

REALIZATION OF AN ELECTRONIC DEVICES REMOTE CONTROL SYSTEM BY VOICE AND BRAIN SIGNALS

D. Chogueur¹, D. Boucha², A. Amiri²

¹Sustainable Development & Computing Laboratory, LDDI, Ahmed Draia University, Adrar, Algeria
chog_dji@yahoo.fr

²MI Department, Faculty of Science and Technology, Ahmed Draia University, Adrar, Algeria
djemaabo@yahoo.fr; adrrayoub@yahoo.com

Abstract - The realization of electronic devices remote control system by voice and brain signals is a project that can be used for controlling home appliances or wheelchairs remotely. This system is designed to be used by all categories of people but must particularly be used to assist and provide support in order to fulfill the needs of elderly and disabled people. The main control system implements wireless technology through a Bluetooth module, an Infrared LED, and a radio frequency signal. This system was designed to be of low cost (compared to other projects) and scalable allowing a variety of devices to be controlled with minimum changes to its core. The design is based on a standalone Arduino board and the home appliances are connected to the input-output ports of this board via relays. The project has two parts. The first which is 'voice control' that means using human voice to control any device or motor (in case of a wheelchair). The voice recognition is done in real time using an HMM model. This work provides three applications concerning the voice control, one is run on a window platform and two on an android platform (Home/Wheelchair Voice Control is an application run on a computer while Control Wheelchair and Control Home Appliances are two other separate applications for cellphones). The second part is 'thinking control' that uses brain signals to control the wheelchair under the window platform. These signals are captured using a headset called Epoc+ from Emotiv. Those signals will be converted to actions.

Keywords: Voice control, Brain signals, Epoc, Emotiv

INTRODUCTION

In recent years and with the rapid development of science and technology, the need for an easy life became very important. Throughout this evolution, the human-machine or machine-to-machine communication emerged as a new type of dialogue. Therefore, it will be great to develop, for example, home devices that can communicate between them or be controlled by the home's owner. That is what we call a smart home or home automation. Home automation systems or smart home technologies are systems and devices that can control elements of your home environment [1, 2]. A typical home automation system allows one to control household appliances (lights, fans, air conditioners, television sets, etc.) from a centralized control unit [3, 4]. The project "Realization of an electronic devices remote control system by voice and brain signals" comes to allow people with special needs (elderly and disables) to move autonomously. The project purposes to control home devices or a wheelchair remotely using voice or thinking (mind control) without really changing the home infrastructure.

Talking about voice control means discussing the recognition process in real time. The HMM (Hidden Markov Model) is used in recognition. Mind Control is the second part of this implementation. Several programs are written to control different interfaces using Electroencephalography (EEG) data [5]. The brain activity monitoring is a main part of the programs to perform different tasks such as controlling a wheelchair robot or home devices. EEG data is being recorded while users are concentrating on given tasks through a headset

called Epoc+ from Emotiv [6]. Activity on different regions of the brain is measured. Using these measurements, EEG data is classified for different cognitive actions to control the wheelchair.

The project is based on collaboration of computer science and electronics domains. To get the objective, we used an Arduino micro controller (on which are some programs to respond to our needs), which converts signals received from the developed software into actions. We used relays as switches and Bluetooth modules because our platform is based on wireless communication or precisely Bluetooth communication.

MATERIALS AND METHODS

First part: Voice Control

Materials

Wireless communication is often required in fields such as tele-health, household security, industrial safety, home automation, etc. [7]. Bluetooth was selected as the way of communicating computer/mobile with a central system. In this project, the home appliances and the wheelchair will be controlled by a remote system based on Bluetooth; and two operating systems, mobile and computer. The appliances in question are appliances such as lights, TV, air-conditioner, digital satellite receiver, etc. The system can be used to remotely switch on or off any household appliance using a prototype of Arduino Uno to achieve hardware simplicity and a Bluetooth module for feedback from a computer/android device to toggle the switch state [8, 9]. This project realizes a remote control of electronic devices using voice. This control includes home electrical devices and the wheelchair. To achieve this aim, an electronic circuit was developed, which contain Bluetooth module (HC-05) shown in figure 1(a), Arduino Uno as microcontroller shown in figure 1(b), infrared signals transmitter/receiver (to control the TV and digital satellite), relays instead of switches. Those units are linked together and controlled by two devices which are the computer and the cellphone. This circuit powered by an AC-AD supply.

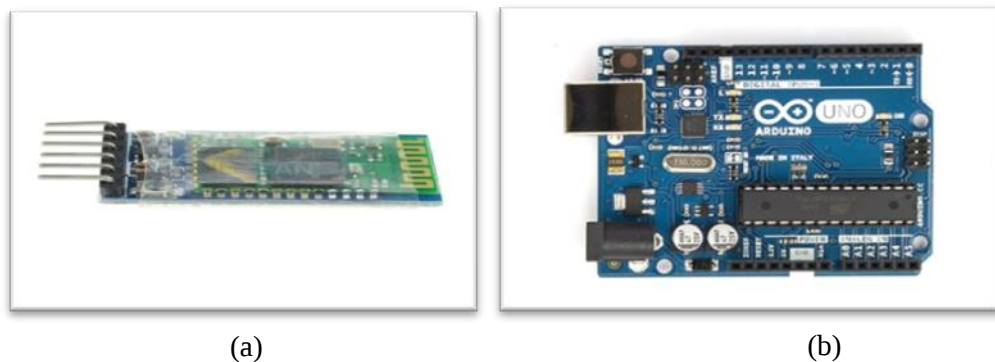


Fig. 1: (a) Bluetooth module HC-05 (b) Arduino Uno board

Methods

The voice control is largely used in our daily life. Therefore, thinking about this technology in order to help some categories of people in society will be great. Voice Control lets you command your device with your voice using your computer or cellphone. Its functions

include activating home appliances, deactivating them, moving the wheelchair in the four directions, and so on. When talking about voice, we directly think of recognition. There are many methods and systems for voice recognition. In this project, a toolkit called Sphinx based on HMM Model is used. This part of project developed on Microsoft visual studio C# for the computer and android for the cellphone [10]. The communication between the programming language and the Arduino is done by exchanging specific messages.

Second part: Mind Control

Materials

The mind control's electronic circuit is similar to the voice one. Just in this part, a new unit has been used to extract the brain signals. This unit called Epoc+ headset (Figure 2) from Emotiv.



Fig. 2: Epoc+ headset

Methods

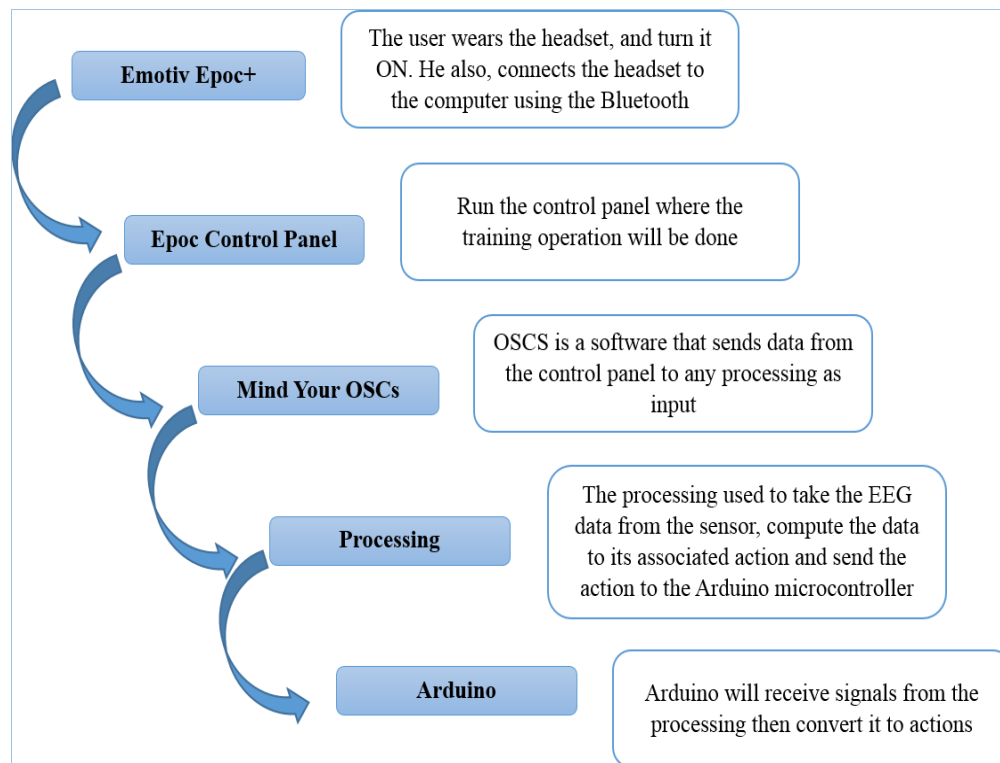


Fig. 3: Realization Diagram

The idea is to allow person to communicate with the computer through the brain wave sensor (Emotive Epoc+ in this case) and control different objects like a wheelchair, a remote control, a car or home devices. The brain signals will be extracted using the headset, then through its panel the train will be done i.e. in the control panel there are many tabs, one of them called cognitive panel where we can associate for each extracted signal a specific action (left, right, etc.). First of all each user have to login to the control panel with his username and password (reasons of security and because each one have different brain signals). The signals and their associated actions will be send to the main system through a mediatory software (Mind Your OSCs). The main system will send messages to the Arduino where the instruction will be converted to real actions. The diagram shown on figure 3 shows this process.

RESULTS

As results, three voice control applications were developed and run under both windows and android systems, and one mind control application run under windows system.

Voice control application

Computer Application

It is set to run automatically when the computer is started. It contains three tabs. The first interface of figure 4 is called configuration tab. When we run the application for the first time, we have to configure the Bluetooth connection [8].



Fig. 4: Configuration Tab Interface

The second tab is a Control Home Devices Interface where we find a set of devices and how to control them.



Fig. 5: Control Home Devices Interface

You can either control your devices using buttons click or using voice control. Using the sound of your voice makes you able to control any devices you want; you just have to say the specific instruction. The table below shows some instructions and their specification:

Table 1: Appliances Control Orders and their meaning

Order	Specification
Ecouter	It is a word key to make the program start recognition; the user has to say it before any other order
Allume la lampe	Turn the lamp ON
Eteint la lampe	Turn the lamp OFF
Allume le démo	Turn the digital SAT ON
Volume plus	Rise the volume of your SAT by 3 units
Volume moins	Make down the volume of your SAT by 3 units
Programme suivant	Change the actual channel to the next one (Example: from 1 to 2)
Programme avant	Change the actual channel to the previous one (Example: from 5 to 4)
Prise ON	Turn the power socket ON; any devices attached to the socket will be ON

The third tab is Control Wheelchair. The user can move the wheelchair in the four directions and can stop it.



Fig. 6: Control Wheelchair Interface

The table below shows the orders of the wheelchair and their meaning:

Table 2: Wheelchair Control Orders and their Meaning

Orders	Specification
Stop	To stop the wheelchair
À gauche	Go left
À droite	Go right
Avant	Go ahead
Arrière	Go back

Cellphone Application

For the cellphone, there are two separate applications (figure 7); One for the home appliances and the second for the wheelchair.

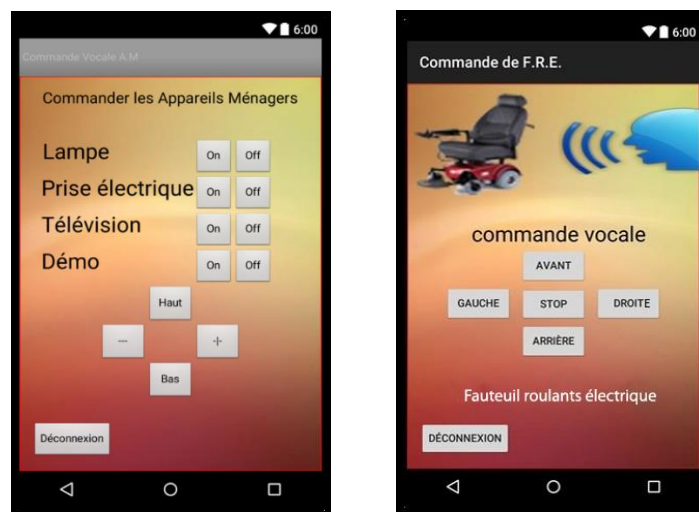


Fig. 7: Cellphone Applications, “Commande Vocale A.M” for home control and “Commande de F.R.E” for wheelchair control

When click on the icon of the application, a Bluetooth connection interface will appear to oblige you to connect with the specific module. Each button explain the instructions used to control either home devices or the wheelchair, for example; “D mo On” to turn the digital satellite (SAT) on, “Avant” to move the wheelchair forward, and so on.

Mind control application

Figure 8 shows the interface of the application witch run into the computer only.

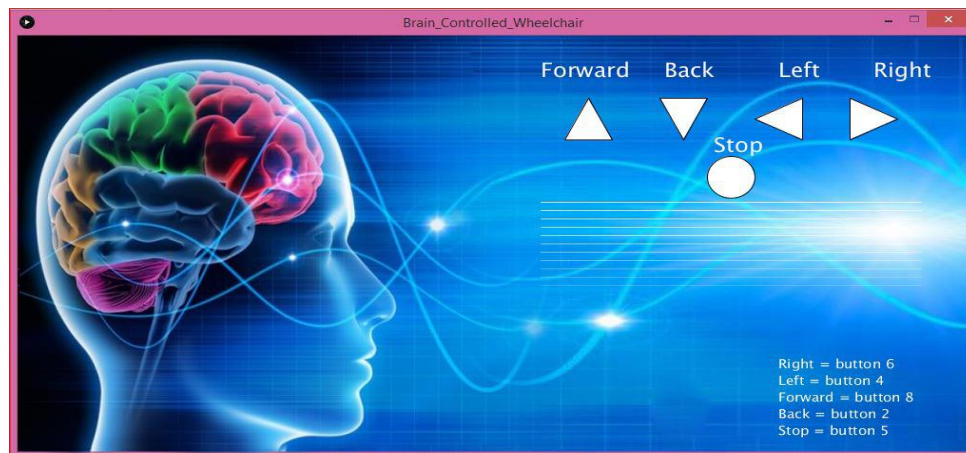


Fig. 8: Control Wheelchair Interface

The user can control his wheelchair by thinking on specific direction, then the wheelchair will move on that direction. In addition, he can move it using the keyboard of his computer, for example, the key 6 to move right.

DISCUSSION

Instructions of Voice control take around 0.7-1.5 second to recognize and execute, where in the beginning of project it was take until 3-5 seconds to execute. About the mind control, It is important to authenticate for security (to save who drive the wheelchair) and because each person has a special brain signals that are different from another one. The results are acceptable, where the error rate is around 0.36 (calculated when try control a smart car using brain signals, between 25 orders 9 was wrong) and execution time for each instruction take between 1 to 5 seconds depending on the level of person’s concentration.

CONCLUSION

The project develop two different types of control (voice and mind) using different platforms and methods and two electronic circuits one for the home and the second for the wheelchair. The project reduces the cost of changing the home infrastructure in order to get a smart home. One circuit can control all home devices with very few external changes on home (for example, light switch will replaced by relays). All the use tools such as relay, Bluetooth modules, etc. are very cheap just the headset, which is somehow expensive. The quality of thinking control depends on the level of concentration. The voice recognition can be done either offline or online.

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