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Design of a controlled remote hand based on radio frequency protocol

Roua Baccouche[1], Dhafer Mezghanni[2,*]

[1]3 beni mtir ,korba,8070 Nabeul, Tunisia
[2]Faculty of Sciences, University of Tunis el Manar,2092 Tunis, Tunisia

*Corresponding author. Email address: dhafer.mezghanni@gmail.com

Abstract

Today's technology has increased the interest in robotic systems and increase the number of studies realized in this area. There are many studies on robotic systems in several fields to facilitate human life in the literature. In this study, a robot hand is designed to repeat finger movements depending upon flexible sensors mounted on any wearable glove. It deals with the design and development of a robotic hand with real time control, which is precise and cost-effective. This five fingered robotic arm mimics a small degree of dexterity and could be used for other applications such as prosthesis for leprosy patients. Thanks to the prototype of robotic hand in this study is developed with different materials and mechanisms: The angle data on the sensors and servo motor position information are transmitted through the RF 24L01 wireless module. The determinations related to robot hand control are performed with Arduino card.

Keywords: Robotic Hand, Wireless RF modules, Flex sensors

1. Introduction

A Robot in lay man's terms is a mechanical device that has come into existence not only to make the human life simpler by replacing or replicating human activities, but to offer an excellent amount of precision and accuracy. It is defined as a programmable, multifunctional manipulator designed to move material, parts, tools or specialized devices through various programmed motions for the performance of a variety of tasks.

Medical robotics is a growing field and regulatory approval has been granted for the use of robots in minimally invasive procedures. Robots are being used in performing highly delicate, accurate surgery or to allow a surgeon who is located remotely from their patient to perform a procedure using a robot controlled remotely.

The arm to travel specifically in a designed pattern, with sensors ensuring that all movements are exactly of the similar pattern (Howe and Matsuoka, 1999). They are endowed with several degrees-of-freedom, giving them the flexibility to move in many directions through multiple angles with utmost ease and agility. The movements of the robotic palm are controlled by moving the user's fingers using the Flex sensors and Wireless RF (Radio Frequency) modules. Wireless RF (Radio Frequency) module provides unprecedented range in a low-cost wireless data solution. RF modules are widely used in electronic design owing to the difficulty of designing radio circuitry.

Number of researchers on the anthropomorphic multi-fingered robotic hand have been reported till date (Trayer and Priya, 2011; Cipriani et al., 2006; Hoshino and Kawabuchi, 2006). The MIT hand developed by Jacobsen is operated by actuators which are located in remote place from the robotic hand

frame and attached by tendon cables. Hirzinger et al. designed DLR-Hand II, which built the actuators into the hand. Each finger of robot hand is attached to a motor, 6-DOF fingertip force torque sensor and integrated electronics along with curtain controller [6,7]. Kawasaki et al. developed anthropomorphic robotic hand called the Gifu hand III, which has a thumb and four fingers with the suitable controller [8]. The thumb has 4 joints with 4-DOF and each of the fingers has 4 joints with 3-DOF. Moreover, the assigned tactile sensor which is made of conductive link is arranged about 859 sensing points on the palm and the fingers of the robotic hand. Shimojo et al. used the pressure conductive rubber as a pressure sensing material [9]. They attached the sensor onto fingers of robotic hand and demonstrated its grasping operations with a column, sphere, etc.. Although many researchers have been done already, however, their motion of robotic hands is different from human. The mechanism of robotic hands developed by MIT was different than others because they utilized 32 pneumatic actuators to operate three fingers and a thumb through a bunch of cables [10].

The main purpose of this work is to develop the hardware and software of the system, which enables remote manipulation of five finger movements, which can be controlled remotely by human wearing gloves. The main distinction of the system is that the angle resistance relationship is obtained with the flexible sensor for the detection of the human fingertip angle . This device can be used easily in the fields of medicine, industry and defense industry owing to developments and new additions. In particular, it can be used in dangerous humanitarian works for human health and safety such as bomb disposal, private laboratory operations. Furthermore, thanks to that the system is attractive in terms of cost, it will enable the growth of commercial artificial robotic hand. The project aims to design and implement a cost-effective and an affordable prototype model of robotic hand for . The movements of the robotic palm are controlled by moving the user's fingers using the Flex sensors and Wireless RF modules. The flex sensor system gives control signals to the arm wirelessly via RF module and arm mimics the movement of the flex sensor system. Mini servo motors were used to move the fingers of the hand.

2. Hardware description and system design

The system basically consisted of three parts:

1. Master Section - This section includes the flex sensors connected to the transmitting Arduino board along with the Nrf shield and the Nfr module.
2. Nrf Wireless Network - This is the section which physically doesn't exist. It consists of the wireless communication between the NRF modules attached to the Transmitter and Receiver Arduino board.
3. Slave Section - It includes the Receiver RF module attached to the receiver Arduino board via the RF shield. The output of the Arduino board is connected to the servo motors on the Robotic Arm enabling the corresponding motion of the arm.

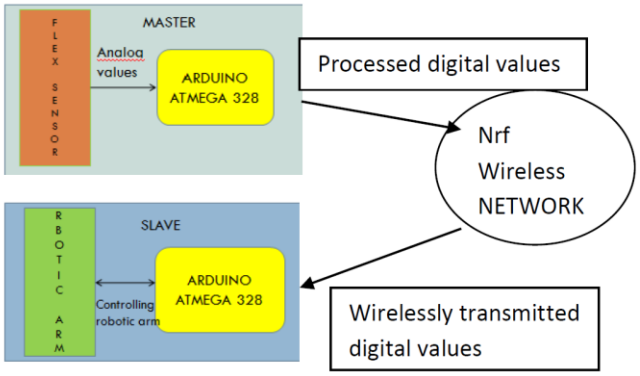

Figure 1: Block Diagram of a wireless robotic arm

For the project, The signal from the flex sensors are given to a voltage divider circuit and correspondingly signals are sent to the robotic hand by RF wireless module . To move the fingers of mechanical hand servo motors are used. The motors shafts are fixed with readymade PVC part which will help in holding the finger position. The parts used are shown in Fig 1. This small part will hold the current position until the new digital value is received by the motor. Internal assembly of a servo motor is shown in Fig 2. The mechanical finger is connected to the motor with the help of cables. Another important part of this project that was flex sensor. These flex sensors are used in measure the bend in the each Fig.

Figure 2: PVC part

The PVC part shown in Fig 2 is mounted on the shaft of the DC servo motor.

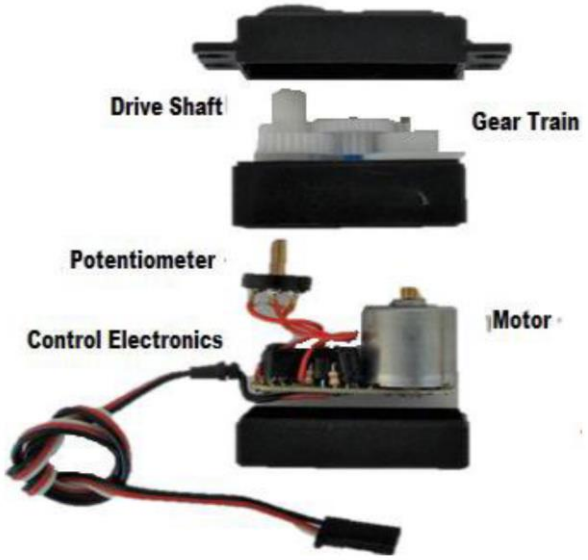

Figure 3: Internal of servo motor

Figure 4: Flex Sensor

Fig. 4 shows the flex sensor. It gives the variation in resistance as flex sensor is bent. This variation in resistance is provided to voltage divider circuit. So variation in resistance as converted in voltage variation. This voltage is analog in nature as to convert it into digital ADC present in the controller is used.

Communication: Wireless communication provides great convenience to receive information from mobile or stationary units that provide ease of movement or to send over a wide area. In this project, the RF24L01 MHz module, which is low cost and easy to find on the market, is used for wireless communication of glove and robot hand. The data from the five different flexible sensors are sent sequentially to the servo motors. A protocol for discrimination of this data on the receiver has been developed. The analog data received from the fingers are converted to digital values and then converted to angle values of the integer type.

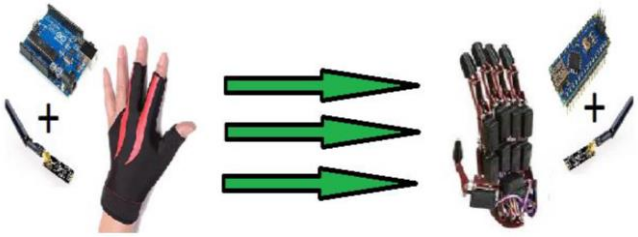

Figure 5: The main idea of the project

3. Flowchart

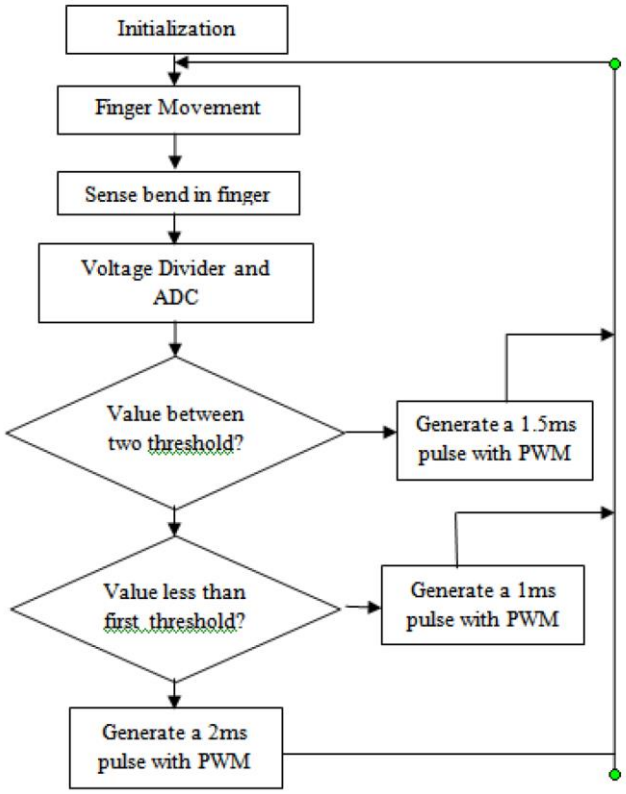

Figure 6: Flowchart for the algorithm

4. Conception

The assembly drawings and final definition drawings were made using the "SOLIDWORKS" Computer Aided Design (CAD) software.

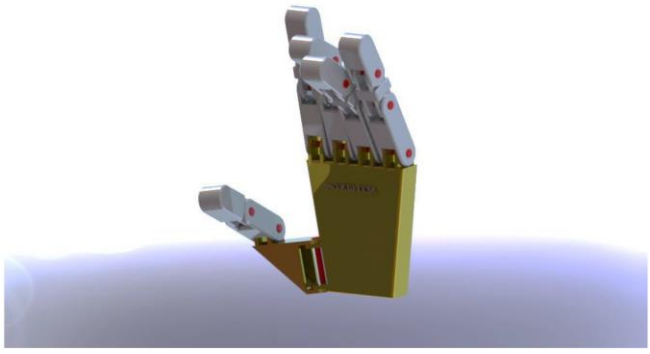

Figure 7: 3d design of the robotic hand

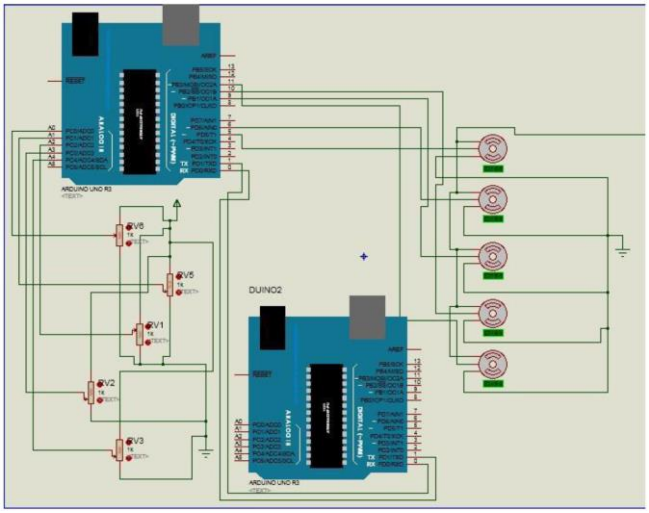

Figure 7: Electronic diagram on ISIS. (1) The bending sensors are replaced by the potentiometers (Rv1, Rv2, Rv3, Rv4, Rv5), since they have the same operating mode and the bending sensor component does not exist on ISIS. (2) They are the two arduino connected to each other by the RX-TX link since the remote link does not exist on ISIS. (3) They are the servomotors responsible for moving the fingers of the hand.

5. Conclusions

The research on robotic hand is certainly important in development and learning. In this study, it has been observed that finger movements are perceived and imitated with high accuracy without any problems thanks to the flexible sensors mounted on any glove. Thanks to the RF 24l01 MHz module, more comfortable movement is possible and the usage area is expanded. Since the servo motors high current at the start, the supplies are made separately. This system is possible that the robot hand will become commercially more widespread Since it is low cost. It can be also used in defensive industry, in bomb disposal works, in dangerous places in terms of human health and security, in animatronic works, in people who are living with discomfort at birth or later on their fingers. However there are still some problems that need to be addressed. Research is still being carried out to improve the wireless transmission of signal and reduce the delay and for the simultaneous movement of two servo.

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