DESIGN AND DEVELOPMENT OF A MODEL FOR ASSISTING WRIST PROPRIOCEPTIVE FUNCTION

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Abstract
Nowadays various neurological disorders are associated with somatosensory deficits. One of the well known disorder is referred as Stroke. In such cases the assessment of wrist proprioceptive function is required. Proprioception is the sense of the body awareness. There are Numerous methods available to measure proprioceptive acuity. However, no such globally accepted protocol exists. Our proposed model can be used to monitor and provide the wrist movement for the affected person. The sense of body awareness is frequently impaired after stroke which directly affects recovery after the neurological injuries. But still the clinical tests of proprioception lacks sensitivity and reliability. The hardware device of the proposed system consist of two motors, that can apply torques in two axes of rotation on the human wrist. The two axes of rotation are wrist flexion/extension and radial/ulnar. Patients can now actively move the wrist of the unaffected limb to match the reference position of the affected wrist, which is displaced by the system to a target across all four directions.

Index Terms: Wrist Proprioceptive function, Somatosensory, flexion/ extension, radial/ ulnar.

I. INTRODUCTION

Stroke occurs when the blood flow to the brain stops. It is caused due to high blood pressure, cigarette smoking and obesity. The main symptoms of stroke is numbness of face, arm, wrist or leg. To overcome the stroke physical work is to be done. Hence the Doctor advises to take physical exercise or physiotherapy treatment at the affected region. Physiotherapist will help for fast recovery by regular monitoring of the patient. But the physiotherapy treatment is quite expensive and should be done at regular interval of time. So the movement of the wrist, arm or leg can be given by the electronic devices which will reduce the complexity. There are many devices to produce the movements of arms and legs. But there is only few research products available for wrist proprioception. The device can apply the torque in six axes of rotations like flexion/extension, radial/ulnar and pronation/supination.

II. BLOCK DIAGRAM

The block diagram of the proposed system is shown in fig.2.1.

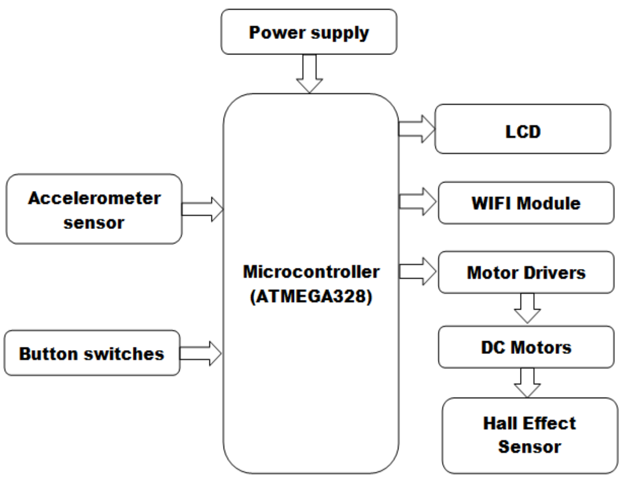


Fig 2.1 Block Diagram

III. COMPONENTS USED

From the above block diagram, the following components are required to design the system.

1) **Arduino:** It is a microcontroller (ATMEGA328) which can be programmed to interact with the hardware used.

2) **Wi-Fi Module:** Wi-Fi module(ESP8266) is a device used to store the data in the cloud(internet). Here, separate website is created and the data is uploaded. The website used is wristbot.co.in.

3) **Accelerometer Sensor:** Accelerometer sensor (ADXL337) is used to measure the movements of the wrist in two directions namely x-direction and y-direction.

4) **LCD Display:** It is used to display the options available in the device. Here, 16x2 LCD display is used

5) **Power Supply:** It is used to supply the power to the loads. 12V power supply is required for the operation of the device.

6) **Motor Driver:** Motor Driver (L298) is used to drive the dc motor in a particular directions.

7) **DC Motor:** DC motor(30 rpm) is used to provide the wrist movements. Two DC motors are required for four axes of rotation.

8) **Buttons:** Buttons is used to enable or disable the operation. Four buttons are used for operations like menu, start, increment and decrement.

9) **Hall Effect Sensor:** Hall Effect sensor(HE44E) is used to provide the motor rotation only in the presence of magnetic field. Hence magnets are placed between the sensor and the lever.

III. EXISTING SYSTEM

Young children with hemiplegic cerebral palsy show evidence of learning new motor skills and having better independent performance through regular physical therapy. The challenging and motivational exercises needed to promote these improvements must be performed inside and outside of therapy hours, but are often not when outside of sessions. Technology based systems that gamify the exercise process are shown to motivate children and stimulate physical and mental activity. These solutions are typically expensive or difficult to use by both caregiver and patient, and may not adapt to the child's need over time. The Robots Encouraging Action in Children (REACH) robot aims to promote upper extremity movement in children and provide the child's success metrics using a game-like system. This system is accomplished through low-cost consumer electronics and DIY kits that make them an accessible option for home-based physical therapy.

A. Disadvantage

The main disadvantage of the REACH Robot is to set of locations and limited to certain adaptability in children.

IV. PROPOSED SYSTEM

The proposed system allows for guided and controlled movements of the wrist by delivering assistive, resistive, perturbation or no forces. This may aid the design of more effective sensory motor intervention programs. Proprioceptive development for the wrist continues well into early adolescence. Accelerometer is used to measure the axis of rotation in two degrees of freedom. It can be viewed in excel sheet as well as in the website (wristbot.co.in). The accelerometer readings will be updated in every 20 seconds. By setting the count, the corresponding wrist movement is given using a dc motor to improve quality of life for patient. This system does not need supervision of doctor. It is used to provide effective, accessible, user-friendly and low-cost product.

A. Flowchart

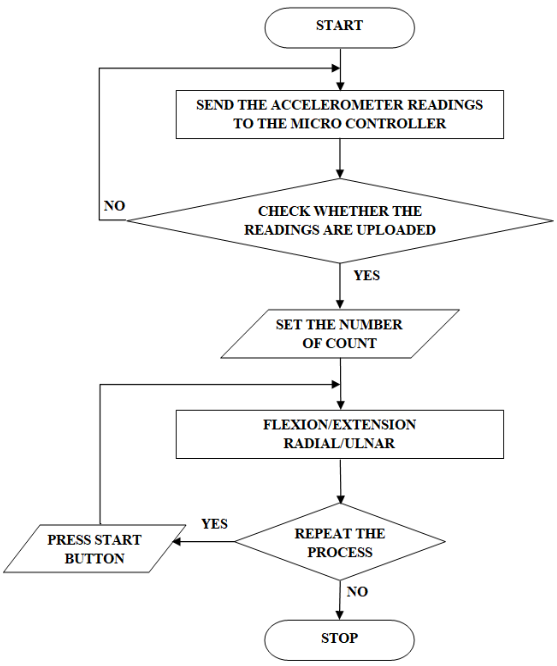


Fig 5.1 Flowchart

The accelerometer data is given to the microcontroller and to the Wi-Fi module. The microcontroller stores the data and can be viewed in the Excel sheets and the Wi-Fi module will upload the data in the web. If the data is not uploaded, then check the Wi-Fi connection and redo the operation. Once the data is uploaded, the number of count is set. Using the motor, wrist flexion/extension and radial/ulnar movement is given to the patients. To repeat the process, click on the start button.

B. Prototype for the proposed system

The prototype of the proposed system is shown below.

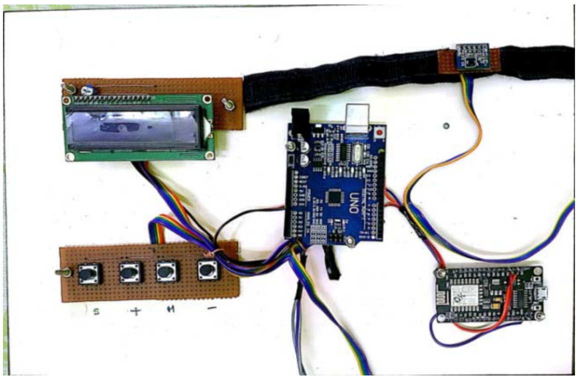


Fig 5.2.1 Prototype

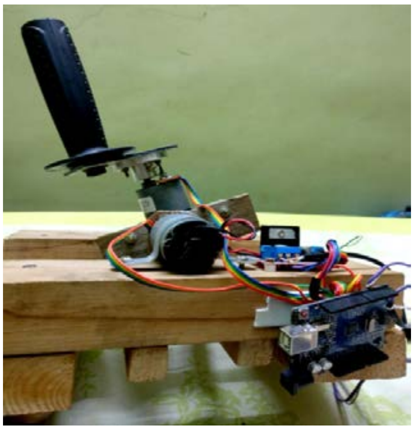


Fig 5.2.2 Prototype

From the images, it is clear that the components used are less in number and are simple in nature.

V. PRACTICAL OUTPUT

The whole working of system is explained:

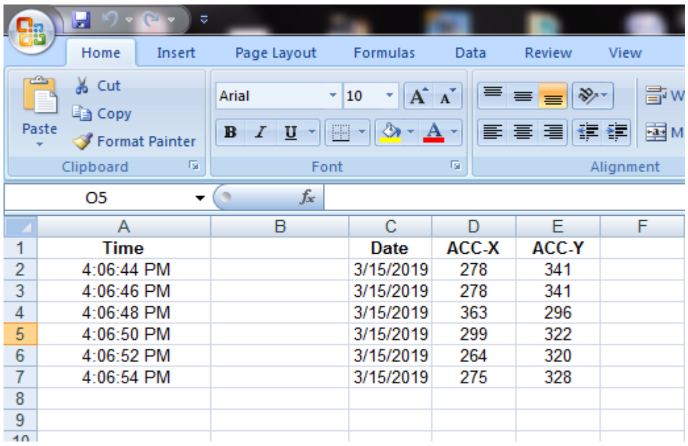
Step 1: Powering on the device.

Fig 6.1 LCD Display

LCD displays the message "WRISTBOT" and "press start btn" when it is powered on.

Step 2: Accelerometer Readings

The menu button and the start button is pressed at a same time for a delay of 3s. Then the accelerometer will start reading the values. The Accelerometer readings uploaded in the Arduino as well as in the website (wristbot.co.in).



	A	B	C	D	E	F
1	Time		Date	ACC-X	ACC-Y	
2	4:06:44 PM		3/15/2019	278	341	
3	4:06:46 PM		3/15/2019	278	341	
4	4:06:48 PM		3/15/2019	363	296	
5	4:06:50 PM		3/15/2019	299	322	
6	4:06:52 PM		3/15/2019	264	320	
7	4:06:54 PM		3/15/2019	275	328	

Fig 6.2.2 Accelerometer readings in Excel sheet

The accelerometer readings can be viewed in the Excel sheet. The corresponding readings can be converted into graph by plotting ACC-X in x-axis and ACC-Y in y-axis.

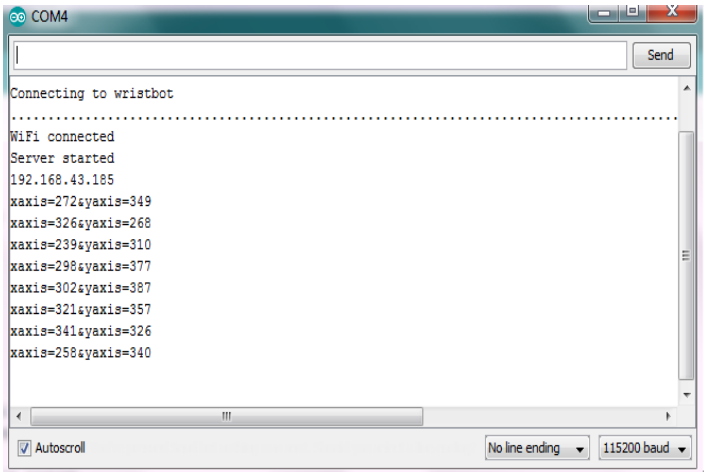


Fig 6.2.3 Accelerometer readings in Arduino IDE

The accelerometer readings can also be viewed in the Arduino IDE software. The readings are displayed in the serial monitor of the software by choosing the respective port number of the PC where the microcontroller is connected.

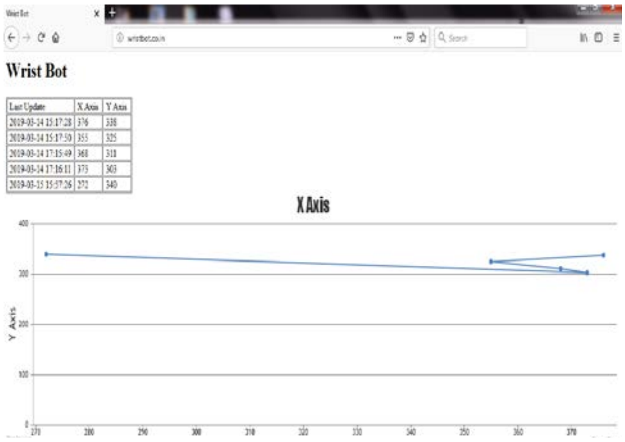


Fig 6.2.4 Accelerometer readings in the Website

The accelerometer readings are uploaded in the website (wristbot.co.in). It is used for monitoring the motions of the wrist by the caretaker or doctor at his own place itself. The website displays the information like the axis of rotation and the respective graph.

The menu button is pressed for 5 seconds to set the count. The count can be increased and decreased depending upon the need of the patients. The count can be increased by pressing the increment button and it can be decreased by using the decrement button.

Step 4: Start the operation

Once the count is set, then the menu button is again pressed to exit from the count option. Then the start button is pressed to start the operation. The Wrist Extension and Flexion motions are given at the starting stage. These motions are given to the affected wrist of the patients. The movement stops when the number of count is completed.

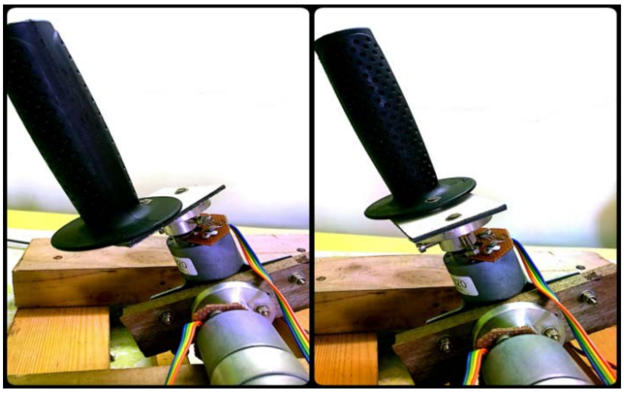


Fig 6.4.2 Flexion and Extension

Once the Wrist Extension and Flexion is completed, the Ulnar and Radial motions of the wrist gets started. The movement stops when the number of count is completed.

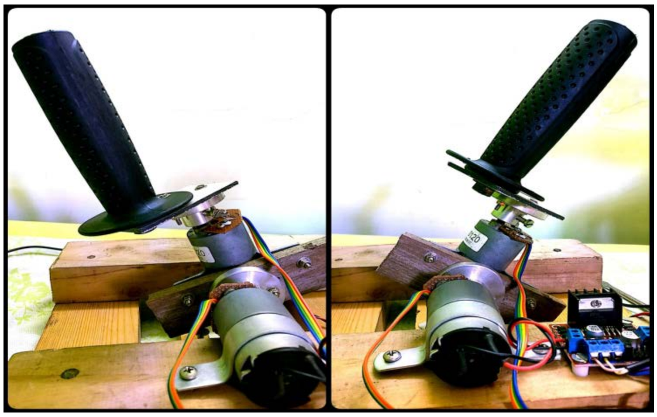


Fig 6.4.4 Radial and Ulnar

Hence the Wrist motions like Extension and Flexion, Radial and Ulnar are given to the stroke affected persons. The operation can be repeated by pressing the start button.

VI. CONCLUSION

The results show that the system can quantify proprioceptive impairment for stroke affected person. Stroke also can trigger partial or complete paralysis. This makes it difficult or sometimes impossible for the patient to move his/her limbs. The degree of proprioceptive impairment may vary across the joint degrees of freedom of the wrist. Evaluating proprioceptive changes over time through multiple assessments by mean of the same device and protocol in order to evaluate its correlation with rehabilitation practice and motor recovery helped the patients with the wrist therapy. In comparison to hospital based rehabilitation**,** the proposed system offers various levels of advantages like quick recovery and suggest proprioceptive assessment should include all the four possible movement directions.

Future work aims at relating proprioceptive and motor impairment to rehabilitation motor and functional outcome in order to guide rehabilitation professionals to select best practices for each patient. All the six movements including pronation and supination are yet to be experimented.

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