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A Comprehensive Study of Lip Controlled Human Computer Interface using Machine Learning

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ABSTRACT: Human Computer Interface is just a way to connect user to the computer who are unable to interact with computer (physically) as a normal user. These users can have some physical problems or they are physically challenged so that they are not able to interact with computer system i.e. they may be the physical disorder like Tetraplegia. This paper focuses on the use of lower lip used for input device instead of thumb, fingers or even hand. Working with lower lip is just same as that of thumb throughput. This will helps for the future researches to use lower lip to operate on the input devices.

Keyword: Human Computer Interface, Machine Learning, Feature Extraction, LCS.

I. INTRODUCTION

We are going to work on the concept of Human-Computer-Interface using Bluetooth controlled joystick operated by the lip. In this, people having a disorder due to paralysis in case total loss of use of all four limbs can operate on input devices using their lower lip same as other use their thumb to operate on input devices. This comes to be a better option for the physically challenged people to access the computer system. Because of this ease for the physically challenged people to have an interaction with computer system we called it as Human-Computer-Interface. Basically, Interface used for communication between Human and Computer is just use for enhancing information flow using the minimum efforts. Efforts may either physically or mentally which are required to use it. [1],[2].

This technology have various other alternatives to interact users to the computer system, they may be like Eye Tracking, Cheek Controlling, Electromyography (EMG), non-invasive brain-computer interfaces, mouth control, head control [3],[4] etc.

In these above alternatives, one is sip-and-puff which is mainly used for operating power wheel chair[5],[6] for the users having a disorder called tetraplegia. But in sip and puff, we can move only in four discrete directions. It is difficult to use also.

In chin control system, a joystick is provided as a moving input device which helps the user to move freely, and it is operated by chin. This proves to be a better option for the users having tetraplegia in comparison with sip-and puff. Chin control and head control same in many cases depends on the movements of the neck region. In this, only the head should be move freely in all directions and remaining body will be fixed. This condition is provided by the Power wheel chairs but vibrations occurred during the drive or body spasms can generate the false commands results in wrong movement in wrong direction. Chin control is completely based on joystick provided which is controlled by the chin. User can control only wheel chair but outside it user has no control because of the equipment given on wheel chair structure.

Muscles of the lips are directly connected to the brain and controlled by facial nerve. So, people having problem of Spinal Cord Injury SCI [7],[8], had not to worry because there is no connection of lip to the neck and it is independent of neck movements therefore it is the best option for these people to interact with the computer system by lower lip as it is run by the nerve of face and instantly connected with mind. This ground-breaking research is completed for the use of people having tetraplegia which is discussed in paper which specify outstanding possibility.

II. EASE OF USE

The given lip commanding system is a interface between human & computer which have a head mounted device i.e known as headset and a device called joystick situated opposite to the lower one lip. The researches to build up model presents that the lip control have to be mounted on head as to catch the movements of muscles of the lip . The joystick, like a communication technique, had been selected as this is simple to operate on, makes available instinctive control, which is well-matched to movements of lips & was broadly recognized.

Several other significant properties of the controlling the lip movement are given below:

A) Lip Control System is controlled and run by the lip (lower one), which is an outer part of the body, and also it has less issues regarding to hygiene;
B) LCS permits smooth freely movement for all directions because LCS is controlled by a device called joystick;
C) LCS is person's individual system which can exist with open mouse or either on a Wheelchair, a simple chair, a bed, etc;
D) LCS stays away from fake instructions deriving from vibrations of wheel chairs.

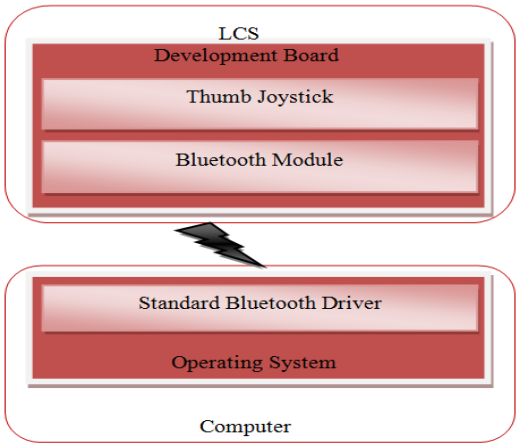
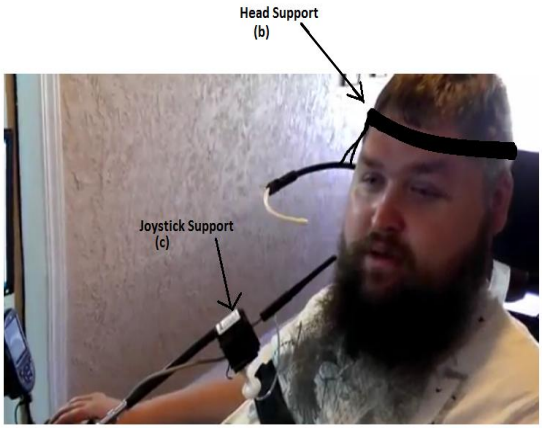


Figure 1 (a) LCS Architecture (b) Head Support (c) Joystic



III. ARCHITECTURE OF LCS & ITS IMPLEMENTATION

The hardware of LCS resides of a board of development, a thumb joystick, and a Bluetooth module, Fig.1 (a). This structure is organized like a standard mouse (having Bluetooth technology) with a person interfacing device(PID). Every communication take place just like using a normal Bluetooth oriented mouse.

The Lip Control System is developed particularly to be run by lip(lower one); The head mounted support, which is mentioned in Fig.1 (b), develop cautiously for giving the mandatory solidity throughout function; the joystick support mentioned in Fig.1 (c), progressed to be double and to give measure of angle & length for the adjustment of the joystick in accurate functionality location. Multidirectional Tests corresponds to the support vector machine of machine learning were done to select the response of joystick having better throughput result.
The complete headset template has weight of approx 150 g, inclusive of joystick with the cable required to connect with joystick. There is a cable (USB) which is attached with the computer system only for providing power throughout those tests as these templates don't have any battery.

IV. FEATURE EXTRACTION

Descrete Wavelet transform

The wavelet transformation was mostly used in within the field of signal processing wavelet properties of scalable window allow pin pointing signal components. These properties allow the extraction of the component for different shifted function in the time domain. Wavelet scanning permits all information of the signal while small shows signal detail by zooming into signal components.

All signals generated through joystick movement by the lower lip are to be recorded and transform to wavelet form. The joystick movement generates the signal which is to be elaborated and analyzed by machine learning. Joystick is just as a transformation of mouse Fig. 2(a) to thumb control system Fig. 2(b) and from thumb control system to joystick Fig. 2(c) which is controlled by lower lip Fig. 2(c).

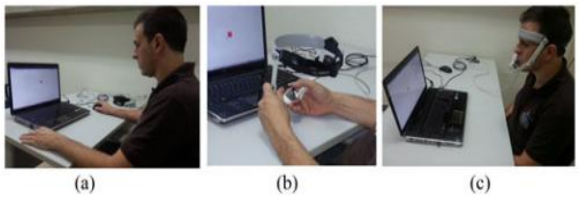


Figure 2 (a) Mouse (b)Thumb Control System (c)Joystick with Headphone

V. MACHINE LEARNING

Support Vector Machine and Neural Networks learning algorithms were used and provide classification of signal generated form joystick movement by lower lip. First we select the feature from wavelet transformation then it will analyze all movement of pointer and pushing the particular application.

A supervised learning model support vector machine provides the classification of pointer movement onto the screen. Linear classification has the property that minimizes the classification error and maximizes the geometric area. So SVM is called Maximum Area classifier[9].

SVM is used for linearly separable binary sets that to design a hyper plane that classify all training vectors in two classes. The best choice will be the hyper plane that leaves the maximum margin from both classes.

For the classification of all four moves neural network is to be used. Now generate the three layers for NN. First Input layer provide input pattern that would be classify and passed to a hidden layer then passed to output layer and generate output pattern. It is called feed forward neural network. In each layer we have one or more elements for processing. Parameter weight assigned to each element associate for processing [10].

The simplified process of feed forward neural network is associated in each layer Fig.3.

1. Input data is propagated through the input layer to the output layer.
2. The final outcome is compared with actual output to find error value.
3. The neural network then uses the support vector machine to train the data.
4. The forward process start again and this cycle is continued until error is minimized.

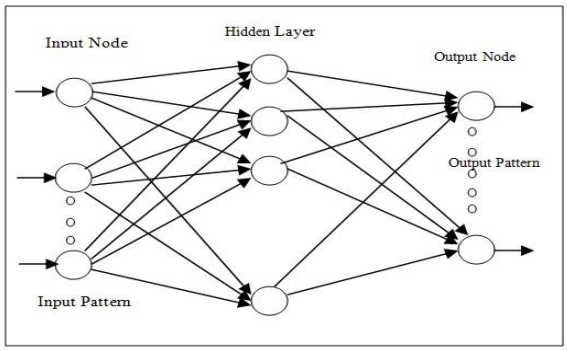


Figure 3 Artificial Neural Network

As shown in Fig 4 the NN and SVM classifier will created with some inputs the output of SVM is used to enable the NN and classify all four movement and one of the push operation.

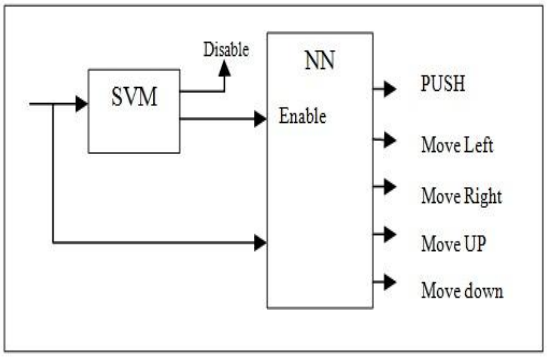


Figure 4 Hybrid Machine Learning System

VI. PROCEDURE TO CONTROL JOYSTICK MOVEMENT

As shown in Fig. 5 there are four operation of joystick which is used to provide the input for pointer movement and one push button for generating the command to perform a particular action[11].

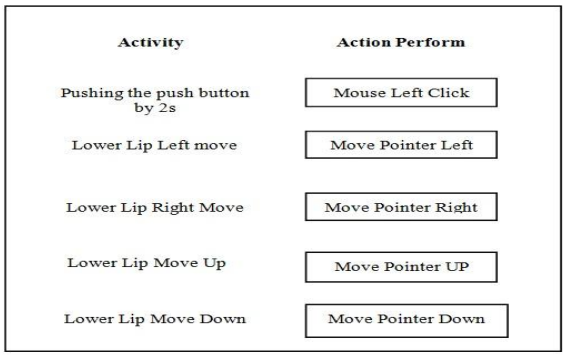


Figure 5 Joystick Control System

Time Required For The Movement

As mouse pointer or any pointing device has the time required for animation explained when using the mouse button of a target object and on the button screen. Joystick is also required time to point out any object but it will be perform using lower lip so it is to be proportional to the time required as per mouse.

The time of movement cannot consist of the period between the next targeted object activation and the moment when the cursor enters the area under new targeted object area (starts a new time) is defined as the movement time, only under the condition, cursor stays in the targeted object area. The x, y position is recorded to compute the effective distance D and effective width W, in the bases cases, the beginning and the end of movement time.

VII. CONCLUSION AND FUTURE WORK

This paper represented an assessment to control joystick using lower Lip. The person who is suffered from paralysis and four limbs are not in a normal condition can interact with computer using head mounted joystick. We have all four moves left, right, up, down operation and one pushing operation, the signal is transmitted into the computer that can be classified using the SVM and NN.

The joystick will present its potential to have control on human computer interface. We have to find out the x, y position and the movement of the pointer to determine the final joystick event.

These outcomes cheer us to amplify the use of joystick to other applications (for example wheel chair), researching the use of other input devices that can have better throughput than the joystick or to introduce a other input device specifically developed and controlled by the lower lip.

We have two new ongoing duties.

1) Enhance development with a little trackball using machine learning which would replace the joystick.

2) Assessing the Lip Control System using machine learning to keep control on power wheelchairs.

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