

Vocabulary Management in Modular Interpersonal Communication Aids

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Abstract. This paper describes a system for lexical knowledge representation and retrieval in interpersonal communication aids, developed in the context of an innovative modular architecture for the design and development of functionally adaptable interpersonal communicators. This module supports user language adaptability, and communication between users of different languages.

Keywords: *Augmentative and alternative communication (AAC), modular architecture, lexical knowledge, lexical translational equivalence.*

Introduction

Effective and efficient utilisation of Interpersonal Communication Aids by non-speaking persons needs to address user abilities, requirements and preferences at the levels of: (i) communicative and linguistic resources, providing each user with an appropriate orthographic or symbolic language and a corresponding vocabulary set, (ii) system functionalities necessary for the user to be able to communicate in different social environments, (iii) access to the communication aid user interface matching user motor, sensory and cognitive abilities.

The variety and diversity of user requirements is particularly difficult to satisfy in a general way, since individual user characteristics may vary significantly, and in principle each user may require a communication device specifically tailored to her/his specific circumstances. Technology advancements have led to the development of a wide variety of communication devices, some of which allow a certain degree of adaptation to user requirements. However, at present, the majority of available products are oriented towards providing solutions to specific communication problems of specific users, or user groups.

The TIDE-ACCESS TP1001 Project has introduced methodologies and tools which have led to the emergence of a general-purpose methodology enabling the design and implementation of highly adaptable communicators at the level of the user interface, device functionalities and user language ([8]). The project focused on the elaboration of methodologies and tools for the development of unified user interfaces, adaptable to different user abilities, requirements and preferences ([10], [9]).

An innovative approach to the development of Interpersonal Communication Aids, named «Access To Interpersonal Communication» (ATIC) has been proposed, promoting resource sharing and reusability ([4]). Several modules compatible with the proposed architecture have been developed and integrated into demonstrator communication aids for speech-motor and language-cognitive impaired users ([5], [6]). One of the important modules is the User Vocabulary Definition and Meaning Mapping Module (UVDMM

Module), a multilingual lexical knowledge base containing information related to both orthographic and symbolic user languages, which exploits Natural Language Processing and Machine Translation techniques to ensure the unified and consistent linguistic treatment of user languages. The Module facilitates the tailoring of Interpersonal Communication Aids to the individual user requirements concerning language and vocabulary, and communication between users understanding different languages.

1. The ATIC Modular Architecture

The design and development of currently available communication aids suffers from the lack of a general technical solution facilitating the implementation of user-adapted and functionally flexible systems ([2], [3], [7]). An ideal solution would be one that meets individual user requirements by exploiting their abilities and avoiding the introduction of unnecessary functionality. However, it is not practical for developers to construct many user-specific systems, nor to develop all-encompassing systems that can be configured to meet individual needs. In the first case the main drawbacks concern the overall development cost, while in the second case, the resulting communication aids can be impractically complex.

The ATIC approach offers a new development framework consisting of a novel modular software architecture upon which communication aids can be built and a set of software tools providing a high degree of flexibility, both during implementation and at runtime. The ATIC architecture supports the design and development of interpersonal communication aids that are flexible, adaptable to a variety of user requirements and easily developed and adjusted. It has been based on an in-depth analysis of the technical specifications and functionality of currently available communication aids and a thorough investigation and understanding of the requirements of various user groups.

According to the ATIC approach, a communicator is a system providing a number of functions and/or services dependent on the particular user-needs, abilities and cognitive level. Each function may be implemented independently, either as a separate entity, or as a set of elementary services. The communicator consists of a set of such entities (modules), which may be developed separately as individual components and then assembled in order to constitute a system that meets specific user needs. A module, or a set of modules is responsible for the implementation of a function, or service in a way transparent to the architecture and the communicator itself. Multiple components, which may be implemented independently by different developers, can cooperate provided that some basic principles (i.e. the communication protocol and functional behaviour of an underlying common architecture) are respected.

The ATIC architecture follows a modified «client-server» model (Figure 1). A specific

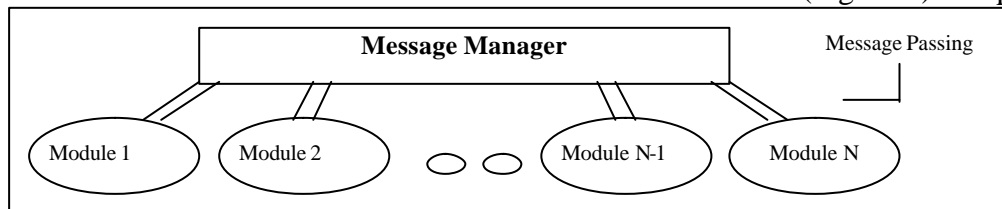


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module, called the Message Manager, undertakes the task of requesting and providing a service by controlling the communication between the client and the server (no direct communication between modules is allowed). The «client» does not need to know which module(s) provide the requested service, but only of the existence of the service itself.

Therefore, a communicator based on the ATIC architecture will be composed of a set of modules providing the required services and a Message Manager. Every module represents a component of the communicator, which can be regarded at any given time as either a «client» or a «server». The specific set of modules that may comprise a particular communicator, depends on the specific functionalities the communicator will be expected to have. Typical modules of a communicator are ones that provide functionality appropriate for: symbol selection, sentence reception, sentence composition and editing, rate enhancement, sentence transmission (with sub-modules: remote, voice output [digital play-back or text to speech], printer, screen etc). Each module has its own configuration facilities and an appropriate user interface (if required). A variety of modules can be added, for example symbol editor, language training, etc.

2. The UVDMM Module

An important aspect of adaptability in communication aids concerns the selection of an appropriate language and vocabulary set for each user, without excluding communication with users of different languages. We refer to the combination of a linguistic form (either orthographic or symbolic) with a lexicon set as *user language*. An almost infinite variety of orthographic or symbolic user languages can be used in Interpersonal Communication Aids, ranging from a subset of a universal language such as English or Bliss, or the whole Pictograms symbol set, or a small collection of pictures representing objects familiar to the user, etc. The more appropriate language for each user has to be carefully selected taking into account the user's basic requirements and her/his communicative and linguistic capabilities. Furthermore, communication between users understanding different languages may become very complicated, unless some form of translation is provided. Current communication aid systems offer only very limited support to both user language configuration and translation between user languages. This is due to the fact that user languages in communication aids are conceived simply as collections of lexical items, with little or no associated information and no structural organization of the lexicon ([12]).

Providing system assistance to facilitators and users in accomplishing vocabulary related tasks requires encoding lexical knowledge and making it easily and effectively available to all Communication Aid functions which may require it. The UVDMM Module, designed and implemented as an ATIC compliant module, is a knowledge base containing lexical information related to symbolic and orthographic user languages (Figure 2). It fully encapsulates all the functionality and storage / retrieval facilities required for its operation and is therefore totally independent of external services, and can therefore be integrated in any modular or component based architecture. The lexical knowledge base has been designed for satisfying the specific requirements of user language management in Interpersonal Communication Aids (i.e. multifunctionality, multilinguality, ease of extension).

In the UVDMM Module, lexical knowledge is represented by means of a type feature structure representation language (the Attribute Logic Engine, developed at Carnegie

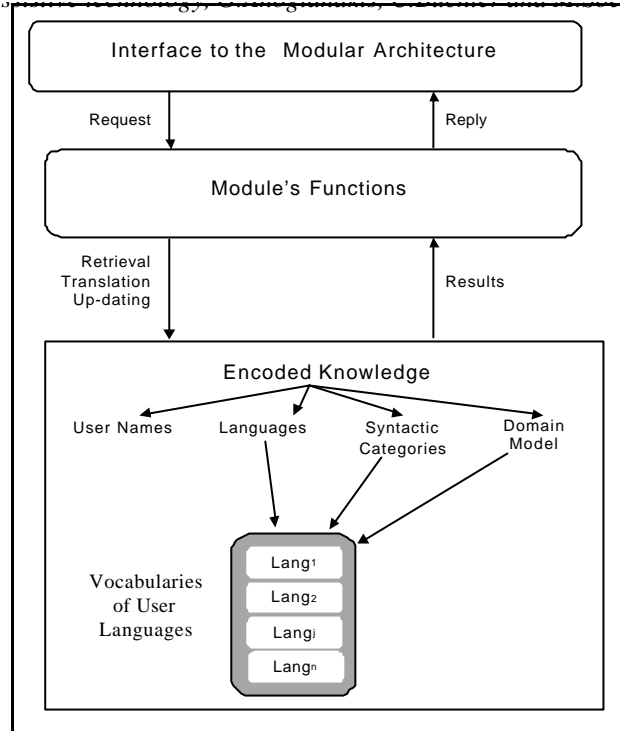


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Mellon University and available for research purposes, [1]). Among other information, the UVDMM Module includes a simple hierarchical domain model for common

communication topics like food, family and people in general, house equipment, weather, etc), which is exploited for deriving semantic relations between lexical items and establishing lexical translation relations. Other actually encoded knowledge concerns some basic characteristics of user languages (orthographic vs. symbolic, etc) and part of speech categories. Lexical entries in each vocabulary contain features representing parts of speech and domain model concepts. Small vocabularies for two orthographic and two symbolic languages (English, Finnish, Bliss and Pictograms) have been implemented ([11]).

The UVDMM Module functionalities include various forms of retrieval and view of lexical entries and domain model entities and sub-hierarchies, retrieval of translationally equivalent lexical items, and up-dating facilities for creating or modifying user languages and related vocabularies. The Module's functionalities can be called by other Communication Aid modules in order to support various types of interaction with user language vocabularies and communication between users of different languages. For example, in the language configuration module, the functionalities of the UVDMM Module can be used in order to enable the user's facilitator to get information about available user languages, to consult vocabularies by means of various retrieval criteria and to use the retrieved information for the creation/modification of user languages. In the communication module, the retrieval functions may be exploited for allowing the non-speaking users to easily access their vocabulary, while lexical translation relations offer the possibility of establishing some form of communication between users understanding different languages.

Conclusions

Work carried out on Interpersonal Communication Aids in the framework of the TIDE-ACCESS TP1001 project has provided methodologies and tools for the design and implementation of devices adaptable to user abilities, requirements and preferences at three levels, namely user interface, communicator functionalities and user language.

The design and implementation of the ATIC architecture offers the potential of a number of considerable advantages such as modularity, enhanced functionality, independence of vendor and programming language, cost-effectiveness, independence from service implementational details, possibility of "loading" or "unloading" individual modules at any time, possibility of incorporating easily new modules, and possibility of integrating the applications developed in other domains, such as, for example, environmental control.

The introduction of multilingual and hierarchically structured lexical knowledge in the design and operation of modular communication aids constitutes an innovative step with respect to current practice, and enables the adaptability of the system to user requirements related to vocabulary, and communication between users of different languages. In the context of the ATIC Modular Architecture, the UVDMM Module provides a unified source of lexical knowledge available to all other modules in the architecture. Due to its design characteristics, this Module can be easily extended to cover a larger domain model, larger vocabularies and other types of linguistic information exploitable for the addition of further functionalities such as, for example, rate-enhancement techniques.

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