Design and Implementation of Tactile Sensor Based Low Cost Prosthetic Hand Device

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Abstract: **-As there is a large development in the field of prosthetic devices and mechatronics .we are about to use it in the patients with upper limb loss .usually the prosthetic is defined as wearable machine that covers the parts of the body. It could be installed in any parts including wrist ,finger ,elbow .Tactile sensing plays an important role in prosthetic hand to achieve high efficiency .Most prosthetic hand will have slippage .our project explains about how to avoid slippage using tactile based force sensor .Generally if a patient with upper limb loss gets a prosthetic hand they will experience the slippage to avoid such condition we are using tactile based force sensor. which gives constant voltage on all material and specific force needed for the type of material we are holding. Most of the available device will have problems in their cost and weight . They will be very expensive and heavy to lift . our goal of the project is to design low cost prosthetic hand device for the patients with upper limb loss based on tactile sensing. Here we are using a pic microcontroller to control the hand, wrist and finger and it improves the quality of life and there by restores functionality of hand.**

Keywords—Mechatronics, Upper limb loss, Prosthetic Hand, Force Sensor, Slippage, Tactile sensing

I)Introduction

A prosthesis is a device to replace a part of the body which is missing and make the parts to work better. Diseased or missing eyes, arms, hands, legs, or joints are commonly replaced by prosthetic devices

In medicine, a prosthesis, is an artificial device that replaces a missing body part, which may be lost through trauma, disease, or congenital conditions.

Prosthetic components include the socket, suspension and control system, joints, and appendage. There are many different options for prostheses, but all options aim to achieve a stable, comfortable fit for maximum function. The prosthetist (an expert who designs, fits, builds, and adjusts prostheses) helps people choose the type of prosthesis and options they need to accomplish their goals. For example, prostheses can be designed for general daily mobility, for specific activities such as swimming, or for high-impact and competitive sports such as running. The person's physical and cognitive abilities and gadget tolerance are important in the initial selection of prosthetic components. The loss of one hand can significantly affect the level of autonomy and the capability of performing daily living, working and social activities.

A. Human hand anatomy measurement

Human hand plays important role in daily life. It is used as a symbol for salutation expression of diseases, etc., as a weapon and defense, and the most important use of the human hand is as a tool. With the hand humans may write, eat and communicate. It is obvious that the human anatomy is complex due to the hand connection with the brain. The functional capabilities of a prosthetic hand requires both structural characteristics and sensory control characteristics development. The hand bones are classified by 8 carpal bones that compose the carpus, the 5 metacarpal bones and 14 phalanges. All bones are connected between with articulations and ligaments. The carpal bones and metacarpal bones have a similar structure regarding articulations. Their movement is very limited the intercarpal articulations are for bones connection, in order to prevent the lateral and dorsal volar translation the ligaments are used. Exception of the metacarpal bone is the thumb. The thumb have missing the second phalange and the movement is presented between the carpo-metacarpal articulations. The phalange joins are composed by collateral ligaments that prohibit the collateral deviation and volar plate.
When the human hand realize a grasping movement the bones assume a fixed position. The speed of the movement is controlled by different inputs and the speed starts from slow to fast. The speed of the hand movement also implies the activity to be realized as the activity requires different intensity and direction. As an example, writing, involves different movements of the phalanges and joins. Ballistic movements are usually the repetitive movements as typing. This kind of movement is fast movement. In order to realize the prototype, is necessary to define: - The measurements of

the human hand bones. - The degrees of freedom of the human hand. - The control system

*B.E**xisting system***

In this existing paper presented a wearable hand gesture recognition and finger angle estimation based on modified barometric pressure sensing.

Barometric pressure sensors were encased and injected with Vyta Flex rubber such that the rubber directly contacted the sensing element allowing pressure change detection when the encasing rubber was pressed A wearable prototype consisting of an array of 10 modified barometric pressure sensors around the wrist was developed and validated with experimental testing for three different hand gesture sets and finger flexion/extension trials for each of the five fingers.

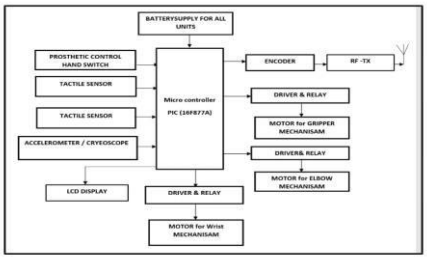
They estimated physical pressing pressure changes by covering the barometric sensor in vyta flex rubber

DISADVANTAGES

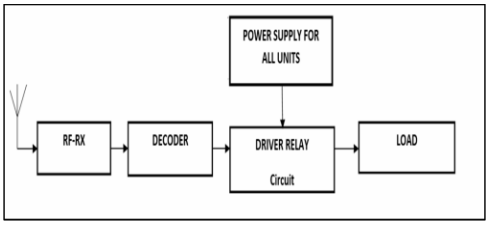
- It is not accuracy.
- If we want to use this, we want to depend other.
- Difficult to find the position of the hand.

c.proposed system

This project aim is to design a portable, light weight, low cost prosthetic hand to prevent slippage. Prosthetic hand enabled with Tactile sensors are emphasized in contact force determination for grasping control and object recognition.



LOAD CONTROL UNIT



Working

The microcontroller that has been used for this project is from PIC series .PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instructions and data allowing of program and data memory. there are two tactile based force sensors has been used in the fingers that helping in measure the amount of force applied to an object. these sensors consist of sensing films and electrodes force-sensing resistor is based on the property of “contact resistance”. accelerometers are electromechanical devices that sense either static or dynamic forces of acceleration. static force includes gravity, while dynamic forces includes vibration and movements.in our project the accelerometer is used for controlling the home appliances through RF communications

(1)***Tactile force sensor***

A Force sensor is a sensor that helps in measuring the amount of force applied to an object. Most of the force sensors are designed using Force-Sensing Resistors. These sensor consist of a sensing film and electrodes Force-Sensing resistor is based on the property of “Contact Resistance”.

(2) ***Accelerometer***

Accelerometers are electromechanical devices that sense either static or dynamic forces of acceleration. Static forces include gravity, while dynamic forces can include vibrations and movement. The sensing capabilities of this network can be furthered to six degrees of spatial measurement freedom by the addition of three orthogonal gyroscopes.

II) IMPLEMENTATION

1)Hardware implementation

A. Tactile Grip Force and Pressure Sensing

The Grip system measures and evaluates static and dynamic pressures from grasping objects. Grip measures interface pressure for human hand and finger gripping applications to assess comfort, design, and ergonomics. The

system is used to improve design for a more ergonomically sound product, study carpal tunnel and repetitive motion syndrome, or analyze the human hold on various tools and sports equipment. It is an ideal tool for collecting vital information and insight to enhance product design, manufacturing, quality, and research.

Figure 2.1 tactile force sensor

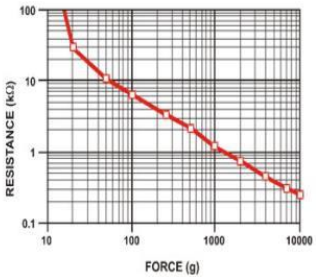


Figure 2.2 characteristic curve of force sensor

B. Prosthetic Control Switch

A simple switch has an open state and closed state. However, a microcontroller needs to see a definite high or low voltage level at a digital input. A switch requires a pull-up or pull-down resistor to produce a definite high or low voltage when it is open or closed.

A resistor placed between a digital input and ground is called a "pull-down" resistor because it normally pulls the pin's voltage down to ground. A switch placed between the digital input and the voltage supply will short the digital input to the voltage supply when it is pressed. This means the voltage seen at the input will be low when the switch is open and high when the switch is closed.

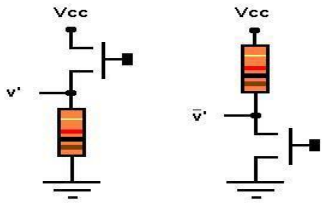


Figure 2.3 prosthetic hand switch

C.Accelerometer

Accelerometers are electromechanical devices that sense either static or dynamic forces of acceleration. Static forces include gravity, while dynamic forces can include vibrations and movement. The sensing capabilities of this network can be furthered to six degrees of spatial measurement freedom by the addition of three orthogonal gyroscopes.

Specifications

A typical accelerometer has the following basic specifications:

- Analog/digital
- Number of axes
- Output range (maximum swing)
- Sensitivity (voltage output per g)
- Dynamic range
- Mass

2) Software description

A. MPLAB IDE SOFTWARE

MPLAB is a proprietary freeware integrated development environment for the development of embedded applications on PIC and ds PIC microcontrollers, and is developed by Microchip Technology.

MPLAB X is the latest edition of MPLAB, and is developed on the NetBeans platform. MPLAB and MPLAB X support project management, code editing, debugging and programming of Microchip 8-bit, 16-bit and 32-bit PIC microcontrollers.

MPLAB is designed to work with MPLAB-certified devices such as the MPLAB ICD 3 and MPLAB REAL ICE, for programming and debugging PIC microcontrollers using a personal computer. PICK it programmers are also supported by MPLAB.

III.RESULT AND DISCUSSION

A. RESULT

In this system, two prototype artificial skin tactile force sensors were created. First, a two number of small piezoelectric force sensors were manufactured. With their wires zig- zagged, the sensors were then embedded into a flexible and stretchable silicone rubber, allowing for the overall tactile sensor design to also stretch and bend. These sensors were buffered through a number of operational amplifiers, and sampled using a multiplexing scheme by a microcontroller. From there, the sensor readings were used to the hand gripper mechanism which showed the sensor data in real time. While additional research is required to perfect these designs, the prototypes successfully serve as proofs-of-concept for a method of reading a large number of small piezoelectric sensors embedded in a realistic-looking silicone rubber glove.

The main area of contact when grasping an object with the prosthesis is distal region of the index finger. As a result, a two sensor on the finger could be continuously sampled until contact is detected. Once the prosthetic hand initiates contact with the desired object, the control unit can begin monitoring the remaining sensors. This allows multiple sensing elements of the system to become active only when they are needed.

All the conclusions drown by the microcontroller is transmitted by the RF transmitter to the RF Receiver. The operating rang of the transmitter is 434 MHz. The signal transmitted into the air is received by the RF Receiver from the antenna. Similarly the operating range of the receiver is same as the transmitter 434 MHz. receiver and microcontroller Atmega16 is communicate through the decoder. The output of the decoder is given to the microcontroller and then home appliances are process according to the received and stored hand movement.

B.OUTPUT VALUES

S.NO	PRODUCT TESTED	VOLTAGE PRODUCED	FORCE SENSOR(1)	FORCE SENSOR (2)
1.	Plastic	5v	71	68
2.	wood	5v	73	69
3.	glass	5v	70	67
4.	steel	5v	75	70

C. Advantages

- Easy to use
- Portable
- Light weight
- Low cost

IV) CONCLUSION

In this paper, we described a method for the automatic detection of slippage through a tactile sensor embedded in a prosthetic hand. To solve the problem of limited tactile sensing in prosthetic hand as well as provide for future planned mechanical prostheses, an innovative tactile sensor system was created and embedded into two realistic-looking artificial hand. These prosthetic hand tactile force sensors used small piezoelectric ceramic disks to measure applied force at multiple points on fingers. The sensor outputs were buffered by high impedance voltage-following operational amplifiers, and then read sequentially using a multiplexing scheme by a microcontroller. The method consists of a network of analog filters and of a stage of rectification and envelope. The enveloped signal is then converted into an ON-OFF signal by means of a thresholding mechanism. The filter network extracts a meaning full slippage content from the tactile traces recorded by the tactile sensor.

The following rectification and envelope modify the filtered signal in a such a way that the thresholding mechanism is easier to be applied. The method has been mainly implemented by means of a hardware, i.e. a PCB, which avoided the lag due to the use of digital filters as in . The sole thresholding has been performed via software. Simple sensors measuring only the normal force component can be used, as no tangential forces are required. An experimental setup has been created for the validation of the proposed method. The setup included a robotic arm-hand system. The hand has been endowed with bio inspired fingertips embedding FSR tactile sensors. The arm-hand system has been actuated in order to: 1) slide the fingertip onto six flat surfaces with different frictional properties 2) slide two objects with non-flat surface while being grasped by the prosthetic hand 3) perform real manipulation experiments featuring hand reaction.

By combining tactile sensors with other sensors commonly used by prosthetic to structure their environment, the variety and quality of tasks capable by robots will greatly increase, enabling them to act as capable human-companions or aides. In order for these robots to be accepted into society, as well as be able to perform the types of tasks and use the 83 same tools that humans do, they will need to look and perform similarly to humans; specifically their sense of touch. Also benefiting from the advances made in electronics, current research is developing the next generation of electromechanical prostheses. These prostheses are returning the use of limbs to people who have lost them, and soon the biological-technological connection required to convert electronic sensor data to nerve impulses will be perfected. Advanced tactile sensors might one day return the sense of touch to those who have lost it. These prototypes successfully demonstrated the viability of small piezoelectric elements embedded in prosthetic hand for use in creating flexible and elastic tactile sensors. The gesture controlled system provides an easy mechanism for people, specially people with special challenges, illness, old age etc.

In future, the hand were created using silicone rubber to stimulate both the texture and look of human skin, while maintaining both flexibility and durability. In future more, home appliances can be controlled by incorporating those devices with newer versions of gestures, also implemented in every home at low cost. The devices helps the aged people who have less mobility.

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