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Arm Rehabilitation Assistive Device

Sudhanshu Tripathi*, Ashutosh Thakur, Tarun
Dept. of Instrumentation and Control Engineering, Amity School of Engineering and Technology, Delhi, India

ABSTRACT
This work proposed an Arduino based arm rehabilitation assistive device. The proposed approach helped us in identifying the problems that a stroke patient might suffer during their rehabilitation and how they can be helped by developing such a device. Certain perimeters that we took into consideration were the angular movement of the arm, the angular movement of fingers and the muscle strength of the forearm. These are some of the basic parameters that can be used to determine the movement of the arm. Presently the devices that are being used by doctors are very expensive and complex, this idea can revolutionize the process of the treatment of the stroke patients. The device designed is cheap and less complex which can easily be used by the patient at their home.

Keywords : Arm Rehabilitation, diagnostic tools, Arduino, Sensors, Treatment

I. INTRODUCTION

The stroke patients mainly include elderly people who undergo the rehabilitation process to cure their disability. Post stroke rehabilitation is necessary for them to regain their mobility of their arms and do their work. After a stroke the patients undergo a rehabilitation process which include certain types of exercises and certain motivation to cure themselves. The exercises can be exhausting for the patients as the patients are old and hand not working properly[2][3]. Due to this they need self-motivation to complete this rehabilitation process successfully. The series of exercises might become exhausting and sometimes they lose interest in doing the exercises because of which certain motivational speech is needed by the patient from family or the doctors[1].

Researchers from various universities and companies are continuously trying to figure various methods, exercises or devices that will or might help the stroke patients in curing their disability. These systems may include attaching thedevices to their limbs in order to monitor the patient's movement in any environment during rehabilitation.

These robots are called the ARM which has six degrees of freedom and are equipped with position and force measurement sensors. There are other robot-assisted devices which show some promising results. However, due to its heavy and complex structure it is only suitable for the usage in clinics.

There are researchers who have developed devices which are complex and heavy in structure and can be attached to the patient's limb. However, these devices do not include data logging capabilities. Due to this incapability after every reading it has to be worn off and as they are heavy and complex it becomes a very hectic job for the patient as well as some time for the doctors.

Further the motion sensors are only calibrated to measure certain range of motion and do not tell us

about the muscle activity. Strong muscle activity is important to provide information regarding fatigue due to certain movements or physical workouts. Therefore the work described in this paper describes the designing the arm rehabilitation assistive device which includes various sensors and data logging capabilities. We aim to produce a device which will help the post stroke patients and improve their condition[5].

We used three types of sensors : the gyroscope sensor, electromyogram sensor and a flex sensor.

All the three sensors have three different work to do and the combined data of all the three sensors will tell us about the condition of the hand of the stroke patients.

II. METHODS AND MATERIAL

The stroke patients suffer during their rehabilitation process. This is due to the reduction of interest in the process or the lack of motivation. This can occur due to the difficult exercises, heavy and complex machines etc. This isone of the major reasons why most of the people do not complete the rehabilitation process. As most of the people suffering stroke are elderly people, their self-motivation is already low due to certain factors, increasing their self-motivation is the main and most important factor. Which can only be done by removing the fear from them of the heavy and complex devices. These complex devices make some people impatient due to which they refuse the full treatment process [1].

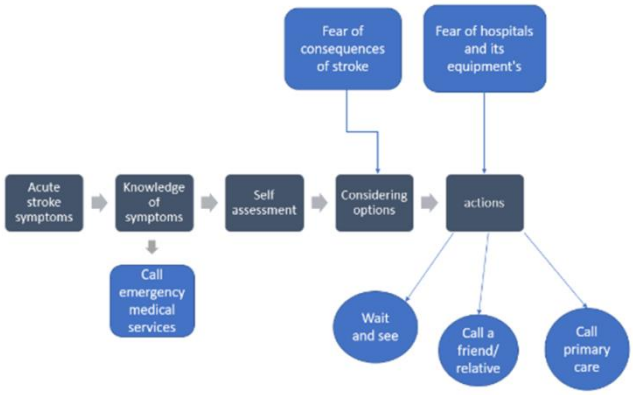

Fig 1. Block diagram of various phases during the treatment process

Furthermore, some devices do not even have data loggingcapability which can help the patient in many ways. The block diagram in Fig 1 shows some of the phases that a stroke patient goes through while being diagnosed with stroke.Two of the major problems showcased in this diagram are the,

- Fear of consequences stroke
- Fear of hospital professionals

Fear of the consequences of stroke is the psychological problem which can be treated by doing enough exercises and for doing enough exercises the patient needs self motivation. For this self motivation the patient needs to see and feel the improvement in his/her condition. Through this the fear of consequences of stroke in the patient might be reduced and the patient can recover as quickly as possible.

Fear of hospital professionals is the fear which is caused by seeing the heavy machines and devices which are used for the treatment of the stroke patients. The patients get feared of the process that the patient has to go through in their whole rehabilitation process. Some of the fear caused is also due to the high cost due to the using of complex devices for the rehabilitation process.

The device discussed in this paper is designed to tackle all the problems that a stroke patient might face.

The device discussed is light, less complex and has data logging capability which tackles almost every type of problems faced by a stroke patient.

First to make it light and less complex only three types of sensors are used which will be fitted on the gloves and the elbow guard which can be worn and taken off easily. So for the first problem that is related to the lack of motivation, when a patient can monitor their improvement on their own then they become self motivated on their own as it affects directly on

their psychology and mind that leads them in doing more of the physiotherapy which leads to the more improvement in their condition.

For the second problem that is the fear of the hospital professionals, according to us is due to the heavy and complex devices which are used in the treatment of the patient. The device discussed in this paper has data logging capability which in most of the current devices used in the industry does not exist. With the help of this data logging capability the patient with the comfort of their home can record the readings in a micro SD card or a personal computer and then send the reports to the doctor who then can analyze the report and give suggestions based on the data. As the device is less complex and easy to wear andtake out it can be bought and used in their own houses at their own comfort.

HARDWARE/ SOFTWARE REQUIREMENTS

The software portion of the module is developed using Arduino integrated development environment (IDE) and MATLAB. The Arduino module programming is created to take the data from the sensors used and to store it into the memory card. In the MATLAB all the data which is collected by the arduino is sent to it and the MATLAB creates graphs showing the betterment or the worsening of the patient's condition[8].

There are certain modules that are included in the MATLABwhich connects it with Arduino and provide a synchronized output.

There are mainly five hardware components used in this device, namely Arduino microcontroller, Arduino shield, flex sensors, accelerometer, electromyogram (EMG) sensor.

The Arduino UNO[4] is an open-source microcontroller which is developed by arduino.cc.The Arduino board has a number of ways to communicate with the computer. It can communicate through the USB cable and the other way is that it has Rx and Tx pins where we can connect the wifi or the bluetooth module which can communicate with the computer.

Arduino shield is a board that can be mounted on the top of the Arduino board[10]. The bending angle of the arm from elbow is measured using flex sensor, directly connected to the Arduino board[9]. To measures the force of acceleration due to gravity accelerometer is utilized. The sensor measures the acceleration in the X,Y and Z axis and gives analog voltage output proportional to the three axis[6].measure the small electrical pulses generated by the muscles during slightest of the muscle activity is measured by EMG sensor.Electrical activity detected is either stored in the SD card or displayed on the computer screen in the form of waves[9].

III. RESULTS AND DISCUSSION

The device discussed in this paper has three sensors attached to it which should give expected outputs. As per the expectations the flex sensor should show that when it will bend inwards the output resistance reading will increase significantly and vice versa. The readings will be taken when the sensor will be attached to the subject's elbow. An expected result as an example is shown in the figure 2 with 10 readings,

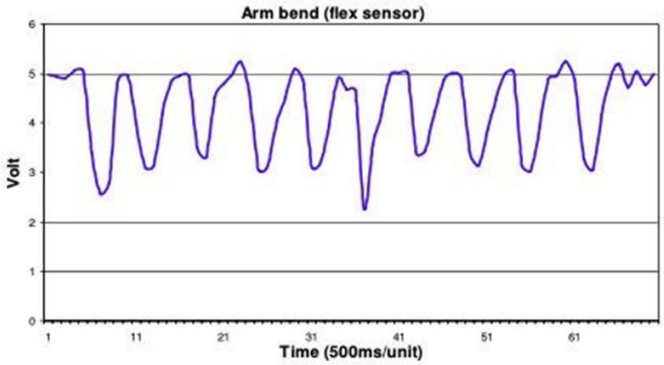

Fig 2. OUTPUT OF THE FLEX SENSOR

These assumptions suggest that the flex sensor is the best suitable sensor for the recording of the angular movementof the arm. The output of EMG can be shown on the LCD The accelerometer measures the force generated due to the movement of the arm in the presence of gravity in g units. There are certain activities designed which the subject will do with the

device on the hand and due to these activities the accelerometer can record as per the expectation readings as the hand will move in each and every direction.

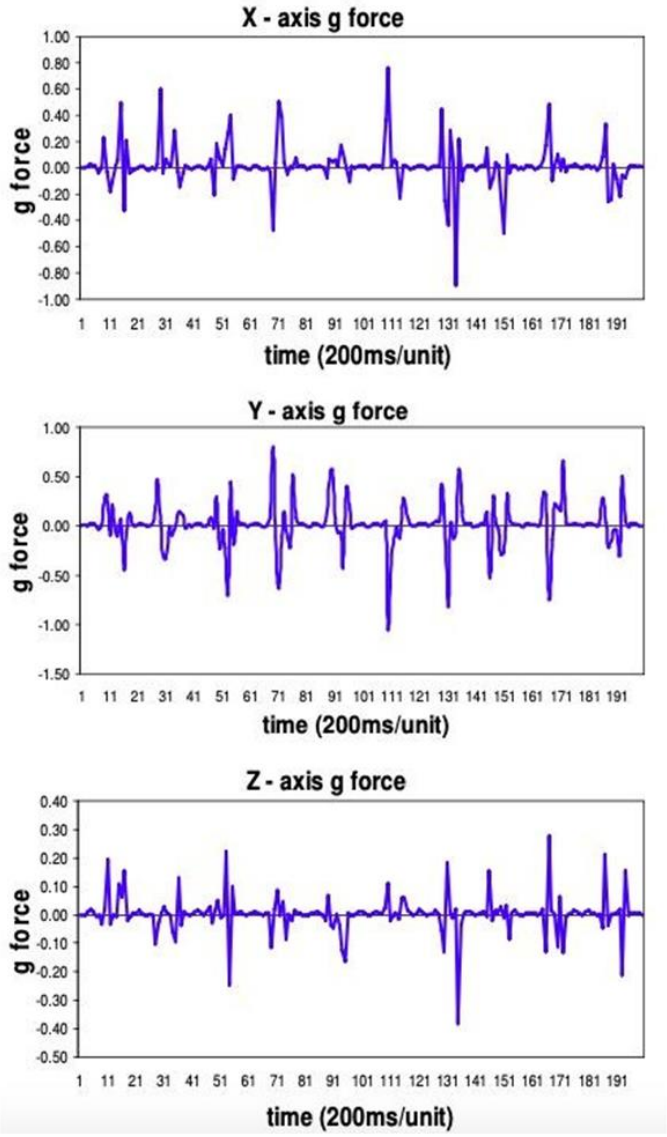

Fig 3. OUTPUT OF THE ACCELEROMETER

An expected result is shown in the figure 3 which is shown in the graphical form different for every X,Y and Z-axis by combining various readings.The quantified results such as force generated during certain workouts could be useful in estimating the fatigue conditions of the subject due to certain continuous workouts.

IV. CONCLUSION

A wearable rehabilitation device with a monitoring system is designed for stroke patients. The describedmicrocontroller based system has mainly three sensors that are flex sensor, accelerometer and the EMG sensor. The device discussed will have two types of monitoring systems: first the data logging capability which is present in very few machines in the market and second the real time monitoring by connecting devices with the computer. This rehabilitation system has certain advantages,

System is compact and lightweight.
Easy to attach to arms without assistance.
Two types of data logging capability
Can be used in the patients comfort at home.

Our future work will focus on the treatment of the subject by the addition of pulse generators which produce electric pulses in synchronous with the movement. As when hand moves muscle activates and this activation releases some very sensitive and small electrical pulses which is sensed by the EMG sensor this then activates the pulse generator.

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