

Short Abstract

Alternative communication specifies a set of techniques, resources and tools in order to help handicapped people in order to produce speech or texts to communicate. This concerns typically persons suffering from neurodegenerative diseases like ALS. These patients keep only few muscles under control (in particular eyelid) and cannot speak any more, while keeping intact their cognitive capacities. The objective of this project is to help the user in composing messages that can be visualized or synthesized by means of a text-to-speech synthesis system. Moreover the possibility of a nonverbal communication has been integrated. Such a communication is helpful on the one hand in the case of fast or stereotyped communication, and on the other hand in case of loss of language (for example certain cases of aphasia). The effectiveness of a communication system is measured by the minimization of the number of interactions as well as the speed of the system. The main factors influencing this effectiveness are on the one hand the relevance of word prediction and on the other hand minimization of the interactions with the system thanks to an adapted interface, the two aspects being linked in certain cases. We have developed several resources (in particular a broad-coverage French lexicon) adapted to the prediction techniques. This project was given a complementary aid for its industrialization. It has been prizes winner of the contest 2002 "*Creation of innovating technology companies*" organized by the Ministère de la Recherche. Our project is currently accompanied by the incubator "Impulse".

Main goals

Alternative communication designates a set of tools facilitating the communication for handicapped people. These tools rely on speech and written text technologies, they are used in order to assist the user in a communication process. The goal is to allow the user to communicate with valid or handicapped people by means of a text-to-speech synthesis system to which a set of tools facilitating the composition of message is integrated.

The principle of a simple and flexible assistance consists in generating one or more sentences, by means of an editor, and to synthesize them. Several questions arise. If speech technology reaches a sufficient level of maturity today, on the other hand the question of the assistance to sentence generation remains an open problem. It opens many questions in particular analysis of the situation of communication from a cognitive, linguistic and ergonomic point of view. The first question is that of human-machine interface. It can be directly the keyboard (plus different tools), but also sensors. A large variety of sensors is available today. The system benefits from all their functionalities and adapts their possibilities. For example, the use of function keys can be associated to words or memorized sentences.

This project has addressed different aspects concerning the development of an alternative communication environment. Such a system brings together a set of tools from word prediction to speech synthesis. They rely on hybrid techniques mixing statistical and symbolic approaches and making it possible to exploit different kind of knowledge: word frequency as well as syntactic constraints. Moreover, the system can be adapted to different communication situations

Results

We have developed comprehensive software for assistance to communication that helps disabled people to compose messages by means of sensors by using a set of word prediction techniques. The message can then be synthesized with a text-to-speech system.

Our augmentative communication technology, called “PCA” (“*Plateforme de Communication Alternative*”) consists of three families of components (i) a set of sensors allowing a control over the system, (ii) a set of message editing and prediction tools for message composition, (iii) a speech synthesis system.

The tools for message composition represent the core of our process. They can be subdivided into two large subfamilies: message composition tools (strictly speaking) and tools for controlling the system. The latter have functionalities allowing access to the various menus usually proposed in standard softwares, as well as to controls of the operating system.

In addition, we are currently developing a virtual mouse (hand-free mouse alternative) controlled by binary signals (eye-blinks) but being also able to capture more evolved movements when they are still possible. The composition tools strictly speaking represent a set of virtual keyboards for the user. Each of these keyboards corresponds to a particular composition technique. The basic keyboard is a reproduction of a standard keyboard on the screen. It contains all the keys customarily used, which makes its use completely intuitive and natural. A customizable scanning mode assists the user in selecting the character he/she wants: the scrolling is done by a cursor, which scans the keys linearly, or the line of the keyboard and then the keys belonging to the line, or others scrolling structures. Here, the scrolling allows a selection of any character of the keyboard by means of a binary (yes/no) interaction. A word prediction functionality is also proposed. It offers to the user the possibility of keystroke saving by selecting directly the desired word in the prediction window, thus reducing the number of interactions with the system. Other composition techniques are also implemented. They take advantage of the word prediction mechanism by proposing alternative keyboards containing a sub-selection of keys from the standard keyboard. As long as the lexicon supporting the word prediction process is complete enough, it is possible to reduce the number of characters of the virtual keyboard and thus to increase the speed of word composition. Our word prediction is based on (i) the absolute lexical frequencies of the word, which have been calculated by analyzing a set of corpus, (ii) morpho-syntactic information, (iii) the linguistic habits of the user itself. Indeed, most of the existing systems are exclusively dedicated to the composition of written texts. However, the experience shows that it is a relatively limited vector of communication because it satisfies only part of the user needs. We thus extended our field of reflexion to ergonomics and multimodality areas.

- *User Model*: In addition to the environmental accessibility (sensors adapted to most of the mobility impairments) the constitution and automatic update of a model user make it possible to answer the first point. This model is useful to customize the techniques of situational assistance according to the preferences of the user.
- *Situation of communication*: the analysis of situations of communication allows not only to adapt the linguistic resources, as we saw previously, but also to privilege, in connection with the user model, certain techniques of message composition.

- *Multimodality*: It is a question of taking advantage of every controlled movement of the user, each constituting a potential input of the system. For example, in the case of a dumb and tetraplegic user, it would be movements like blinking, breaths or head movements. Each of these movements makes it possible to control a function directly. The multimodality (simulated, if the input possibilities are reduced to a binary signal) takes advantage of the possibilities of using simultaneously different devices. The functionalities of the system are specified and developed according to this multimodal ability. For example, the cancel function is managed in a particular way. The problem is complex. First, it consists in specifying the architecture of the interface according to the control modes. The interface must preserve the possibility of using whole or part of these modalities. This fundamental constraint is essential to be able to adapt to degenerative pathologies.
- *Sensors*: The nature of the available control mode influences not only the design of the interfacing, on the interactions between these various modalities, but also on the functionalities themselves. Several functions are mainly determined by the model of sensor used. It is the case, for example, of the virtual mouse, which can be controlled in a different way, with different possibilities according to whether it is simulated with the keyboard or that it is controlled by an analogical signal (for example an ocular movement).

Industrialization

The part of this project consisting in the industrialization aspects has received a specific financial support from the “Programme Cognitique “. The first version of the prototype has been installed 6months ago for evaluation and testing with five impaired persons. A psychologist specialized in cognitive ergonomics has been in charge of following the evaluation process and has collected a large panel of observations, both on how the system was used by impaired persons and on the conception mechanisms of the system itself.

In 2002, we competed for the prize awarding the creation of companies in the field of innovative technologies organized by the French Ministry for Research and Education “Concours 2002 de l’aide à la création d’entreprises de technologies innovantes, catégorie Emergence”. Our project entitled “*Communication and Handicap*” has been awarded as laureate and won financial support dotation that we affected to a study of feasibility on the opportunity to create a compagny. We have currently joined a structure specialized in the management and consulting for innovative high-tech projects (“Incubateur Impulse”). In some few months, we plan to create a company in the field of augmentative communication and re-education. The company will be in a first step designed to distribute our software “*Plateforme de Communcation Alternative*”, hereafter PCA.

Several aspects distinguish PCA from others existing tools or softwares designed for alternative communication. First of all, in terms of efficiency, PCA is currently the best for the French language. Alternative communication needs indeed the minimization of the number of interactions with the system (number of clicks) combined both with an optimization of the typing speed rate of the message. This twofold imperative leads us to implement in PCA a powerful prediction engine and to propose as well a various panel of composition methods.

We use for that a lexicon gathering more than 400 000 forms, for which the frequency of occurrence, the morphosyntactic description and phonetic information are given. It is worthwhile to mention that, up to date, this resource is unique for French. Moreover, the prediction engine is using in addition with frequency information some special filters allowing the discrimination of proposed words in function of their syntactic forms.

Our software PCA is a global solution for helping impaired persons in their quotidian communication needs and, thanks to its iconic mode, also proposes assistance in terms of re-education. The iconic mode implemented in PCA has been developed in collaboration with speech therapists. It leads us to consider the problem underlying the use of icons on two aspects: proposition of a structured access to an iconic dataset and progressive re-introduction of written language.

The accessibility to icons is an important point. Due to the large number of icons used (even for basic communication needs), it is not possible indeed to propose a linear access by showing the full iconic dataset on the screen. The solution implemented in our software proposes to structure the iconic dataset by assorting icons accounting for both their semantic and syntactic characteristics. That kind of structuration allows, if not a full prediction tool, to simplify the accessibility by filtering to some extent the iconic dataset. The re-educational aspect of the software is based on the way we make use of icons. As a matter of fact, the morphosyntactic description associated with each icon allows us to reformulate simple structures. However, in opposition to others experimental systems existing in the field, we make the choice to introduce or re-introduce when possible the written language and not complex iconic language such BLISS for example.

Our system is also proposing an innovative use of text-to-speech tools. In addition to classic speech synthesis from a written input, we are also proposing a phonetic access to our lexicon. It allows to speech each word separately, a useful property especially for communication system based on iconic representation.

In terms of conclusion, our system is characterized by its adaptativity to user's needs. It means in particular that accessibility methods proposed in the system are just not some reproduction of virtual keyboard on the screen, but constitute appropriate tools specially designed for scrolling accessibility mode. That ergonomic characteristic can be found more generally in the choices made in terms of functionalities, modes and accessibility. We propose as well the possibility to make simultaneously use of two or more sensors controlling the system, which may be seen as a restricted multimodal approach.