Application of the Device of Measurement of Bioelectric Activity of Muscles and Nerve Structures for Gesture Recognition

Application of Gesture Recognition on the Example of Action Game

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Abstract: Using the device bioPlux we can identify a set of user gestures, and based on them to create a multimodal interface. Gestures are selected so that they are not dependent on each other. The main goal of the research is to create a simple game which can be controlled by using different hand movements. Relevance of the topic from the practical point of view is determined by the need to create a software system that can use sign language interface in real time.

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1 INTRODUCTION

1.1 Relevance of the Topic

Currently, research and development of human-machine interfaces based on pattern recognition and visualization of multimedia information is leading edge in the development of modern software. The developers of these interfaces are interested in natural ways for people to communicate with computers using gestures, voice and other modalities. Gestures are particularly promising for building interfaces to control software and the hardware of computers, robots, to empower the interface for people with hearing problems and speech disorders. Relevance of the topic from the practical point of view is determined by the need to create a software system that can use sign language interface in real time. The advantages of this system compared to the system of pattern recognition is a higher accuracy.

1.2 The Purpose and Objectives of the Research

The aim of the research is to develop a common methodology for capturing, tracking and gesture recognition of the arm movements in the real time with high reliability to create a human-machine interface based on bioPlux device.

To implement this goal, the following objectives:

- Carry out a comparative analytical review of existing methods of capturing, tracking and dynamic gesture recognition of the human.
- Develop a computationally efficient algorithm for capturing and tracking and gesture recognition using a device bioPlux.
- Create a real-time system that uses these algorithms to dynamically change its state depending on the user's gesture.
- Conduct experiments to assess the reliability and efficiency of the system in real time, confirming the theoretical results.

1.3 Description of the Device

BioPLUX device collects and digitizes the signals from the sensors and transmit it to the computer through Bluetooth, where they can be processed. BioPLUX channels have 12 bit and sampling rate of 1000 Hz. BioPLUX also has a digital port, the terminal to connect the AC adapter and charge the internal battery (with the regime of autonomy 12 hours), and a channel to connect electrode (ground), which are necessary for proper monitoring electromyographic signals.

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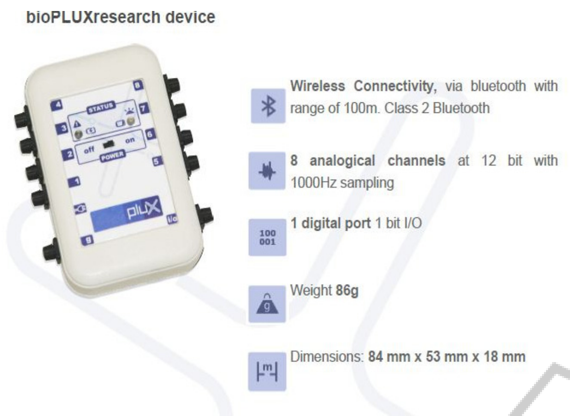

Figure 1: The look and characteristics of the instrument.

2 GESTURE MODALITIES

The scientific interest in the verbal (speech) and nonverbal (gestures, mimicry, touches, etc.) behavior of people during the communication arose only in XX century. The theory of verbal and nonverbal communications for a long time was developed at an intuitive level. Serious scientific investigations of verbal and nonverbal communications began in the 1920s–1930s within the framework of the journalism theory. Psychologists established that a percentage of information transferred by nonverbal signals during the people interaction was from 60% up to 80% [Ekman & Friesen, 1969].

Moreover, most researchers adhere to an opinion that the verbal channel is used substantially for transferring the factographic information while the nonverbal channel is a means of transferring the interpersonal relations and only in rare cases it is used instead of verbal messages. This fact testifies to the important role of the nonverbal information transferred by gestures and mimicry for the people behavior analysis and developing human-machine interface in computer games. For the most part scientific matters deal with gestures performed by hands.

Generally, a gesture is the sign unit carried out by human body parts consciously and unconsciously for the purpose of communications. In order to decode the information incorporated in gestures it is needed to define their classification. Gestures are subdivided into natural and artificial ones. Natural gestures are inherent in a person by nature or are produced by the humanity during the evolution. Gesture classifiers describe images and senses of gestures to use them with a high degree of adequacy.

It should be noted, that all positions are connected with knowledge of environment properties in which the gesture is made or with knowledge of the context accompanying the gesture. And many cultures interpret the same gesture completely in a different way. Moreover, the frequency of gesticulation (a number of gestures made per unit of time) in West Europe is higher than in Russia, but gestures of West Europeans occupy less space, than those of Russians as West Europeans gesticulate with elbows pressed to the body. West European gestures do not intrude at all in the personal space of the interlocutor. As against the Russian tradition, in West Europe symmetric gestures prevail, a handshake is less long, than that in Russia, and gestures are made by the half-bent arm, instead of the outstretched arm as in Russia.

3 RECEIPT AND PROCESSING OF SIGNALS

With a special API we have created software that allows getting real-time data from sensors attached to the hands of the user and, after processing and recognizing, change the status in the software.

To select the suitable gestures for recognizing, we have made a series of experiments. We identified five independent unconnected gestures associated with the work of different muscles, or a superposition of their work. After that, we have chosen two gestures, which are used in our gaming application.

Those gestures are:

Normal state of the hand:

Figure 2: Normal state of the hand.

Hand in fist:

Figure 3: Hand in a fist.

But how have we analyze all the data, coming from device? 1000 Hz means 1000 values per second – and it really a lot of information. First off all, we have made thousands of measures and saved all values to different files. Then, we analyze each file to find maximum and minimum value. Next – we have found those gestures, that are independent to each other on the same channels.

How is our sample application works? There is a ball on the screen. When user rotates his or her hand, the ball starts the movement. When user clenched his or her fists, the ball starts jumping.

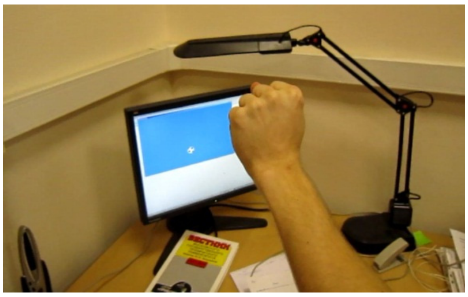

Figure 4: Hand in a fist – ball is jumping.

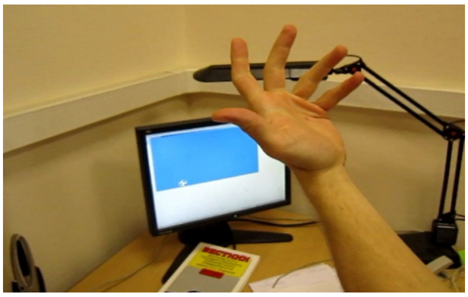

Figure 5: Rotated hand – ball is rolling.

4 THE RESULTS OF THE SYSTEM

This section presents data about the accuracy and reliability of the developed system. To test the system we have conducted a series of experiments. In these experiments, the user controls the movement of the ball with the help of special gestures. We evaluated the accuracy and reliability of the gesture recognition. Data illustrating these experiments are shown below:

Table 1: Accuracy of the system.

Data	The total number of tests	The number of false measurements	Percentage of successful recognition
Data for the right hand	500	0	100%
Data for the left hand	500	2	99,6%

Table 2: Reliability of the system.

Data	The total number of tests	Number of failures in the system	Percentage of stable system operation
Data for the right hand	500	3	99,4%
Data for the left hand	500	1	99,8%

5 CONCLUSIONS

Have been solved the problem of dynamic gesture recognition of human right and left hand. Shows the experimental evidence of high accuracy, stability and speed of the system. In the future we plan to add other gestures for recognition and more advanced graphics to create full biofeedback system.

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