place safety is increased.

### 6.2 Limitations:

1. The wiring of such robots could be complicated at certain levels.
2. The initial investment in robotics is significant.
3. As wireless communication is there, hacking of controllers could be a disadvantage.
4. In open environment some time surrounding conditions may affect the communication between transmitter and receiver.

## VII. APPLICATIONS

There are numerous applications of gesture based technology, here the implemented gesture based technology to control the robotic arm could be used for picking and placing application in various industries such as in automobile industries, it could also be used to pick up small parts of the assembly line and place them in respective positions, it could be used as a safety gadget by army to pick up and diffuse bombs, as this robot is controlled wirelessly it could be used in hazardous environment such as gaseous explosions to carry out various tasks required.

## VIII. CONCLUSION

The paper focuses on the controlling the robotic arm through simple human hand gestures. It shows how the robots could be controlled with great precision to get fine adjustments.
In this model we have used simple gestures such as moving and bending of arms in any fashion in the three dimensional space and tracked it so that the robotic arm mimics the movement of hand, another gesture which is used is folding of finger to which the robot reacts by closing its claws.
The paper shows how the various gestures could be used to design new age controllers where instead of switches we could control various objects with simple movements.

## IX. FUTURE SCOPE

Wireless gesture recognition technology can be used to make the robots understand the human gesture and make them work accordingly like picking and placing of objects. The topic can be extended to produce voice information or display the information on LCD based on the hand gesture of the user. This can be more useful for specially challenged people to communicate their thoughts exactly as others do.

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