Motion Sensing Gloves for Arthritis Patients

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***Abstract*— Arthritis is a disabling and agonizing disease. Rheumatoid Arthritis is a disease that affects joints of the body. RA disease results in a reduction of the physical activity level of the patient. Traditional methods require a personal examination for analysis of arthritis rehabilitation. In this paper, we presented the design of a smart motion sensing glove through the integration of sensors, processors, and flex sensor technology. The proposed glove facilitates the rehabilitative process through smart technology. The glove uses breathe-able glove, MCB (Motion Sensing Glove), microcontroller unit, five finger flexible sensors, 16 IMU (Inertial Measurement Unit), Arduino Uno to detect joint movement. By examining the movement of joints the physician prescribes medicines accordingly. Traditional ways of diagnosis are less accurate landing the patient in trouble whereas our glove provides accurate and original data value of the joint movement. No environmental issues can affect the accuracy and hence technology being used at its best to human wellness.**

***Index Terms*— Joint movement, Rheumatoid arthritis, Smart glove,**

I. INTRODUCTION

Rheumatoid arthritis (RA) is a progressive autoimmune disease that at first causes signs and manifestations like joint torment and expanding in the feet and hands. The "rheumatoid factor" is a counteracting agent that can be found in the blood of 80% of individuals with rheumatoid joint inflammation. Rheumatoid factor is identified in a basic blood test. Rheumatoid factor is recognized in a straightforward blood test. Conceivable hazard factors for creating rheumatoid joint inflammation incorporate hereditary foundation, smoking, silica inward breath, and microorganisms in the insides (gut microscopic organisms). The World Health Organization (WHO) estimated every year 1.9 million deaths because of physical inactivity induced by the disorder. It has been suggested that high-intensity exercise should play a role in disease management. There is no cure for RA. The treatment of rheumatoid arthritis optimally involves a combination of patient education, rest and exercise, joint protection, medicines, and occasionally surgery. [1][2]

II. HOSPITAL SURVEY

Today in the present scenario, doctors are using Goniometry or Scales to measure the deflection as shown in fig 1 and 2 which is not an accurate way of diagnosis. It relies more on the experience of the doctor.

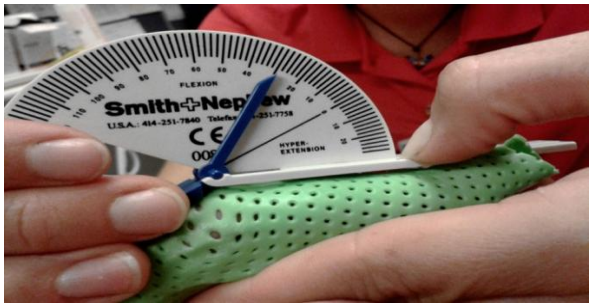


Fig. 1(a) Doctor using orthodox methods of measurement

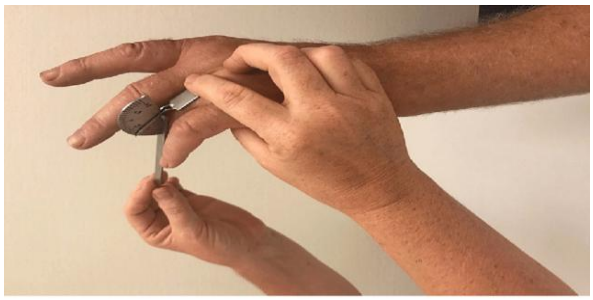


Fig. 1(b) Goniometric instruments

Fig 2(a)

Fig. 2(b)

So, our motion-sensing glove replaces the naked eye with a more scientific instrument with accurate correction value.

We were able to talk to the patients suffering from rheumatoid arthritis shown in Fig 2(a) and listen to their problems that they face being a victim of this disease. Many of the patients have to travel long distances just to get in touch with the doctor to whom they consult regularly.

III. METHODOLOGY

The main objective of the glove is for the measurement of joint range of the hand, including: flexion, extension, adduction of joints of the fingers and thumb in degrees. The Glove is designed with a total number of 16 sensors and 3 axis accelerometers to capture hand and finger motion. [3]

IV. COMPONENTS

Following components are to be used for a successful arrangement of a Motion Sensing Glove

Hardware

- Breathe-able glove
- MCB (motion capture board)
- Microcontroller unit
- Five finger flexible sensors
- 16 IMU (inertial measurement unit)
- Bluetooth module
- Arduino Uno
- LED
- Mini breadboard
- 10KΩ resistor
- 1kΩ resistor
- Connecting wires

Software

- Blender
- Arduino web editor

1) Breathe-able glove: We need to use a breathe-able glove to ensure that if in a case during the check-up the person sweats in hands the sensors on the gloves don't get damaged.

2) MCB: Motion capture board, this Board as the name suggests captures the motion of the sensors and feeds this information to the microcontroller unit for further process.

Fig. 3(a) Motion capture board

3) Microcontroller unit: This unit is being integrated as the main control unit which accepts data of all the sensors and sends this data to the host machine.

Fig. 3(b) Microcontroller unit

4) Five finger flexible sensors: These are the sensors used to see and record the resistance value of the finger joints at the back of the gloves.

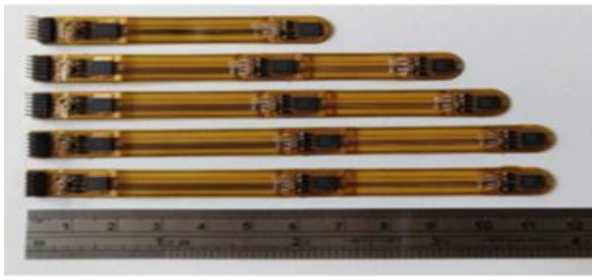


Fig 3(c) Flex Sensors

5) 16 IMU (Inertial Measurement Units): These units calculate the angular velocity, linear movements, and angular movements of the joints, and this is sent to through wires to the MCU.

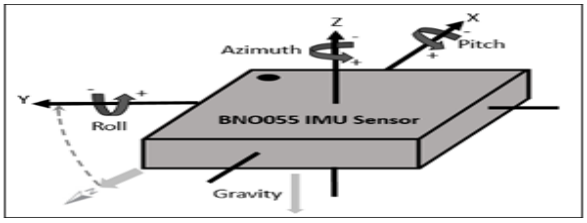


Fig 3(d) IMU

7) Arduino Uno: The mainboard in which the code is fed to achieve the whole process to run.

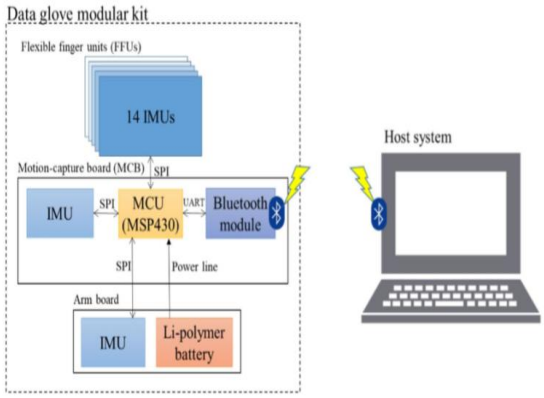
Fig 3(e) Arduino Uno

8) Blender: The first software that comes to play is the blender, it is basically a free and open-source 3D creation software and therefore it is capable of doing pipeline -modeling, rigging, animation, rendering, motion tracking, video editing, etc. all these jobs.

9) Arduino Web Editor:

This is basically the second important software that will require most of our attention as the basic code which is to be fed to Arduino to extract all the values of sensors attached accurately.

Block Diagram



V. IMPLEMENTATION DETAIL

Motion Sensing Glove contains deliberately positioned IMU sensors constrained by hardware that provides the acceleration and velocity of the joint movement. The Flex sensors (FFU) give us the resistance value through which doctors can easily judge the amount of joint movement of individual fingers compared to the resistance value when unflexed. The flex sensors are interfaced with Arduino through breadboard and connecting wires. Breadboard also has a microcontroller unit connected to it. The breadboard is placed in the arm board and connecting wires are used to connect every component. The Arduino web editor tool has the interface to show all the values and results of the flex sensors. An LCD screen can also be connected to note all the values. The proposed modal is shown in fig. 4.

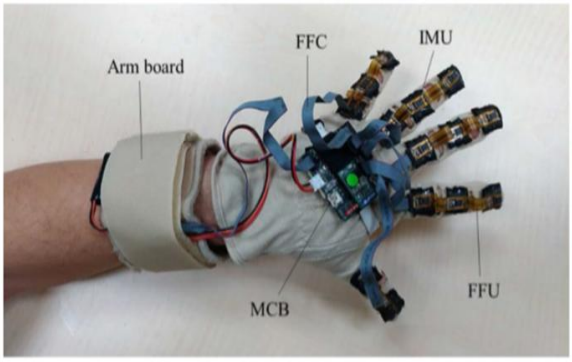


Fig 4 Proposed modal of the Glove

Interfacing of Flex Sensor With Arduino

To interface the flex sensors, we require certain components they are mentioned below:-

- Arduino UNO
- Flex Sensor
- LED
- 10KΩ Resistor
- 1KΩ Resistor
- Mini Breadboard
- Connecting wires

VI. CIRCUIT DESIGNING

One end of the flex sensor is connected to GND while the other end is connected to analog input A0 of Arduino. A 10KΩ resistor is connected between A0 and +5V. This connection means the flex sensor and the 10KΩ resistor for a voltage divider. Just to show some output, I have connected an LED (along with its current limiting resistor of course) to Digital I/O Pin 7 of the Arduino board. [4]

Key Features

- Give a precise value of the bending movement of the joints of hand.
- Allow the doctors to diagnose accurately from any part of the words with the help of the readings shown by this device on LCD screen.

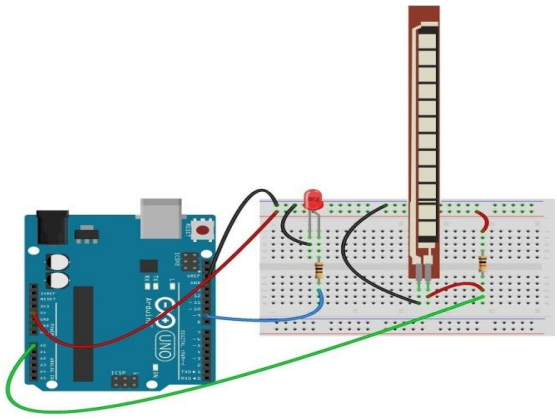


Fig. 5(a) Connection of Flex Sensor with Arduino

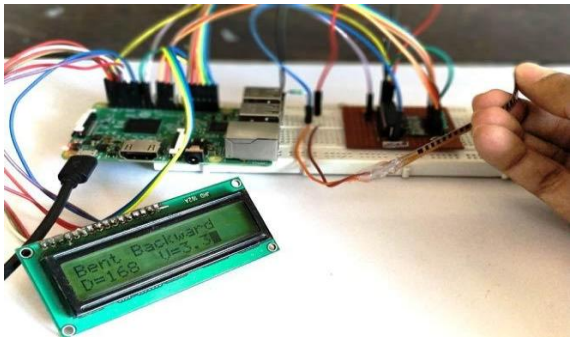


Fig 5(b) Value of Resistance shown on Screen

VII. RESULTS

The values can also be seen on the Arduino web editor for individual finger movement and at the same time can also be sent to the distant doctors by using the cloud feature of the software. The values of the resistance shows accurately the hand joint movement compared to the previous days. [5]

Fig. 6 Arduino Web Editor showing the value of resistances

VIII. CONCLUSION

"MOTION SENSING GLOVE FOR ARTHRITIS PATIENTS" is used for the betterment of the arthritis patients as it is very much helpful for the doctors to diagnose arthritis patients. With the help of the exact values of the joint movement, doctors can come to know about the state being of the patient even without meeting the doctors. In times like this, where everyone is in PANDEMIC, patients who need regular attention from doctors for their medication are facing a lot of problems. So, with the advancement in technology, this Motion Sensing Glove can prove to be a blessing for arthritis patients where they would not have to visit their doctor. They can just give the reading of the value sitting at their safe home comfort.

Future Scope

Feedback from patients during clinical visits demonstrated the need to reduce the bulk of the motion- sensing glove skin to improve comfort and fit. The glove skin is now undergoing modifications to improve wearability.

We are currently planning to...

- Make a similar device for the knee. So that the device can measure the movement of the knee joint also in arthritis patients.
- Make a simplified data glove should meet the economical demands of healthcare providers.

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