HLT and communicative disabilities: The need for co-operation between government, industry and academia

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Abstract

To improve the position of people with communication disabilities, it is first essential to identify the tools they require to improve their communicative capabilities. HLT can be instrumental in restoring functions and compensating for impairments by providing solutions that integrate knowledge of speech and language into automatic processes. Against this background, an initiative was taken of analysing the specific needs of communicatively disabled people in terms of applications and related HLT resources so as to identify a minimum common set of HLT resources that would be useful for developing applications for a number of communicative disabilities. The priorities set in this survey could be used to inform policy, research and development and eventually stimulate take-up by industry. In this paper we describe this approach.

Index Terms: communicative disabilities, HLT applications, health telematics.

1. Introduction

The Dutch Language Union is a Dutch-Flemish intergovernmental organization that has the aim of promoting the Dutch language. In the last decade, the DLU has taken a serious interest in human language technologies because these can play a vital role in strengthening the position of a language in the information society. Together with the relevant ministries in the Netherlands and Flanders, the DLU has set up a number of initiatives aimed at promoting the development of digital language resources and language and speech technology for the Dutch language. Governmental support was considered to be mandatory because since Dutch is a so-called mid-sized language [1, 2], companies are not always willing to invest in developing such technology for a language with a relatively small market. On the other hand, the development of language and speech technology is considered to be crucial for a language to be able to survive in the information society.

To promote the use of Dutch, the DLU tries first of all to create the right conditions for making it easier for Dutch speakers to get by with their language in as many different situations as possible. The DLU wants to achieve this for all speakers of Dutch, hence also for those who have communicative disabilities. Given that information and communication technology are gradually but steadily pervading our lives, creating the right conditions for ensuring the use of Dutch in daily life partly entails supporting the development of HLT applications. For the group of communicatively disabled speakers of Dutch, HLT can be instrumental in restoring functions and compensating for impairments by providing solutions that integrate knowledge of speech and language into automatic processes. In the field of communicative disabilities, HLT can be used for diagnosis, therapy, training and monitoring, compensation and augmentative and alternative communication. This policy is in line with European policy aimed at realising an inclusive information society where accessibility, universality and user-friendliness are considered to be essential to ensure full participation and to enhance the quality of life for all individuals.

2. HLT and communicative disabilities

To improve the position of people with communication disorders in the Netherlands and Flanders, it is first essential to identify the tools they require to improve their communicative capabilities: tools that assist verbal dialogue, reading and writing, and the use of communication devices. Against this background, the DLU was first interested in finding out whether people with communicative impairments need specific HLT products and services that are currently unavailable or insufficiently so. In addition, it was important to find out what role the business sector can play in providing these products and services.

To answer these questions, Rietveld and Stolte [3] carried out a survey in which recent research and initiatives in the Netherlands and Flanders were examined and experts, care providers, providers of communicative tools were interviewed as well as professionals from consultancy and knowledge centres such as MODEM [11].

Employing the World Health Organisation's ICF classification system, the researchers identified target groups from the viewpoint of the person as an organism. They identified four body functions and related impairments:

- mental (aphasia, dyslexia, mental disabilities)
- sensory (blindness and partial sight, deafness and partial hearing, deafblindness)
- voice and speech (dysarthria / anarthria, mutism, stuttering)
- movement and mobility (RSI / UEMSD, dyspraxia / apraxia).

It is also important to distinguish between congenital disorders and those acquired in life, because congenitality or acquiredeness can determine the suitability of a tool. Comorbidity (a combination of disorders) also imposes specific requirements on tools.

From the viewpoint of how disabilities limit human behaviour, the researchers examined the HLT applications that could help disabled people understand (read, hear, or understand sign language) and express (write or speak) messages and operate communications tools (telephones, fax machines, mobile phones).

For each category, the researchers tried to answer four questions:

- Who has this disability (which impairments cause it)?
- What HLT tools are available to compensate for this disability?
- What experiences have users had with tools (in terms of user friendliness, knowledge of the product, quality, and applicability)?
- How can the requirements relating to this disability be met in the short, mid, and long term?

The study that resulted form this investigation, Human language technologies and communicative disabilities [3] showed a world of very diverse desires, requirements, and possibilities – which helps explain why communicative disabilities arouse so little interest in the business sector. The diversity of disorders and requirements makes it impossible to develop products that everyone can use. Furthermore, the development of HLT-based products requires considerable investments in basic language resources, and the majority of HLT companies are not in a position to make such investments, especially for languages with a relatively limited market, like Dutch.

The researchers concluded that the Netherlands and Flanders have a wide range of requirements for HLT product and services. They also indicated which ones should be realized in the short term (i.e. synthetic whisper voice), in the mid-term (i.e. high-quality speech training for the deaf and hard of hearing) and in the long term (i.e. automatic lexical simplification of texts). Furthermore, the researchers noted a number of ways in which the business sector could help meet these requirements, such as by localising products, by making them more accessible and flexible, and by offering information and product support. Finally, they pointed out the need for a more extensive programme for action in the mid and long term.

In spite of the difficulties highlighted by Rietveld and Stolte [3], it seems nevertheless that HLT could play an important role in the development of solutions for communicative disabilities. It seems therefore worthwhile to consider how the problems signalled in the above-mentioned report could be surmounted or at least alleviated to try and make it easier for companies to develop HLT-based products.

A viable solution would seem to be an approach similar to the one that was adopted some years ago in the Dutch language area for strengthening the digital language infrastructure [4]. This approach is shortly described in the next section.

3. Basic Language Resources Kit

At the end of the previous century an initiative was launched by the DLU to strengthen the Dutch-Flemish HLT infrastructure. An important element of this initiative was a survey of existing HLT resources at that time, which was carried out by a working group of researchers who in turn were supervised by a steering committee of HLT experts. This committee first defined what the BLARK (Basic LAnguage Resources Kit) should be and then the working group carried out the survey on the availability and the quality of the existing resources.

In defining the BLARK several matrices were used. A distinction was made between applications, modules, and data [5, 6].

Applications: refers to classes of applications that make use of HLT. The following classes were defined: CALL (Computer Assisted Language Learning), access control, speech input, speech output, dialogue systems, document production, information access, and multilingual applications or translation modules.

Modules: refers to the basic software components that are essential for developing HLT applications. A distinction was made between 'Language Technology' modules (such as Morphological analysis, Parsers and grammars, Shallow parsing, Constituent recognition, Semantic analysis, Referent resolution, etc.), and 'Speech Technology' modules (such as Pronunciation lexicon, Speaker identification, Speaker tracking, Utterance verification, Language identification, etc.) [see 5, 6].

Data: refers to data sets and electronic descriptions that are used to build, improve, or evaluate modules. The following types of data were defined: monolingual lexica, multilingual lexica, thesauri, annotated corpora, unannotated corpora, speech corpora, multilingual corpora, multimodal corpora, and multimedia corpora.

In order to guarantee that the survey would be complete, unbiased and uniform, matrices were drawn up by the steering committee describing (1) which modules are required for which applications, (2) which data are required for which modules, and (3) what the relative importance is of the modules and data.

These matrices served as the basis for defining the BLARK. For instance it indicated that monolingual lexicons and annotated corpora are required for the development of a wide range of modules; these were therefore included in the BLARK. Furthermore, semantic analysis, syntactic analysis, and text pre-processing (for language technology) and speech recognition, speech synthesis, and prosody prediction (for speech technology) serve a large number of applications and were therefore included in the BLARK, as well. Note that only language specific modules and data were considered in this survey.

By defining a general BLARK, by identifying which elements were missing in the BLARK, and by analyzing the availability and the quality of the various resources, priority could be assigned to the development of those parts of the BLARK that were considered to be crucial and appeared to be missing. One list of priorities for speech technology and one for language technology were drawn up and were subsequently submitted to representatives from the whole HLT field (about 2,000 people). Definitive priority lists were then produced [5; 7] and submitted to various policy institutions such as the Dutch Ministry of Economic Affairs, the Netherlands Organisation for Scientific Research (NWO), the Dutch Ministry of Education, Culture and Science, the Flemish Institute for the Promotion of Innovation by Science and Technology (IWT), the Department of Economy, Science and Innovation (EWI) of the Ministry of the Flemish Community, and the Flemish Fund for Scientific Research (FWO).

These institutions acknowledged the importance of developing the resources mentioned in the priority lists. Besides, the Dutch Ministry of Economic Affairs decided to carry out an additional study aimed at determining whether some other form of economic support, in combination with the BLARK proposal, would stimulate the HLT sector even more. The results of this study indeed provided interesting insights into how effective action in the HLT sector should be shaped. The view developed [8] appeared to be shared by the other Dutch and Flemish financing institutions, which decided to combine their HLT subsidies in one common research and industry stimulation programme called, STEVIN, which started in 2004 under the auspices of the DLU [9].

4. A new initiative to stimulate the development of HLT applications for communicative disabilities

The success of the STEVIN programme [10] has convinced us that a similar approach with respect to HLT for communicative disabilities is worth investigating. This is also in line with the recommendations by Rietveld and Stolte [3] concerning the more extensive programme for action in the mid and long term.

With this aim in mind the DLU took the initiative of organising a round table conference with experts from the HLT sector and experts from various disciplines covering different communicative disabilities. New target groups are people suffering from dementia and cognitively impaired adults and children. The aim of the conference was to discuss whether an approach similar to 'BLARK / STEVIN' would be feasible for this sector. The initiative DLU had in mind was a survey aimed at identifying a minimum common set of HLT resources that would be useful for developing applications for a number of communicative disabilities, some sort of minimum common denominator. The rationale behind this initiative is that if indeed it is possible to identify such a core of resources that could be employed for developing applications for a wide range of disabilities, then it would be easier to convince policy institutions to finance the development of such HLT resources.

The similarity between this approach and the BLARK / STEVIN one lies in the fact that in both cases priorities are set as to the resources to be developed and that important criteria in setting priorities are multipurposedness and reusability.

4.1. Matrices

At the round table conference mentioned above, a working group of experts was formed, who has the task of investigating whether matrices can be defined that can later be used for drawing up an inventory of HLT resources that would be required for developing applications for people with communication disabilities, as was done for the BLARK for HLT in general. In other words, what we aim at is an overview of the specific needs in terms of applications and related HLT resources to guide policy, research and development and stimulate take-up by industry.

The MATRIX working group discussed the various possible dimensions of these matrices. Below some preliminary results are presented. However, the dimensions presented below may be subject to change, as s result of feedback from the field. This was also the case with the BLARK: during the survey we often had to adjust the taxonomy. Nevertheless, the dimensions presented below indicate that the matrices in this case clearly differ from those used for defining the BLARK. Regarding the applications we discern the following three dimensions:

- the purpose of the applications: diagnosis, monitoring, training, therapy, compensation, and augmentative and alternative communication (AAC).
- the function it concerns: reading, writing, listening, and speaking
- the target group, the disability: visual, hearing, mental / cognitive, motor, neurological, and oncological.

The combination of these three dimensions indicates what kind of applications should be considered. Clearly, some combinations make more sense than others. Nevertheless, these dimensions can be employed for defining (classes of) applications. Concrete examples of applications that appear to be needed are: training systems using speech recognition for dysarthria patients, diagnostic instruments and training material capable of self-adaptation for patients with cochlear implants, automatic recognition of sign language, automatic conversion of speech to symbols, and speech-based applications for cognitively heavily impaired people.

On the one hand we thus have the applications. On the other hand, we should consider which types of HLT are needed for these applications. It turned out that a useful way of looking at the technologies is to consider them as conversions between the following five modalities:

1. Auditive – spoken language
2. Visual 1 – written language
3. Visual 2 – images, animations: symbols, gestures, agents
4. Tactile – Braille, 3D-images (with relief)
5. Cognitive – concepts

To make clear what the relation is between conversions of modalities and (classes of) technologies, some examples are given here:

- 5 → 2 : text (language) generation: e.g. writing tools
- 2 → 2 : text modification, summarizing, indexing, etc.
- 1 → 2 : speech recognition
- 2 → 1 : speech synthesis
- 2 → 4 : text to Braille conversion
- 1 → 1 : speech manipulation, e.g. delayed or frequency-altered auditory feedback (DAF & FAF)
- 2 → 3 : from text to virtual talking heads, agents, gestures, etc.

Also in this case some combinations make more sense than others, but again considering these combinations is useful for defining the possible (classes of) technologies.

A possible fourth dimension is age, since some of the demands will differ depending on the age of the users. For instance, the interface will often differ between age groups, and automatic speech recognition of children is different from speech recognition of adults. However, with age it is difficult to specify the classes: in some cases distinguishing between children, adults, and elderly people could be a useful classification, but in other cases a more detailed classification is needed, and in other cases age is not an important factor at

all. The conclusion is that in making an inventory and priority list one should always keep in mind that age could be a factor.

4.2. Future steps

Once the matrices have been defined, important questions about relevance, availability and assessment have to be answered such as:

- What is the relevance of technologies to applications?
- What is already available, and what isn't?
- What is the quality level, is it suitable?

These results together could then be used to define a priority list that indicates what is most needed and which technologies have the highest priority.

Also in this case it is important that the majority of the actors in the field of communicative disabilities subscribe to the priorities and recommendations identified by the working group. To this end, a provisional report containing the inventory, the priority lists and the recommendations will be submitted to a large number of people active in the field of communicative disabilities, ranging from healthcare professionals, care providers, research centres, universities, health, social service organizations, patient and user organizations, and other stakeholders in this domain. In addition, a serious attempt will be made to involve HLT companies and potential product manufacturers to make them aware of the opportunities that emanate from HLT. The relevant comments will then be incorporated in the report and the same group of people will be invited to participate in a workshop in which the results (priority lists and recommendations) will be officially presented to the public.

On this occasion some people will be given the opportunity to publicly present their views on the results of the survey. The workshop will be concluded with a general discussion between the audience and the panel of experts that were responsible for the survey.

As was the case with the BLARK, the next step will consist in finding funds to finance the development of the resources that have been prioritized. Beside the institutions that are now involved in the STEVIN programme, other policy institutions may be interested in stimulating the development of HLT for communicative disabilities. For instance, many of the resources could be used to develop telecare systems, many of the possible products and services may be relevant for health telematics and could contribute to cutting down health expenditure while maintaining the same level of quality in health care. In addition, since a number of communicative disabilities are related to growing older, the number of people with communicative disabilities is likely to increase as a result of the ageing population. HLT applications will then play an important role in ensuring non-invasive personal assistance and independent living, in improving or maintaining functional abilities, in enhancing productivity and in improving the quality of life. Therefore, it is to be expected that health institutions may also be interested in supporting a stimulation programme in the domain of HLT and communicative disabilities in which government, industry and academia cooperate.

5. Conclusions

The Dutch Flemish STEVIN programme for HLT constitutes a good example of co-operation between governmental bodies, academia and industry to stimulate resource development, strategic research, knowledge transfer and eventually innovation and take-up by the HLT industry in the Netherlands and Flanders. In the field of HLT and communicative disabilities there is even more need for such a programme because in this case the market is even smaller, the needs and abilities are more heterogeneous and the user groups are smaller. A comprehensive stimulation programme supported by government, industry and academia would contribute to reducing the barrier of fragmentation that clearly characterizes this field and to making industry, politicians and users aware of the new market opportunities offered by this sector.

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