

Development of Simultaneous Translation Algorithm for Sign Language: An Example of International Language

ÖzerÇelik¹

¹(Department of Mathematics and Computer Science, Eskisehir Osmangazi University, Turkey)

Abstract:

Background: The sign language is used by 466 million hearing impaired and deaf people all over the world. It is aimed to develop a system that translates the text into sign language in order to enable individuals with hearing disabilities to better adapt to social life and lead a life without disabilities.

Materials and Methods: Sign language dictionary was created by identifying words in American Sign Language (ASL). Sign language animation videos of the words in the prepared dictionary were created. Morphological analysis was done using natural language processing (NLP) algorithms to identify surface forms, suffixes and the roots of words in a particular sentence and to adapt the sentence to ASL.

Results: By analyzing the structure of ASL, an algorithm has been developed that converts English text into ASL. As a result of the morphological analysis, the words whose roots are detected and the videos of all the items in the sentence to be translated are pulled from the database and combined and played. Thus, the translation system of the text to ASL was created.

Conclusion: It is thought that people with hearing impairment who do not understand what they read can improve the quality of education and life with the text-to-sign translation system.

Key Word: American sign language(ASL); Natural language processing (NLP); Sign language.

Date of Submission: 20-03-2020

Date of Acceptance: 06-04-2020

I. Introduction

Sign language is a visual language created by hearing impaired individuals using their gestures and facial expressions while communicating among themselves. Hearing impaired individuals have difficulties in daily life, although they can easily communicate among themselves with the help of sign language. For example, individuals with hearing disabilities who go to the hospital or another public institution to express themselves and have great difficulties in understanding others [1]. To prevent these problems, many private and public institutions provide guidance to the limited number of staff on sign language training; however, both the limited training period and the fact that the staff learning the sign language do not use this language frequently cause them to forget. This unfortunately causes wasted labor and time. In official institutions (Hospital-Notary-Courthouse-Land Registry etc.) hearing sign language interpreters or hearing-impaired teachers working in schools with hearing disabilities are required for hearing-impaired individuals to perform their procedures [2]. Hearing impaired have trouble communicating in many other private and public institutions without their relatives. Except for the sign language interpreter or relatives, there is no system to help hearing-impaired individuals to communicate [3].

Today, nearly 50% of the hearing impaired are illiterate. Since the literate hearing-impaired people do not have the word attachment concept in sign language, they have difficulty in understanding what they read. In general, three-dimensional avatars have been designed to facilitate the life of hearing impaired people with these problems [4].

According to the reports of the World Health Organization (2018), the number of hearing impaired living in 2018 and the number of hearing impaired to be expected until 2050 are shown in Figure 1. According to these statistics, only 34 million hearing impaired people exist in Europe today, this number is expected to be 46 million by 2050 [5].

II. Material And Methods

Natural Language Processing

Language Processing is today a research field that combines many different fields such as linguistics, language education, computer engineering. According to the Natural Grishman (1986) study, Natural Language Processing studies started to use computer translation method in 1950 [6]. Natural Language Processing activities gained speed in 1970 and 1989. In his study, Chowdhury (2003) stated that speeches are Natural Language Procedures to perceive texts by computer and to teach them how to process them [7]. Natural

Language Processing aims to analyze and understand the regular structure of natural languages. Natural Language Processing; It has various uses in the fields of automatic translation of written documents, question-answer machines, automatic speech and command comprehension, speech synthesis and speech generation, automatic text summarization, providing information. Artificial Intelligence and NLP are frequently used areassuch as text classification, finance [8], image processing [9], social media and sentiment analysis. Google Translate, chatbots, Siri (iPhone, Apple), search engines are used effectively in Natural Language Processing methods.

There are four basic methods (functions) used in Natural Language Processing.

Part-Of-Speech (POS) Labeling: POS Tagging aims at a unique tagging that shows the syntactic role of each word. For example; Plural, Name, Envelope, etc. [10].

Morphological Analysis: Morphology is the study of the internal structure of words and today forms an essential part of linguistic study. Morphological Analysis is examined in 2 parts:

a) Rooting the given word, Root Analysis

A root database is needed when finding the root of an English word. The word can be labeled and rooted by comparing it with this database.

b) Separating word into suffixes, Suffix Analysis

In English words, there are additional sets of appendages that can come after each root. In addition, there are certain sets of attachments that can follow each suffix. In this way, additional analysis can be made with chain rules.

Normalization: Normalization can be seen as the filter of Natural Language Processing. Many errors in spelling, such as spelling and spelling, can be corrected by the Normalization Function. Also, the normalization of data before processing it with other functions brings successful training and accurate results.

Named Entity Recognition (NER): Named Entity Recognition (NER) basically works on identifying and tagging 5 key entities in natural language texts.

American Sign Language

Hearing impaired existed anytime and anywhere, but until recently, the hearing impaired have been isolated from both themselves and those around them. Haunaland (2007) and Murray (2008) in their work the hearing impaired for international activities in the field of sports and entertainment although they've been together for over a century, but only over the past fifty years the contact between the hearing impaired from different communities states that they have grown substantially as well as between countries [11, 12].

There are 124 different sign languages in the world and sign languages have similar sides but they are not mutually understandable [13]. The most common of these sign languages is the American Sign Language (ASL). The precise beginning of ASL is not clear, but some suggest that it appeared 200 years before the local sign languages were mixed with the French Sign Language (LSF or Langue des Signes Française). Today's ASL contains some LSF elements. Modern ASL and modern LSF are separate languages and while still contain similar signs, they cannot be understood by each other's users. English Sign Language (BSL) is a language different from ASL, and Americans who know ASL may not understand BSL.

In ASL, all letters are made with one hand, and each letter has different symbols. The letters in the ASL alphabet are given in Figure 2.

Words made using ASL letters:

- Locations
- Organizations
- Brands

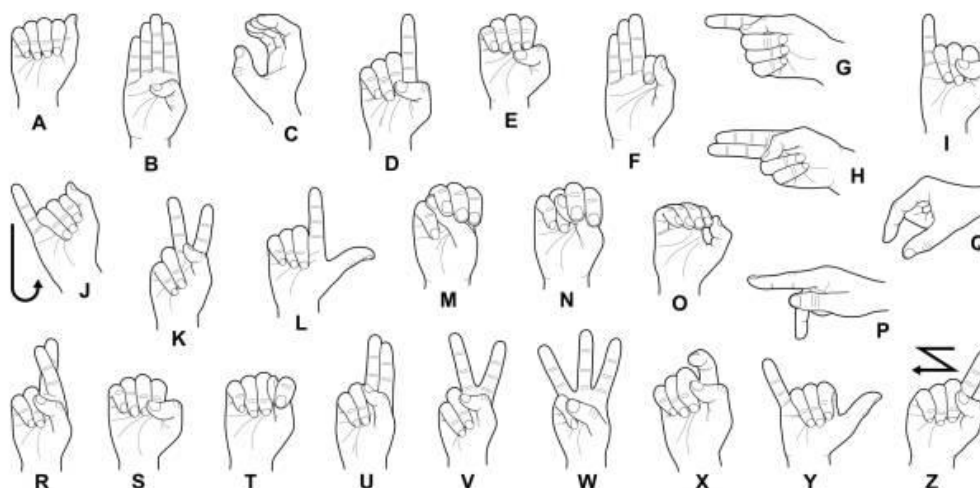


Figure no 1: Letters in ASL

However, generalization cannot be made according to this list. For example, some dishes have signs while others do not have a counterpart, it is used letter by letter in sign language. However, not all names are used letter by letter, some important names have their names in ASL. Individual names are normally made letter by letter. There are special moves for the names of some famous people.

Although most countries and cities have special movements, those who do not are made letter by letter. The animal and plant have special action. Those who do not are being made letter by letter. Morford J, & Carlson M. (2011), DuBow, S., & National Association of the Deaf. (2000), and Fant, L. J., & Miller, B. G. (1994) stated the following features about ASL and language structure [14-16].

- There are approximately 6,000 words in ASL.
- ASL is not a universal sign language.
- It is estimated that ASL is used by 15,000,000 people.
- As in other languages, certain ways of expressing ideas in ASL vary as much as ASL users do. In addition to individual differences in expression, ASL has regional accents and dialects. As certain English words are spoken differently in different parts of the country, ASL has regional changes in signing, form and pronunciation rhythm. Ethnicity and age are several factors that affect the use of ASL and contribute to its diversity.

When deriving words from English words to sign language, complete versions of words are generally used. For example; it is performed as "Teacher" = "Teach" + "Agent", but while doing the movement, the lip is moved as "Teacher" rather than "Teach Agent". There is no specific rule for which word to combine with which suffix. In English grammar, the sentence structure is used as "Subject + Verb+ Object" and ASL as "Object + Subject + Verb". For example; "I have a brown dog." in English, "DOG BROWN I HAVE" in ASL.

The direction of the hand or fingers affects the word structure in general. For example; the phrase "meet-you" means "see you", and if you make the index finger facing yourself, it means "you came / approached me". The suffixes in English grammar rules are not used in ASL, the words consist of their roots. Only words that indicate time are added to the beginning of the sentence. Example; "WEEK-PAST MY CAR I WASH".

In English question sentences, the structure is in the form of "Auxiliary verb + subject + verb + object", while in ASL it is "Object + Subject (Generally Not Used.) + Verb". For example, the phrase "Do you love strawberries?" means "Strawberry you love?" / Strawberry love?" In ASL Format.

Generally, pronouns are not used in question sentences. The sentence is ended with the "Wh question" sign (For details, see: <https://www.handspeak.com/word/search/index.php?id=2392>). As English speakers raise their voices, ASL users ask questions by raising their eyebrows, widening their eyes, and tilting their bodies forward. In English negative sentences, the structure is "Subject + auxiliary verb + "not"+ verb + object" whereas ASL is "Object + Subject + Verb + 'not / none'". For example, the sentence "I don't have any dogs." Is used in ASL as "DOG I HAVE NONE". The term "none" is often used to negate words in the sense of possession. As a result of the morphological analysis, the words whose roots are detected and the videos of all the items in the sentence to be translated are pulled from the database and combined and played. Thus, the translation system of the text to ASL was created.

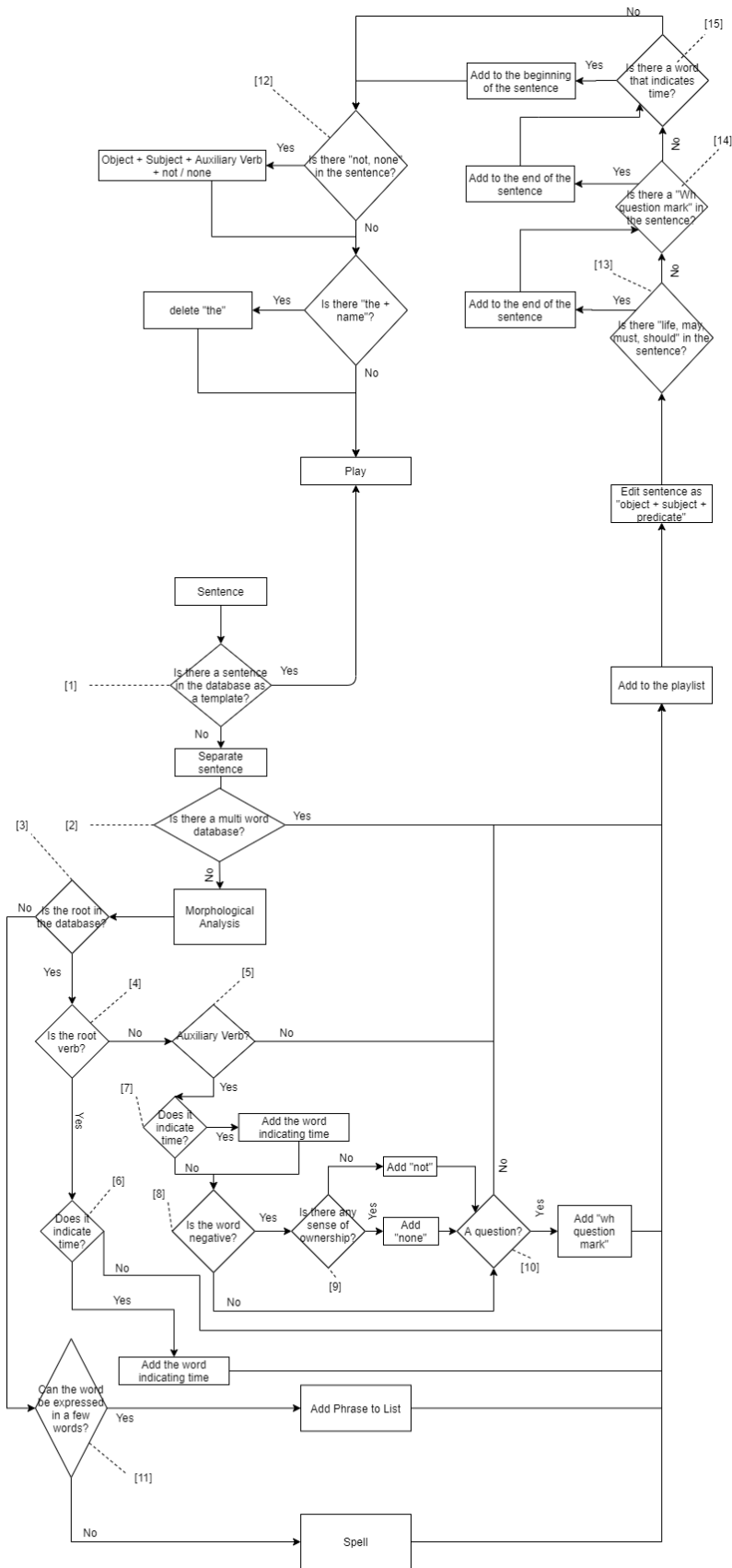


Figure no 2: English to American Sign Language translation system algorithm

III. Related Works

Eken et al. (2011) have developed a system that translates the voice / text into sign language by using the Hidden Markov Model. They used 3D animation to visualize sign language and tested for 40 words in this context. However, there are approximately 4,000 words in sign language dictionaries [17].

Marshall et al. (2003), Bungeroth and Ney (2004), Almohimeed et al. (2011) developed systems for translating texts into sign language for sign languages such as Arabic and English. In these studies, rule-based and sample-based methods were used. In the systems they developed by considering the sign language grammar rules, the texts were translated into sign language using animations or video images [18-20].

IV. Discussion and Conclusion

Hearing impaired literacy rate is low. Moreover, even those who can read and write cannot understand what they are reading. Within the scope of the study, a real time translation system from text to sign language has been developed. The English sentence was processed with natural language processing techniques and the suffixes of the words in the sentence were removed. Later, the text-sign language translation system algorithm was converted into a sentence suitable for the structure of sign language grammar. The registered words were determined in the database created from sign language dictionaries and the unregistered ones were separated letters and the relevant alphabet signs were taken from the database. As a last step, animations corresponding to words combined in accordance with sign language grammar are visually translated into sign language via the avatar. In this way, the translation of the sentence into sign language has been completed within the scope of the study.

References

- [1]. H. Tutar, M. K. Yılmaz and Ö. Eroğlu, "GenelTeknikİletişim", 6. Baskı, Ankara: SeçkinYayıncılık, (2014).
- [2]. A. Uysal, "İşitmeengellilerdeTürkçeöğretimi, sorunlar, öneriler", YüksekLisansTezi, İstanbul ÜniversitesiSosyalBilimlerEnstitüsü, İstanbul, (2010).
- [3]. Y. Türk, "Türk-AlmanİşaretDilleritercümesietkinliğininörneklerleincelenmesi", YüksekLisansTezi, SakaryaÜniversitesiSosyalBilimlerEnstitüsü, Sakarya, (2015).
- [4]. S. Bayrak, "İşaretdilininbilgisayarlıyorumlanması", YüksekLisansTezi, KaradenizTeknikÜniversitesi Fen BilimleriEnstitüsü, Ankara, (2009).
- [5]. World Health Organization, Blindness and Health Report, (2018). <https://www.who.int/pbd/deafness/estimates/en/> (Access Date: 2.10.2018).
- [6]. R. Grishman, "Computational linguistics: an introduction", Cambridge Cambridgeshire/New York: Cambridge University Press, (1986).
- [7]. G. G. Chowdhury, "Natural language processing", Annual Review of Information Science and Technology, 37(1), 51-89, (2003).
- [8]. Çelik, Ö.,&Osmanoğlu, U. Ö. (2019). Comparing to Techniques Used in Customer Churn Analysis. Journal of Multidisciplinary Developments, 4(1), 30-38.
- [9]. Osmanoğlu, U. Ö.,Mutlu, F , Gürsoy, H , Şanlısoy, S . (2019). GörüntüİşlemeveAnalizininTıptaKullanımiveBirUygulama. Osmangazi Tıp Dergisi , 41 (1) , 6-16 . DOI: 10.20515/otd.426347
- [10]. R. Collobert and J. Weston, "A unified architecture for natural language processing: Deep neural networks with multitask learning", In Proceedings of the 25th international conference on Machine learning (pp. 160-167), ACM (2008, July).
- [11]. H. Haualand, "The two week village, The significance of sacred occasions for the deaf community", In BenedicteIngstad&Ssuan R., Whyte, ed., Disability in local and global worlds, 33-55, Berkeley: University of California Press, (2007).
- [12]. J. J. Murray, "Coequality and transnational studies: understanding deaf lives", In H.-D. L. Bauman (ed.) O"pen your eyes, Deaf studies talking", 100-110. London: University of Minnesota Press, (2008).
- [13]. R. Gordon, "Ethnologue: Languages of the world 15 th Edition." Dallas, TX: Sil International (2005).
- [14]. J. Morford and M. Carlson, Sign perception and recognition in non-native signers of ASL, Language learning and development, 7: 149, (2011).
- [15]. DuBow, Sy, ed. Legal rights: The guide for deaf and hard of hearing people. Gallaudet University Press, (2000).
- [16]. Fant, L. J., & Miller, B. G., 1994, The American sign language phrase book (Rev. ed.), Chicago: Contemporary Books.
- [17]. Eken, B., Sahin, B., Akbulut, F., Akbulut, E., & Oz, C., 2011, Translating Turkish Speaking and Writing into Sign Language Using the Hidden Markov Model, Electric-Electronic and Computer Symposium, Elazig.
- [18]. Almohimeed, Abdulaziz, Wald, M., and Damper, R.I., 2011, Arabic Text to Arabic Sign Language Translation System for the Deaf and HearingImpaired Community, In, EMNLP 2011: The Second Workshop on Speech and Language Processing for Assistive Technologies (SLPAT), Edinburgh, UK, Scotland, pp. 101-109.
- [19]. Marshall, I., &Sáfár, É., 2003, A prototype text to British Sign Language (BSL) translation system, Proceedings of the 41st Annual Meeting on Association for Computational Linguistics - Volume 2, Sapporo, Japan: Association for Computational Linguistics, pp. 113-116.
- [20]. J. Bungeroth& H. Ney, Statistical sign language translation, In Proc. of the Workshop on Representation and Processing of Sign Languages (LREC2004), pages 105–108, Lisbon, Portugal, 2004.