Measurement and Analysis of Hand Tremor Using Iot

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***Abstract:** The main aim of this work is the measurement of the exact frequency of hand tremor. Tremors cause the bending of fingers constantly, this bending is determined using the flex sensors whose resistance changes according to the bend. Thelinear acceleration is measured by accelerometer based on vibration and a gyroscope is intended to determine angular position based on the principle rigidity of space.The data from these components is used to precisely measure the position and vibration of the hand caused due to tremor. A low-cost arduino pro mini microcontroller with an ESP8266 Wi-Fi module is used to calculate the frequency from the raw flex sensor, accelerometer and gyroscope data. This frequency information is sent to the cloud so that doctors can monitor the condition of the patient using web application. The web application is developed using HTML in the front end,PHP in the back end and MySql as a database.*

***Keywords:** arduino, flex sensor, accelerometer, gyroscope, ESP 12E Wi-Fi module, PHP, HTML, MySQL.*

I. INTRODUCTION

Shaky hands are commonly known as hand tremor.Hand tremor is not a disease which is life-threatening, but it can make daily tasks difficult. It could be a warning sign of neurological or degenerative conditions. One of the most common is Parkinson disease. Patients will face difficulty in picking up and holding objects because of tremor and vibration of hands.Tremor is an abnormal repetitive shaking movement of the body which is unintentional, rhythmic and roughly sinusoidal. Elimination or reduction of this tremor is the final goal of any research related to this area. In order to achieve this, relevant data on the disease and types of the disease should be obtained.

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Frequency and amplitude are the main features of each tremor are. Tremor frequency is mostly dependant on the patho-physiological mechanism and is fairly stable over time. There are three main positions to measure hand tremor, they are resting, postural and action. Rest tremor occurs when the affected body part is completely supported against gravity (e.g., hands resting on the lap). Postural tremor occurs when the affected body part maintains a position against gravity (e.g., extending arms in front of the body). Action tremor is produced by voluntary muscle contraction (e.g., during movement of the affected body part from one point to another.There are many approaches to measure hand tremor. This work proposes a method where an embedded system with Wi-Fi (IOT) is used which would replace the most complex and costlier methods. This system consists of various components like the flex sensor, accelerometer and gyroscope. This determines the position and vibration of the hand. The Arduino microcontroller uses a wifi module to calculate the frequency and amplitude of the tremor. This data and data from the sensorsare sent to the web application. Thus the patient can be easily monitored by the doctors sitting at a hospital many kilometres from the patient.

II. LITERATURE SURVEY

A huge amount of research work has been performed in various institutions across the globe to provide a cost-effective and efficient aid for controlling the tremor.Hand tremors are rhythmic movement with oscillations in one or more parts of the body. Parkinsonian tremor is the most common disease that affects approximately 3.8 million people around the world. With frequent diagnostics, we can detect tremor in patients and apply appropriate treatment. The most commonly used system by doctors to differentiate the various types of tremors is using the Electromyography technique. Everyone is not capable to afford EMG for repeated tests as it is very costly and requires frequent check-up to assess the patient's condition and improvement. This section contains a review of a few of those methods to measure and characterize tremor. Swathyet.al.,had proposed that the launch of spacecraft generates extreme conditions, such as vibrations.

Swathy's paper explains the algorithm to extract vibration data over I^2 C interface from ADXL345, which is a MEMS based accelerometer works on differential capacitance working principle. The digital output of the sensor will give the error-free data even in noisy conditions. ATmega microcontroller reads the data from the sensor and sends it to Lab VIEW software running on the computer which will extract and display the data from the serial port. Hong Ji Lee et.al., had proposed the analysis of tremor characteristics under resting-state and stress-state conditions. The tremor was measured using an accelerometer on the finger, under stress-state and resting-state (calculation task) conditions, during rest tremor and postural tremor. The changes in the reading of peak power, peak frequency, mean frequency, and distribution of power spectral density (PSD) of tremor were evaluated across conditions.Shill HA et.al.,had proposed a discussion focused on phenomenology and phenotypes, therapies and clinical trials, patho-physiology, pathology and genetics. The paper suggests standardized data collection using common data elements for genetic, clinical, neurophysiological, and pathological studies. Patients should be studied properly to collect bio-samples, characterize the natural history of the clinical syndrome including patient-oriented outcomes.Rodger J Elbleet.al., had proposed that transducers provide measurements of tremor amplitude that are quite accurate, and valid, but the precision and accuracy of transducers are mitigated by natural variability in tremor amplitude. This magnitudeof variability is very much great that the maximum detectable change in amplitude, exceeding random variability, is comparable for scales and transducers. Research in this area is needed to determine the feasibility of detecting smaller change using averaged data from continuous long-term recordings with wearable transducers. XiaochenZhenget.al., had proposed that a system composed of a smartwatch, a smartphone and a NoSQL database server is used to monitor the movements of the patients. A data analysis method is proposed to detect tremor and identify connected actions. Tremor is detected on the basis of the movement frequency difference and voluntary actions can also be recognized. It helps doctors to analyze the relationship between the tremor and a certain action. Cheraghizanjaniet.al., had proposed a study that is intended to assist neurologist in measuring and identifying the level and range of tremor in some patients who suffer neurological disease. A tremor test rig was designed and fabricated. Tremor behaviour at hand in X (horizontal) and Y (vertical) directionswere quantified using two laser displacement sensors. In this paper, two types of tremor condition namely postural and rest tremor were discussed. (Rest Tremor: 2-10Hz, Postural Tremor: 4-10Hz, Action Tremor: 10 Hz or more) Houde Dai et.al.,had proposed a quantitative assessment of parkinsonian tremor based on inertial sensors can provide reliable feedback on the effect of the medication. The features of Parkinson's disease tremor and its unique properties such as motor fluctuations and dyskinesia are taken into account. Least-square-estimation models were used to accuratelymeasure the severities of rest, postural, and action tremors. In addition to this, a time-frequency signal analysis algorithm for tremor state detection was also included in the tremor assessment method. Anto Bennet et.al., had proposed a portable system was used to monitor tremor continuously during daily lives. The module consists of a smartwatch with a triaxial accelerometer, a smartphone, and a remote server. An experiment was conducted involving a few ET patients. The average effective data collection time per patient was estimated to be 26 (6.05) hours. Fahn-Tolosa-Marin Tremor Rating Scale (FTMTRS) which is considered as the gold standard scale was adopted to classify tremor as accurate as possible and to validate the performance of the system. Quantitative analysis of tremor severity was validated on a different time scale.

III. PROPOSED SYSTEM

The proposed system consists of the following main hardware components (1) ArduinoPro mini microcontroller (2) Flex Sensor (3) Accelerometer(4) Gyroscope and (5) ESP8266 Wi-Fi module. Block diagram of the proposed system to measure hand tremor is shown in Fig. 1.

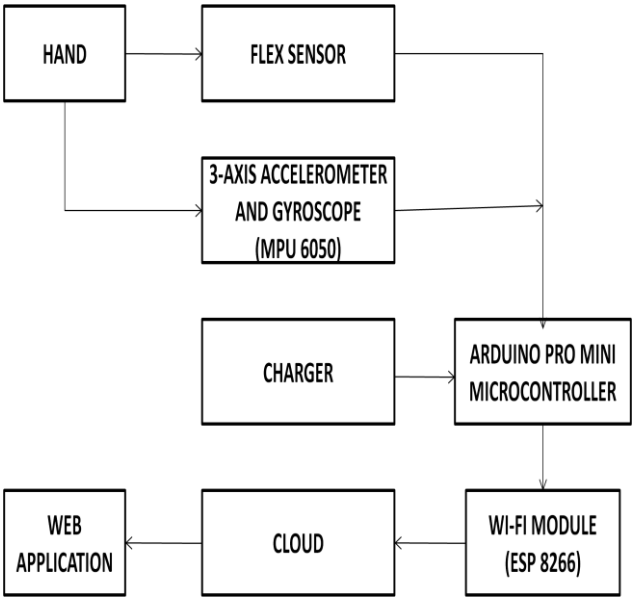

Fig.1. Block Diagramof measure hand tremor

A charger plugged in the switch port is connected to the microcontroller and is switched on. As soon as the device is turned on the sensors start taking measurements of the tremor. Tremors cause the bending of fingers constantly, this bending is determined using the flex sensors whose resistance changes according to the bend. Flex sensor is used to measure the amount of deflection or bending of hand due to cause of tremor. MPU 6050 is a combination of gyroscope and accelerometer along with digital I2C interface. The development of MEMS technology makes the original accelerometer small, accurate and consume less power.

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The I2C (Inter-Integrated Circuit) is a serial protocol for two wire interface. The accelerometer is used measure linear acceleration based on vibration of the hand and a gyroscope is intended to determine an angular position based on the principle of rigidity of space. The data from the flex sensor, accelerometer and the gyroscope are sent to the microcontroller using Wi-Fi module which calculates the frequency,Arduinopro mini is the microcontroller board used,it is based on the Atmega328P.This data can be monitored by the doctors anywhere with the use of a web application. The web applicationis developed using PHP and HTML in the front end and MySQL as the database.

IV. USED HARDWARE COMPONENTS

A. ArduinoPro Mini Arduino pro mini is a microcontroller board developed by Arduino.cc and comes with Atmega 328 microcontroller which is incorporated inside the board. This arduino board comes with 14 digital I/O out of which 6 pins are used for PWM output. 8 analog pins are also available on the board which is smaller when compared to the size of Arduino Uno. Over current protection, ability is another important feature that makes this microcontroller safe to use in applications where passing current can affect the performance of the work.

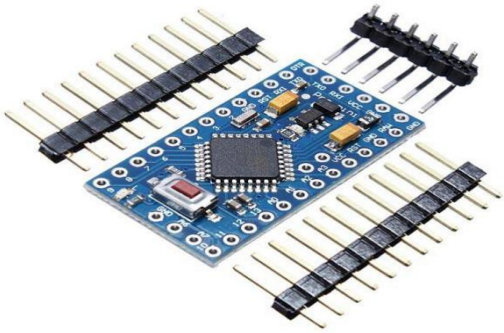

Fig.2. Arduino Pro Mini

Operating voltage	5V and 3.3V
Input voltage(recommended)	5V-12V
Input voltage(limits)	6-20V
Digital I/O pins	16
Analog input pin	8
Maximum current per I/O pin	40mA
Flash memory	32KB
Internal RAM	2KB
EEPROM	1KB
Clock speed	3.3---8MHz 5V---16Mhz

Table 1: Specifications of Arduino

B. Accelerometer and Gyroscope (MPU 6050)

MPU 6050 is a combination of accelerometer and MEMS gyroscope and comes with a digital I^2C interface. For accurate tracking of both fast and slow motions, the clip feature is designed to be a user-programmable gyro full-scale range of 250, 500, 1000, and 2000°/sec (DPS) and an accelerometer which is user-programmable has a full-scale range of 2g,4g,8g, and 16g. Input voltage is 5V.Fig.3. shows an MPU6050.Digital Motion Processing (DMP) engine offloads complex motion fusion, sensor timing synchronization and detection of gesture.

Fig.3. MPU6050

C. Flex /Bend Sensor

It is a variable resistor. The resistance of the flex sensor increases as the body of the components bends. In this project, theflex sensor is used to measure the amount of deflection or bending of hand due to the cause of a tremor. Fig.4. shows a flex sensor. An unflexed sensor has a nominal resistance which is approximately 10,000 ohms (10 K). Resistance will range between 30-40 K ohms when the sensor is bent at 90 degrees.

Fig.4. Flex Sensor

D. ESP 8266Wi-Fi Module

Esp8266 Wi-Fi Module has lower power consumption. It is a UART-Wi-Fi module and it is designed especially for mobile devices and also for IoT applications, the user's physical device can be connected to a Wi-Fi, internet or ethernet communication, wireless network and networking capabilities. Table 2 shows specifications of ESP8266. The module supports the standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack.Fig.5. shows an ESP8266Wi-Fi module.

Frequency range:	2.4 GHz-2.5GHz
Operating voltage:	3-3.6V
Operating current:	Average value 80mA

Table 2: Specifications of ESP8266

Fig.5. ESP8266 Wi-Fi module

E. Charger

The charger used is lightweight. A charger is used instead of battery because for the convenience of taking accurate tremor measurements. The charger is shown in Fig.6.

Fig.6. Charger

V. FINAL PROTOTYPE

The proposed system is turned on using a battery and fitted on tc hand in the form of a glove. The flex sensor is fitted in the thu small finger. The combination of accelerometer and gyrosco 6050) is fitted in the forefinger.

Fig.7.Proposed System

The flex sensor and MPU 6050 is connected to the Arduino pro mini microcontroller which lies on the top of the hand i.e. on top of the glove using wires. The charger is connected to the switch board and the device is turned on.

The proposed system is shown in Fig.7. Tremors cause the bending of fingers constantly, this bending is determined using the flex sensor whose resistance changes according to the bend. Flex sensor is used to measure the amount of deflection or bending of hand due to the cause of a tremor. The 3axis accelerometer measures vibration in x, y and z-axis. The accelerometer is used to measure linear acceleration based on the vibration of hand and a gyroscope is intended to determine an angular position based on the principle of rigidity of space. The data from the flex sensor, accelerometer and the gyroscope are sent to the microcontroller. It calculates the frequency of vibration. This information is then sent to the cloud using ESP8066 Wi-Fi module. This data is then displayed on the web page. This web pageis shown in Fig.8.

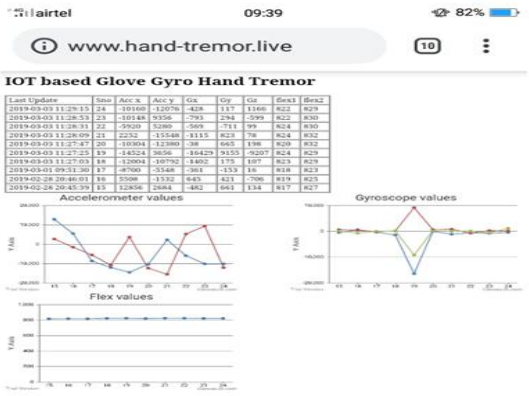

Fig.8.Hand Tremor web application

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The web page is developed using PHP and HTML in the front end. This web application is used to display the tremor frequency values of the patient's hand tremor and helps doctors to analyse tremor characteristics and monitor their patients in the simplest and cost-effective way. The graph is plotted for different sensor values so that doctors can understand the trend in the tremor measurements. MySQL is used to store the data in the database for future use.

VI. CONCLUSION

The measurement and analysis of Hand Tremor using IOT are presented. The proposed system helps doctors to measure the exact frequency of hand tremor. It also helps doctors to classify according tothe range of tremor. Using the data collected in MySQL a graph can also be plotted in indicating the intensity of hand tremor of the patient during a period of time. This is especially useful when it is to be known whether the particular treatment that the patient is undergoing is useful or not. This information can be found out from the rise or fall of the graph.

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