

VITIPI

Versatile Interpretation of Text Input by Persons with Impairments

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ABSTRACT :

Tetraplegic people who want to use a computer have another handicap because they write very slowly. Before showing VITIPI abilities, we want, in the first part of this paper, to make a background of existing systems in order to point out the add value and the difference with such systems. In the second part, we will see the technical aspects of VITIPI system. Precisely, we will describe how to build the database and how VITIPI works. In the third part, we will give results and evaluation tests. In conclusion, we will see how to increase VITIPI efficiency.

1. INTRODUCTION

Physically disabled people who want to write documents have to use electronic devices such as computers and word processing. A lot of physical disabled people have difficulties to write at a « normal speed » (more than 15 characters/minute). Tetraplegics are faced with **low speed writing** problem.

If writing is very important for everyone in everyday life, it takes a very huge place in tetraplegic life. Tetraplegics have to use writing for several reasons :

On one hand, they have to write documents, as everyone does in everyday life. On the others, writing is for part of them the only way of communication (some of them cannot speak).

Moreover, computers are also used to store a great amount of information (CD ROM, networks, Electronic mails, ...) and some time, a new way of entertainment. It is very important for disabled persons to access those new technologies because some of the network services are especially adapted for disabled users. For example, 36 18 FRANCE TELECOM's service allows user to write messages on a MINITEL which are then read by an operator to the correspondent. Other groups like : « listserv@sjuvn.stjohns.edu » provide on INTERNET network services that give information about daily life, activities for disabled persons (law, technical helps, ...) and discussions about new devices and information for disabled people. We have got to outline that it is more convenient for them to use a CD ROM or Internet network, than to access an encyclopaedia.

Presently, keyboard is the most convenient way to access those information and to control computer.

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Nowadays, tetraplegic population is made up of young people, ready to use those new technologies, but unfortunately, they are inappropriate to disabled persons : « Time is money » on networks.... It is clear that *Low speed writing* is a real problem for tetraplegics, so they need a system which increases speed text acquisition in all computer applications.

Before showing VITIPI abilities, we want, in the first part of this paper, to make a background of existing systems in order to point out the add value and the difference with such systems. In the second part, we will see the technical aspects of VITIPI system. Precisely, we will describe how to build the database and how VITIPI works. In the third part, we will give results and evaluation tests. In conclusion, we will see how to increase VITIPI efficiency.

2. OVERVIEW OF EXISTING SYSTEMS

Softwares have been developed to increase speed writing (« write now », « RapidText », « HandiWord », « Reactive Keyboard », ...) but most of them are not convenient and need specific software and/or special computers.

Write Now is for example a specialised word processing. With « Spelling suggestions » option, it displays a lot of different words in a prediction window and user have to select the correct one. Prediction window hides text wrote. It cannot be adaptable to other words processing software.

RapidText is a French software (11) which provides in the same package, words processing and « single switch » system, so it can not be used with ordinary software and new CD ROM or networks. On the other hand, its « single switch » system is not very adaptive and ergonomics because it displays at the bottom of the screen four words that disturb the user. This system takes a long time. for example it requires an hour to write 12 lines of poetry.

HandiWORD is a memory-resident facility which provides statistically-weighted prediction for IBM PCs and compatibles. Statistical weighting means that HandiWORD learns which word you use most often and adjusts itself to predict those words first. The more you use HandiWORD, the more it learns to « think » like you... HandiWORD's prediction feature matches your input to a word / abbreviation list. As you input each character, HandiWORD revises its match « pick list ». When you see the desired word, just press the associated numeric key (HandiWORD will complete your input). This isn't a good way to select words, because you have got to use digits, instead of letters, to choose your elected word. We just have to notice that numeric pad is right side on keyboard (far from letter pad), so it needs a lot of hand movements. It is difficult to use it with networks and CD ROM.

KOMBE [8], [9], is a German and French project built for A.L.S patients (amyotrophic lateral sclerosis, kind of tetraplegics). This project was carried out under the TIDE Pilot Phase 1992 and 1993. As in Write Now or HandiWORD projects, persons with a disability have to select a word in a list. Words are implemented in a net with a lot of syntactic and semantic attributes [6]. These attributes are very helpful in building sentences but it seems to be very hard to add new words because you have to choose good attributes for each new word, as in Artificial Intelligence [7]. If you want to write in another language, you have got to change all the net.

Reactive keyboard [5], [13] is a system which provides words (or part of them) while we are typing letters, as WriteNOW or HandiWORD do. The disadvantage for the user is that he has to deals with at least four windows which are :

- *Screen keyboard* : It is a matrix which displays on the screen all keyboard keys.

- *Remote Control* : It is a window which contains eight main commands of words processor.
- *PIA Phrases* : It is a windows which displays words or part of them predicted by the system.
- *Text editor* : It is the window where user edit its text.

If we eventually add others Window's applications, the user wastes time changing windows and may be disturbed.

PROFET is a TIDE Sweden project driven by HUNNICUTT [10], [1], [12] and all. User has to choose its word in two steps : In the first one he has to select the root of the word (i.e. the beginning of the word) ; in the second one he chooses the ending of the word according to the syntax. The main problem with PROFET is that user has to indicate the syntactic class of each new word. It could be difficult for people with grammatical impairments ; and it may be a long way to build personal vocabularies.

ALADIN Project 1035 from TIDE Bridge Phase - currently under development. The system will include a model of conversational interaction which will provide non-vocal physically impaired persons with appropriate conversational material, prompts, and predicted utterances. An easy to use control interface will provide the users with predicted texts from a large pre-stored inventory.

To conclude, all those systems don't allow letters prediction in unknown situations (typing or orthographic mistakes). It is some time difficult to enter new words in lexicon systems, and they don't make **on line** orthographic and typing corrections. It seems difficult to adapt some of these systems to other languages. They are also limited to a single software application and do not allow multimedia abilities.

3. VITIPI ABILITIES AND TECHNICALS ASPECT

The VITIPI (**V**ersatile **I**nterpretation of **T**ext **I**nterface by **P**ersons with **I**mpairments) system is an intelligent and adaptative interface which is intercalated between the keyboard and the computer.

Its aim is to speed up text acquisition in all computer applications. When a user starts writing the first letters of a word, the system displays either the ending of a word or a part of it as soon as there is no ambiguity. As long as the word remains incomplete, it goes on writing as many letters as possible and automatically corrects typing or orthographic mistakes in real time for the user. It accepts words which do not belong to the data base vocabulary and allows their automatic storage in its data base.

Characters generated by VITIPI are perceived by the computer as an output of the keyboard. So it can work with every software (word processing, data base processing, mail box, ...).

VITIPI has been built to be used by disabled people even if they cannot use an ordinary keyboard. It also allows the access to Windows, Internet and CD ROM applications.

First we are going to see the functioning principle of VITIPI and to explain how the system is built. Then we will see how the system works when it is faced with unknown situations (new or altered words).

3.1. VITIPI principle

The functioning of the system can be understand with the following vocabulary :

cache	certain	chaise	directeur	direction	docteur
égalisateur	égalisation	égalisatrice	élevateur	élévation	élevatrice
faute	farine	février	forme	instituteur	institution
institutionnalisation	institutrice	pharmacie	photo	potable	poteau
qui	quille	quiproquo	table	troisième	trottoir

If we want to write the French word *cache*, we have to enter the character *c* and when the character *a* is entered, the string ***che*** is automatically displayed by the system.

In this vocabulary, bold letters are automatically displayed by VITIPI. It is clear that if the vocabulary was biggest, the ratio of displayed letters will be lower.

3.2. VITIPI Creation

The system is modelled by a transducer. A transducer transforms an input string into an output string. To create a transducer, we have got to input a list of useful words, and the system builds itself automatically. It doesn't need linguistic rules or probability samples.

In order to explain how the system is created, we have drawn a transducer made up with a part of the above vocabulary (Fig 1). Letters on arrows are input letters, those surround with rectangular are automatically displayed by the system. B and E in circle respectively denote beginning and final states.

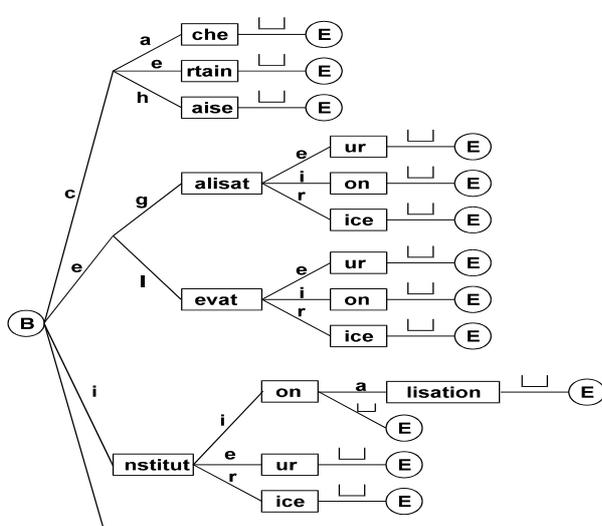


FIGURE 1 : VITIPI Creation

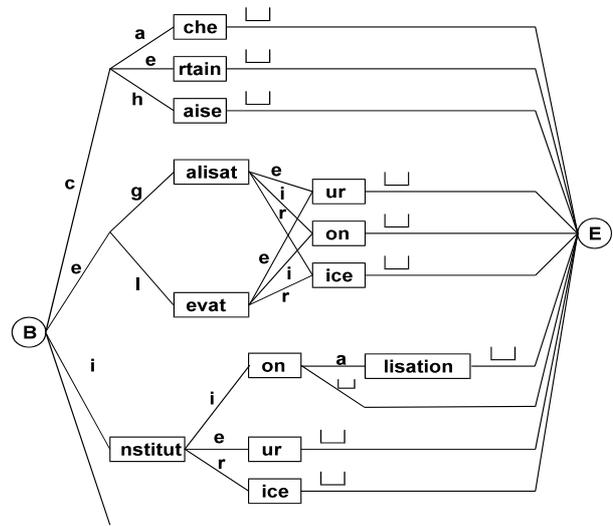


FIGURE 2 : VITIPI Minimisation

3.3. VITIPI Minimisation

Once the transducer created is then minimised but the minimisation is not classical. It will not bring out new strings (or words) others than those present in the training sample (or vocabulary). We can notice that with the above example, the word *égalisationnalisation* (which is not a French word), is not generated. When transducer is minimised, VITIPI can work.

3.4. How VITIPI works

When a user starts writing the first letters of a word, the system displays either the ending of the word or some parts of it as soon as there is no possible ambiguity. As long as the word remains incomplete, the system goes on writing as many letters as possible.

When the transducer is faced with an unknown situation, it cannot normally produce an output. Existing systems are blocked when words that do not belong to the lexicon or contain mistakes are typed. To avoid that, we have realised a system which allows the transducer to adapt and modify itself in order to provide an output string that satisfies the user. An unknown situation can arise from a word which is not present in the basic vocabulary or an altered word (misspelled words and/or typing mistakes).

In the first situation, the word does not belong to the vocabulary, we have to use an single *analogy inference* where as, in the second one, it is altered (misspelled words and/or typing mistakes), we need several *string alteration inferences*.

When the system is faced with a new or altered word, it has to choose "the good" inference. Various strategies are explained at the end of this paragraph.

3.4.1. Analogy inference

The goal is to find a word which has a similar behaviour with a word belonging to the basic vocabulary.

If VITIPI supposes that it is faced with a new word, thanks to an *analogy inference*, the system can produce the ending of the word even it has never appeared before. It then stores the new word for future uses. So that a training has been made.

For example let us consider the French words *instituteur*, *institutrice*, *directeur* belonging to the basic vocabulary. If we want to type the French word *directrice* which does not belong to the vocabulary, we start writing *directr* the system is faced with an undefined transition. The nearest state with a defined transition for the input *r* has got *rice* as output. So the *rice* string is inferred and displayed on the screen.

3.4.2. String alteration inferences

If VITIPI supposes that it is faced with an altered word, then four solutions could be considered namely : *substitution*, *elision*, *insertion*, *orthographic mistakes*. An inference procedure has been made for each kind of string alteration.

a) Substitution This inference deals with typing mistakes. A mathematical distance has been defined between two keyboard characters. The character which is nearest to the input is chosen.

For instance, if we write the string « *trpisième* » instead of the French word *troisième* then thanks to the mathematical distance, the system finds that character *p* has been substituted to character *o* (*o* and *p* are neighbouring on the keyboard).

The VITIPI system has been made for disabled people, thus substitution mistakes has been carefully treated. Special characters could be substituted to alphabetical letters if the word we are writing is not finished. Typical French stressing (accentuation) mistakes are also taken into account [3].

b) Elision The goal is to find which letter has been omitted (i.e. which letter could appear before the last one entered). Two cases must be consider.

The first can be illustrated by the French word *quiproquo* if the following string « *quproquo* » is entered. There is an undefined transition on the *p* input. The system is going to search all future states to see if there is a single transition which has *p* as input. In the current state, if *i* is entered, a transition leads to a future state and in this future state there is a transition which has got *p* as output. So the system infers that the letter *i* has been omitted.

The second case can be illustrated by the French word *trottoir* if the following string « *trottoir* » is entered. The system is faced with an undefined transition on the second *o*. In the current state some of the output transitions produce more than one character. When all outputs are analysed the system can only find one of them with letter *t* as input and letter *o* in second position. So it infers that *t* has been omitted.

c) Insertion This is the easiest inference procedure because the system has to suppose that the character has been inserted, so it just has to skip it and wait for the next one. We do not give any example.

d) Spelling mistakes We now have to consider the case where the undefined transition is due to a spelling mistake. This mistake can be attributable either to an orthographic substitution of the last letter or to a group of letters badly spelled. To make a correction, we have built a small expert system with about 200 French orthographic rules. Those rules rewrite a part of a word with an equivalent letter group, and sometime, they are able to display the end of the word.

We have partitioned the set of rules such that each rule packet is assigned to a letter. If one of the rules can be applied, the correction is made following the way the rule works. As long as there are letters in the word, we go back in the word.

We have got to notice that orthographic correction is made « on line » (while we are typing the word and not after the word is typed.)

For example if we type the string « *farm* », instead of the correct French word *pharmacie*, what happens ? In a first step, thanks to the rewriting rule : (f ---> ph) the system infers, that if it substitutes the letter *f* with the equivalent string *ph*, it then obtains *pharm* which is a correct beginning French word. In a second steps, it considers that if the string *pha* was typed, VITIPI would display *pharmacie* ; so with the incorrect string « *farm* », it **corrects and displays pharmacie**.

Another interesting example is when the user writes the word « *foto* » instead of the correct French word *photo*. Once the string « *fot* » is typed, VITIPI detect an error. Two orthographic corrections can be done because two rewriting rules are true :

(o ---> au) for *faute*, (f ---> ph) for *photo*.

VITIPI displays a miss spell warning message and ask the user to input next letter. If *o* is entered, then *photo* is automatically displayed, else, if *e* is entered, *faute* is displayed.

We can notice that by this way, the user is not disturb by unexpected words.

3.4.3. Strategies

When the transducer is faced with undefined transitions he has got five ways of making inferences ; how will it choose ? Various solutions has been explored, we have chosen a solution which mixes strategies based on « inference probability » and « inference most frequently used ».

For some typical cases, the couple formed with the last but one letter and the current letter can orient to the "good inference" choice. If the couple never appears in a language (or with a weak probability), the system can suppose that the word has been altered. In the same way, if the same letter is found three times, then it can suppose that an insertion has been made and call the insertion inference.

If the couple probability is not weak, the analogy inference is first tried unless the similitude function is very weak. String alteration inferences are then orderly proposed to the user depending on various strategies such as the Last Recently Used (L.R.U.), the most frequently used or some more sophisticated strategies shown in [4].

If the proposed solution does not satisfy the user, he will tell the system. Depending on the strategy, the system will then propose another solution and consequently modify its choice criterion. Hence the system adapts itself to all new unknown situations. If no solution is satisfactory, the word is automatically added to the lexicon and the system will be able to act on it as a database word. So a training will be made.

At the end of the session, VITIPI displays all new words and asks the user which word he wants to save definitively. By this way, several lexicons can be created on various topics.

4. RESULTS AND EVALUATION TESTS

We first have made an estimation to compute the ratio of letters the system automatically predicts. The estimation has been made on different vocabularies made up of useful words. For a French lexicon (5.930 words) the ratio is 26 %. For a English lexicon (2.566 words) the ratio is 35,3 %. For a German lexicon (5.835 words) the ratio is 44,3 %.

We then have tried to evaluate the inference system performances. We noticed that 72 % of typing mistakes and 75 % of orthographic mistakes were corrected (French vocabulary).

Additionally, an evaluation of VITIPI was made with 11 French disabled end-users. VITIPI was compared with another existing system (HandiWord). We could outline that they were globally satisfied : On VITIPI, typing errors are better taken into account, and the writing speed is better (they write for 2 to 3 times faster).

5. CONCLUSION

We have got to outline that this system was not especially made for French language but can be adapted to other languages. If we want to have the orthographic option, we just have to change the orthographic rules and warning messages.

VITIPI system is now able to work on French version. We plan to adapt it to other European languages. With the development of the multimedia, we think that our conception could be very useful.

We are fully aware that VITIPI system could be perfectible. We try to add syntactic and semantic constraints in our system to add predictions. We also plan to develop other devices to adapt VITIPI system to all kinds of physical impairments. With such devices, VITIPI will be a useful interface between tetraplegics and new computer systems or communication networks.

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