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NRF24L01 Transceiver Based Hand Gesture Controlled Robotic Arm Replication

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Abstract: *Robotics is the most influential field in technology. Use of robots is exponentially growing in every industry. A gesture controlled robotic arm is proposed in this paper. The structure of the arm comprises of four fingers, a thumb, a rotating arm, and an elbow. Bend sensors also known as flex sensors are used to control the movements of the fingers and accelerometers for the movement of the arm and the elbow respectively. The arm is controlled wirelessly using transceivers. The movements of the fingers are controlled by cables that act as cords of the human arm. The interface between hardware and software is achieved using ATmega microcontrollers.*

I. Introduction

Robotics being a current emerging technology in the field of science, globally a number of universities are working in this field. Robotics is the field, which will be very useful for the society in the coming years. At present, various wireless robots are being developed and are used in majority applications. We have developed a robotic arm, which is controlled wirelessly using manual gestures that transmit signals to the robot through a transceiver fixed on the gloves instead of controlling it manually. The arm moves and acts in accordance with the gestures made by the hand from a certain distance. The arm picks up the objects and keeps them at the desired place as indicated by the movements of the fingers and the hand[1]. The robots are also used in perilous situations like a bag that can explode while opening. A UGV with a robotic arm is a good and safe solution for this type of problem[2]. PUMA (Programmable Universal Machine for Assembly) robot is used in almost every industrial application today such as disposal of hazardous waste which is unfavorable for humans. In the last decade, there has been a lot of research in the field of humanoid robots with the inventions of many technologies to control robots that are further discussed[3]. The objective is to make the robotic arm understand the language of the human body, thus building a bridge between humans and robots[4]. This system consists of a robotic arm with a mechanical base. The range for the robotic arm and human hands is approximately 50 meters since both are spatially separated.

II. Literature Survey

In robotics tremendous efforts have been made to create reliable and user friendly robots. Here a human and machine communication was established using a Leap motion sensor. The Leap motion controller was used to track the mapping between the user hand movements with the help of optimum algorithms. With ambient assisted living the applications of the human robot interactions were discussed[5].

This paper shows a design of robotic hand using a atmega microcontroller. Gesture controls were used to replicate the movements of the user hand. The gestures are sensed by the number of potentiometers which are embedded on the gloves. The parts of the arm are driven by regulating the movements of the potentiometer[6].

In this paper an accelerometer-based system to control an industrial robot is proposed. These accelerometers are attached to the human arms, capturing its behavior. An Artificial Neural Network trained with a back-propagation algorithm was used to recognize arm gestures and postures, which then will be used as input in the control of the robot. The aim is that the robot starts the movement almost at the same time as the user starts to perform a gesture or posture. The results show that the system allows the control of an industrial robot in an intuitive way. Finally, the results of some tests performed with an industrial robot are presented and discussed[7].

[redacted] In this paper, impact of individual sensor on the performance of a navigation system with the use of accelerometer is shown[9].

It gives the design of a controller intended for teleoperation, which is capable of controlling a robotic arm through a LAN or via the Internet[10].

This provides a review of relevant mobile robot positioning technologies like Odometry, Inertial Navigation, Magnetic Compasses, GPS Model Matching etc. Pick and place operation by controlling the speed and position using FPGA and sensor circuitry[11].

The important contribution of present work is that any human arm moments can be mapped onto the robotic arm with good precision. Further the flexibility of micro controller programming makes the task easier. Gesture identification has been developed to replace the approach of conventional controlling mechanism of robots via buttons etc. by hand gesture based controlling [12].

III. Technical Description

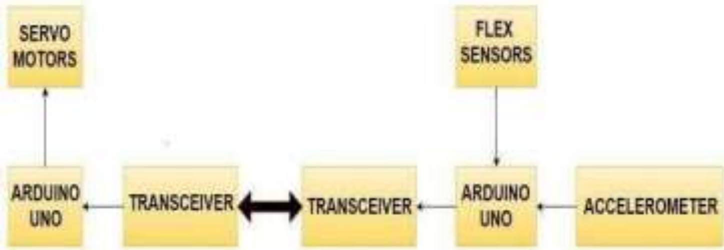
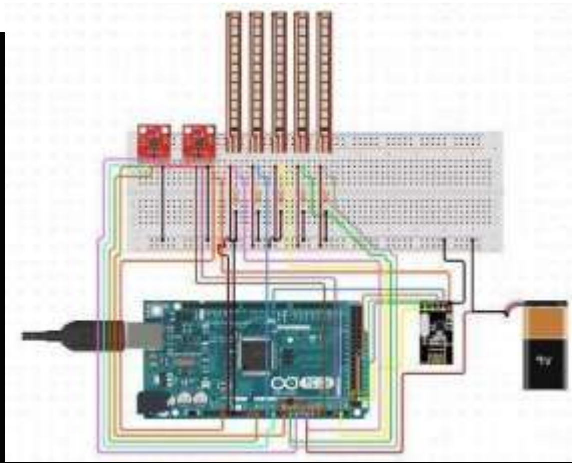


Fig. 1: Block diagram of Robotic arm

The microcontroller receives input from the accelerometer and flex sensors. The microcontroller used in this project is Arduino Uno which is based on microchip atmega328P and is developed by Arduino.cc. It has onboard 14 digital pins and 6 analog pins. The programs are uploaded to the board via Arduino IDE (Integrated Development Environment) using a type B USB cable. It can be powered by a USB cable or by an external battery. The accelerometer used is ADXL335 which gives complete 3 axis acceleration measurement. It provides an analog voltage at the output pins, which is proportional to the acceleration in respective directions i.e. X, Y, Z. The flex sensor is a variable resistor. The resistance of the flex sensor varies in accordance with the bent of the component. The microcontroller sends this input to the receiving section via NRF24L01 transceiver. It uses the 2.4 GHz band and it can operate with different baud rates. If used in open space its range can reach up to 100 meters. This data is received by a similar transceiver which results in the movements of the fingers and the arm of the model using an SG90 servo motor. The servo motor has a torque of 2.5kg/cm.

The hand glove has been designed in such a way that it consists five flex sensors, attached at every finger of the glove. Processing unit consist of a microcontroller at both end of transmitter and receiver. RF transceiver is used to communicate between hand held unit and robotic unit. Robotic unit consist of a mechanical structure with seven servo motors.

4.1 Transmitter Section



[redacted]

4.2 Receiver Section

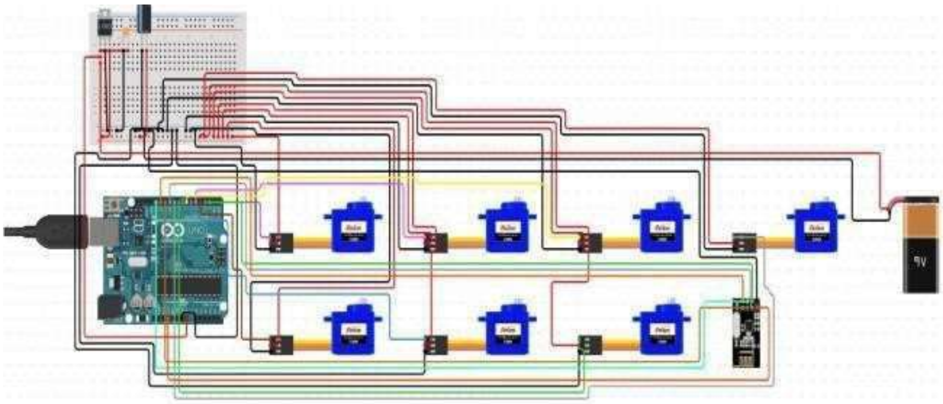


Fig 3: Circuit diagram of Receiver section

The microcontroller is responsible for controlling the action of the robotic arm. It receives the input variation of the bending sensor through the NRF24L01 transceiver and sends it to the ADC pin of the microcontroller that converts these equivalent values to their digital value. These digital values are converted into the required PWM signal that is used to drive the servomotors connected to the robotic hand. The servomotor can be moved to a desired angular position by sending PWM signals (pulse width modulation) on the control cable. Which further results in the movements of the fingers and the hand.

IV. Applications

Scientific: Gesture control robotic arm can help the scientist to perform hazardous experiments in a safer way by using a robotic arm to pick the dangerous liquids. This can also help scientist to perform with the chemicals which are highly flammable[15].

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

Space: Gesture Controlled Robotic arm may also facilitate the astronauts to repair or obtain objects in zero gravity without going outside the area craft, wherever movement is quite difficult and is dangerous for human life[15].

V. Conclusion

The paper presents a gesture controlled robotic arm which provides a convenient way to control the arm wirelessly using accelerometers, flex sensors and transceivers which is more instinctive to work. Applications which require precise control and work like human beings can be easily implemented using this approach and it provides more flexible control mechanism. To endure smoother movement of the arm a gyro sensor is used with the accelerometer. Although we can gain the gesture control, but the problem of noise may exist which can be further removed by calibrating and taking more observations and using a much precise smoothing algorithm. Also by using Ethernet connectivity and a camera for visual feedback, we can operate the robotic arm over the internet.

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