SOTAC: A Software for Knowledge-Based Automatic Translation

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Abstract: This paper presents an analysis for the SOTAC (Software of Automatized Translation based on Knowledge), which aims to automatically translate texts based on knowledge. It is presented the project and a prototype of a system for authorship and use of automated translators to support the translation. The presented prototype of SOTAC allows the manipulation of the elements used in the process of machine translation and the automatic translation of texts in a source-language. The translated output is provided in a target-language and can be presented either in the form of text, video, or audio. The paper also presents an analysis of usability, navigability, functionality and complexity of the system. It is also discussed the flexibility of the SOTAC system, as well as its capacity of integration with other existing technologies.

Keywords: Machine translation, translation memory, formal languages, grammatical inference, Libras

1. Introduction

The auditory deficient (AD) people demand for access to information resources, particularly resources for learning support. Some legal support have been proposed to meet some basic needs of these people, but little was really done to bring such support to them. Although AD children who study in literacy schools have the right to an interpreter to follow them up, in practice, schools are still reluctant to accept those students because of the cost and difficulty to maintain interpreters (Breda, 2005).
Currently, the use of multimedia mechanisms for communication has made a very strong growth and thus new tools and features frequently appear. However, there is a lack of information organized in a more precise way and targeted to AD people and interpreters specialized in Libras, which is the Brazilian Sign Language. The work of those interpreters, currently, has been extensive because of how the information they use are generated and transmitted.

The interpreters act as intermediaries of information in situations that require an interpretation, either from Portuguese to Libras or from Libras to Portuguese. Some of these situations require a previous preparation in order to obtain specific vocabulary, which requires time and hard study. The materials used are often the digital and bilingual (Portuguese-Libras) dictionaries. These resources have many limitations regarding the dynamic support and information storage (Tavares, Coradine, Breda, 2005).

There is a very important law for the integration between AD people and listeners, which formalizes the Brazilian sign language as one of the official languages in Brazil (Libras - LAW N. 10,436 in April, 24th, 2002). With the opportunities offered by this law, many inclusive approaches have started, such as the Falibras project, designed and coordinated by Luis C. Coradine, from the Federal University of Alagoas (UFAL) (Coradine et al., 2002) (Coradine et al., 2004). This project aims to translate the audio captured by the computer microphone, to the appropriate animations in Libras. For this, the system has two stages of processing: first, the audio captured by the microphone is converted to text in Portuguese; second, the text is translated into sequences of videos. Many advances have been possible with Falibras's approach, which facilitates the social integration due to the use of computational tools and technologies for the development of systems capable of translating audio to videos in Libras. Falibras's initiative spurred a wide range of new multimedia tools and features which intended to meet the specific audience, specially in which regards the teaching-learning process (Tavares et al., 2006) (Coradine et al., 2007).

Aiming to improve the features of this larger project called Falibras, we have designed and implemented various complementary tools. Among these tools, there is the Falibras-MT translator (Breda, 2005) (Tavares, Coradine, Breda, 2005), which aims to provide authorship when using an automatic translator based translation memory. This system allows users to build automatic translators from Portuguese texts to Libras, as well as to manage translation memories and dictionaries in order to provide an accurate output. In the case of interpreters specialized in Libras, the Falibras-MT system provides a more dynamic support on the management and use of translation information in order to facilitate the daily work. Moreover, the Brazilian sign language grammar is not yet formalized and is influenced by many regionalisms. So, the translation memory technique to support the automatic translation from Portuguese to Libras is very appropriate. This technique allows the selection of domain-specific dictionaries and other important characteristics, such as the fluency and pragmatic of the languages involved (Tavares, Coradine, Breda, 2005).
During the development and maturation of these projects, there was the possibility of creating a system capable of inferring correlation between grammatical patterns from Portuguese to Libras considering the examples stored in the translation memory of Falibras-MT. Thus, it is possible to generate more general descriptive grammars of Libras, as well as improve the efficiency of translators. In the context of interpreters and AD people, this system supports the language learning, both Libras and Portuguese. We have also observed the possibility of generalizing the translation process in order to enable the translation from any written-language to any target language (either written, spoken, or signaled). This generalization can be also applied to the grammatical inference process, which allows us to infer the translation rules from the examples contained in the translation memory. So, although the Falibras-MT uses translation memory to translate texts in Portuguese to signals in Libras, the mechanisms used by the translation does not limit the languages involved, but only the format of input and output of languages. The SOTAC is compliant with this generalization, but it remains focused on the translation from Portuguese to Libras as a case study for both automatic translation and grammatical inference.

The rest of the paper is structured as follows. Section 2 presents an analysis about the characteristics of the SOTAC tool. Section 3 presents some discussion about the applicability of SOTAC in order to support the resolution of real problems. Finally, Section 4 presents some conclusions and directions of future work.

2. Software Analysis

This section presents a preliminary analysis of the features contained in SOTAC. We analyzed the following aspects of the tool: usability, navigability, functionality and complexity.

**Software Description.** Figure 1 presents the use case diagram of SOTAC following the UML notation. There are three actors in the system: Collaborator, Default User (shown in the diagram as AD) and Administrator. The first interaction between a used and the system is the login window presented in Figure 2. In this window, the user informs his login and password and then chooses one of three options: confirm the information and execute the login; access system settings; or exit the application.

**Administration Module.** When an administrator is logged in the system, it will be forwarded to the task selection window. In this window, the Administrator has three options: switch user, exit the application or choose a task, which consists on managing either the system setup; user accounts; or grammatical classifiers.
Figure 1. Use cases of SOTAC (in UML)

Figure 2. Login Window

**Configuration Module.** Figures 3, 4 and 5 present the three tabs of the System Configuration Window, in which the user has three options: select a tab, confirm the system settings and return to the previous window. The customization of the settings can be done by any user of the system, even if the user is not Administrator.

In the Connections tab shown in Figure 3, the user can enter or modify the information needed to establish connection with a database of translation memories and also test the connection.
In the Video tab shown in Figure 4, the user can enter or change the directory where the videos contained in the database are stored into. It is also possible to inform or modify the video file which is presented in case of error.

In the User tab shown in Figure 5, the user can change his access password with no administration privilege.
**User Registering Module.** Figure 6 presents the User Registering window and the context menu with all the options available, as well as their respective icons and shortcut keys. Here, the Administrator can add, modify and delete other users.

![User Registering](image1)

**Figure 6. User Registering**

**Grammatical Classifiers Management Module.** Figure 7 shows the window of the Grammatical Classifiers Editor and the context menu with all the options available, as well as their respective icons and shortcut keys.

![Grammatical Classifiers Editor](image2)

**Figure 7. Grammatical Classifiers Editor**
In this window, the administrator can add, modify and delete the grammar classifiers. Only the Administrator can manage the grammatical classifiers, which are dependent on the source and destination languages involved in the translation. In the context of this paper, the source language is Portuguese and the destination language is Libras. Moreover, these processes can be very lengthy because they influence many records of different database tables and also affect the work of other users (possibly in progress). The Administrator is responsible to manage such situations involving synchronization of concurrent processes.

**Text Translation Module.** When a Default User accesses the application, he is directed to the Text Translation window presented in Figure 8. Then, the user can select a translation memory among the available memories in the database, enter a text in the source written language (e.g., Portuguese) and ask for translation to Libras. After the translation, the field "Símbolos em Libras" will contain a partial translation of the final text, which in our case contains identifiers to the signals of the Brazilian sign language. Finally, the videos of signals will be displayed in the "Media Player" area. Several other features are also available for the user.

![Figure 8. Text Translator Window](image)

When a Collaborator logs into the application, he may choose one of two tasks: translating texts or managing translation memories. Even during the system execution, the collaborator is able to switch between the tasks of text translation and translation memories management, which facilitates the test of the knowledge embedded into the translation memory. This option is not available to default users.

**Translation Memory Management Module.** In this window, the Collaborator can access the main menu of the editor, as well as the four dictionaries tabs: symbols dictionary; videos dictionary; rules dictionary and terms dictionary. Moreover, it is also possible to access the system navigation on-line help options. In the Symbols Dictionary Option window (Figure 9), the
Collaborator can manage the content of the symbols dictionary of the translation memory.

![Figure 9. Symbols Dictionary Window](image)

In the Videos Dictionary Options window, the Collaborator can manage the contents of the videos dictionary of the translation memory. Through this option, the Collaborator can edit the field "Seqüência de Vídeos" (Video Sequence) in order to choose the respective files used in a phrase.

Regarding the Rules Dictionary Option window, the example presented in Figure 10 shows that when the system is not able to neither automatically translate nor grammatically classify a term by inference, it asks those data to the Collaborator in order to update the dictionary. This is a Rule Dictionary Option.

![Figure 10. Grammatical Classification and Translation](image)
Finally, the Collaborator can also add a new grammatical classifier with no interference of the Administrator.

Two other options are possible. First, the Terms Dictionary Options, which allows that the Collaborator manages the contents of the terms dictionary of the translation memory, as well as add a new grammatical classifier. Then, if the Collaborator has requested the inference process in the rules dictionary tab, this window will be automatically filled with all the additional terms whose grammatical classification and translation were informed to the system by the Collaborator. Please note that the grammatical classifications may be changed, but not the grammatical classifiers. Another is The Merge Dictionary Option, which the he SOTAC tool also allows dictionaries of different translation memories to be merged. The Collaborator can do this by adding and deleting merging links.

3. Applicability of SOTAC

Besides the friendly user interface, the SOTAC tool is a very flexible platform, which is able to build and use a knowledge base of language translation via multiple users.

The translation activity from Portuguese to Libras, for example, would allow deaf students discuss among themselves and with the teacher the meaning of words in Portuguese, as well as identify the structures and forms of sentenced in Libras and the more appropriate signals to represent the ideas recorded in the text. The repetition of this activity proportionates the enrichment of linguistic knowledge of both Portuguese and Libras.

This activity should be further enhanced by the use of translation memory, since it is possible to store the translations chosen by groups of students. These memories can be analyzed by students, either individually or collectively. When these redefinitions are registered individually, there are opportunities to discuss them at the classroom, thereby generating new learning opportunities.

Another important application of SOTAC is support the teacher on monitoring the learning of each deaf student by analyzing the individual translations registered in the translation memory.

Finally, the more SOTAC tool is used, the greater the translation memory is. This database can be used as a valuable reference for increasing the knowledge of the teachers about Libras.

In addition to the pedagogical applications detailed above, we aim that other benefits can be achieved by using SOTAC: (1) support the learning of a second language; (2) support activities of cultural and social inclusion, especially in the case of people with special needs, such as deaf and blind people; and (3) promote the development of language and thought.
4. Conclusions and Future Works

This paper has presented the SOTAC tool, a software for knowledge-based automatic translation, which allows that a textual input be translated to a second language. The output can be provided either in the form of text, audio, video, or a combination of them.

The paper has also presented the potential of SOTAC to provide pedagogical support in classrooms. In the context of this paper, the usage of SOTAC has been instantiated to translations from texts in Portuguese to video in the Brazilian Signaling Language (Libras), which is officially used by deaf people in Brazil.

The flexibility of SOTAC should facilitate the evolution of the system, especially activities of expansion and functional integration with other technologies. For example, SOTAC could be receiving the output of softwares for speech recognizing. Moreover, other existing technologies such as avatars and text-to-speech can also be integrated to SOTAC.

References