HUMAN ACTIVITY RECOGNITION USING FLEX SENSORS

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Abstract - *This paper represents the research made for the betterment and simplicity in the life of elderly people or any person with disability. For this purpose, many tools of technologies were used previously including, deep neural networks, accelerometer, Internet of Things (IoT), voice system, etc. For further improvements in the previously done works, we have basically developed a system that allows living life in simpler way by making the computer system understand about the requirements of the users by getting the retrieval of information from flex sensors used by the user in their familiar environment. This can be made possible by the use of "assistive technologies" and the "Internet of Things (IoT)" along with mixing the concept of neural networks. Here, we have aimed to bring together the latest achievements in the field of IoT and neural networks and then develop a more complex form with the capability to adapt with the user and learn the behavior of him. It is used to monitor in real-time the state of the patient and then get the sensitive data that can be analyzed and respective working solution can be worked out. Use of MatLab is done to get the system trained by a number of possibilities of human activity. Flex sensors made it easy to command the system to separate out the required output command and work accordingly. The commands are sent through the Bluetooth module to the computer system and the correct output is given on the LCD screen.*

***Key Words*: Assistive Technologies, Artificial Neural networks, Internet of Things, Activity Recognition**

1. INTRODUCTION

Human Activity Recognition is the process of getting the correctly recognized output of any movement done by human with the help of the trained set of data values stored in the computer system. It has various applications, spanning from activity understanding for intelligent surveillance systems to improving human-computer interactions. Recent approaches have demonstrated great performance in recognizing individual actions. However, in reality, human activity can involve multiple people and to recognize such group activities and their interactions would require information more than the motion of individuals [5].

Motivated by the use of various technologies used by different researchers in the field of activity recognition, we also tried to get few modifications done in those technologies or otherwise merge few of them to get the desired and a little bit more reliable solution to the problem. In the previous researches related to the activity recognition, few of them inspired us a bit more. One of the researchers used a study to investigate the dependency of the e-Watch classification accuracy on given different body positions. He investigated wearing the e-Watch in the following locations: the belt, shirt pocket, trouser pocket, backpack, and necklace. The results of the study would help him decide on the best position to place such a sensor platform, and understand the nature of the trade-off between wearing position and classification performance [5]. Another researcher presented a more detailed and novel version of an HAR-IoT system that employs a single device with occasional usage. This system is intended to be used by patients with chronic heart diseases, patients that have their health status in a non-critical condition but still need constant monitoring. The presented system focuses on the daily routine, activity and physical therapy that each patient must have as part of their recuperation process [3]. One research study proposed a privacy-preserving framework for activity recognition. This framework relies on a machine learning technique to efficiently recognize the user activity pattern, useful for personal healthcare monitoring, while limiting the risk of re-identification of users from biometric patterns that characterizes each individual. On the basis of this observation, he designed a second novel protection mechanism that processes the raw signal on the user's smartphone and transfers to the application server only the relevant features unlinked to the identity of users [7].

These various proposed systems have worked a lot in their concerned field but have lagged in some of them. In this research work, we have tried to merge a few technologies like IoT, Artificial Neural Networks and provide a better design of the system solution that can be helpful for the various different kinds of persons with many different profiles. These profiles can vary from, a patient that is not able to move all his body parts but can move a few, to the person who are unable to speak out (dumb) for any kind of requirement. Therefore, in this work, we propose an artificial neural network (ANN) based model to recognize the human activity by taking advantage of its probabilistic reasoning power and incorporate multiple sources of context information. ANNs have helped us in this project when we wanted to use the flex sensors for the training purpose of the computer system as well as the training of the patient that will learn the actions using these flex sensors. The development of the assistive assembly of flex sensors used on the human body that is smart enough to read the assistive environment and get the equipment trained in the human activity and a few health monitoring systems.

For each feature, we carefully designed the network structure to get the higher level representation of input features, and the combination of different representations the probability of getting more correct output values.

In summary, the main contributions of this paper are:

• We introduced the most sought after feature of “modularity” in the project that will help to remove the previously stored data set of values and feed in the new set of input values for a patient having a new type of disability profile.
• An Artificial Neural Networks model for human activity recognition that is using the flex sensors as the data input device as well as the training data device.

2. LITERATURE REVIEW

In human activity recognition systems, various low level features are introduced to describe the activity observation that used only single technique to produce the result. Also, they were lacking the feature of modularity which has been compensated in our research work.

Stefan Oniga et. Al., (2014) introduced about developing a system that allows living for as long as possible in familiar environment. He also used IoT technologies to monitor in real time the state of a patient or to get sensitive data in order to be subsequently analyzed for a medical diagnosis. He presented the state of his work related to the development of an assistive assembly consisting of a smart and assistive environment, a human activity and health monitoring system, an assistive and tele-presence robot, together with the related components and cloud services. He used ChipKit Max32 microcontroller development board, a 3 axes accelerometer sensor, a heart rate belt sensor and communication modules.

Min-Cheol Kwon et. Al., (2018) proposed a human activity recognition system that collects data from an off-the-shelf smart watch and uses an artificial neural network for classification. The proposed system is further enhanced using location information. He considered 11 activities, including both simple and daily activities. In this study, he proposed an HAR system that collects data from an off-the-shelf smart watch and uses an artificial neural network for classification. Smart watches are effective and readily available wearable devices for use in HAR systems.

Diego Castro et. Al., (2017) He used machine learning algorithms to determine the activity done within four pre-established categories (lie, sit, walk and jog). Meanwhile, it is able to give feedback during and after the activity is performed, using a remote monitoring component with remote visualization and programmable alarms.

V.Padmanabhan et. Al., (2014) He proposed a new technique called artificial speaking mouth for dumb people. It will be very helpful to them for conveying their thoughts to others. Some peoples are easily able to get the information from their motions. The remaining is not able to understand their way of conveying the message. In order to overcome the complexity the artificial mouth is introduced for the dumb peoples. This system is based on the motion sensor. According to dumb people, for every motion they have a meaning. That message is kept in a database. Likewise all templates are kept in the database. In the real time the template database is fed into a microcontroller and the motion sensor is fixed in their hand. For every action the motion sensors get accelerated and give the signal to the microcontroller. The microcontroller matches the motion with the database and produces the speech signal. The output of the system is using the speaker.

Li Wei and Shishir K. Shah (2017) In his paper, he proposed context features along with a deep model to recognize the individual subject activity in the videos of real-world scenes. He has proposed a deep neural network model for human activity recognition from video. The input features of the deep network include motion feature and context feature. He designed the scene prior feature and scene context feature to capture the environment around the subject of interest global and local levels.

Theo Jourdan et. Al., (2018) In his paper, he proposed a privacy-preserving framework for activity recognition. This framework relies on a machine learning technique to efficiently recognize the user activity pattern, useful for personal healthcare monitoring, while limiting the risk of re-identification of users from biometric patterns that characterizes each individual. To achieve that, he first deeply analyzed different features extraction schemes in both temporal and frequency domain.

3. RESEARCH METHODOLOGY

Human Activity Recognition has seen various number of technologies being used ranging from Deep Neural Networks, Internet of Things, Accelerometer, Smart Phones, Smart Watches, etc. This research paper will give an idea about the combination of technologies that can help to improve the complexities and make the way for the modification that can be done in the existing software for patients of any kind of health profile. This feature of modularity helps to change the pre-defined values of the resistance of the flex sensor for any kind of bending angle. This will change the trained commands of the system software and a new patient can be trained according to his disability and new set of data values can be fixed for particular angles.

The following Block Diagram of the research process will help to show the outline of the internal process that is taking place in the software:

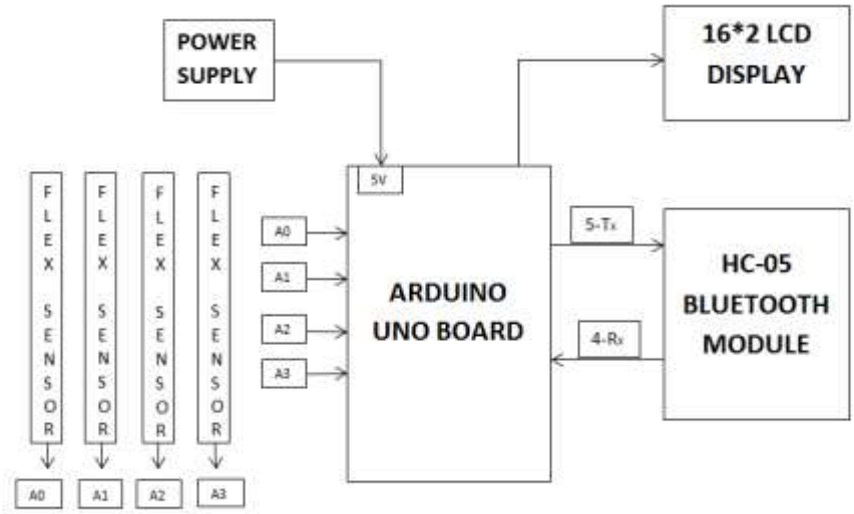

Fig- 1: Block Diagram

In the above shown block diagram, four flex sensors are used. A flex sensor has different blocks of resistive substance that are closely placed together. In a flex sensor, the bending angle fluctuate the resistance values of the sensor. For a particular angle, a flex sensor will show a different value. Now, each of these flex sensors is attached to the input pins of the Arduino Board. Each input pin is inserted by flex sensors namely, A0, A1, A2, A3. Arduino Board is given the power supply of 5V to operate. In the Arduino Board itself, there is a communicating device, HC-05 Bluetooth is attached that helps to communicate the inputs given by the patient to the system software, which then recognizes the type of input command. After recognizing, the system shows the output value on the 16*2 LCD Display. And, accordingly the action is taken.

Algorithm used in producing the system software and the functioning of the project has been implemented separately in the project. Algorithm used is:

Steps:

i. Get gesture data from flex sensor using analogue input in Arduino board hardware.
ii. Read analogue data and convert it into digital format.
iii. Arduino UNO will communicate with HC-05 blue tooth.
iv. Set communication port in PC/Laptop.
v. Bluetooth connected with arduino will communicate to Bluetooth of PC/Laptop.
vi. Send data to PC or Laptop using wireless communication with Bluetooth.
vii. PC or Laptop will process the data:

   a. Get analogue to digital converted data from hardware
   b. Create neural network for given data training
   c. Process and compare data from pre trained database
   d. Compare combination of data using neural networks
   e. Get best approach results from neural network
   f. Show output data from results

The algorithm used is implemented in a particular format which need not break in between to get the correct and accurate results. The format is shown below by the flowchart:

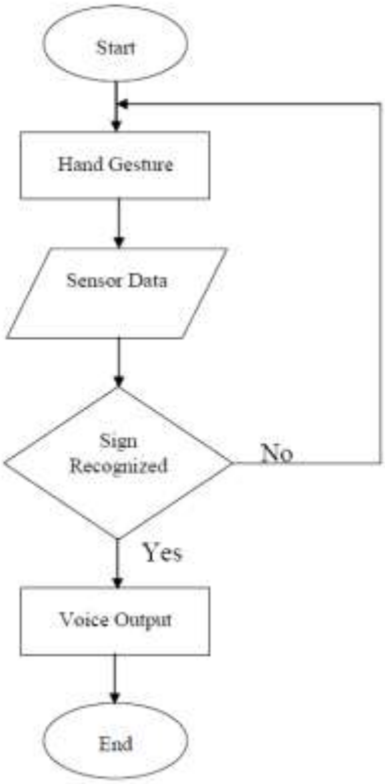

Fig- 2: Flow Chart of the Project

4. EXECUTION AND ANALYSIS

This research paper shows the recognition of human activities and the hardware components which are used include Flex sensors, Bluetooth device in both transmitter and receiver, LCD Screen, Adapter. Now, when all the configurations and the components are connected well and the software like Matlab and Arduino UNO are encoded and run, then a lot of observations are shown by them.

The main execution of the program starts by connecting both the Bluetooth devices of the transmitter and receiver and after their connection, main work of giving the inputs by the use of Flex sensors is done. The patient will try to move the flex sensor by any one of the possible combinations that can be made from the all four flex sensors. The movement of the flex sensor is mainly done in three possible ways which are:

a) At the angle of 0, that is at the straight position of the flex sensor. The values of the resistance of the flex sensor are shown by the graphs
b) At the angle of 90, that is the position in which flex sensor is bent from the middle.
c) At the angle of 180, that is the position in which the flex sensor is bent from top to the base of the flex sensor.

All these values are little bit fluctuating in nature but we can find the average value from the graphs that can be fixed for any particular angle value. Then, these values are set in the code for a particular position which will represent some kind of message or signal from the patient and action is required.

Some of the graphs which show the angular deviations of the flex sensor are as follows:

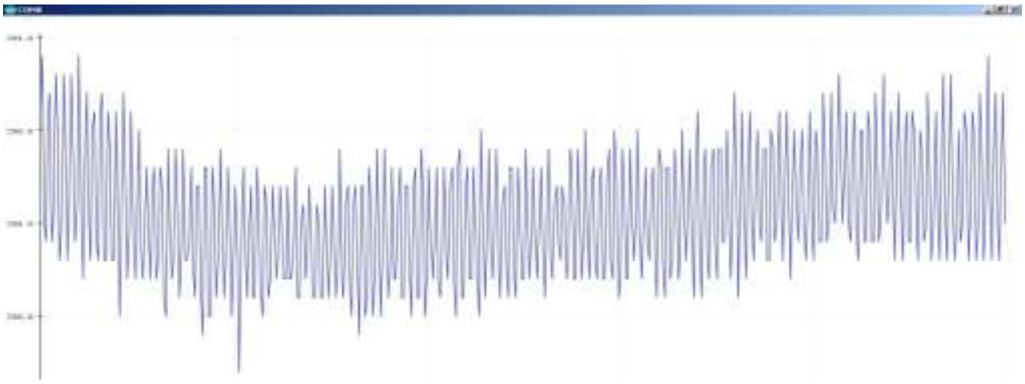

Fig- 3: Normal state value (at 0 angle) of flex sensor 2

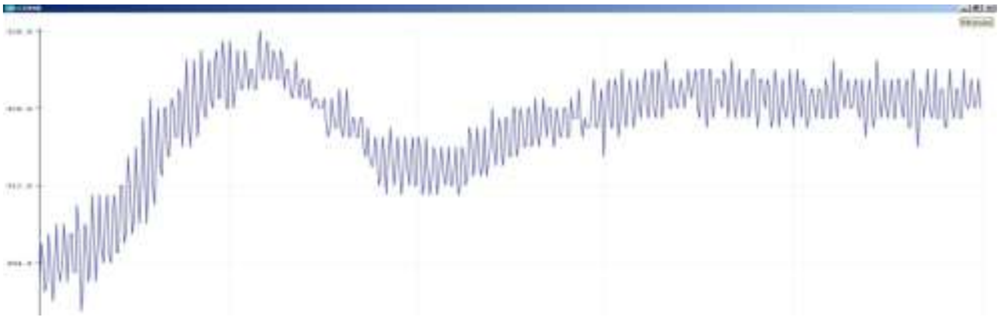

Fig- 4: Flex sensor 2 bent at 90 angle

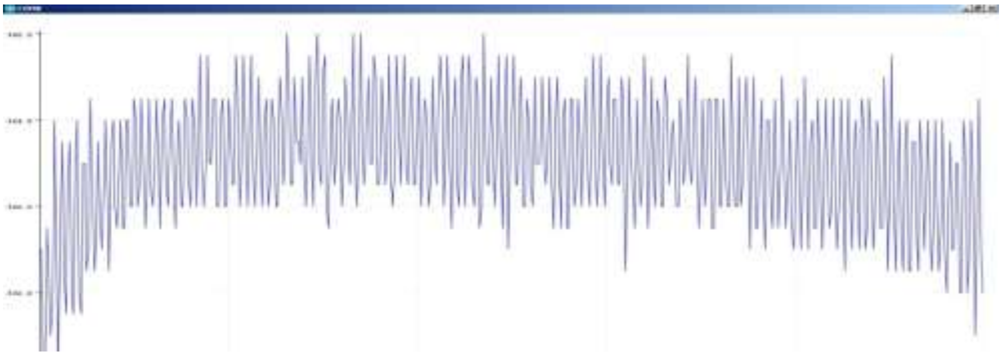

Fig- 4: Flex sensor 3 bent at 180 angle

The following is the set of data value in analogue form in the Normal state:

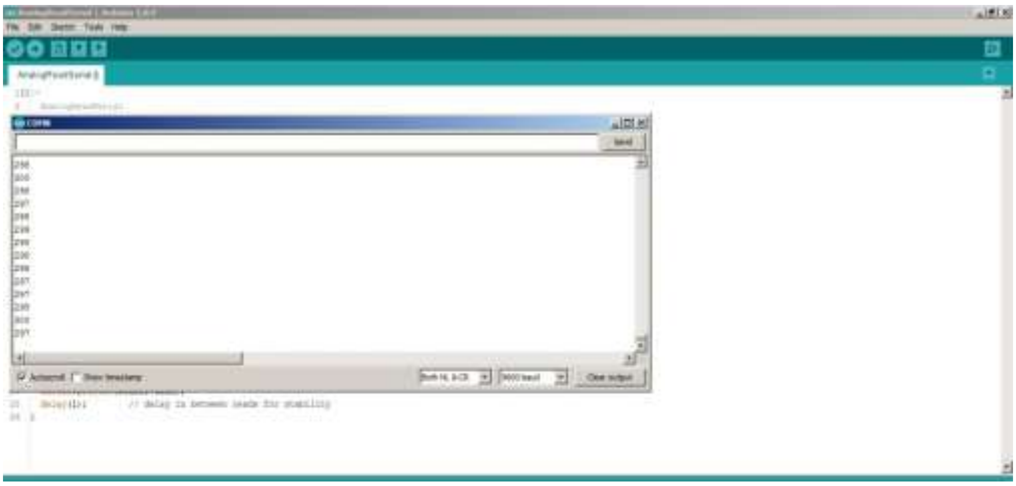

Fig- 4: Analogue values at normal state of flex sensor 2

5. CONCLUSION

In this Paper, Human Activities, that needs to studied before and then tested along the software thus produced, have been recognized successfully. This paper work finally presents the research in the field of Artificial Neural Networks and Internet of Things that will merge both these technologies to produce the output to its optimum value. There have been previously many works done but those were not producing the accuracy and were consuming a lot of effort from the customer. The modularity that is provided in this research work has taken this project to newer heights of understanding the informatics used and simplify things for the required customers. Under the modularity section, one can use the produced code for more than one patients i.e. if the readings for one of the patient are recorded at one time in that system, they can be easily saved for future use along with that, we can modify the required code and values for the new patient that comes to use the product according to his needs. The flex sensor can take any number of different inputs according to the permutation and combinations of the hand movements. The further extension of the project can be done by placing more high range Bluetooth devices or connecting the whole project to the network so that this project can be taken to the smartphones in the form of applications that can be reached to view the progress and improvement in the patient. So, the kind of algorithm that has been implemented in this project can be easily extended to further modifications.

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