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Control of a powerpoint presentation using eye movements

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***Abstract*—*The purpose of this paper is to present a system capable of helping a person to control the slide shows during his/her presentation without the use of his/her hands. In fact, a particular movement in the eye will allow a change in the slide (towards the next or the previous slide). To do so, some electrodes were used in order to record the eyes movements and some electronic circuits as well as a microcontroller were deployed for recognizing the eye movement signal from the noise in order to limit any faulty signal. A wireless signal is sent to the computer in order to move the presentation up or down. The system was tested on several persons while taking into consideration the age, the skin color, the fatigue, the quantity of light, the use of glasses / medical lenses and the results were very promising especially with the hitting percentage that reached more than 90%, which means, in other words, that the error percentage was less than 10%.*

Keywords—Embedded system; EEG system; Electrodes; Microcontroller; powerpoint presentation control; analog filters;

I. INTRODUCTION

The control of a power point presentation is sometimes difficult for people with some movement difficulties or when the computer is placed far from the presenter. Added to that, lots of persons usually use both hands when explaining their ideas which render this tough to handle, in their hand, a remote control during all the presentation.

Lots of researchers were interested in developing tools to help controlling a presentation automatically. From among these researchers, we list the work of *Otsuki* et al. who designed a new method to control presentation in hybridcast [1]. As for *Hsu* et al., they presented a new technic for a multimodal interactive control system in a museum [2]. Concerning *Suta* et al., they implemented a novel way for presentation using tablet PCs in classrooms or meeting rooms [3].

As for the applications deployed using eye movements, they are also numerous and they are mostly developed for paralyzed persons or for those with movement difficulties. In the following, we will list some of these applications: automatic control of a wheelchair by some eye movements [4], control of computer cursor [5], development of a communication supportive device for patient who have motor paralysis – and therefore can not talk [6], implementation of real time text speller [7] and much more,…

Hence, the aim of this work is to include these two features in order to create a wireless system to control the PowerPoint presentation by some eye movements. In fact, some eye movements may be sufficient to control the slide show in a presentation. Two main signal must be recognized: one to move the slide forward whereas the second is to move it backward.

As for the main constraints of this system, they can be resumed by the following: system must be portable, small in size, light weighted, harmless, easily implemented and used, have affordable price and could be extended to control more advanced systems.

So, based on the above, this paper will be organized as follow: in section 2, some important information about the eye physiology, the electroencephalogram (EEG) and the electrodes will be provided. Section 3 will present the hardware tools needed for the implementation of such system. Section 4 presents the microcontroller as well as the implemented code. In section 5, the whole system will be proposed along with the obtained results. This paper will be summarized in section 6 and some future works will be also projected.

II. EYE PHYSIOLOGY AND APPLIED TOOLS

A. Eye physiology

As proposed by *Litzinger*, the eye is a tiny organ composed of structures that work with respond to others. For example, during its movements, the contraction of the muscles, the dilating, and the narrowing occur [8]. This results in a variation on the electric voltage measured at the eyes boundaries.

Noor et al. presented, in the article entitled “Study the different level of eye movement based on electrooculography (EOG) Technique”, the effect of different levels of eye movement strength on the EOG signal. They found out that the values of the EOG range from 0.05mV to 3.5mV and the frequencies vary from 0 to 100 Hz [9]. The sensors are placed as shown in figure 1. Base on this figure, one can record the five eye movements: up, down, left, right and blink.

In order to measure the left and the write movements, one can measure the voltage difference between HL and HR. as for the up and down movements, the measurement must be made between VU and VL.

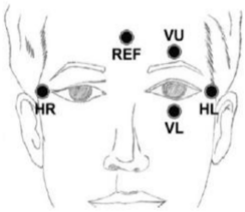

Fig. 1. *Position of the sensors when monitoring eye movements*

B. *Biosensors*

Biosensors are sensors connected to human body. Special attention should be attributed to these sensors as being non invasive and with no secondary effects.

Two types of biosensors exist: the needle electrodes which require a medical professional to insert them and the surface electrodes which can be mounted by any person but they present lots of noise in the delivered signal.

Once again, as our main target is to develop a low cost system, we have used the surface electrodes that require the insertion of a conductive gel between the skin and the electrode to limit (without eliminating) the noise effects. Figure 2 shows the used electrodes.

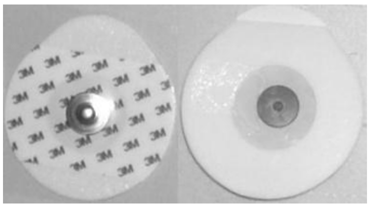

Fig. 2. *Position of the sensors when monitoring eye movements*

C. *Electrophysiological system*

In order to record the eye movements, the EEG (Electroencephalogram) and the EOG (Electrooculogram) can be used. Although the very accurate results both systems deliver, the cost of using such systems is very high. Added to that, the features found in these systems are very developed and will not be used for our system.

Hence, we decided to do our own system that will consist on capturing the values coming from the biosensors and processing the signal as shown in figure 3. The design of the electric circuits needed to do the required tasks will be defined in details in the next section.

III. HARDWARE DESIGN

A. *Block diagram*

Figure 4 shows the system which is based on three parts:

- the biosensors which read the eye movements and transform it to electrical voltage;
- the processing and transmission circuit which captures, processes, analyses and transmits the commands to the PC via a Bluetooth communication;
- the PC where the powerpoint presentation is running;

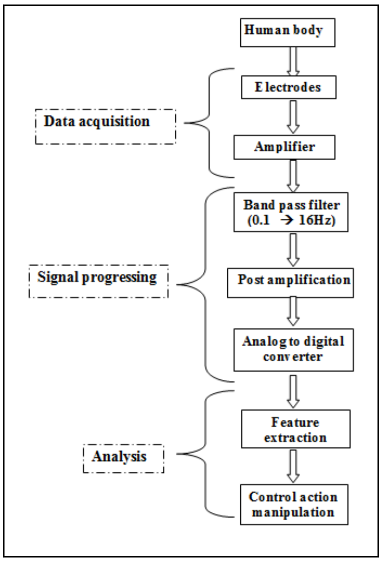

Fig. 3. *Flowchart for the signal processing method*

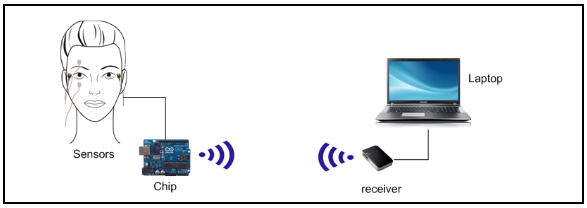

Fig. 4. *Interconnections of the microcontroller.*

B. *Analog filters*

Once the signal is captured from the electrodes, its value is in the range of few microvolts. The first step, as indicated in figure 3, is to pre-amplify it. A high amplification would damage the original signal and would not allow recovering the part coming from the eye movement. Hence, amplification by a factor of 50 was used.

The second step of this process required the use of a band pass filter to filter the signals whose frequencies range between 0.1 and 16 Hz. To do so, the cutoff frequencies used were at 0.01Hz (for the low cutoff frequency) and 35Hz (for the high cutoff frequency). A Sallen Key filter was used whereas the filter order is 8 (second order for the low pass and sixth order for the high pass). The gain of this filter is 10.

As the applied gain is still not sufficient, a third step was deployed in order to post amplify the filtered signal. This stage gain is 50. Thus, the system overall gain would be about 25.000 which will allow to have an output signal in the range of hundreds of millivolts.

This signal will be then transmitted to the microcontroller through its AD module in order to convert it to digital signal and to do further processing.

Note here that although a high selective filter was used with very accurate electrical components (for example, the AD620 operational amplifier was used for the pre- and post-filtering as this integrated circuit is known for the low noise ratio it delivers), the output signal is still noisy. A comparator could have been used in order to identify if the user has made a blink or the eye were moving but we have chosen to use the ADC feature of the microcontroller.

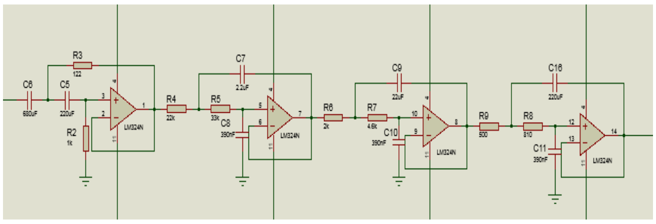

Fig. 5. *Electronic circuits used to filter the signal coming from the electrodes*

IV. Microcontroller

Several choices could have been deployed for this application. The cost, the simplicity of use and the size were the major aspects taken into consideration. Thus, the Arduino microcontroller was used for this application. In fact, the Analog to Digital module was used as well as the Bluetooth communication module.

As for the interconnections, two analog inputs are used for the electrodes. In fact, the outputs of the electric circuit are connected to A0 and A1. The difference between these two values represents the voltage output. As for the outputs, the TX/RX pins are used to connect the Bluetooth module whereas pins 2 and 4 are connected to the wireless device that controls the powerpoint (as will be shown in figure 7).

A. Flowchart

This section will be dedicated to show the whole system and to present some results after the several tests made.

As we need two different signals to control the powerpoint presentation (one to move to the next slide and the other to move to the previous slide), we have chosen to use the following two eye movements:

- A long blink (that is identified by the output voltage) to move to the next slide;
- Two consecutive blinks (with a delay less than 3 seconds between them) to move to the previous slide;

A normal blink has an average output voltage (delivered at the output of the electric circuit) of 3.2 V whereas a long blink has an average output voltage of 4V. Thus, we have set 3V to detect a blink movement. If the value is above 3.5V, this blink is considered as a long blink and the slide will move forward. Otherwise, we will be waiting for another blink (without differentiating if it is normal or long) for the next three seconds to move the slide backward.

Note that a special attention was considered especially for the left and right eye movements as the electrode output can't differentiate between these movements. However, the output voltage of these movements ranges between 1.5V and -1.5V as an average, which is far from the values of the blink movements.

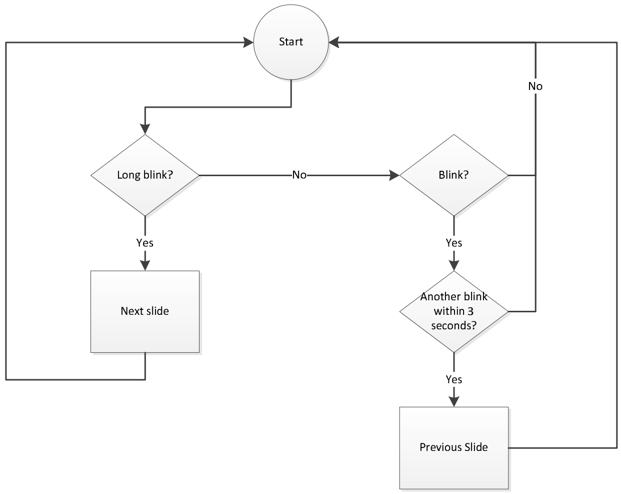

Fig. 6. *Flowchart of the micrcontroller program.*

V. System Assembly

This section will be dedicated to show the whole system and to present some results after the several tests made.

Let's start first by presenting some images from the developed system. So, figure 7 shows the whole system whereas figure 8 presents a person wearing it.

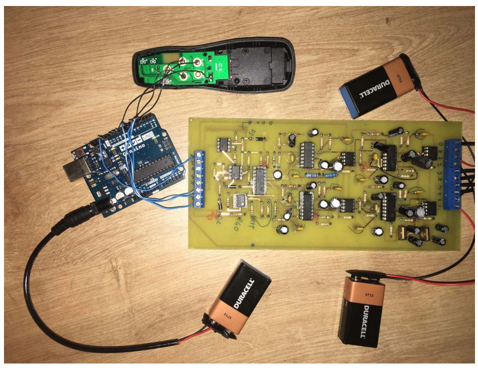

Fig. 7. *Whole assembled system.*

From figure 8, we can recognize that the user is wearing only three electrodes. In fact, as we are only searching for the blink movement, we can place the electrodes at REF, HL and HR or REF, VU and VL. VU or HL are connected to the +Vin of the op. amp., VL or HR are connected to the –Vin of the op. amp. and REF will be connected to the system ground.

Fig. 8. *Photo of a person using this system*

As for the results, the system was tested over 80 persons while taking into consideration the following aspects:

- Color skin (white, corny and black);
- Age (ranging between 20 and 55 years);
- Fatigue (tests made at the morning, at noon and at the night);
- Light mode (dark, medium light, high quantity of light);
- Eyes (wearing medical lenses, glasses, nothing);
- Normal and paralyzed people;

The differences between the obtained values were very small. Hence, table 1 summarized the recorded values of 7 participants.

TABLE I. MEASURED VALUES WHEN TESTING THE SYSTEM ON SEVERAL SUBJECTS

Movements (lightened room/dark room) Subject at rest	S1	S2	S3	S4	S5	S6	S7
Upwards	3.2 V	2 V	3V	1.5V	2V	2.1V	2.1V
Downwards	-1.6 V	-1 V	-2.1V	-1.8V	-1V	-1.5V	-1.8V
Right	2 V	1.2 V	1.8V	1V	1V	1V	1.5V
Left	-2 V	-1 V	-1.6V	-1V	-1.8V	-1V	-1.9V
Long Blink	6 V	4.5 V	4.1V	2V	4V	6V	3.8V
Normal Blink	3.8V	2.9V	3.4	1.7V	2.7V	3.7V	2.9V

When comparing the obtained values to the thresholds set in the microcontroller, one can see that the considered values work well for all subjects except subject 4 where all output voltages are very low compared to the average voltage.

Added to that, one can see clearly that the difference between the upward (moving the eye up) and the blink is big and both signals can be differentiated.

VI. CONCLUION AND FUTURE WORKS

As a summary, we were able to develop a system, based on some eye movements, to control a powerpoint presentation. This system relays on the use of biosensors (electrodes), an electrical circuit to process the signal coming from the electrodes and a microcontroller to deliver the desired output in order to control the powerpoint. The accuracy of this system was about 90% after testing it on several persons taking into consideration their age, skin color, fatigue, the lenses or glasses they are using and the quantity of light inside the room where the tests have been made.

As a future work, lots of ideas can enrich this work. We will list the following:

- Design of a mask that embeds these sensors in order to facilitate the use of the system;
- Develop a genetic algorithm that could control the powerpoint presentation and which will lead to a lower error percentage;
- Apply the eye movement system on other manual system in order to facilitate the life of humans, especially the ones with movements disabilities;
- Work on developing this system using a smaller size to be handled easier;

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