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A Development Platform for the Demonstrator Generation for Research on AAC

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Abstract: This paper presents the development platform EDiTH2. This platform will make it possible to generate demonstrators of man/machine interface integrating some communication modules of AAC. One of the significant items of this platform is the sharing, the integration and the management of modules developed by researchers who works in this research field. These demonstrators thus generated, designed on the principle of scanning interfaces, are flexible and adaptable to the user needs which will be able to test modules in the process of development while daily using an application of assistance to the communication.

Key words: AAC, motor handicap, Man/Machine interaction, communication, demonstrator, development platform

1. Problems

Search on the AAC domains (Augmentative and Alternate Communication) for the motor disable people exists since approximately about thirty years. These studies integrating knowledge of cognitive sciences, the automatic, data processing, are undertaken to design technical devices making it possible these disabled people to communicate with their human and technical environment and to thus reach a social life [1] [2].

For the AAC users the loss or the strong deterioration of the speech associated with motors problems, can have various origins: a LS (Locked-in Syndrom), an ALS (Amyotrophic Lateral Sclerosis)… The people suffering from these pathologies keep control only few muscles (like the eyelid, the jaw…), their cognitive abilities remaining generally intact. They do not have other possibilities to communicate only to use an assistance system with the communication. In 2013, we counts in France 8000 cases of ALS with currently 1000 new cases diagnosed each year [3].

In the communication assistance systems use a virtual keyboard to write text is only one functionality among all that it is possible to make with a computer with some functionalities multi-media and Internet (music, email, navigation…) where the communication exceeds the environment close to the user. The difficulty of access to these functionalities within the framework of systems AAC arises then because much of users do not have a good knowledge of the use of a computing system (Microsoft Windows or other) which is planned for a keyboard use/mouse. We start to find on the market of the systems adapted to certain user profiles in particular the old persons who want to use these new functionalities of communication with their family. The success of the use of the tablets in is a proof: the basic functions are present without proposing as many options of processing one finds on a computer.

In addition the validation of search in this AAC field is not easy because it is very difficult to make tests in ecological situation because of great diversity and the specificity of pathologies and the situations of handicap. Generally the applications are validated in real time according to tests very few with potential users. These tests can bring to the design of models of interaction which integrated into system AAC will be able to then adapt the application to the user.

One of the lacks in the field of the AAC is the absence of common platform of development, test and use which would make it possible to integrate new functionalities conceived in the laboratories (optimization of text entry, design of new sensors of command like the eye follow, EMG or BCI…).

It is starting from our experience in the AAC field in particular with the development of the project EDiTH (Environment Digital de Teleactions for person with motor Handicap) that we propose to develop a common platform (EDiTH2) of integration of specific modules AAC answering functionalities developed in laboratory [4]. A coherent whole of modules AAC could be developed/tested/used in an environment adapted to the user. It is envisaged to open this platform at the community of the researchers of the field.

This project will make it possible to work on various scientific bolts and their interactions like:

- study of new devices of sensors of command (EMG, EOG, BCI, eye follow…),
- modeling of the interaction of system AAC in its globality,
- ergonomics of the interface (topics, templates),
- simultaneous use or not of two types of control: scan and pointing,
- adaptation of the scanning time in the case of a ON/Off switch command,

- study of the use of haptic to improve system monitoring,
- text entry optimized according to the task in progress,
- modeling of the profile (physiological, driving, cognitive) of the user allowing to configure in an objective way the system,
- access to complex functionalities like navigation Internet.

The objective of this paper is to have on the one hand the structure of the EDiTH2 platform and on the other hand our advances/reflections on some scientific bolts quoted above.

2. Return on existing: EDiTH

The EDiTH system on which the platform is based was developed at laboratory LASC of the ex-university of Metz; This project continues at laboratory LCOMS of the university of Lorraine (fig. 1). This system was an integral software whole of multiple functionalities of assistance to the communication and the control of a multi-media environment [5]. It is about a system with sequential scanning, column-line or according to the screens of the various modules, controlled only by on/off sensor adapted to the user. The design of this system had two objectives:

- The primary goal, practical, consisted in providing to the potential users communications tools and of control of environment who integrated the conclusions of our experiments and our search in the AAC field.
- The second objective, theoretical, was to have a tool allowing an evaluation in real condition of our results of a search. In fact the calculation algorithms of scanning time which targeted major the part of our theoretical work while attempting to model this time in an objective way based only over time of user action [4].

The functionalities available in EDiTH were the following ones: To invite medical staff - To read texts - To communicate in writing (fig. 1) - To communicate verbally (preregistered sentences) classified by topics (care, courtesy…) - To reach a multi-media environment (MP3, Movie).

The scanning time was configurable according to two modes: a traditional fixed mode and an “adaptive” mode allowing to regulate the various parameters intervening in the calculation algorithm of the scanning time.

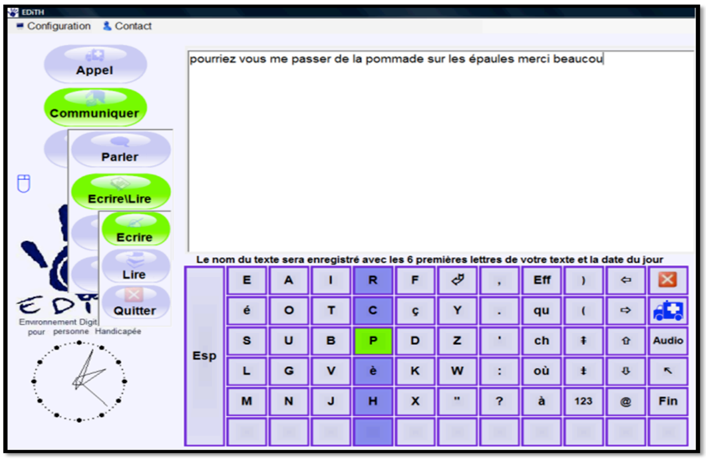

Fig. 1. Capture screen of the system EDiTH (keyboard)

The technical development of the EDiTH system was not planned for a work with several people who would like to test new functionalities and modules.

3. EDiTH2 a generic platform for generating AAC demonstrator

To develop this platform we were based on the experiment of the system EDiTH (knowledge of the users, their needs, tests in ecological situation conducted in France (15 users) and to Brazil (6 users): [6] [7]) to carry out a EDiTH2 demonstrator which will result from this generic platform of development in which modules coming from search AAC of laboratory LCOMS and others could be established and tested in ecological situation.

With our experiment on the development of application AAC and various collaborations which we carried out with other laboratories of which the BioLab laboratory of the Federal University of Uberlandia (Brazil), the platform must be able to propose these functionalities at least:

- A single framework on which will come to be grafted the modules AAC which will respect a communication protocol between them.
- An internationalization of the interface according to the country where the demonstrator is installed.
- A management of the versions of the demonstrator generated on the platform to obtain several types of demonstrator AAC according to the needs.
- A management of the various people who will use the platform for their own developments which could be amalgamated after validation.

With this intention, in order to be able to manage the various developments as well as the workspaces (users, wiki…) on EDiTH2, we left on the combined use of REDMINE and GiT (fig.

2). REDMINE is an Open Source web application of complete project management [8] while GiT [9] is a management system decentralized of versions allowing each one to work at its rate/rhythm independently then to offer a means of exchanging respective work.

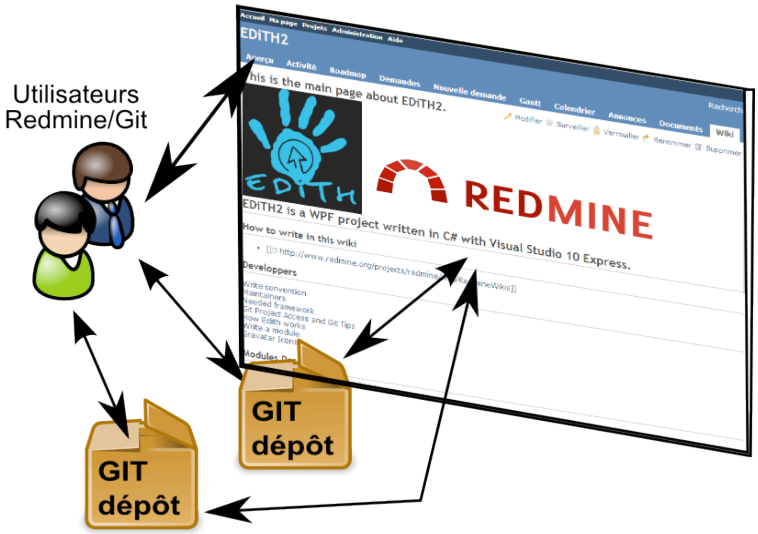

Fig. 2. Management system of the developments of the EDiTH2 platform

EDiTH2 is written in C# - WPF (Windows Presentation Foundation), under the environment of development Visual Studio Express 10. The use of the WPF to manage interfaces H/M in EDiTH2 makes it possible to solve certain problems involved in dimensions of the screen where the system will be used.

In first phase of development, it is expected that the demonstrator is controlled by the user with an on/off sensor which emulates the click of a mouse in order to be able to interface many sensors present on the market of the AAC via an adapted mouse.

To be able to carry out the developments of the modules AAC which will communicate within EDiTH2, we set up a framework of development of components to be respected which integrates (fig. 3):

- The management of the module of configuration of the module: each module AAC has its own functionalities of configuration which are included automatically in a single environment of configuration (a frame by module) (fig. 4),
- The module of management the scanning time of the items/choices options which distributes the user actions to the modules which make the request of it,
- Processing of the specific states (validated, validable…) of each item/choice,
- The management of the topics of the HMI (Interface Human-Machine),
- The management of the internationalization (I18N) of EDiTH2: each module contains in its language dictionaries the various versions of the displayed on the screen terms,

Syntax to provide to record in specific files logs (times of action, modules used…) all interactions of the user with the system for a processing a posteriori.

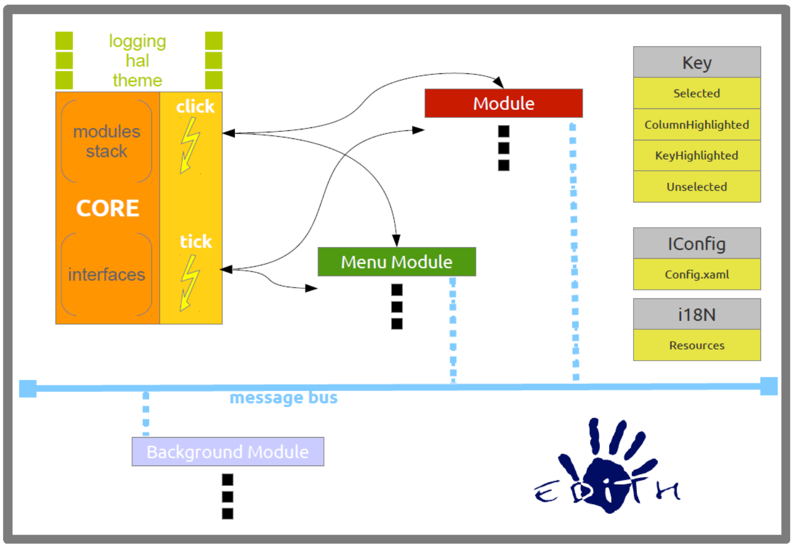

Fig. 3. Component frameworks of EDiTH2

The framework of EDiTH2 was conceived and carried out, so that each one can develop its own module AAC which will be integrated in a more complete environment, thus answering the problem to have to develop for each module a specific application.

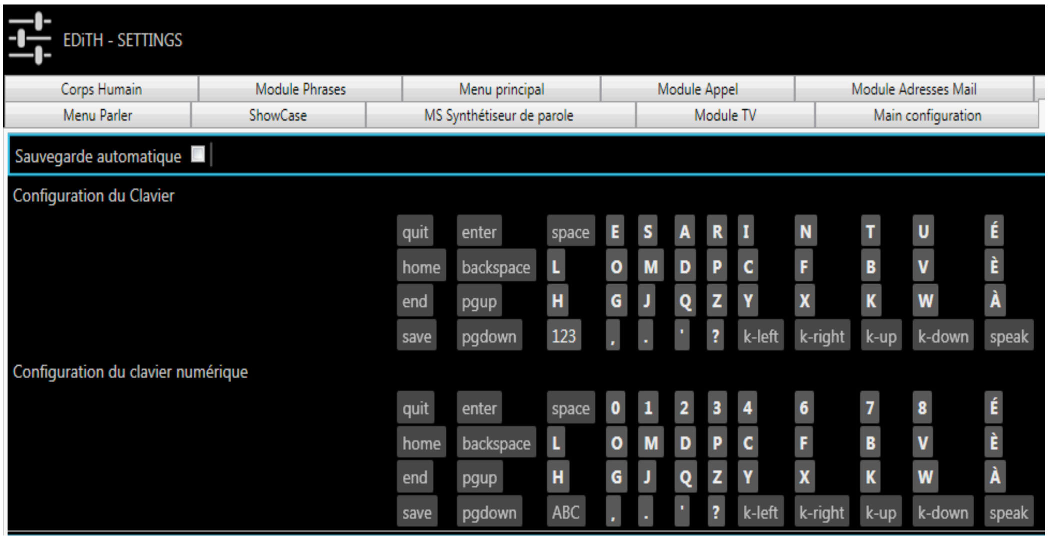

Fig. 4. Configuration interface of EDITH2

Each module AAC is thus autonomous and integrable in a configurable whole of modules according to the needs for functionalities of the user (fig. 4). The user of EDiTH2 will thus have a system which enables him to use basic communication functions (to call, read, speak…) for then being able to test/use more specific modules AAC developed in the laboratories (Fig.5).

Fig. 5. Screen captures of EDiTH2 (module speech module keyboard, and module care body)

While respecting the framework suggested which is itself configurable to a certain extent (management of the topics, the models), the researchers will be able to generate demonstrators adapted under investigation of their modules AAC, that they will be able to then share.

4. Study of physiological signals in EDiTH2

In certain cases the person reached of a motor impairment controls a “mechanical” man/machine interface of pointing (mouse adapted, trackball, mini joystick…). This allows a communication via a direct designation of the items. If this mode of entry is not usable by the person it is necessary to call upon more specific sensors such as for example the sensors of direction of the eye. The latter however have the disadvantage of being expensive and difficult of use. The principle consists in here pointing directly on item. The difficulty of the validation of the position arises then if the user is not able to use a switch. Systems of automatic “clic” exist but they increase the mental workload of the user.

The signals physiological, electroencephalographic (EEG), electrooculographic (EOG) and electromyographic (EMG) can bring intermediate information between the repeating spring and control 2D of a cursor [2], [10]: they make it possible to control the displacement of a cursor in a dimension what, associated with an adequate interface, can strongly improve the speed of communication compared to a traditional system with scanning.

In research in physiological signals, it is difficult to find studies referred in the literature using the "Potentials of Action of Driving Unit" (MUAP) which compose signal EMG for control of a communicator. The form of these potentials of action making it possible to include/understand the behavior of the neuro-muscular system lets suppose that they can bring an alternative interesting for the command of the assistance systems to the communication. On the basis of this report we proposed to study the potentialities of signals EMG, in particular of "activity MUAP" extracted from these signals, as ordering informations of a help to the communication. First advanced in this direction were the subject of the thesis of Carlos Galvao [11] and must continue with experiments in real situation.

5. Study of the interaction modeling: Impact of command sensors choice on AAC modules interface

The potential users of an assistance to communicate have physical and cognitive possibilities very different. The technical assistance with the communication must thus be customizable and adaptable. The choice of the sensor of man machine interface as of the mode of dialog is carried out most of the time in an empirical way. It is thus a question of associating information collected with a graphical interface of dialog optimized. Optimization is function of the wealth of information available: one or more data repeating spring (switch, EOG…), analog information (1D displacement of a cursor), analog information associated with an on/off information (standard mouse), of an accelerometer…

The first criterion retained for the bench-marking of these interfaces human-machine is the average time of access to a character. This time can be measured but also predicted by using traditional laws: law of Fitts [12] for the pointing, model MHP (Human Model Processor) [13] for the response time to a visual stimulus. We will have to associate thereafter with this temporal parameter, an error rate obtained in experiments which in practice strongly influences the performance [14]. An evaluation off line of the physical and mental workload of the user is also considered.

The final objective is to propose ergonomic recommendations for the use of the signals EMG, EOG and accelerometer as an interface of ordering of an AAC.

This continuous study with the BioLab laboratory which works on a case making it possible to connect several types of sensors to control an AAC [15] (fig. 6).

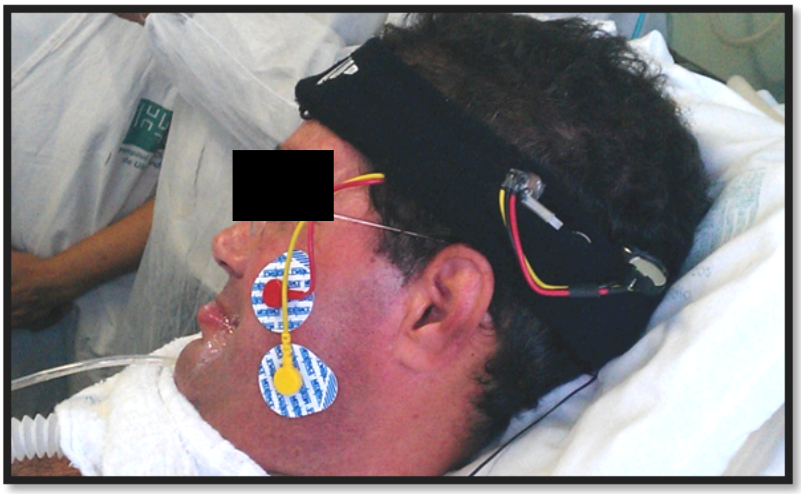

Fig. 6. Subject suffering of ALS; he controls with a sensor EMG (jaw) a demonstrator AAC generated with EDiTH2.

6. Study on adaptive scanning time

The systems with scanning remain often the only way of communication and/or control of the environment for a person with the severe motor deficit. The principle of these systems consists of a luminous scan on a screen. An action on a switch makes it possible to validate a choice or a group of choice. Their main issue is the slowness of communication which they induce but their undeniable utility for a great number of handicapped people makes that they remain an object of search only for a few researchers throughout the world [16], [17].

The essential parameter for the speed of communication remains however the digit time of scan (*Tscan*): a too short tuning of *Tscan* generates a significant number of errors of selection whereas a too long tuning decreases the speed of communication in significant proportions. This time is defined in an empirical way and guard often its value throughout the use of the system for a given person.

Our objective is to regulate *Tscan* initially in an objective way then automatically to adapt it in the course of use according to the physical status (fatigue) and cognitive (concentration, stress) of the person. Some rare work in this direction is evoked in the literature [18] [19]. One can note that two parameters are used to adapt real-time the time of scan: response time of the user and errors of selection. This last parameter supposes however that the errors are for the majority indeed locatable. One realizes however in practice that to gain of speed of communication much of users their typing errors do not correct as long as the sentence remains overall understandable. One can also note that all work previously quoted was tested, to our knowledge, in laboratory. It is thus desirable to supplement these evaluations in ecological situation over long periods.

We for our part developed an automatic algorithm of scanning time based on the analysis of the response times of the person by the means of the modeling of the interaction between the handicapped person and the communicator with scanning. This algorithm was validated in experiments on valid people in laboratory, people handicapped in imposed scenarios and finally on people handicapped in ecological situation [4].

The continuation of our work in this field has two aims. The first consists in validating from a theoretical point of view the model of the algorithm rising from our work by confronting it with data resulting from other disciplines, cognitive psychology and neurosciences in particular. The second objective is to test in ecological situation and over long periods the algorithm of adaptive scan quoted above. All the data of use and more particularly the response times of the user are recorded in a file log allowing an analysis in time differed from the interaction human-machine and later an analysis real-time for a finer adaptation of our algorithm.

7. Study on entry on adaptable text for EDiTH2

For our study on text entry within the framework of the EDiTH2 project, we use a scanning communications system using the virtual keyboards [20].

The virtual keyboards generally have a dictionary and a prediction of letter or words in order to improve comfort or the performance. The correction allows a "fuzzy" striking whereas completion allows a theoretical gain in terms of number of strike. If the preceding solutions rest on virtual keyboards with keys, very different solutions exist based on navigations in a space of characters, words and sentences like Dasher [21].

A great number of virtual keyboards proposed make it possible to adapt to the user thanks to one big offer personalization. That can go from the keys position, of their organization to the enrichment of the dictionary.

The entry text module of EDiTH2, on which one proposes to work, aims at proposing new solutions in order to facilitate the selection, to save the number of selection and the distance to be traversed between the various selections. For example, a first proposal of virtual keyboard will be pressed on a keyboard based on a joker [22]. Is the writing of a word done starting from a subset of the possible letters, the remainder of the letters being represented by the joker (the character "?" on figure 7). For example, in the configuration of figure 7, the owner "? and? cap" makes it possible to reach the word "handicap". According to the number of letters represented by the joker, the number of scan is reduced, because the number of letters to be reached is reduced. The system is pressed on a dictionary to present to the user the words corresponding to the seized owner. A scan makes it possible to choose the word if the most frequent word presented in first is not that desired (fig. 7).

Fig. 7. Screen capture of the prototype of the keyboard joker AAC

A second proposal of keyboard will be pressed on a digital keyboard [23]. Each letter corresponds to a number. To write a word, it is enough to write a string of numbers. The digital keyboard is tiny room compared to a traditional keyboard, which will reduce the scans and will facilitate the training.

8. Conclusion

The majority of modules AAC developed in laboratories require application developments which are not designed to communicate between them. That distorts the tests in real situation, the users not being able to change module. For example, to test a virtual keyboard is carried out in a long time among the use of other functionalities. It is the experiment of the tests users in real situations which showed us that to test an autonomous module of way was not satisfactory because the user must be able to use this module during a very long time, time which is not easy to manage in medical environment or in the user.

With the platform EDiTH2 (REDMINE+GIT+Framework of development), we have base of an environment of development conceived to generate demonstrators AAC allowing to integrate on the one hand a specific module AAC coming from the search undertaken in laboratory and on the other hand to integrate several communication functionalities (word, read/write, house automation, access to the Internet…).

These generated demonstrators being completely flexible and adaptable to the user (functionalities, language and topic of the interface), this last will be able to use with its own way of modules AAC in phase of test within an application which is dedicated to him, adapted to its communication needs.

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