An Optimised method to measure the rehablitation for fingers

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***Abstract*— In present day, X-rays are more commonly taken for reviewing the development of fractured bones, this method is quite hazardous and has a lot of side effects due to the radiations and thus there comes a requirement for a radiation less treatment. In this project, rehabilitation process is done by optimising the present day methods using non radiating (IR) sources. A Leap Motion Sensor is coded in such a way that the accuracy of the sensor is increased and the gesture is captured which is then compared with the standard gestures of a normal finger. This method helps in evaluating the abnormalities by oneself. The main purpose of this research reported here is to evaluate an abnormal finger motion using Leap Motion Controller to measure the finger joint angles by using "Criss Cross matrix" algorithm. This sensor is a 3D non-contact motion sensor which can detect gestures.**

Keywords—Leap Motion Sensor, Infrared, Criss Cross Matrix Algorithm,Performance evaluation.

I. INTRODUCTION

In the past decades, bone dislocations occur when the finger bones are dislocated from their anatomic positions, these dislocations can be accompanied by a break in the bone but frequently it happens without a break. In such cases there comes the need for monitoring the growth of the damaged part on a regular basis. The doctor will continuously ask for an X-ray report or a scan report in extreme cases in order to confirm the realignment of the bones and to check for any other breakage. This process will continue over a period of time and it is costly when the treatment is for a longer period.Through this analysis we can see that a lot of radiations get penetrated into the body which is hazardous and might cause inconveniences along with side effects to the patient in the later stages.

So aiming to this problem, by the use of sensor technology, we design a non radioactive monitoring system, this system uses the algorithm 'Criss Cross Matrix' which helps in increasing the accuracy of the obtained output. Monitoring the patients should be done without stress and estimated results must be accurate. In this way we can increase the work efficiency and data reliability. Hence developing a low cost device to evaluate the abnormal finger motion during Rehabilitation.

II. OVERVIEW

A. Trigger Finger

The trigger finger is a condition that affects the tendons in the finger become inflamed [3].When the affected finger or thumb is bent towards the palm, the tendon gets stuck and the finger clicks or locks. It can affect one or more fingers. The symptoms can include pain, stiffness, clicking and a small lump in the palm at the base of the affected finger or thumb.

B. Leap Motion Controller

A Leap Motion Controller is actually quite simple [12].This sensor recognizes and tracks hands, fingers and finger like tools. The device operates in an intimate proximity with high precision and tracking frame rate and reports discrete positions, gestures, and motion. The heart of the device consists of two stereo cameras and three infrared LEDs. These tracks infrared light with a wavelength of 850 nanometers, which is outside the visible light spectrum. The origin is centered at the top of this sensor. The x- and z-axes lie in the horizontal plane, with the x-axis running parallel to the long edge of the device. The y-axis is vertical, with positive values increasing upwards (in contrast to the downward orientation of most computer graphics coordinate systems). The z-axis has positive values increasing toward the user as seen in Fig 2.1. 3D picture of the leap motion sensor The device has a large interaction space of eight cubic feet, which takes the shape of an inverted pyramid – the intersection of the binocular cameras' fields of view. It's viewing range is limited to roughly 2 feet (60 cm) above the device as is seen in Fig.2. This range is limited by LED light propagation through space, since it becomes much harder to infer your hand's position in 3D beyond a certain distance. LED light intensity is ultimately limited by the maximum current that can be drawn over the USB connection. The LEDs generate pattern-less IR light and the cameras generate almost 300 frames per second of reflected data.

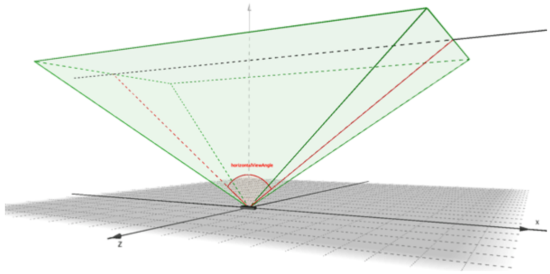

Figure 2.1 Interaction area of leap motion sensor

C. Voice Board

An attachment to assist a human speaker. Microphones are used in many applications such as telephones, hearing aids, public address systems for concert halls and public events, motion picture production, live and recorded, two-way radios, megaphones, radio and television broadcasting, and in computers for recording voice, speech recognition, VoIP, and for non-acoustic purposes such as ultrasonic sensors or knock sensors. Several different types of microphone are in use, which employ different methods to convert the air pressure variations of a sound wave to an electrical signal. The most common are

1,1	**1,2**	**1,3**	**1,4**	**1,5**	**1,6**	**1,7**	**1,8**	**1,9**	**1,10**
1,5	**1,7**	**1,9**	**1,1**	**1,8**	**1,2**	**1,10**	**1,4**	**1,3**	**1,6**
2,1	**2,2**	**2,3**	**2,4**	**2,5**	**2,6**	**2,7**	**2,8**	**2,9**	**2,10**
2,3	**2,5**	**2,4**	**2,2**	**2,7**	**2,1**	**2,8**	**2,10**	**2,6**	**2,9**
…			**…**		**…**		**…**		

the dynamic microphone, which uses a coil of wire suspended in a magnetic field; the condenser microphone, which uses the vibrating diaphragm as a capacitor plate, and the piezoelectric microphone, which uses a crystal of piezoelectric material. Microphones typically need to be connected to a preamplifier before the signal can be recorded or reproduced.

D. Criss Cross Matrix Algorithm

We have used 50 transmitters and receivers and we have coded them using the Criss Cross Algorithm. So that the signal being transmitted by the first sensor will be received by all the receivers in model. This increases the system accuracy. Table 2.1 represents the process flow of the algorithm which is being used in our proposed work. This coding is done using Python language.

Table 2.1 Criss Cross Algorithm

E. Performance Evaluation

We have taken the leap motion sensor to assess the accuracy of the performance. Our results also demonstrate the accurate rehabilitation of the finger on coding the sensor. The Infrared sensors present in the Leap Motion Sensor is highly accurate and the efficiency is high. On comparison with X-rays , Infrared radiations are non hazardous and radiation less.

III. METHODOLOGY

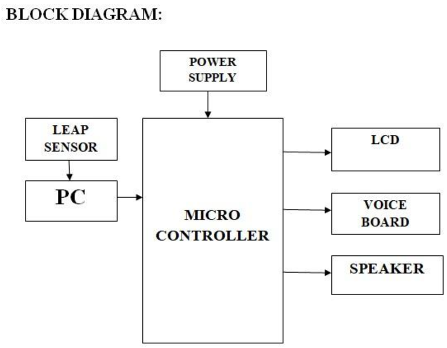

Figure 3.1 shows the general block diagram

Figure 3.1 shows the process flow of the system being proposed. Leap motion sensor is the main component used to produce the output with more efficiency and accuracy. In this, process is depicted. First step, a hand posture was detected by the Leap Motion sensor which can detect fingers and report a position, direction and motion information of finger to the user. Next, this posture is captured more accurately by using the Criss Cross Matrix algorithm. The captured signals are given as input to a PIC controller which on further comparison process produces an output in the
form of voice and in the display.

IV. RESULTS AND DISCUSSIONS

Leap motion sensor is one of the main components, it is generally responsible for capturing of gestures with the help of a camera. But in our project we have used the IR sensors and coded them by using a new algorithm known as the Criss Cross matrix. This increases the output accuracy.

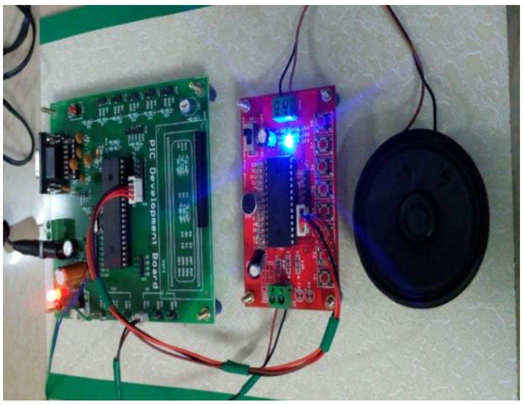

Figure 4.1 Circuit connecting the sensor and the audio output

The above figure 4.1 represents the hardware setup which is connected to a PC in order to get a successful output. Here in this figure the components used are, a PIC development board which helps us in embedding the code into the controller and this PIC is connected to a voice board which produces the sound via a speaker connected to it. The voice is recorded by placing the voice board in recording mode, this audio and the finger postures are linked. By using the Prolific software, the voice data is sent in order to match with the Leap signal. So that when a finger is shown as input to the sensor, the controller plays the voice accordingly.

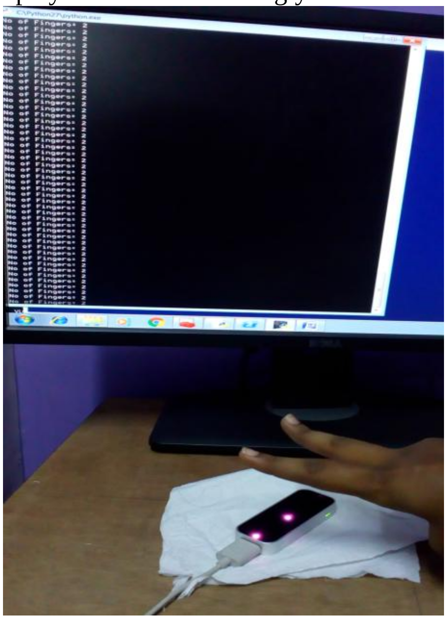

Figure 4.2 Output showing two perfect finger

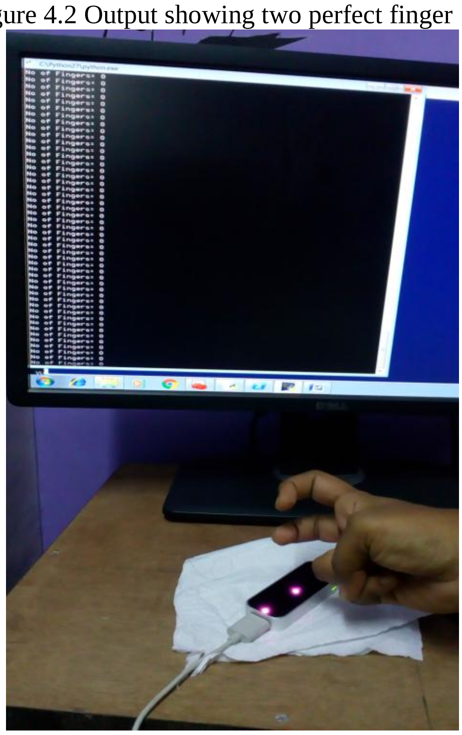

Figure 4.3 Output showing an improper finger

V. CONCLUSION

This project has evaluated the strategy for the utilisation of the Criss Cross Matrix for the rehabilitation. The effects of the harmful radiations (X-Rays) are eliminated by this method completely due to the usage of non radioactive source (Infra Red). With the help of this algorithm the pair of the sensors i.e., the transmitters are paired with a number of receivers in order to increase the accuracy of the gesture being captured by the Leap Motion Sensor. By using the Prolific software, the voice data is sent in order to match with the Leap signal. So that when a finger is shown as input to the sensor, the controller plays the voice accordingly. The experimental output viewed from the system is thus extracted in the form of an audio which reads the displayed output.

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