Smart Rehabilitation Device For Paralyzed Patient

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Abstract- *With the huge development and the latest technological advancement in mechatronics prosthetic devices have acquired interest in many different fields such as medical and industrial fields. A prosthetic device can be an external wearable mobile machine that covers the body or part of it. The goal of this project is to design portable devices which helps paralyzed person as well as aged people. As movement of one side of the body and communication are the main problems faced by paralyzed person, this wearable devices allow a user to perform specific movements, exercises to train the patient's impaired hand and to communicate using hand gestures. By performing exercise using this device, the user can gradually start to restore the functionality of his hand.*

I. INTRODUCTION

Stroke can cause deficiency in various neurological areas and mainly it causes disability in the motor system [1]. Most of the stroke survivors suffer from paralysis of one side of the body. Motor rehabilitation research has shown that to speed up the recovery process of the upper limb function, activity dependent interventions can be used to assist the use of paralyzed limb [2]. To be able to understand and repair the hand motor function after a person undergoes stroke has been the major focus of rehabilitation research as human hand play a vital role in the daily life activities. Furthermore, in the rehabilitation of the hand motor function the major concern has been how to achieve the optimum restoration of hand function. While positive outcomes have been obtained from therapies in general, the stroke patients who have undergone harsh, moderate or mild motor deteriorations, an optional therapy known as bilateral movement training has demonstrated positive results. In addition, based on neurophysiologic and behavioral mechanisms an immense assurance in hastening upper limb chronic stroke recovery has been shown by bilateral movement practice [3]. In comparison to the unilateral training patients, the bilateral training indicates better improvement of the upper extremity functions and decrease in movement time of the damaged limb [4]. The major aim of the paper is to design and develop a post stroke remedial system that can assist the stroke patient to flex/extend the impaired hand based on the flexion/extension movement of the healthy hand fingers. By performing bilateral movement training, the hand motor function of the impaired limb of the stroke survivor can be enhanced due to plasticity of the human brain. The robot manipulators are required to have the same number of joints. Their advantages of over fully actuated robots led to many studies to predict their behavior. The advantages such as light weight, low power consumption and low cost automation can easily overcome the failure due to an unexpected accident. Mahindrakar et al. [5] has proposed a dynamic model that takes into account the frictional forces acting on the joints. The results obtained were also verified through numerical simulation.

I. LITERATURE REVIEW

In this paper Quiapo et.al. Cover the various prevailing methods of deafmute communication interpreter system. The two broad classification of the communication methodologies used by the deaf –mute people are - Wearable Communication Device and Online Learning System. Under Wearable communication method, there are Glove based system, Keypad method and Handicom Touch-screen. All the above mentioned three sub-divided methods make use of various sensors, accelerometer, a suitable micro-controller, a text to speech conversion module, a keypad and a touch-screen. The need for an external device to interpret the message between a deaf –mute and non-deaf-mute people can be overcome by the second method i.e. online learning system. The Online Learning System has different methods. The five subdivided methods are- SLIM module, TESSA, Wi-See Technology, SWI_PELE System and Web-Sign Technology [1]. In another research Abhinandan Das et.al proposed ISLR system is considered as a pattern recognition technique that has two important modules: feature extraction and classification. The joint use of Discrete Wavelet Transform (DWT) based feature extraction and nearest neighbor classifier is used to recognize the sign language. The experimental results show that the proposed hand gesture recognition system achieves maximum 99.23% classification accuracy while using cosine distance classifier [2] .In their research Anetha K et.al. presented a scheme using a database driven hand Smart Wearable Rehabilitation Device for Paralyzed Patients Department of Electronics and Communication, PESITM, Shivamogga Page 4 gesture recognition based upon skin color model approach and thresholding approach along with an effective template matching with can be effectively used for human robotics applications and similar other applications.. Initially, hand region is segmented by applying

skin color model in YCbCr color space. In the next stage thresholding is applied to separate foreground and background. Finally, template based matching technique is developed using Principal Component Analysis (PCA) for recognition [3]. Aarthi M et.al. presented the static hand gesture recognition system using digital image processing. For hand gesture feature vector SIFT algorithm is used. The SIFT features have been computed at the edges which are invariant to scaling, rotation, addition of noise [4]. PriyankaLokhande et.al proposed a method for automatic recognition of signs on the basis of shape based features is presented. For segmentation of hand region from the images, Otsu's thresholding algorithm is used, that chooses an optimal threshold to minimize the within-class variance of threshold black and white pixels. Features of segmented hand region are calculated using Hu's invariant moments that are fed to Artificial Neural Network for classification. Performance of the system is evaluated on the basis of Accuracy, Sensitivity and Specificity [5]. Another Authors Anetha K et.al presented various method of hand gesture and sign language recognition proposed in the past by various researchers. For deaf and dumb people, Sign language is the only way of communication. With the help of sign language, these physical impaired people express their emotions and thoughts to other person [6]. Priyanka R Potdar et.al. Proposed a system to aid communication of deaf and dumb people communication using Indian sign language (ISL) with normal people where hand gestures will be converted into appropriate text message. Main objective is to design an algorithm to convert dynamic gesture to text at real time. Finally after testing is done the system will be implemented on android platform and will be available as an application for smart phone and tablet pc [7]. Another Author proposed a real time vision based system for hand gesture recognition for human computer interaction in many applications. The system can recognize 35 different hand gestures given by Indian and American Sign Language or ISL and ASL at faster rate with virtuous accuracy. RGB-to-GRAY segmentation technique was used to minimize the chances of false detection. Authors proposed a method of improvised Scale Invariant Feature Transform (SIFT) and same was used to Smart Wearable Rehabilitation Device for Paralyzed Patients Department of Electronics and Communication, PESITM, Shivamogga Page 5 extract features. The system is model using MATLAB. To design and efficient user friendly hand gesture recognition system, a GUI model has been implemented [8].

III. WORKING

In this system we have two modules, In first part a camera is connected to the arduino microcontroller, as the camera captures the hand gestures in order to assist the disabled people in their basic needs, here we are using MATLAB software to capture the images and send it to the microcontroller and display it on the LCD screen about the gestures.

In second part we have designed , where these people are curious about doing work on their own hence we have designed a robotic arm using DC motors to help these disabled people in their movement so we have connected a Bluetooth device to send the respective commands for the movement of the arm. Simultaneously the heart beat rate and the temperature of the person will be displayed using LCD display.

IV. BLOCK DIAGRAM

The block diagram of the ARM REHABILATION ASSISTIVE DEVICE is shown below. The block diagram shows the overall view of the system.

The blocks that are connected here are Arduino Microcontroller, Bluetooth, Heart beat sensor, Temperature sensor, Power supply, Motor driver, DC motors, Camera and 16*2 LCD.

The Bluetooth device is used for the communication with the hardware that is connected to the serial pins that is RX and TX of the arduino for the serial communication.

Two analog sensors are connected to the analog pins of the arduino those are heart beat sensor and temperature sensor, these sensors gives analog values to the arduino and in programming part we convert those values.

Simultaneously the heart beat rate and the temperature of the person will be displayed using LCD display .Liquid Crystal Display that is used to display the values is connected to four data pins to the arduino micro controller along with RS and EN pin that works as a gate between LCD and Arduino.

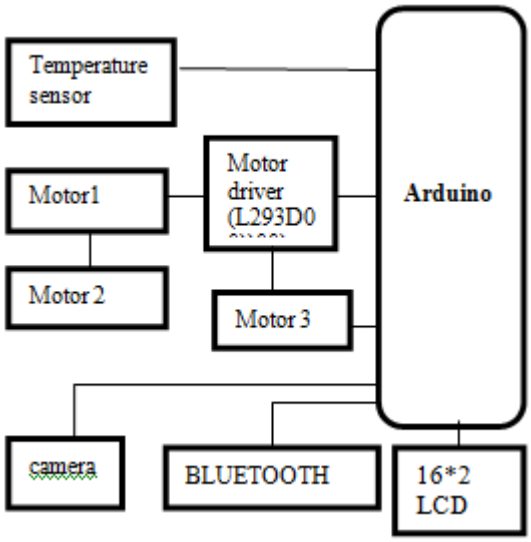

Figure 1.Block Diagram of Arm Rehabilitation Assistive Device

V. IMPLIMENTATION

MATLAB is widely used as a computational tool in science and engineering encompassing the fields of physics, chemistry, math and all engineering streams. It is used in a range of applications including: signal processing and Communications, image and video Processing, control systems, test and measurement, computational finance, computational biology.

Viola-Jones algorithm has four stages:

1. Haar Feature Selection
2. Creating an Integral Image
3. Cascading Classifiers

1. Haar Features

Haar-like features are digital image features used in object detection. Or we can say that these are rectangle shaped dark and light areas having similar kind of features like our face. So basically we move those features throughout our face to find the output of each feature.

For example:

All faces share some similar properties

- The eyes region is darker than the upper-cheeks.
- The nose bridge region is brighter than the eyes.

So this features of face are used for developing haar like features. Each feature is related to a special location in the face.

Output of Rectangle features.We will move the related kind of rectangle throughout the face to get different values.

2. Integral Image

We know each point of an image is represented by a pixel value. As we so we need to know the output of applied Haar features so we need to find the sum of pixel value of all those area and solve the summation. But this is a huge task. To reduce the number of calculation concept of INTEGRAL IMAGE is introduced.

Basically Integral image is a matrix same as size of the window. The integral image at location (x, y) is the sum of the pixels above and to the left of (x, Y)
For example

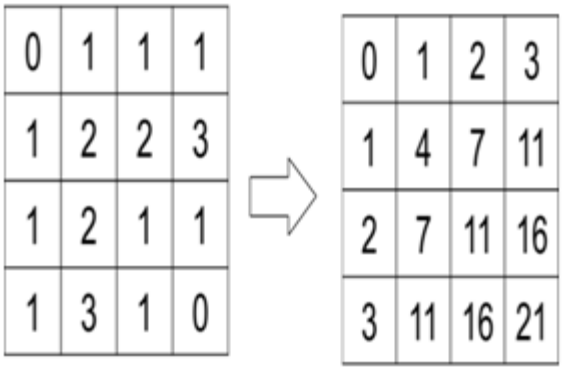

Figure 2.Integral Image Formation

3. Cascade

After going through Adaboost stage now let's say we have 600 no of strong classifiers. So to detect if a frame contains a face or not: Instead of applying all the 600 features on a window, group the features into different stages of classifiers and apply one-by-one. If a window fails the first stage, discard it. We don't consider remaining features on it. If it passes, apply the second stage of features and continue the process. The window which passes all stages is a face region.

VI. RESULTS

Prototype of smart rehabilitation device for paralyzed patient was designed using MATLAB and arduino. It was tested for different cases and the output was as expected, this

device will capture the different signs and compare it with pre-feeded signs. If it matches, corresponding output will displayed in LCD as shown below

Figure 3.LCD displaying the message

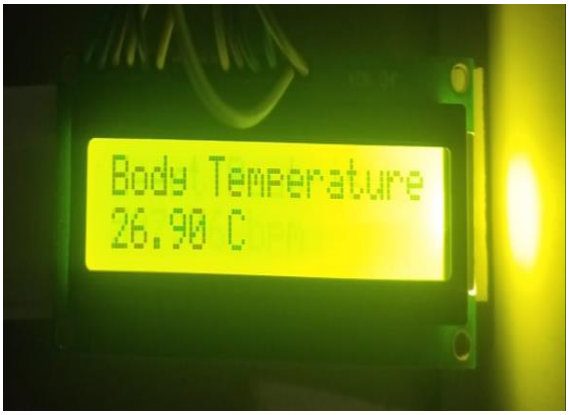

Figure 4.LCD displaying body temperature

Figure 5.LCD displaying heart beat

Figure 6.LCD displaying the message "hungry", which is recognized through hand gesture

VII. CONCLUSION

Development of arm motor function rehabilitation device based on sensor has been developed. The device was able to achieve full flexion/ extension motion of arms. In order to achieve better accuracy, feedback control needs to be developed by MEMS sensor for the prediction of under actuated systems behavior. Data were collected from camera fixed on the ARM. Testing of the device on actual stroke survivors and the further discussions with the physiotherapist for suggestions is necessary for future modification of the device.

Our future work will focus on further enhancing the capability of sensory unit by adding 2-axis gyro sensor and an Ethernet shields. By using 2-axis gyro sensor, we predict to be able to improve the rehabilitation process which can be determined by measuring arm joints rotational motion which can give more accurate analysis rehabilitation workout. In conclusion, the finding attained from this project may enable us to contribute towards the development of new arm rehabilitation monitoring device which can benefit human lives

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