RECOGNITION SYSTEM USING MYO ARMBAND FOR HAND GESTURES - SURVEY

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Abstract - *In previous years, the recognition system for hand gestures has been researched greatly as it has the ability to communicate and connect with any IoT device fruitfully with the help of the Human-computer interface. This paper presents an overview of the recent recognition systems using Myo armbands for hand gestures. Common methods used in the recognition system for hand gestures of the referred papers are listed in this paper. A summary of the recognition system for hand gestures with methods, databases, and algorithms used with the aim of the paper and some drawbacks and future work are mentioned.*

KEYWORDS: U-Net, CNN, ANN, RNN, Deep Learning, Myo Armband.

1.INTRODUCTION

The recognition system for hand gestures aim is to implement a natural interaction between humans and computers in a way in which the registered gestures are used in controlling the robotic system or transferring useful information. This research is useful for people who are suffering from hearing loss and people who can gain a helpful way to use input gadgets to obtain peak-level of accuracy while maxing out the convenience at which the users make use of it. As they rely on hand gestures for communication they have to be able to convert any gesture-based language into a text form with the help of recognition gadgets that are used for translations. [1] The Myo Armband for controlling the gesture is one of the few devices used in identifying Hand gestures that usually represents the user's intention to act upon or achieve specific behaviors using devices equipped to the arm to easily capture the data and interpret them. [2]

This device is a new approach to the process of human-computer interaction (HCI) tool that is implemented to capture the forearm's muscular activity of the person its equipped to and then interprets the gestures of the fingers, hands, and arms by analyzing EMG (electro-myo-gram) signals of the muscles.[3] In this, they use EMG sensors for the effective capture of EMG signals.[2][3]

According to the data collected by World - Health - Organization, the values of people suffering due to hearing-loss is approximately more than 1.5 billion people (nearly 20% of the human population in the world) live with hearing loss in 2022, 430 million of them have disabling hearing loss. It is expected that by 2050, people diagnosed with hearing loss may cross 180% of the current cases.[5] The number was 278 million in 2005.[4] Hence, the requirement of a recognition system for hand gestures that the hearing impaired may use to easily express their thoughts, feeling, and knowledge instead of verbal communication is important. In these studies, it has been shown that it is not efficient to construct a basic EMG-based recognition system for hand gestures as the problem is complex because of the various gestures being used, and EMG systems having multiple electrodes.[8] Thus, to build an efficient solution, algorithms/methods of machine learning or deep learning are used to interpret the underlying pattern of the signals to recognize hand gestures automatically. To accomplish such a goal, k-Nearest Neighbor (kNN) [8], Decision-Tree algorithm, Support-Vector-Machine algorithm (SVM) [6][8], and Artificial-Neural-Networks algorithm (ANN) [8] are employed as they are effective in this process. This method can even be of use to the movement of the prosthetic hand with the attachment of the Myo armband to the arm that helps control gestures of the dexterous prosthetic hand by using arm muscles data.[7][13] The data used is tested by a 10-fold cross-validation method to compare the learning algorithms with each other("which are as follows Random Forest[1], RBF-Network[2], Neural-Network[3], Naïve-Bayes[4], KNN[5], NB-Tree[6], J48[7], and Decision Table[8] that can be some of the algorithms"). This is done to obtain the data for the Myo armbands to be trained to recognize.[9] Recent studies have explored supervised learning-based methods, such as CNN (convolutional neural network) and RNN (recurrent neural network) to implement the HCI (Human-Computer Interaction) device.[10] We can make use of deep-learning techniques for feature extraction to be done automatically and classification is also done the same way.[12]This method of recognition is utilized in a variety of topics that includes the recognition of sign language, prosthesis control of the human limb or arm, controlling the robots, and interfaces used in games/VR.[13]Currently, in 2020, using Photoplethysmography to recognize the data of hand gestures.[14] Then U-net was used for hand image processing to recognize the gestures more accurately with respect to hand movements.[15] The UNET architecture can be used to access the semantically segmented mask of the input, which is then given to a VGG16 model for classification.[16]

2.COMMON STEPS IN RECOGNITION SYSTEM FOR HAND GESTURES:

2.1.Preprocessing the data

This method starts with the identification and analysis of signals by calculating the absolute value in its channels by using every value [12]. This process is done to cancel out any noise present in the sample obtained. In order to gain the proper data to train we use certain methods to filter the noise in the image or any data obtained.

2.2.Feature Extraction

A feature is an attribute of the observed process. Using this process, the above mentioned algorithms can easily perform classification [14]. The best way of feature extraction can be done with a proper segmentation method which can lead to successful recognition.

2.3.Classification

After using the method of feature extraction, a certain group or set of feature(s) may degrade or may add no value to the classifier performance, then this may lead to obtaining a good measure for feature selection by classifying the number of times a feature splits a tree.[14]The algorithms used are described in the summary table section of this paper. As compared, the best classifier algorithm is the deep-learning methods and even the SVM method which yield high accuracy.

2.4.Data Collection:

The data set can be obtained from some organization or from a group of individuals who can gain the required data for the process needed. In the table of this paper, we have listed the survey details that are used by different researchers.

2.5.Recognition:

After the analysis of hand images used as input, the classification of gestures is used to recognize gestures. This process is done with the proper selection of attributes or parameters and a suitable algorithm for classification. Here, the analysis of the recognition system is done to check the accuracy of the model [12].

3.AREAS WHERE WE USE THIS SYSTEM

This system was applied for various applications in multiple areas of expertise, as mentioned in [1][4][6][7][10] including; translation of hand signal language, VR-environment, control of robots, in the medical field, etc.

3.1.Recognition of Hand Signal Language: Since hand signal language is used for communication, it is effectively researched [1]. There are numerous systems to recognize gestures for various types of signal languages that are used [4]. For example [1][4] ASL to be recognized, use a model with that feature.

3.2.Control of Robots: Being able to control the machine with the help of gestures is one of the best applications of this system.[6][10].

3.3.Recognition of numeric system: Recognizing numbers with the hand gesture is another application.[8] For example, the way to recognize the number used in the signal languages.[8]

4.MATERIALS REQUIRED

4.1.Myo Armband

This is the device that the recent papers used in the recognizing systems used for hand gestures to be recognized with EMG. The figure below shows Myo Armband, is a digi-device produced by Thalmic Labs. It has 8 EMG sensors. This component has an Inertial-Measurement-Unit (IMU).

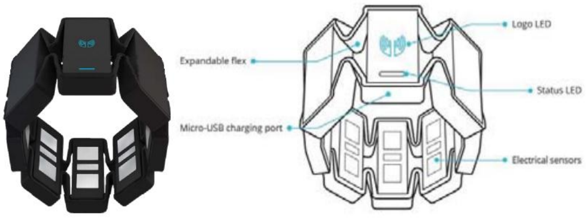

Fig.1. "Myo-armband"("by Thalmic Labs")

5.SUMMARY TABLE

PAPER	Algorithms Used	Test Data Set ----------------- Database used	Level of Accuracy Obtained
[1]	1.MAST (combination of MAST and Dynamic random forest)	3000 gestures for testing -------------------- American Sign Language(ASL)	89% - 93%
[2]	1.cross-correlation coefficients (ACCC) 2.k-nearest neighbor (K-NN) 3. support-vector-machines (SVMs)	Own dataset obtained through 6 volunteers Divided into 24.866 samples	79% - 81%

[3]	1. Artificial neural network(ANN) 2. Kohonen SOFM (self-organizing feature map) 3. adaptive fuzzy k-NN classifier (AFMC) 4.SVM 5. Recurrent Neural Networks (RNN)	1106 test data	60% - 90% 76% - 83% 96.6% 70%- 100%
[4]	1.Support - Vector-Machine (SVM) 2. Ensemble Learning (Bagged Tree)	5200 gestures Of which 4050 used for testing ------------------- Based on American Sign Language(ASL) own database	60.85% 80%
[6]	1. Support - Vector -Machine (SVM)	Size of data 400	84% - 92%
[7]	1. Support - Vector -Machine (SVM)	50 gestures for testing With 9 repetitions	50% - 97%
[8]	1.k-Nearest Neighbour 2.Support Vector Machine (SVM) 3.Artificial Neural Networks(ANN)	Number data set from 0-9 in TSL database i.e., 10 gestures and 55000 data points	87%
[9]	1.Naïve Bayes, 2.Neural Network, **3.RBF Network**, 4.K-Nearest Neighbor, 5.NB Tree 6. J48, 7.Decision Table, 8.Random Forest.	562 samples	61% 52% - 53% 62% - **64%** 52% 53% - 55% 51% - 53% 53% 55% - 59%

[10]	1.convolutional neural network (CNN) model with deep Q-Network(DQN) 2.long short term memory (LSTM) model with DQN	3 gestures, Each has 30 training data and 20 test data Total 90 training data and 60 test data	98.33%
[11]	1.Kalman filter algorithm 2.the neural network classification	30,361 data set from different operator's hand activities. 60% is used as training data randomly.	99%
[12]	"Deep-learning techniques" 1.convolutional neural network (CNN) 2.Artificial Neural Networks(ANN)	5 gestures, 37200 samples data set, 7500 samples were used for testing.	85.08% ± 15.21%
[13]	1.Artificial Neural Network (ANN), 2.Support Vector Machine (SVM), 3.k-Nearest Neighbours (k-NN), 4.Linear-Discriminant-Analysis (LDA) 5.Random Forest	5 gestures, 7800 total data, 200 in a sample Test data 39 used for each gestures.	94.8%
[14]	1.Support Vector Machine (SVM)	4 gestures, 775 data samples, 77% for training and rest is for testing.	92% - 95%
[15]	1.deep learning models 2. "Deep-neural networks" like U-Net, Seg-net, FCN.	Two different datasets: 1.Egohands 15000 images 2.GTEA 4800 images are used. 70% data for training, 20%- validation and 10% -testing.	98% - Egohands, and 90%- GTEA

[16]	1.CNN-based 2.FCN 3.U-Net	Brazilian Sign Language database, with 9600 images	98.97%

6.DRAWBACKS AND FUTURE WORK

As the systems are in the process of being improved further, they are usually expensive and complex [7]. Another drawback to check for is the recognition done by a single hand and check for overlapping images and blurred images. The EMG signals vary from one to another; it changes from one particular time to another in the same person [12]. Dynamic gestures can be used for different orientations [13]. There can be further potential advantages of adding an accelerometer to the developed band [14]. The drawback of U-Net is the time taken to train it is huge. So for larger images, more GPU - memory is needed [15].

7. CONCLUSIONS

The process of data obtaining and the process of selection of algorithm which is for gesture recognition may rely on the research being done and the application needed to establish that as one of the working model. In this survey the areas of recognition system used for hand gesture which is presented in papers are discussed. Explanation of recognition system drawbacks, detail survey on recent recognition systems using Myo armband for hand gestures. And deep learning algorithms, U-net based recognition system for hand gestures are presented. Summary of recognition systems for hand gestures are listed in a tabular for with results, methods used, algorithms used and the aim. In most cases as the summary the commonly used algorithms like SVM, U-Net, Seg-net, and FCN yield most accurate result of recognition. Thus, the recognition system for hand gestures provides an interesting interaction domain in various computer applications.

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