Sensorized Glove for Rehabilitation Purpose

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Abstract— In human life they utilize hands for taking care of any task, so people are gifted users of their hands. They utilize them to hold and control things and to connect with pretty much clear gestural and non-verbal communication. These days' scientists are attempting to gain from the biology for research. As the developing actuation technologies and mechanical detecting empower the development of better mechatronic frameworks, as a result of this there has been a developing enthusiasm for research field. Application arenas are like robotics, entertainment, sign language understanding, medical field etc. In any case to appreciate hand developments and associations, scientists oblige suitable sensing/detecting system, similar to glove based system for information accomplishment. Lamentably a large portion of these system are either expensive solutions for lab utilization, or a few low value arrangements are insufficient, and both grade to be troublesome and hinder the characteristic hand developments. So in this paper we are presenting a moderate system. This system will be helpful in medial field for doctors and also for users. This system will sense the position of hand fingers and will send this data to the doctor utilizing wireless communication. For sensing the position of fingers we have utilized flex sensors, which is only a little strip. This system will be significant in rehabilitation process.

Keywords— Rehabilitation, signal conditioning, Degrees of Freedom, wireless communication, data acquisition, flex sensors, Graphical User Interface.

INTRODUCTION

Human uses the capacity to control and move things with hands to execute all sort of tasks [1]. This capacity has been case of study by scientific community. Researchers search for knowledge through analysis of hand trajectories to handle things and man-machine correspondence for motion acknowledgment. This data is then used to imprecise the standard activities and mechanized activities in gestural cooperation with social robots [2]. Moreover with the development of fields like military, overwhelming industry, physiotherapy, medicine and sports, arrangements are crucial to give robots the capacity to do precision activities like movement recognition, supported surgery, slashes recuperation and even to superior training.

These days we are helping to a change of temperaments. General keyword and mouse are being exchanged by different sorts of information equipment. For instance in Xbox utilizes the Kinect to catch humman movement and submit it to acknowledgment, iPad uses fingers to touch the screen or in Wii that we utilize Wiimote to create movement that is caught by the accelerometer and then converted into commands. However these arrangements don't offer reactions like the stimulus that we get when we interface with real objects. Accordingly in the previous 30 years, various advances were created to help researchers to proceed with their studies [3]. Those innovations are named as data glove based system. They are basically gloves instrumented with sensors used to perform data attainment. However all the presented technologies have a few liabilities since none satisfy the accompanying necessities like good resolution, parallel data acquisition, low cost and wireless communication.

Notice that a glove based system is defined as a collection of electronic sensors to be used for hand data attainment, processing and a provision for the sensors which can be worn on hand. Generally glove is a cloth glove where sensors will be sewn or stuck. Below Fig.1. shows a depicted human hand parts like fingers, wrist, back and palm. Fig.2. shows the bones of human hand which has different hand joints. Human hand is characterized for having Degrees of Freedom (DoF) to define hand motions. During the execution of movements each Finger joint has 1 DoF for the Proximal Interphalangeal (PIP) and Distal Interphalangeal (DIP), 2 DoF for the Metacarpophalangeal (MCP) and 3 DoF for the Trapeziometacarpal (TMCP). A glove prepared with one sensor per DoF may seem to be the most apparent design choice.

LITERATURE SURVEY

The first glove base system was produced amid the 70s. From that point forward some glove based systems have been proposed. This glove based system protypes were created at Massachusetts Institute of Technology (MIT) and were assigned as MIT-LED and Digital Entry Data Glove. In 1977 Thomas de Fanti and Daniel Sandin built up the Sayre glove model in Rich Sayre proposal. This glove was made utilizing light as source that is directed through exible tube, mounted along every finger, that as photocell to quantify light varieties. Right on time in the 80s MIT added to another version that utilized a LED system which was camera-based to track body movement in real time processing [4]. Later in 1983, Gary Crimes created and patented the Digital Entry Data Glove that had sensors installed on material to recognize if thumb is touching any piece of the hand or fingers, measure the thumbs joint exion, hand tilt and the twisting /exing of the lower arm [5].

Fig.1. Human hand parts.

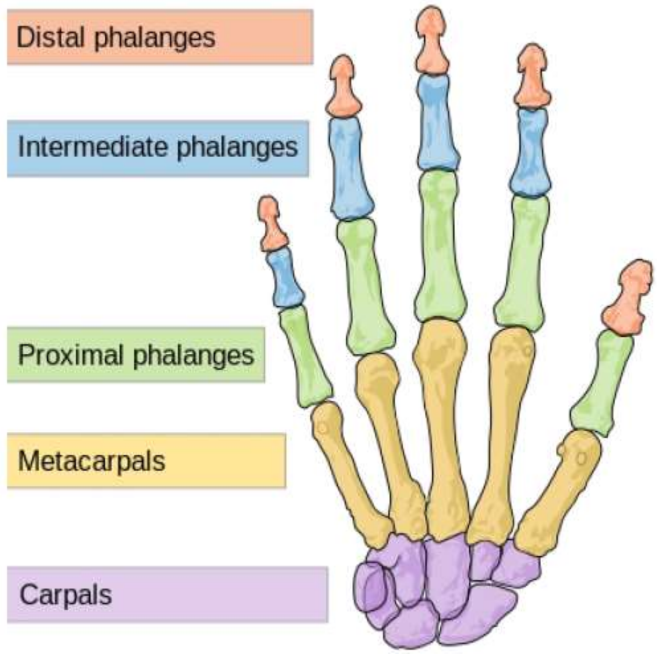

Fig.2. Bones of the human hand.

Zimmermam built up a data glove utilizing exible plastic tubes and detectors installed on a material to catch joint points. Late in 1987, Visual Programming Language Research, Inc. showed up with another adaptation utilizing fiber optics. This new form came outfitted with 5 to 15 sensors to gauge exion, abduction and adduction [6]. In 1989 Mattel Toy Company produced a minimal effort control gadget, the Power Glove, for the Nintendo video games. This glove has utilized resistive ink imprinted on flexible plastic bends which takes after the movements of every finger to quantify the general flexion of the fingers [7]. Nissho Electronics in 1995 developed and commercialized the Super Glove. This glove came with 10 to 16 sensors and used resistive ink printed on boards sewn on the glove cloth [8]. In 2002 Super Glove was updated for Power Glove, the P5 Glove [9].

The data gloves then improved using the force sensors. Which are widely used in many applications such as virtual reality applications, robotics, telecheric applications, and biomechanics. This new data glove will have all information of finger position as well as the force the fingers apply on an object. The force sensor was made of a steel plate substrate where the commercial strain gauges are attached [10].

In [11], they had an aim to create and test an arrangement of five virtual activities on top of a system, which is intended for the determination and restoration of patients with hand debilitations. They have actualized assignment arranged activities taking into account entrenched and basic activities, specifically the Jebsen Test of Hand Function and the Box and Block Test. These incorporate moving a container, masterminding squares, exploring a labyrinth, preparing with a dumbbell, and getting a handle on an elastic ball. In [12], they have introduced a wearable detecting glove with installed heterocore fiber-optic nerve sensors that identify finger flexion to accomplish unconstrained hand movement observing. This wearable detecting glove innovation has gone for decreasing the quantity of sensors for minimal effort and long haul observing without aggravating characteristic action. The hetero-core sensor components are situated on the back of the hand with the goal that they are not influenced by irregular wrinkles in the glove at the joints. Accordingly, the hetero-core flexion sensor after adjustment is equipped for distinguishing the joint edges of the fingers paying little heed to contrasts close by size, and the hetero-core detecting procedure empowers the detecting glove to be built with a base number of sensor focuses.

Artificial Neural Network (ANN) can be utilized for aligning the sensors on the Cyber Glove. There are three principle purposes behind picking ANNs for the adjustment of the CyberGlove. To begin with, ANNs have been effectively sought the alignments of numerous frameworks in a wide range of designing fields. Second, they have seen that there are some immediate and reliable connections between the human-hands portion size and the reporter sensors readings through the test. Third, once the last NNs are found for every sensor, the era of alignment information for any new subject is straightforward and quick [13]. The glove system can also use for the speechless person. In [14], it described an electronic talking glove, intended to encourage a simple correspondence through incorporated discourse for the advantage of speechless patients. Gestures of fingers of a client of this glove will be changed over into incorporated discourse to pass on a perceptible message to others, for instance in a discriminating correspondence with specialists. The glove is inside furnished with different flex sensors that are comprised of "curve delicate resistance components". This project is a helpful device for discourse hindered and halfway deadened patients which fill the correspondence hole between patients, specialists and relatives. As it is compact, obliges low power working on a solitary lithium-particle rechargeable battery and having less weight and strong gives understanding freedom to convey it anyplace at their will.

The glove system which is useful in restoration is given in [15]. This paper concentrates on mulling over and actualizing a framework for measuring the finger position of one hand with the point of offering criticism to the restoration framework. It comprises of a glove where sensors are mounted suitably designed and joined with an electronic molding and obtaining unit. The data in regards to the position is then sent to a remote framework. The goal of this paper is to give a sensorized glove to observing the recovery exercises of the hand. In [16] Giancarlo Orengo et.al introduced another system. In this system the sensor and their extracted models were connected to register the human knee revolution amid a stride cycle, either at moderate pace for a mobile example at 5 km/h, and at high velocity for a running example of a sprinter at 10 m/s, lastly the finger joint pivots at their most extreme precise speed. This was defeated a twofold reason: from one hand, to evaluate the model ability to foresee the sensor execution, following human body fragment turns at diverse velocity, without the need of estimation; from the other hand, to recuperate progressively the genuine sensor pivot from its resistance estimation, particularly in rapid applications, where its reaction is misshaped.

PROPOSED SYSTEM

This proposed system concentrates on study and execution of a system for measuring the finger position of hand with the point of offering solace to do the activity and to the recovery treatment. It comprises of a glove where sensors are mounted suitably arranged and associated with an electronic conditioning circuit. The data in regards to the position is then sent to a receiving section, means PC, utilizing the wireless communication. The proposed block diagram for transmitting section and receiving section is given in Fig.3. and Fig.4. respectively.

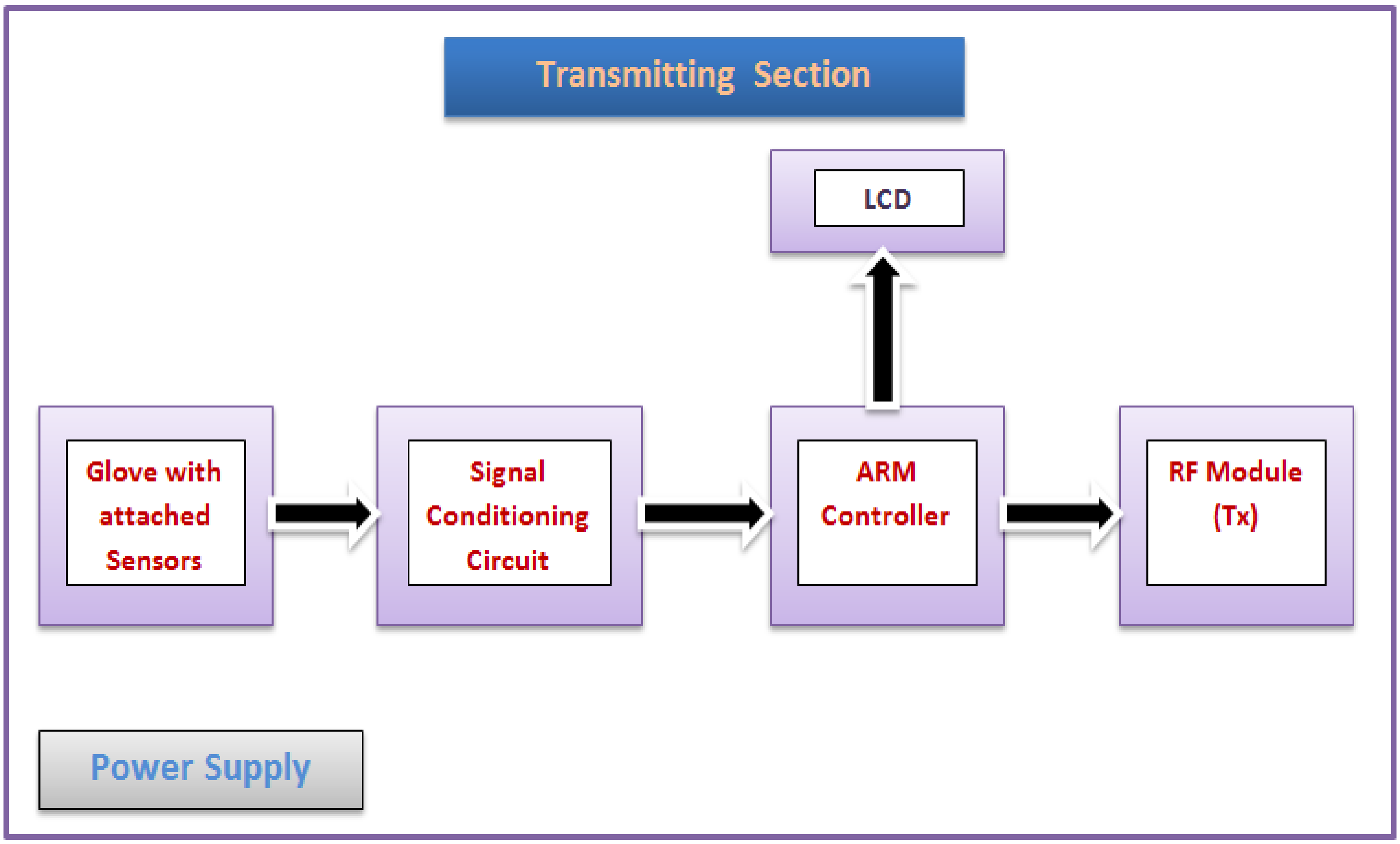

Fig.3. Proposed block diagram of transmitting section.

The system is made out of a transmitting section and a receiving section. The transmitting section is the transduction system and comprises of a glove including 5 flex sensors (one for every finger and number of sensors may change) joined with a microcontroller through front-end hardware. The management of the sensor estimation is allotted to the ARM microcontroller that performs a few capacities: interfacing and conditioning of signals from the sensor block and information transmission. Amid the operation, the receiving section which is comprised of a beneficiary and a PC, changes over, records, and showcases the got measures of joint deflection. In the transmitting section, we have sensors which are attached with the glove. From these sensors we will get output in the form of resistance. In the signal conditioning circuit we will convert this resistance into voltage using voltage divider circuit. The interfacing and conditioning of signals will be done by controller. The output of the controller is then transmitted using the RF module which operates on 433 MHz frequency. The finger movements are detected or not will be displayed on LCD on transmitter side. In this system 16X2 LCD is used. The transmitted data will be received using RF module in receiving section. The received data will be displayed on PC using any MATLAB software.

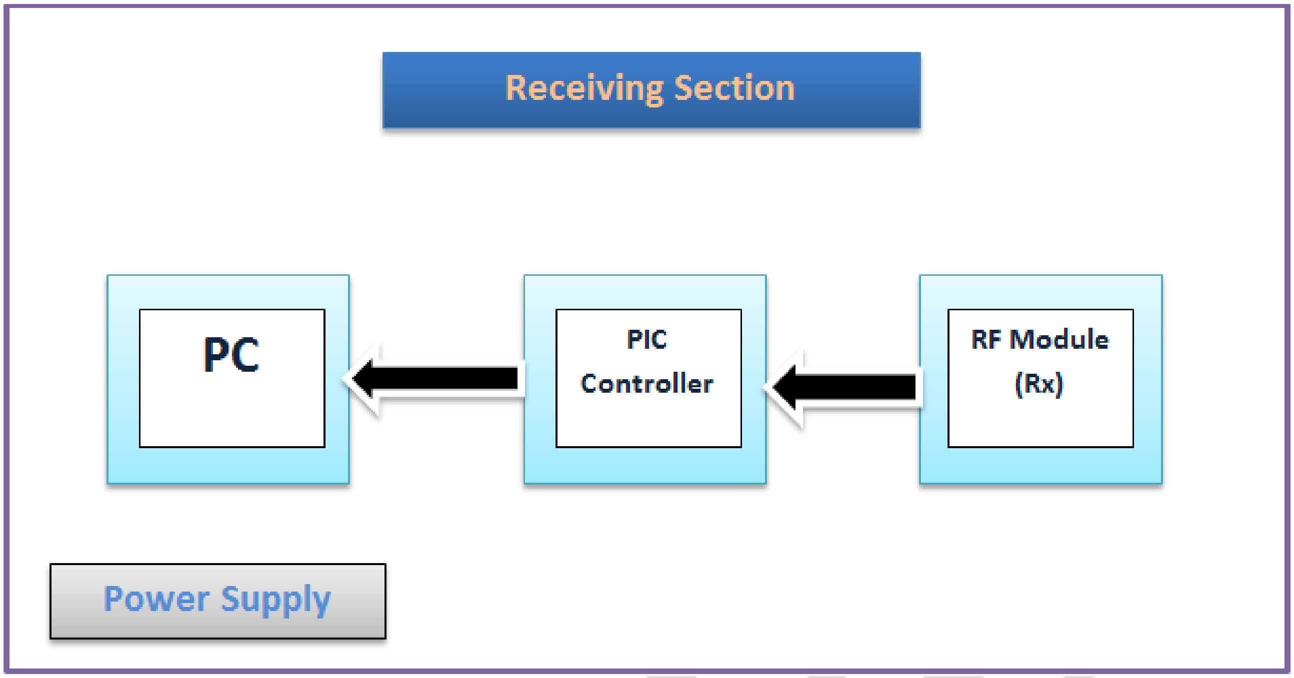

Fig.4. Proposed block diagram of receiving section.

The ARM7 means LPC2148 is used for the processing of the data. As it is 32-bit microcontroller it is very useful in this system. On the receiver side PIC16F877A is used. The flex sensor bends and flexes physically with motion device. The flat resistance (at 0° angle) of this sensor is 10KΩ and when its bend at 90° angle then its resistance will be 50KΩ. It has a power rating of 0.5 Watts continuous. The temperature ranges from -35°C to $+80^\circ$C. The signal conditioning circuit in transmitting section is shown in below Fig.5.

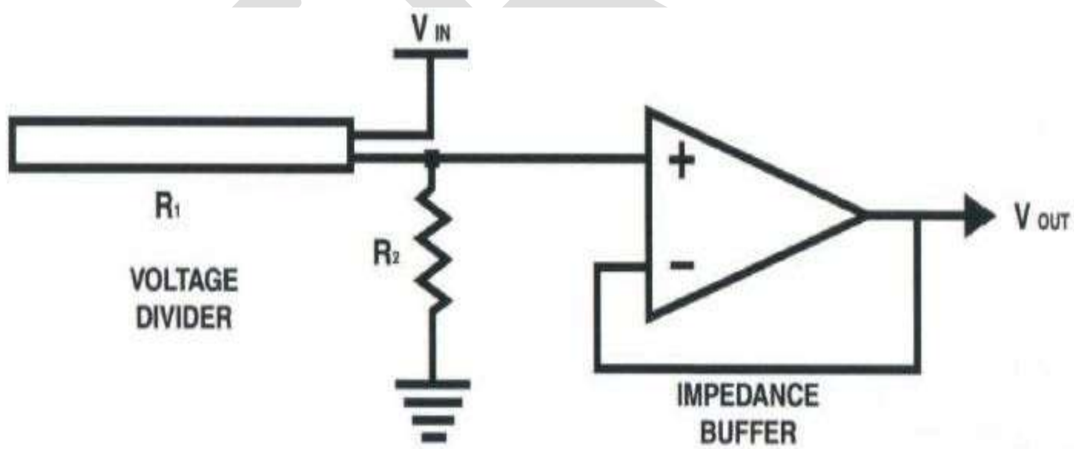

Fig.5. Signal conditioning circuit

The R_1 resistor is nothing but the variable resistance of flex sensor. This resistor is connected serially to R_2 resistor,which is a fix value resistor. Using this circuit the flex sensors output, variable resistance, is converted into the voltag. Each sensor requires its separate voltage divider circuit. The impedance buffer is, a single sided operational amplifier, utilized with these sensors because the low bias current of the op amp reduces error due to source impedance of the flex sensor as voltage divider. Suggested operation amps are the LM358 or LM324.

RESULT

For displaying the data from RF module receiver on PC we have used the MATLAB software. Using this MATLAB software we created a Graphical User Interface (GUI). This GUI is shown in below Fig.6. As shown in figure 5, this GUI shows the angle of each finger in the form of degree.

Fig.6. Result on PC using GUI.

CONCLUSION

In this paper, a new system for measuring the position of the fingers is proposed. This system will detect and measure the position of the fingers using flex sensors and it will be displayed on PC using suitable software. The application of this system is in biomedical field. This system will be useful for trauma, stroke patients to do exercise. It will have ability to perform the exercise at home which will reduce cost and difficulties of transport to hospital.

REFERENCES:

[1] D. R. Faria, R. Martins, and J. Dias "Human Reach-to-Grasp Generalization Strategies: A Bayesian Approach" in Workshop: Understanding the Human Hand for Advancing Robotic Manipulation, 2009

[2] D. R. Faria, H. Aliakbarpour, and J. Dias "Grasping Movements Recognition in 3d Space Using a Bayesian Approach" in Proceedings of the ICAR 2009 - 14th International Conference on Advanced Robotics, 2009

[3] L. Dipietro, A. M. Sabatini, and P. Dario "A Survey of Glove-Based Systems and their Applications" IEEE Transactions on Systems, Man, and Cybernetics—Part C: Applications and Reviews, vol. 38, no. 4, July 2008

[4] D. J. Sturman and D. Zeltzer "A Survey of Glove-Based Input" IEEE Comput. Graph. Appl., vol. 14, no. 1, pp. 3039, 1994

[5] G. Grimes "Digital Data Entry Glove Interface Device" U.S. Patent 4 414 537, AT&T Bell Lab., Murray Hill, NJ, 1983

[6] T. G. Zimmerman "A Hand Gesture Interface Devices" Proc. Humman Factors in Computing Systems and Graphics Interface, ACM Press, New York, pp. 189-192, 1987

[7] D. L. Gardner "The Power Glove" Des. News, vol. 45, pp. 63–68, 1989

[8] J. J. LaViola "A Survey of Hand Posture and Gesture Recognition Techniques and Technology" Brown Univ., Providence, RI, Tech. Rep. CS-99-11, 1999

[9] [Online].Available: http://www.essentialreality.com

[10] Kostas Tarchanidis and John Lygouras "Data Glove with a Force Sensor" IEEE transactions on instrumentation and measurement, vol. 52, no. 3, 2003

[11] Atif Alamri, Mohamad Eid, Rosa Iglesias, Shervin Shirmohammadi and Abdulmotaleb El Saddik "Haptic Virtual Rehabilitation Exercises for Poststroke Diagnosis" IEEE transaction on instrumentation and measurement, vol. 57, no. 9, September 2008

[12] Michiko Nishiyama and Kazuhiro Watanabe "Wearable Sensing Glove with Embedded Hetero-Core Fiber-Optic Nerves for Unconstrained Hand Motion Capture" IEEE transactions on instrumentation and measurement, vol. 58, no. 12, December 2009

[13] Jilin Zhou, François Malric, and Shervin Shirmohammadi "A New Hand-Measurement Method to Simplify Calibration in CyberGlove-Based Virtual Rehabilitation" IEEE transactions on instrumentation and measurement, vol. 59, no. 10, October 2010

[14] Syed Faiz Ahmed, Syed Muhammad Baber Ali and Sh. Saqib Munawwar Qureshi "Electronic Speaking Glove for Speechless Patients, A Tongue to a Dumb" IEEE Conference on Sustainable Utilization and Development in Engineering and Technology, 20 21 November 2010
[15] Michela Borghetti, Emilio Sardini, and Mauro Serpelloni "Sensorized Glove for Measuring Hand Finger Flexion for Rehabilitation Purposes" IEEE transactions on instrumentation and measurement, vol. 62, no. 12, December 2013
[16] Giancarlo Orengo, Antonino Lagati, and Giovanni Saggio "Modeling Wearable Bend Sensor Behavior for Human Motion Capture" IEEE sensors journal, vol. 14, no. 7, July 2014