

# DEVELOPMENT AND EVALUATION OF A 3D VIRTUAL TUTOR FOR MACEDONIAN SIGN LANGUAGE

S. Koceski, N. Koceska

Faculty of Computer Science, University Goce Delcev – Stip, Republic of Macedonia  
saso.koceski@ugd.edu.mk, natasa.koceska@ugd.edu.mk

**Abstract** - According to the National association of deaf and hard of hearing of Macedonia, there are around six thousand deaf persons, and they are representing about 0.3% of the total population. According to the reports of the same association, there are two schools for deaf children and only twelve certified sign language interpreters at national level. Considering also the fact that 90% of deaf children are born to hearing parents who may not know sign language or have low levels of proficiency with sign language, it is evident that there is a huge problem in education of deaf children. They necessitate permanent access to education tools even at home in order to develop language skills. For this purposes we have developed 3D virtual tutor for Macedonian Sign Language (MSL) using Java programming language, compatible with desktop computers and mobile devices. It is composed of two modules: module for learning the alphabet and module for learning individual words. This software was evaluated by two categories of users: deaf persons, and non-deaf persons. The results of this evaluation are reported in the paper.

## I. INTRODUCTION

Deafness is a term used to cover the whole range of hearing loss from mild to profound. The level of deafness is defined according to the quietest sound, measured in decibels that a person can hear. According to Macedonian law, a deaf person is considered a person with hearing impairment above 80 decibels and is unable to hear sounds even when a sound is amplified. First or preferred language of this category of people is a sign language. It is a non-verbal language used by deaf and hard of hearing people as a primary natural means of everyday communication and mutual intercourse. Information is conveyed visually, using a combination of manual and non-manual means of expressions. The manual parameters are hand shape, hand posture, hand location and hand motion. The non-manual parameters include head and body movements, facial expression, and lips movement.

The grammar of the sign language differs from the spoken one. The structure in spoken language

is linear, one word followed by another, whereas in sign language, a simultaneous structure exists with a parallel temporal and spatial configuration.

The hand is an essential tool, which is used in communication with sign language. Characters are represented in a particular movement and a certain set of one or both hands.

However, not any gesture has a meaning. The significance of the sign is determined with the basic elements that need to be taken:

- The placement of hand - positioning of the fingers of the hand or both hands
- Movement of the hand or both hands
- Position-location of the sign in sign space
- Orientation of the palm of the hand.

Sign language is not universal, it differ from country to county. Unlike the bigger countries that pay great attention to this category of people, in Macedonia unfortunately this community is highly marginalized. According to the National association of deaf and hard of hearing of Macedonia, there are around 6000 deaf people deaf persons, which represent about 0.3% of the total population, and only 12 licensed interpreters of the Macedonian Sign Language (MSL) [1]. It is very difficult to find the suitable materials for learning the MSL. There are no e-books, videos or any other type of online content that can help learning the MSL, which is very important in the era of digitalization. Moreover, there are only two schools for deaf children in Macedonia, so when a deaf child is born by non-deaf parents, the learning of the sign language represents a real challenge that affects the whole family. This is the reason why we decided to develop 3D virtual tutor for Macedonian Sign Language. In this way we want to contribute, and at same time to highlight the importance of learning the MSL, which will

facilitate social integration of this category of people.

## II. MACEDONIAN Sign LANGUAGE (MSL)

The Macedonian sign language is based on hand and body gestures, as all the other sign languages. The hands are the basic communication means. The signs are performed with predefined movement and location using one or both hands.

The Macedonian sign alphabet consists of 31 signs, the same number of letters that Macedonian alphabet have. There are two versions of the alphabet: one version is signed using only one hand and the other is using both hands. Figure 1 shows the MSL alphabet signed with one hand, while Figure 2 shows the MSL alphabet signed with two hands.

MSL vocabulary is estimated to be around 2800 signs, including the alphabet.

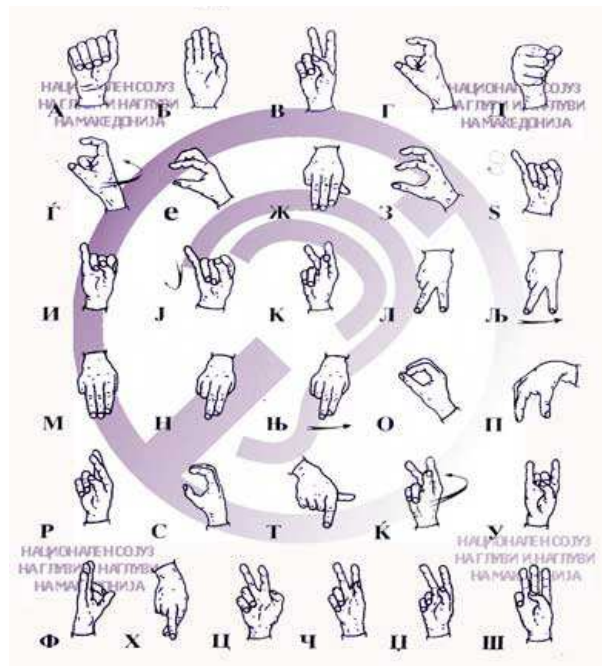


Figure 1. MSL alphabet signed with one hand.

## III. RELATED WORK

One of the key components of any sign language training resource is presentation of the signs themselves. The possible presentation styles usually are in-person, print-based, videotape, and computer/CD-based.

Today with the rapid technology development a new ways of learning sign language appeared. There are research groups, which are focusing their research on improving communication using the visual technologies to translate sing language

into text with devices like mobile phones, such as Mobile Motion Gesture Design for Deaf People [2]. Other research groups are converting text [3] or audio into sign languages. Such examples include Mobile Multimedia Application for Deaf Users [4] and the Lip Assistant [5] that translates the audio signal into animated face so the deaf users can use lip-reading. Another direction of research concentrates on the learning process of the sign languages. Examples of this type of research are the System for Sign Language Tutoring [6], which evaluates users' signing and gives multimodal feedback to help improve signing, 3D Animation Editor and Display Sign Language System for Thai Sign Language [7] - for learning a deaf person with Thai Sign Language and SignOn - a Model for Teaching Written Language to Deaf People [8]. There are also some commercial products on the market like Vcom3D Sign Smith products, which use avatar for signing the American SL. They offer the products like Illustrated Dictionary, Studio, ASL and Signing Science Dictionary [9].

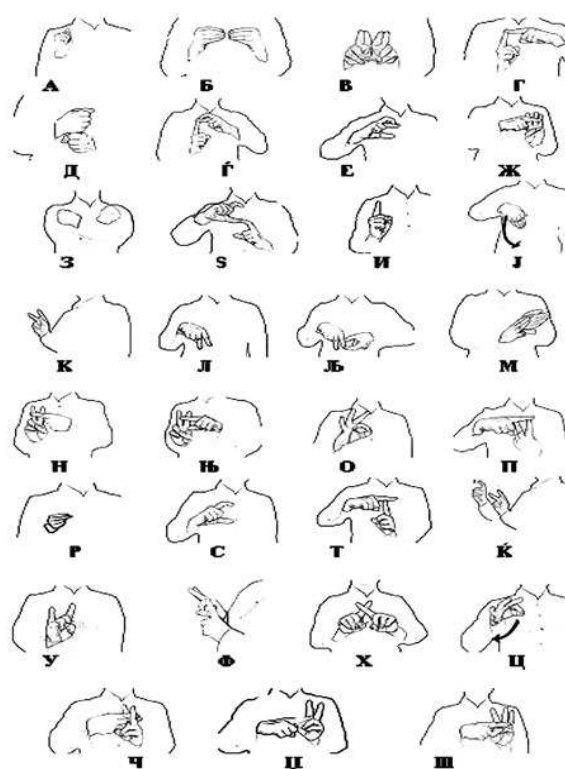


Figure 2. MSL alphabet signed with two hands.

## IV. 3D VIRTUAL TUTOR

Learning sign language presents significant challenge especially to hearing people due, in part, to the difference in language modality, visual vs. aural [10]. The hearing sign language learner must

shift from “listening for language” to “looking for language”. Hearing people, when learning sign language, have much more difficulty recognizing signs than producing them [11]. Therefore, the opportunities to practice sign recognition are a necessity.

3D virtual tutor for Macedonian Sign Language is developed to help non-deaf persons to learn the sign language. Developed using Java programming language, this application is compatible with desktop computers and mobile devices. The current application is composed of two modules: module for learning the alphabet and module for learning individual words. Module for writing sentences is intended to develop in the future.

Figure 3 shows the user interface design of a developed application. It consist of two part, one is for selecting a category for learning signs, and the other part is reserved for a 3D animations of a girl (avatar) that signs the chosen alphabet character or word.

First, user should select a category – letters or words. If a letter category is selected, a list of all letters from Macedonian alphabet is displayed. The user should select one letter, and the avatar will present this letter using a sign language.

The words category is divided in several subcategories containing words used in everyday situations. When a user selects a words category, he/she should also select sub-categories, like relations between people, food/beverage, feelings, seasons, travel/transport, sports/entertainment, professions, object etc.

Then a user should select a particular word from this sub-category, and the avatar will show this word using a sign language.



Figure 3. User interface of 3D virtual tutor for MSL

## V. EVALUATION AND RESULTS

To evaluate the effectiveness of our work, we have conducted two user tests: a test with the deaf persons (who know the sign language and who used it in everyday life), and a test with non-deaf persons (who did not know the language and who want to learn it).

Since MSL is a visual language, it is particularly important for performed animations to be visually realistic, recognizable, and comprehensible. Because of this, we have conducted the test with the 7 deaf participants, who used frequently the MSL. Animations showing different signs (letters or words) were presented to the participants. Max. number of presentation for each sign was 3 times. Participants were asked to rate each animation on a 10-point Lickert scales for understandability, naturalness of movement, and grammatical correctness. These three categories were chosen because we believe that the understandability of the animation is a key criterion, and that the grammatical correctness and naturalness are factors that can contribute to the understandability. This can help to identify possible problems in the animation portion of the system, and will help us for its refinement.

Participants were given instructions about how to respond to each of the survey question. For grammaticality, they were told that “perfect MSL grammar” would be a 10, but “unacceptable/mixed-up” grammar should be a 1. For understandability, they were told that “easy to understand” signs should be a 10, but “confusing/mixed” signs should be a 1. For naturalness, they were told that animations in which the signer moved “smoothly, like a real person” should be a 10, but animations in which the signer moved in a non-natural manner “like a robot” should be a 1.

Participants were also told to write down each sign that was presented, as they understood it.

The results of this test are shown on Figure 4.

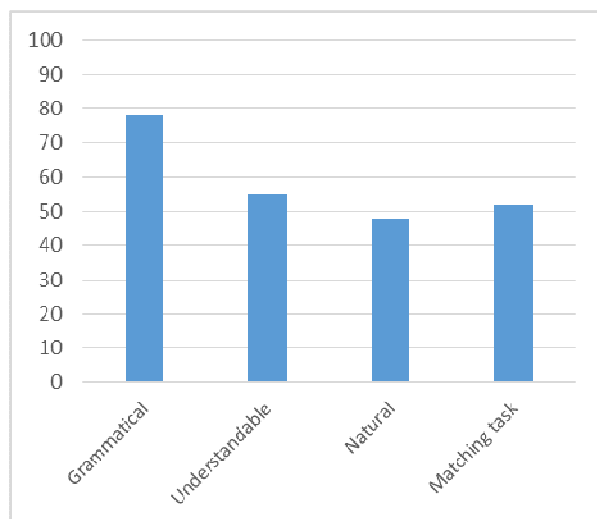


Figure 4. Results from evaluation with deaf participants.

Having in mind those comprehensibility levels of the currently evaluated avatars regarding the sign language is 58-62%, with only a single study reporting 71% [12]; the 51% of matching task in our test is considered a relatively good. This gives us confidence that our overall approach is effective. However, the animations still need improvements to obtain a more natural and grammatically correct movement of the animated person. The animation speed should be corrected, as almost all of participants said that some animations were very slow. Most improvements should be done on non-manual parameters: head and body movements, facial expression, and lips movement. Body movement should seem more loose/relaxed and should move more naturally in order to correspond to the specific sign. A facial expression and mouse movement should be integrated too.

The second test was conducted with non-deaf participants who did not know the sign language. The purpose of this test was to evaluate the effectiveness of our application as a learning tool, for people who wanted to learn MSL. The evaluation includes two phases: first was the learning phase and the second was the testing phase.

During the learning phase, ten participants (ages 30 to 50) have been given the opportunity to learn and practice MSL from a predefined library. They have been used the developed application, for one month, after which the testing phase was conducted.

During the testing phase, participants were shown animations of signs from a set of signs that were studied during the learning phase. They were

told to select which of the three choices that were given to them on paper, matched the sign presented with the animation.

The results of this test are shown on Figure 5a and on Figure 5b (presented results show only a limited number of letters and words).

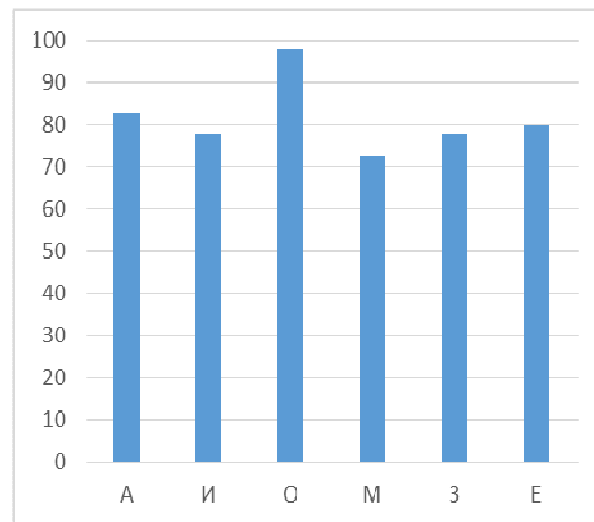


Figure 5. Results from evaluation with non-deaf participants - learning letters.

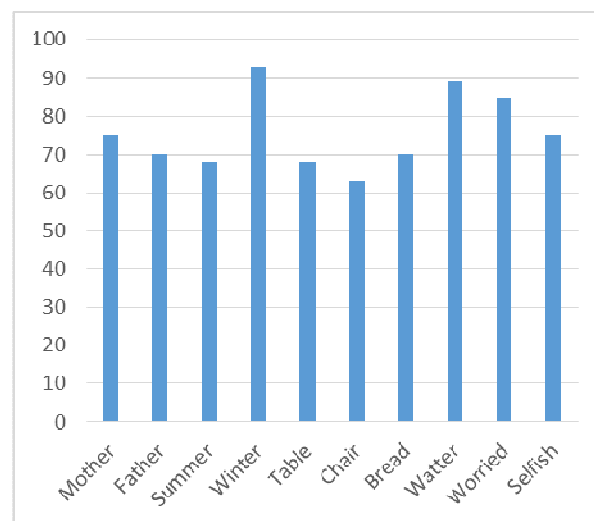


Figure 6. Results from evaluation with non-deaf participants - learning words.

The results have shown high recognition rate by non-deaf users, which mean that this type of application can be used as a tool for learning the MSL. Of course, the results in this test are very subjective since they depend on learning capacities of each person.

## VI. CONCLUSION

The use of IT tools for learning sign language is not new. However, using signing avatars is a relatively young research area, with only a few

ongoing projects for learning the MSL. With this research, we want to give a contribution to this new field, developing a 3D virtual tutor for MSL using Java programming language. The effectiveness of the developed application was tested with deaf persons, who have been used the sign language frequently, and non-deaf persons, who used the developed application for learning the sign language.

Results have been shown a relatively good recognition rate by the two categories of users gives us confidence that our overall approach is effective. However, the animations still need improvements to obtain a more natural and grammatically correct movement of the animated person.

A positive opinion, about this kind of applications, expressed by all participants, is encouraging and gives us an additional stimulation for further work.

#### REFERENCES

- [1] National association of deaf and hard of hearing of Macedonia, <http://www.deafmkd.org.mk/>
- [2] Xue, H., Qin. S.: Mobile motion gesture design for deaf people. In: 17th International Conference on Automation and Computing (ICAC), pp.46-50. (2011)
- [3] Grif, M., Demyanenko, A., Korolkova, O., Tsoy, Y.: Development of computer sign language translation technology for deaf people. In: 6th International Forum on Strategic Technology (IFOST), Volume 2, pp.674-677. (2011)
- [4] Tihanyi, A.: Mobile multimedia application for deaf users. In: ELMAR, pp. 179-182. (2007)
- [5] Xie, L., Wang, Y. and Liu, Z.-Q.: Lip Assistant: Visualize Speech for Hearing Impaired People in Multimedia Services. In: IEEE International Conference on Systems, Man and Cybernetics, Volume 5, pp.4331-4336. (2006)
- [6] Aran, O., Ari, I., Akarun, L., Sankur, B., Benoit, A., Caplier, A., Campr, P., Carrillo, A.H., Fanard, F.-X.: SignTutor: An Interactive System for Sign Language Tutoring. Multimedia, IEEE, Volume: 16, Issue: 1, pp. 81-93. (2009)
- [7] Ittisarn, P.; Toaditthep, N.: 3D Animation Editor and Display Sign Language System case study: Thai Sign Language. In: 3rd IEEE International Conference on Computer Science and Information Technology (ICCSIT), Volume 4, pp.633-637. (2010)
- [8] Hilzensauer, M., Dotter, F.: "SignOn", a model for teaching written language to deaf people. In: This paper appears in: IST-Africa Conference Proceedings, pp.1-8. (2011)
- [9] Vcom3D, "Sign smith," [retrieved: May, 2015]. [Online]. Available: <http://www.vcom3d.com/signsmith.php>
- [10] Poor, G., & Wilkins, D. (1986). Sign Language Instruction with a Pre-production Phase. In Padden, C.A. (Ed.). Proceedings of the Fourth National Symposium on Sign Language Research and Teaching, Las Vegas, NV, January 27-February 1, 1986 (pp. 134-144). Silver Spring, MD: National Association of the Deaf.
- [11] Tennant, R. & Brown, M. (1998). The American Sign Language handshape dictionary. Washington, DC: Clerc Books.
- [12] Kennaway, J.R., Glauert, J.R.W., Zwitserlood, I.: Providing signed content on the internet by synthesized animation. ACM Transactions on Computer-Human Interaction (TOCHI) 14(3), 15{29 (2007).