3D AVATAR AND I-ACE IN THE SERVICE OF THE DEAF PEOPLE

by

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Computer Science, University of Crete, 2014

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

DEPARTMENT OF INFORMATICS ENGINNERING

SCHOOL OF APPLIED TECHNOLOGY

TECHNOLOGICAL EDUCATIONAL INSTITUTE OF CRETE

2018

Approved by:

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Abstract

Greek sign language has been recognized as the official language of the deaf community in 2000. In Greece, there are about 25000 deaf and about 40000 hearing people who use it. These numbers show a huge lack of communication between deaf people and society but also highlight the difficulties in their professional life. The adoption of technology means such as mobile phones and computers, will improve the communication between deaf and hearing people.

In antiquity, deaf were not accepted by society and were considered to be worthy of derision. Only in recent years deaf people were treated as equal members of the society by law. Greece created a special education program in 1981 and integrated it (law 1566/1985) into the pre-primary, primary and secondary schools. This law along with the recognition of sign language as an official Greek language helped the deaf to communicate better with hearing people. Moreover, there are special benefits for deaf people such as tax breaks, medical care, interpreting programs and rights in education which intended to help them integrate into the society as equal members.

Science of linguistics along with the use of technology helped the deaf community today to significantly improve their position in the education program. However, more effective intervention in education is needed because:

• There is no a specialized deaf education program in addition to the special education curriculum.
• There are no guidelines for organizing, evaluating and planning educational work in deaf schools.

The sign language translates the meaning of simultaneously combining the hands the orientation, the arms, the upper body and the facial expressions. Sign languages are not a representation of spoken languages. They are semantic language and they are not common to all countries. Despite the progress made last year in supporting deaf people in the legal and educational level of the state, there are still many inadequacies. The development of technology will be an important help for these people, and the automatic sign language translator that the I-ACE research program delivers, is a big step towards this direction.

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Acknowledgements

By completing my thesis, I would like to thank the Professor of the postgraduate program of the Department of Informatics Engineering of TEI of Crete, Mr. Giorgos Papadourakis, for the valuable knowledge he gave me in the computational intelligence course and the particular interest he has shown for the completion of the present thesis.

I would also like to thank my fellow students and friends Stelios Krasadakis, Manos Petrougakis, Manos Karapiperakis, Philipos Kolymbianakis, Mattheos Moutsakis, Aris Papakonstantinou and Konstantinos Grammatikakis. Also, all my colleagues and friends who worked with me, for their essential help, advice, knowledge and useful criticism they provided me.

I would also like to express warm thanks to the PhD candidate, Mr. Kostas Karampidis, for the excellent cooperation I had with him on the technical part of the research program and his valuable guidance.

In closing, I would like to say a big thank you to my parents, Kalliopi and Minas, for their moral support and to express them my gratitude for always standing by me, to my successes and failures all these years of my studies and also in my life.

Chapter 1 – Introduction

People who belong to the deaf community or have hard hearing problems use sign languages to communicate to each other. It is a common case a sign language to have significant similarities with the respective oral language. A typical paradigm is the American Sign Language (ASL) and American English.

Linguists consider sign languages similar to their respective spoken ones i.e. they emerge through a theoretical, extended maturing process and advanced over time without particular planning.

Sign languages are used even from the ancient times. Two thousand years ago, Socrates in Plato's Cratylus, says: "If we hadn't a voice or a tongue, and wanted to express things to one another, wouldn't we try to make signs by moving our hands, head, and the rest of our body, just as dumb people do at present?" [1]

'Reduction of letters and art for teaching mute people to speak' was the first dissertation of sign language phonetics. It is considered a method of oral education for deaf people and a manual alphabet and it was published in 1620 by Juan Pablo Bonet [2].

Even though sign languages are used mainly by the deaf and people with hard hearing problems, they are also used by hearing people as well. This may occur due to a disability e.g. they may be unable to speak etc.

A common misunderstanding is that there is a common sign language for all deaf people worldwide i.e. there is one international sign language. Ethnologue [3] in its website counters 142 distinct sign languages worldwide but it is quite unclear that this number is not even bigger. A sign language does not directly correlate to the oral language, people in the same country speak.

The relationship between sign and oral languages mainly depends on the country and not on the spoken language itself. For instance, although people who live to the USA and Canada (most part) have English as their native dominant language, the Sign Language (American Sign Language) they use comes from the French Sign Language.

Another example is Spain and Mexico; Spanish is the spoken language but sign languages in these two countries are different. Differences to a sign language (in the same country) may also be found, depending on local dialect or just the geographic location of the deaf.

Each country has and develops its own sign language with different meanings and different structure. There are some common features but there are also many differences. Nevertheless, there is an ongoing attempt to create and use an international sign language (ISL) that contains common words for all sign languages. This way, the communication between people who communicate in different sign languages will be possible.

Even though there are also significant similarities among all sign languages, each country develops its own sign language with different alphabets and meanings. There may be noticed some common features, but usually there are significant differences between sign languages, which depend on the peculiarity of the country.

People may think that sign languages are not "real languages" but mime ones. This is not true; they are as rich as any spoken language. Linguists say that the essential properties found in all spoken languages, also exist in sign languages.

Sign languages are not a visual version of their respective spoken languages. They have complex grammar of their own and can be used to deliberate any topic regardless its difficulty; from a simple day chat to a serious discussion. Sign languages just like spoken languages have phonemes (from the Greek word "φωνή" which stands for "voice") or ''cheremes'' (from the Greek word "χέρι" which stands for "hand").

These phonemes are represented as hand configurations. The combination of these hand configurations along with the orientation, location, movement, body position and facial expression makes possible the form of words and therefore sentences. Figure 1.1 shows hand configurations used to represent any letter of the American Sign Language.

FIGURE 1.1: THE AMERICAN SIGN LANGUAGE

Although today sign languages are considered as a field of linguistics, the term ‘sign languages" was not added to the Linguistic Bibliography until 1988, and unfortunately that there is no legal recognition for all the sign languages.

Chapter 2 - The Greek Sign Language

The Greek Sign Language (GSL) is the official language of the Greek deaf community in Greece. The Greek Sign Language differs from the spoken Greek language and other sign languages and it was recently recognized as the official sign language (Law 2817/2000). Most of the deaf children have listening parents who do not know the GSL. Children learn GSL in school age, informally from other older deaf students and deaf adults.

There are differences between sign languages, but these differences may also exist on the same sign language, depending in the adopted idioms of each region of the country. Two geographical variations, southern and central/northern, can be reported but there are not extensive differences as to be considered dialects. The main difference is found in colors, months, numerals etc. For instance, a deaf in Athens signs the word "black" different than a deaf in Thessaloniki.

Consequently, a GSL knowledgeable may not understand some signs because these signs are idioms of an area. However, regardless this kind of idiom differences, GSL is recognized the GSL as a single language.

Furthermore, we can further distinguish GSL depending on the age of the signer. Older deaf use sign language structures as it is actually, while younger deaf use a variety of it influenced of spoken Greek in the dictionary and semantics.
Greek Sign Language (GSL) is used widely in the Greek Deaf Community and the estimation for GSL natural signers is about 40,600 (1986 survey of Gallaudet University).

There is also a large number of hearing non-native signers of GSL, mainly students of GSL and families of deaf people. Although the exact number of hearing students of GSL in Greece is unknown, records of Hellenic Federation of the Deaf (HFD) show that, in the year 2003 about 300 people were registered for classes of GSL as a second language.

The recent increase of deaf students in mainstreamed education, as well as the population of deaf students scattered in other institutions, minor town units for the deaf and private tuition may well double the total number of secondary and potential sign language users in Greece. Official settings, where GSL is being used include 11 Deaf clubs in Greek urban centers and a total of 14 Deaf primary, secondary and tertiary educational settings.

The estimated number of deaf school-age children, as reported at the Panhellenic Conference of Parents of Deaf Children in 1981, is about 30000, of whom only about 1000 are enrolled in schools for deaf children. Some of these schools are private, and according to reports by teachers and parents overcrowded.

The first Greek Association of the Deaf was established in 1948. According to anecdotal evidence, the association initially consisted mainly of school leavers from the school for the deaf in Athens, though gradually more members joined. The founders of the Greek Association of the Deaf contacted deaf people in other big cities and convinced them to create their own Deaf clubs or associations. The role of the association was mostly recreational, as it constituted a place where deaf people could gather and socialize with each other.

It also organized cultural activities and lessons in Greek language for deaf people and demanded financial support from the Greek government. Established in 1969, the Greek Federation of the Deaf emerged from this association. It organized athletic and cultural activities and also fought for the legal rights of deaf persons in Greece in a systematic and dynamic way. Today, 19 Deaf clubs and associations function in cities around Greece.

All of these organizations are all under the umbrella of the Greek Federation of the Deaf. Nine of them have been founded in the last 20 years. In 1983 the Hellenic Theater of the Deaf was established, and in 1989 the Hellenic Athletic Federation of the Deaf, which took responsibility for the development and organization of the athletic activities of deaf people in Greece. Today, eight athletic associations function all over Greece, under the umbrella of the Hellenic Athletic Federation of the Deaf.

The list below names some of the national and institutional associations for the deaf and foundations in Greece including the following:

• Deaf Hellenic Association.

• Federation of deaf Greeks.

• National Deaf Foundation.

• Pan-Hellenic Association of Deaf.

• Parents & Guardians association of deaf of central Macedonia.
• Greek Society for Mental Health and Deafness.
• Hellenic Federation of Deaf Sport of Greece.

Several studies have shown that the age of learning a language, sign or spoken, affects the final level of linguistic and cognitive development of people, deaf or hearing [4]. Even if the first critical period of linguistic development of deaf children of listening parents, in their majority, remains untapped, the degree of effective exploitation of the second critical period depends mainly on the educational environment.

Deafs who know and use the GSL can get information and decode their significance. Another survey found that self-confidence that deaf students feel about sign language in the school environment contributes significantly to their lifelong development [5]. Learning a language requires the presence and contribution of its users. There must definitely be an interaction between children and people who know the language to be learned.

People obtain and use language-related information through vision. Due to the fact that the respective spoken language is mainly acquired through the hearing channel, most deaf people have limited opportunities to do so. This limitation makes very difficult to develop reading and writing skills, since it is based on a good -or at least fair- knowledge of spoken language. It is found that in Greece the average deaf high school graduate reads as a second-grade student in Greece. This shows the difficulty the deaf may have in learning to read the written language.

Another research showed that only 3-5% of the deaf community can achieve equal acquisition of reading skills with their listening classmates. However, despite this disadvantage there are many deaf people who can get an excellent level of reading skills in the written language even without knowing the spoken one.

Learning of Greek language, is for the deaf children part of their school duties. They must learn to read and write the language at the same time their hearing classmates do. Current situation in deaf education in Greece compared to the past can be summarized as follows:

• There is a curriculum for deaf Education in Greece, harmonized with the curriculum of general education.

• There are guidelines for the organization, evaluation and planning of educational work in deaf schools.

The GSL Curriculum is based on the above-accepted general conditions and aspires to create the conditions for effective intervention in the education of the deaf in Greece.

GSL consist of words, sentences and has its own strict grammar and editorial rules, just like the spoken language. In the same way with the spoken language, GSL has its peculiarities too. GSL follows a verbal and editorial structure to express any abstract meaning. Verbs in the sign language must always come to the end, unless there is a question; in this case the verb position is taken by the question mark ("where do you go?"→ "Go where?"). It is obvious then that when a deaf person the abovementioned syntax, it is very difficult to adapt to the written form of his native language.

GSL has its own linguistic system with its linguistic rules, and syntax not based on the respective of the spoken Greek language.

2.1 Sign Structure in GSL

Greek Sign Language has its own dictionary and grammar. The first attempt to record GSL was made in 1985 in a book form. The adoption of technology resulted to an electronic dictionary of Greek Sign Language. This dictionary (NOEMA) includes more than 3,000 signs. Searching for entries is possible in three ways:

- Based on the series of handshapes that make up every meaning
- Based on the classification of the entries into categories
- Based on the alphabetical order of translations of meanings in Greek spoken language, i.e. by choosing the word from a list, as in other electronic form dictionaries.

The signs of GSL are expressed by one or two hand configurations (handshapes) as well as with non-manual elements, such as the head, eyebrows and mouth movements. Whereas two hands are needed to form a sign, both hands may be active, or one hand may be active while the other is passive. When one hand is active, this is the signer's dominant hand.

Communication in GSL is achieved through movement and vision. More specifically, it is accomplished through hand configurations. A hand configuration is the shape the palm takes and the position that the fingers take. The same hand configuration may have different meanings depending on some parameters. These parameters are:

1. The orientation of the palm.

2. The position of the hand configuration in relation to the body, face or space. Variations to these form different meanings. Words are formed within a space that extends from the top of the head to the body trunk and about 20 to 30 cm to the right and left of the people's shoulders. There are no signs produced at the back of the body, or below the waist, or at the knees although, in some informal occasions this may happen.

3. The movement of the hand; this is necessary to form a meaning. Furthermore, movement may specify the number (singular or plural), the size of an object (small or large, thick or thin), the frequency of an action, or some movement.

4. The movement of the body and the expression of the face. These are also important elements for completing the meaning or to give tension (express feelings etc.), just the same way it happens with the voice tone to Greek spoken language.

Greek Sign Language can be characterized as a combination of four different parameters: handshapes, orientation, movement and location. In NOEMA, 45 handshapes are described while newer research have identified 53 handshapes in Greek Sign Language. Finally, in Greek Sign Language changes of the location of the hands is usually related to changes in meaning.

2.2 Word Order

In sign languages across the world there are different word orders. For American Sign Language, Taiwan Sign Language and Swedish Sign Language the word order is: Subject, Verb, Object (SVO). For Russian Sign Language, Sign Language of the Indians of North, German Sign Language, and Sign Language of the

Netherlands, the word order is: Subject, Object, Verb (SOV), whereas in British Sign Language is described either as SVO or as SOV, depending on the type of verb used. The word order used in Greek Sign Language is SOV.

2.3 Non-manual elements

Non-manual elements include movement of the head or the upper part of the body. Furthermore, they may also include facial expressions mostly produced by the upper part of the face (eyes and eyebrows), and/or by mouth. Non-manual elements are used to modify the meaning of a sign and mark different syntactic structures and different types of sentences, such as questions, conditionals or relative clauses.

They can also be used to express emotions. Antzakas also examined the expression of negation in Greek Sign Language [6]. Antzakas claims that head movement and facial expressions are used for marking negation. However, of particular interest is “the analysis of the backwards tilt of the head which is distinct for marking negation in GSL and which has not been reported in other sign languages until now” [6].

In non-manual elements produced by the mouth, two main types have been identified. The first type is derived from a spoken language. Many terms have been proposed such as “mouthings”, “spoken components” and “word pictures”. The second type “may have formed from within the sign languages and bear no relation at all to the mouth movement of a spoken language” [7]. Many terms have been proposed such as “mouth gestures”, “oral adverbials”, “mouth arrangements” and “oral components”.

Non-manual mouth components also exist in Greek Sign Language. The mouth component included in I FORGET distinguishes the sign from HELLOWEEN, which has an identical hand shape. Mouth movements borrowed from Greek spoken language have been identified in signs such as DADDY (‘father’ from the Greek word “babas”) and MAMA (‘mother’ from the Greek word “mama”).

2.4 Greek manual alphabet

Another key element in the GSL is the alphabet (Figure 2.1). Deaf people use it when they want to mention a name or a word that they do not know. If they do not know the meaning of a word they spell it using the alphabet.

The Greek alphabet is composed of 21 handshapes, each one representing one letter of the Greek alphabet, except for the letters Z, H, Π, Ξ and Ψ, which are represented by the same handshape, but in different orientations. Names for persons, places, etc. are sometimes finger spelled using the Greek manual alphabet.

A common problem that occurs in many sign languages is the lack of a written manual. Unfortunately, and despite the fact that there is a growing interest in learning the GSL, there is a lack of a grammar or language learning manual. There are few or no records of the language or its study is very limited. GSL is no exception to this. The information that has been recorded so far only includes photographs or sketches. The problem to these is the lack of a key component: the movement.

Nevertheless, nowadays some learning schools use video that visualizes the hand configurations and all the parameters needed (palm orientation, hand configuration position, hand movement, body position and facial expressions) to give the right meaning. In general, the sign language is taught verbally, and its learning is getting even more difficult.

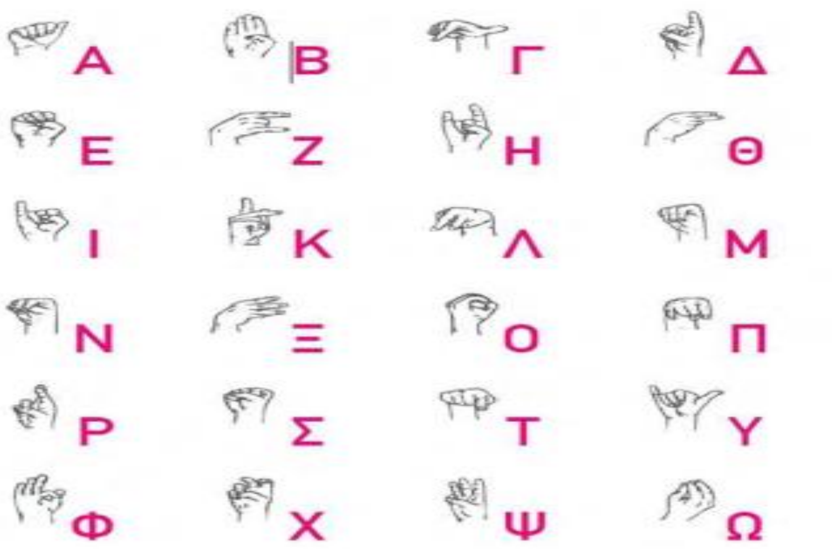

FIGURE 2.1: THE GREEK SIGN LANGUAGE ALPHABET

2.5 The numerical system of Greek Sign Language (GSL)

The numerical system in GSL is a decimal based numbering system. Numbers in GSL, are signed in the same way throughout the country although some differences may occur depending the geographical part of Greece, where the participants are living. Each number has a specific handshape, position, motion and palm orientation. The handshape represents the value of the number.

The combination of position, motion and palm orientation of the hand shape reveals whether it is a unit, a hundred, a thousand etc. Each sequence of elements of the alphabet is considered as one word, except for the sign for the number zero. If we come across the number zero at any other sequence, we do not sign it (as we do using the oral Greek language of numbers).

Ones: The numbers 0,1,2,3,4,5,6,7,8,9 in GSL are formed by the number of fingers used either by one hand (numbers 0-5, Figures 2.2 – 2.7) or both (numbers (6-9, Figures 2.8-2.11). The number 0 is signed using all fingers of the right (or dominant) hand.

FIGURE 2.2: NUMBER 0

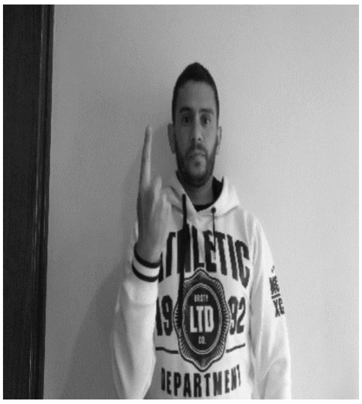

FIGURE 2.3: NUMBER 1

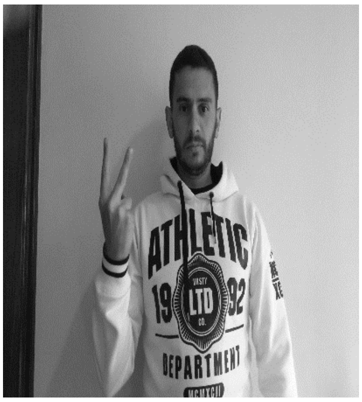

FIGURE 2.4: NUMBER 2

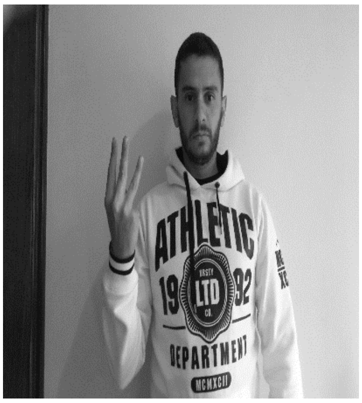

FIGURE 2.5: NUMBER 3

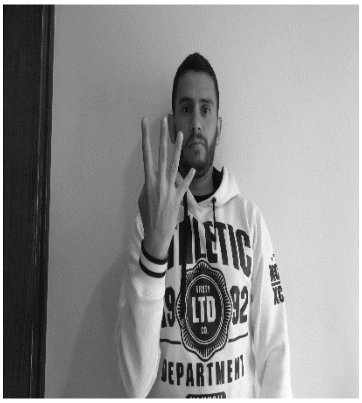

FIGURE 2.6: NUMBER 4

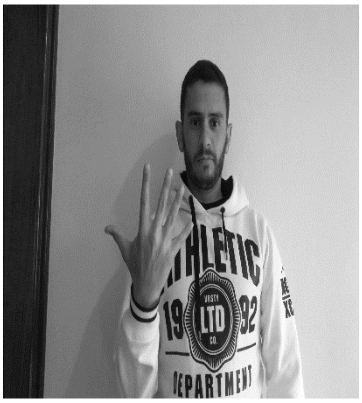

FIGURE 2.7: NUMBER 5

FIGURE 2.8: NUMBER 6

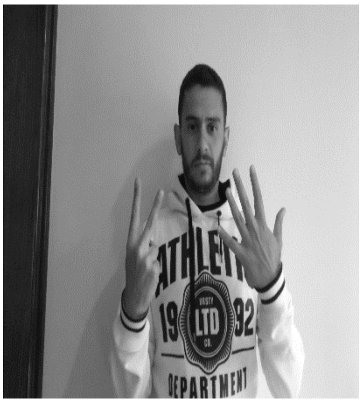

FIGURE 2.9: NUMBER 7

FIGURE 2.10: NUMBER 8

FIGURE 2.11: NUMBER 9

Tens: The signing of tens uses the hand shapes of ones but with a motion that indicates tens (Figures 2.12-2.13).

FIGURE 2.12: FIRST MOVEMENT FOR NUMBER 10

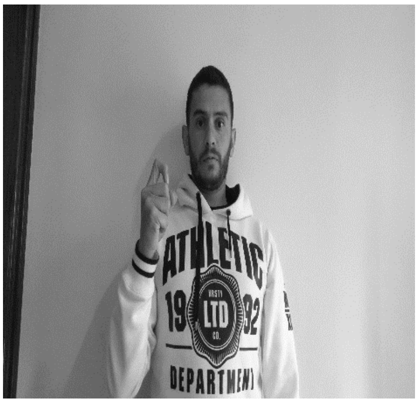

FIGURE 2.13: SECOND MOVEMENT FOR NUMBER 10

Hundreds: For the signing of hundreds, we also use the handshape of the ones but with a different motion (Figures 2.14-2.15).

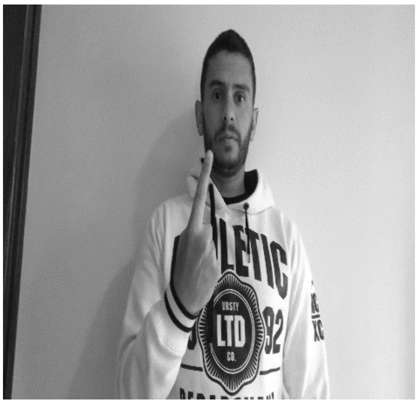

FIGURE 2.14: FIRST MOVEMENT FOR NUMBER 100

FIGURE 2.15: SECOND MOVEMENT FOR NUMBER 100

Thousands are been signed into two phases also. The first phase represents the number and the second phase indicates that it’s a thousand. Numbers 1,000 to 10000 (figures 2.16- 2.34) are signed by the handshape of the respective one i.e. numbers 1-10 but modifying the position and adding motion. Throughout the first phase we keep the hand shape of the numbers 1-10 and for the second phase we move the right hand towards the left one keeping the hand shape unchanged.

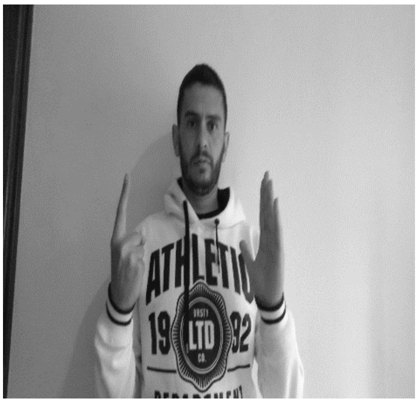

FIGURE 2.16: FIRST MOVEMENT FOR NUMBER 1000

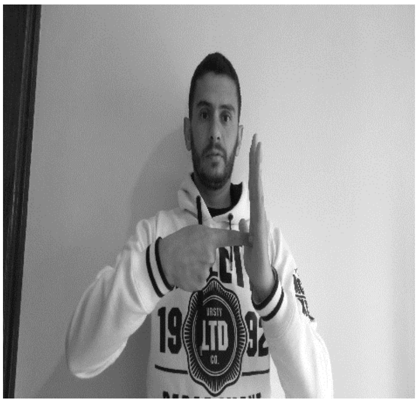

FIGURE 2.17: SECOND MOVEMENT FOR NUMBER 1000

Figure 2.18: first movement for Number 2000

Figure 2.19: second movement for Number 2000

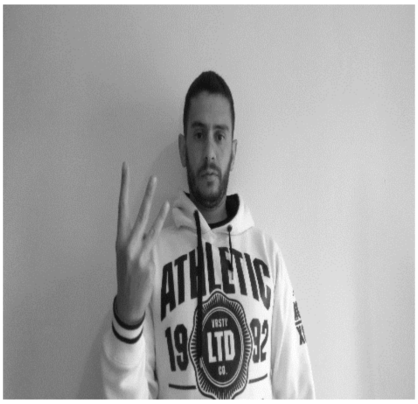

Figure 2.19: first movement for Number 3000

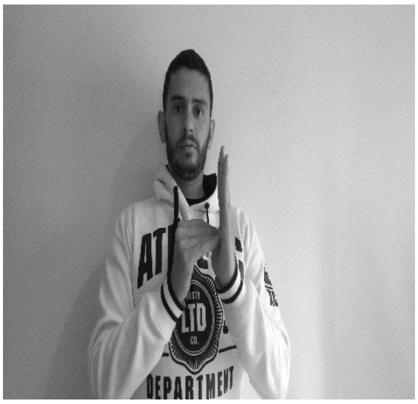

Figure 2.20: second movement for Number 3000

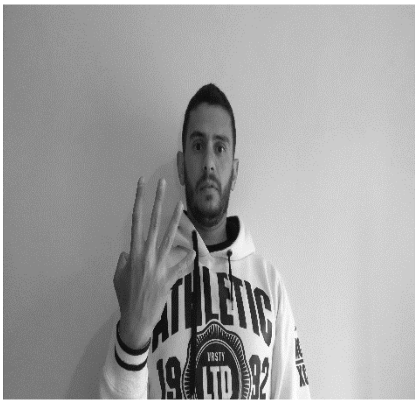

Figure 2.21: first movement for Number 4000

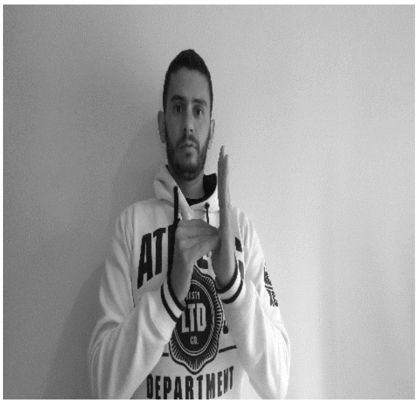

Figure 2.22: second movement for Number 4000

Figure 2.23: first movement for Number 5000

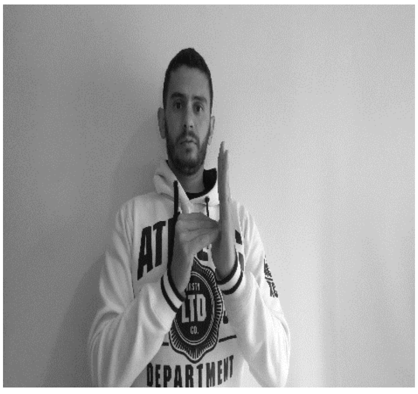

Figure 2.24: second movement for Number 5000

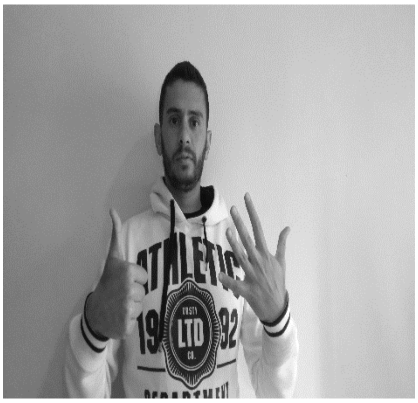

FIGURE 2.25: FIRST MOVEMENT FOR **NUMBER 6000**

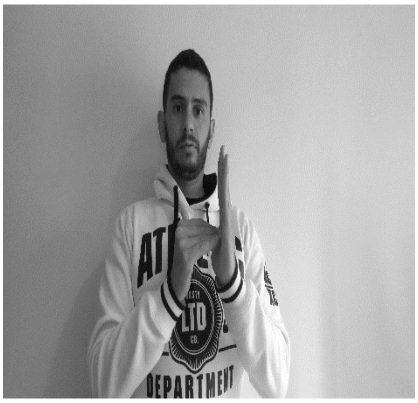

FIGURE 2.26: SECOND MOVEMENT FOR **NUMBER 6000**

FIGURE 2.27: FIRST MOVEMENT FOR **NUMBER 7000**

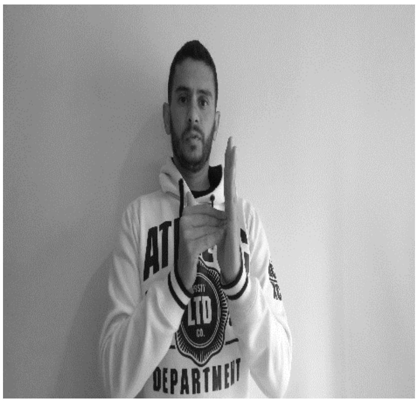

FIGURE 2.28: SECOND MOVEMENT FOR **NUMBER 7000**

FIGURE 2.29: FIRST MOVEMENT FOR **NUMBER 8000**

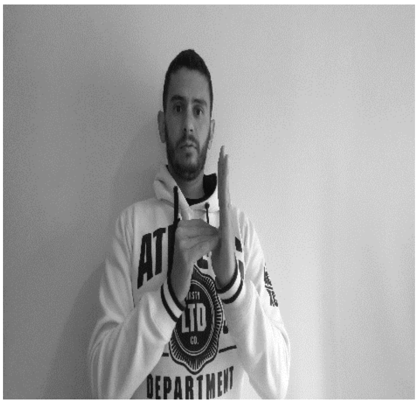

FIGURE 2.30: SECOND MOVEMENT FOR **NUMBER 8000**

FIGURE 2.31: FIRST MOVEMENT FOR **NUMBER 9000**

FIGURE 2.32: SECOND MOVEMENT FOR **NUMBER 9000**

FIGURE 2.33: FIRST MOVEMENT FOR NUMBER 10000

FIGURE 2.34: SECOND MOVEMENT FOR NUMBER 10000

Millions: The signing of larger numbers like millions are simply by signing the number (units, tens, hundreds) e.g. 2, 20, 358 and adding the sign 'million' (Figures 2.35-2.38). Figures 2.35-2.38 show the number one million. If we wanted to form the number two million, we simply had to use the hand shape of number two (Figure 2.4) for the first and the fourth movement, while the other two remain the same.

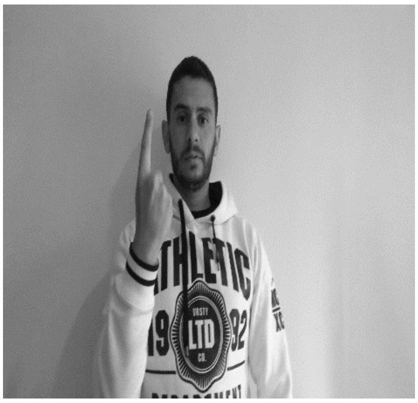

FIGURE 2.35: FIRST MOVEMENT FOR ONE MILLION

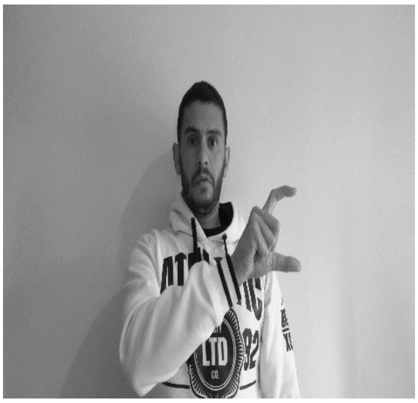

FIGURE 2.36: SECOND MOVEMENT FOR ONE MILLION

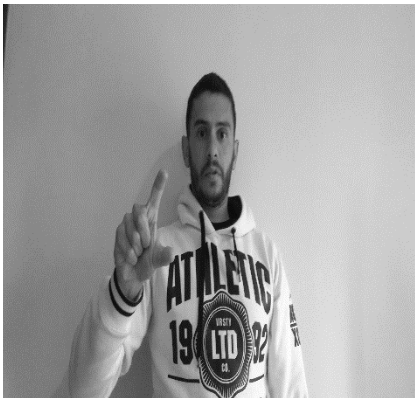

FIGURE 2.37: THIRD MOVEMENT FOR ONE MILLION

FIGURE 2.38: FOURTH MOVEMENT FOR ONE MILLION

Numbers 11 to 19: Numbers 11 to 19 are signed in three phases (Figures 2.39-2.65). In the first and second phase we represent number 10 by placing both hands with the fingers open and every palm facing the other in front of our breast, vertical with the fingers upwardly. In the third phase we use the hand shape for numbers 1 to 9.

FIGURE 2.39: NUMBER 11 – 1ST

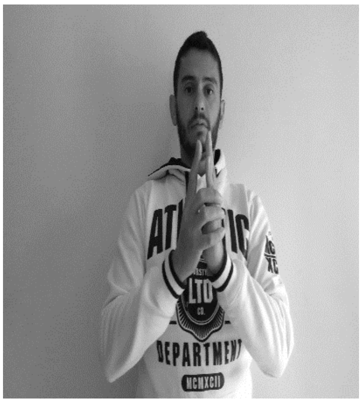

FIGURE 2.40: NUMBER 11 – 2ND

FIGURE 2.41: NUMBER 11 – 3RD

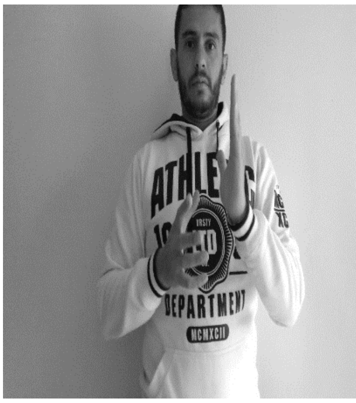

FIGURE 2.42: NUMBER 12 – 1ST

FIGURE 2.43: NUMBER 12 – 2ND

FIGURE 2.44: NUMBER 12 – 3RD

FIGURE 2.45: NUMBER 13 – 1ST

FIGURE 2.46: NUMBER 13 – 2ND

FIGURE 2.47: NUMBER 13 – 3RD

FIGURE 2.48: NUMBER 14– 1ST

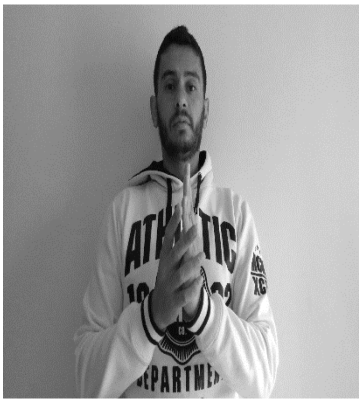

FIGURE 2.49: NUMBER 14– 2ND

FIGURE 2.50: NUMBER 14– 3RD

FIGURE 2.51: NUMBER 15– 1ST

FIGURE 2.52: NUMBER 15– 2ND

FIGURE 2.53: NUMBER 15– 3RD

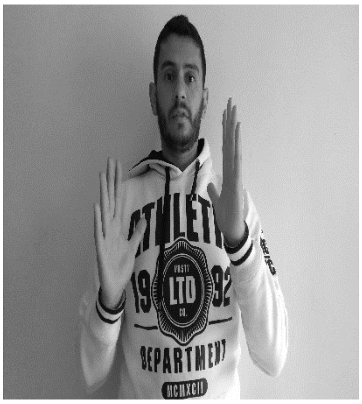

FIGURE 2.54: NUMBER 16– 1ST

FIGURE 2.55: NUMBER 16– 2ND

FIGURE 2.56: NUMBER 16 – 3RD

FIGURE 2.57: NUMBER 17– 1ST

FIGURE 2.58: NUMBER 17– 2ND

FIGURE 2.59: NUMBER 17– 3RD

FIGURE 2.60: NUMBER 18– 1ST

FIGURE 2.61: NUMBER 18– 2ND

FIGURE 2.62: NUMBER 18 – 3RD

FIGURE 2.63: NUMBER 19– 1ST

FIGURE 2.64: NUMBER 19– 2ND

FIGURE 2.65: NUMBER 19– 3RD

Special numbers: Double two digits numbers e.g. 22, 33, 44, 55, 66, 77, 88, 99 can be signed in a different way (Figures 2.66-2.88). We use the hand shape of the digit and we move our hand or hands slightly and horizontal a little bit on the right and on

FIGURE 2.66: NUMBER 22 – 1ST

FIGURE 2.67: NUMBER 22 – 2ND

FIGURE 2.68: NUMBER 22 – 3RD

Figure 2.69: Number 33 – 1st

Figure 2.70: Number 33 – 2nd

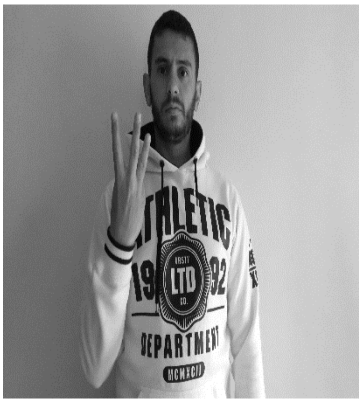

Figure 2.71: Number 33 – 3rd

figure 2.72: number 44 – 1st

figure 2.73: number 44 – 2nd

figure 2.74: number 44 – 3rd

figure 2.75: number 55– 1st

figure 2.75: number 55– 2nd

figure 2.76: number 55– 3rd

figure 2.77: number 66– 1st

figure 2.78: number 66– 2nd

figure 2.79: number 66– 3rd

FIGURE 2.80: NUMBER 77– 1ST

FIGURE 2.81: NUMBER 77– 2ND

FIGURE 2.82: NUMBER 77 – 3RD

FIGURE 2.83: NUMBER 88– 1ST

FIGURE 2.84: NUMBER 88– 2ND

FIGURE 2.85: NUMBER 88– 3RD

FIGURE 2.86: NUMBER 99– 1ST

FIGURE 2.87: NUMBER 99– 2ND

FIGURE 2.88: NUMBER 99– 3RD

Chapter 3 – Other similar research efforts

Indicatively, the following research efforts and applications (open source or commercial) are reported:

Delfe -Distance and Life Long Training for the Deaf People in the E-Commerce and New Technologies Sector through eLearning Tolls: this is a Greek research effort [8] offering an e-learning environment with Greek Sign Language videos in correspondence to every text in the learning environment.

Dedalos [9]: This is an online research program implemented by the research center "Demokritos" aiming to promote the English Language as a second language for the deaf people. In this effort, multimedia applications with video, image, text and sound are combined.

D-signs [10]: This is an online research program for the learning of sign language in the field of work available in English, Irish, Greek, Czech and Cypriot sign languages.

SignSpeak [11] : This is a German attempt to translate the contiguous sign language into text aimed at communication between listeners and non-listeners

Dicta-Sign [12]: Dicta-Sign is a Greek research effort by the Institute of Language and Speech Processing. The Dicta-Sign project is based on research innovations in the field of identifying and producing concepts, exploiting important linguistic knowledge and encoded resources of Sign Language. The Dicta-Sign project deals with data from four sign languages: the BSL, the French Sign Language (LSF), the German Sign Language (GLS) and the Greek Sign Language (GSL).

Auslan Tuition [13]: A program created by the University of Western Australia which uses three-dimensional avatars to form signs. Unfortunately, the development of the full version has been suspended indefinitely

Mobile museum guide: The Finnish museum has created a mobile application that enables its users to watch the museum tour in two sign languages and in three written languages.

Wisdom [14], [15]: This is an application created by the University of Bristol and offers real-time chat service, video transmission based on sign language, remote sign language translation services and automatic recognition of the sign language.

iCommunicator [16] : This is an application that translates English into sign language in the following ways:

- Speech to Text
- Speech/Text to Video Sign-Language
- Speech/Text to Computer Generated Voice

After the translation, the user can use the built-in dictionary or browse more easily on the internet. Currently only ASL is supported.

ProDeaf [17]: It is a program that translates text and voice to Portuguese Libras - Brazilian Sign Language.

Chapter 4 - The I-ACE Research Program

The I-ACE research program provides an automated tool to translate sign a sign language (six sign languages are available) and its respective written text. More specifically these sign languages come from Portugal, Germany, United Kingdom, Cyprus, Greece and Slovenia.

I-ACE outcomes have direct application in the classroom and in daily life. At the school environment I-ACE provides actual communication among deaf students, non-deaf students and teachers. It gives the opportunity to deaf students to have access to written resources, ask questions and to participate in the classes. This reduces discriminations in learning and boosts the digital integration of deaf people in learning and training.

An ideal school should ensure that all students have access to the learning procedure, regardless of their difficulties and / or differences. Students with hearing problems face communication difficulties which become vital obstacles in the school learning process. School should allow the access to appropriate educational services and provide support according to student’s needs.

The I-ACE project delivers an automatic translator between written text and sign language. This will be used by students and teachers, preventing in this way early school leaving.

The translator will allow deaf students to understand the reading of educational resources and digital contents as easily as hearing students. Furthermore, it will make them feel that they are equal part of the school environment and many of them will proceed their studies to Higher Education.

The simplicity of the translator makes it applicable to all education levels from Primary School to Higher Education. The I-ACE through the translator addresses the importance of sign language in education and helps deaf students to integrate into society and make progress at an academic or professional level.

4.1 General overview of the methodology

The preparatory phase of the I-ACE included:

a) the focus groups. This investigation included research, the realization of focus groups in participating countries and an online survey.

b) The intellectual outputs:

❖ Output 1 (O1). This records the challenges faced by deaf students in school and their daily life. State of the art methods were also investigated, and this resulted to intellectual output O1, which is a book providing a comprehensive description of the findings related to communication with the deaf community.

❖ Output 2 (O2). This includes trial installations of O5 and O6 in secondary schools at each partner's region.

❖ Output 3 (O3). The European Sign Language Translator. The translator is available for the following sign languages: Portuguese, German, British, Greek, Cypriot and Slovenian.

❖ Output 4 (O4). The translation models. During the implementation stage translation models were created to support the automatic translator, one per supported sign language.

❖ Output 5 (O5). This includes the applications for effective communication with/between deaf in the classroom. There was delivered an automatic converter from text to sign language represented by a 3D avatar.

❖ Output 6 (O6). This includes applications for effective communication with/between the deaf in daily life. There will be a ICT solution that deploys the automatic translation to be used in public attendance services.

c) A workshop to discuss and promote collaborations with participants on the subject "communication challenges faced by deaf and proposed solutions"

d) the final seminar

Furthermore, one training session at each partner institution was promoted, to train staff on the generation of the translation models and on the setup and usage of the European Sign Language Translator. After these training sessions the attendants were able to adapt the European Sign Language to new languages by generating the required translation model and setting up the translator. These training sessions were open to local participants other than the partner institution.

Chapter 5 - The Configurator

Before describing how the European Sign Language Translator works, we must explain the way a translation model is created. In our case Greek will be the translation model.

5.1 Creating an account

The first thing to do is to create an account. We can either add ourselves as editor, as validator or both. We have to press the button “Sign Up” as shown in Figure 5.1.

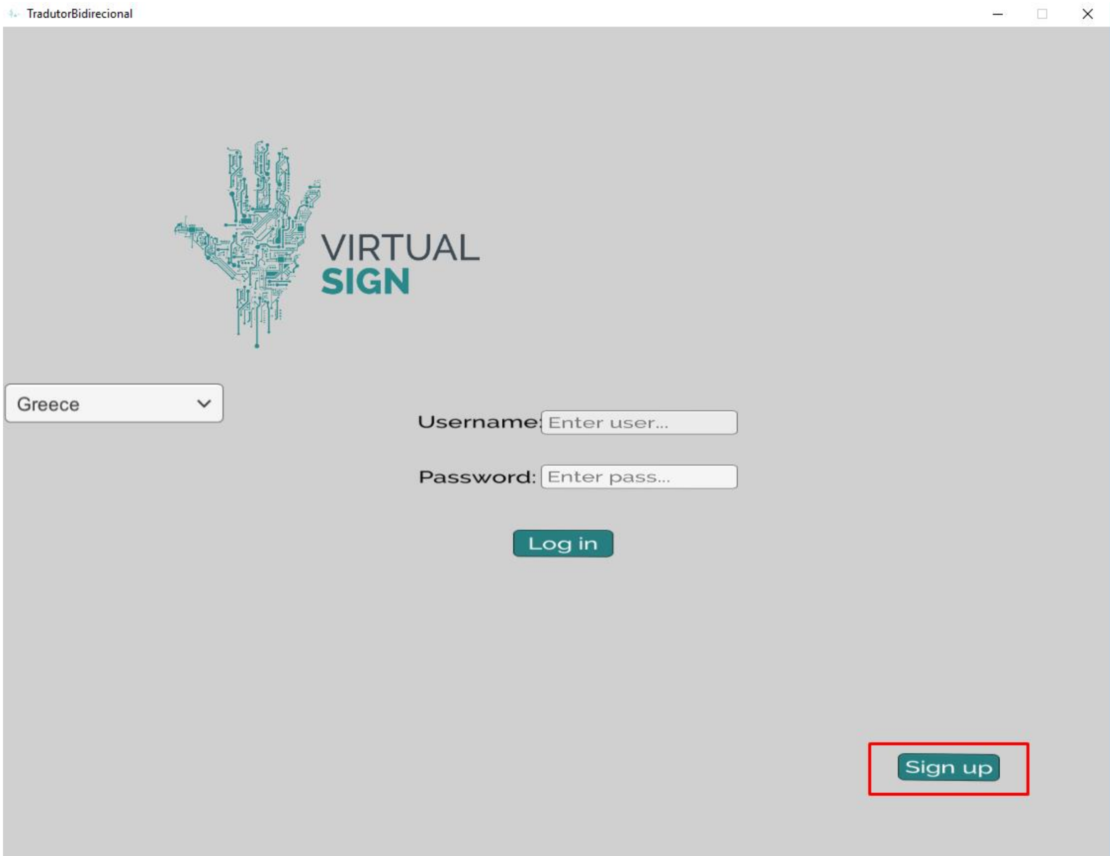

FIGURE 5.1: CREATING AN ACCOUNT

In step one, we have to fill out the form as in Figure 5.2

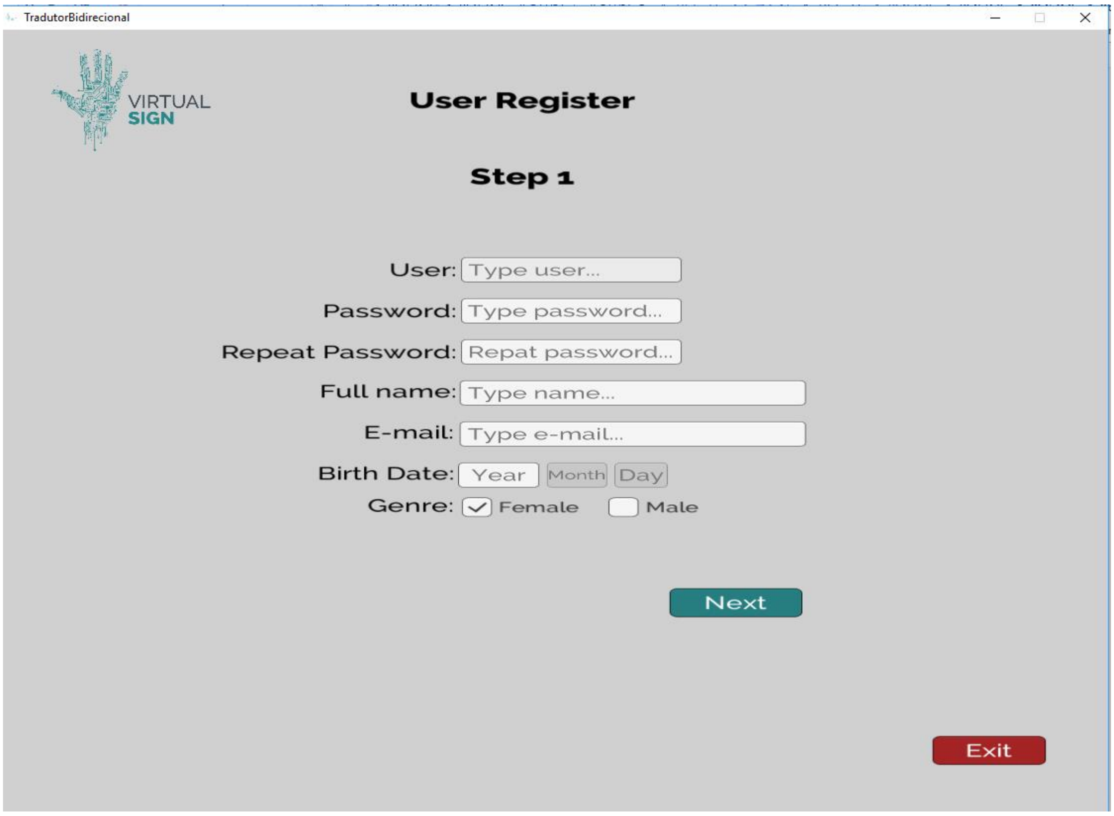

FIGURE 5.2: CREATING AN ACCOUNT – STEP 1

Then in step two (Figure 5.3) we have to enter some personal information such as whether we are deaf or not, our qualifications and profession etc.

FIGURE 5.3: CREATING AN ACCOUNT – STEP 2

The final step is to choose the sign language we want to work with, whether to register as a validator or editor and the institute we belong to (Figure 5.4).

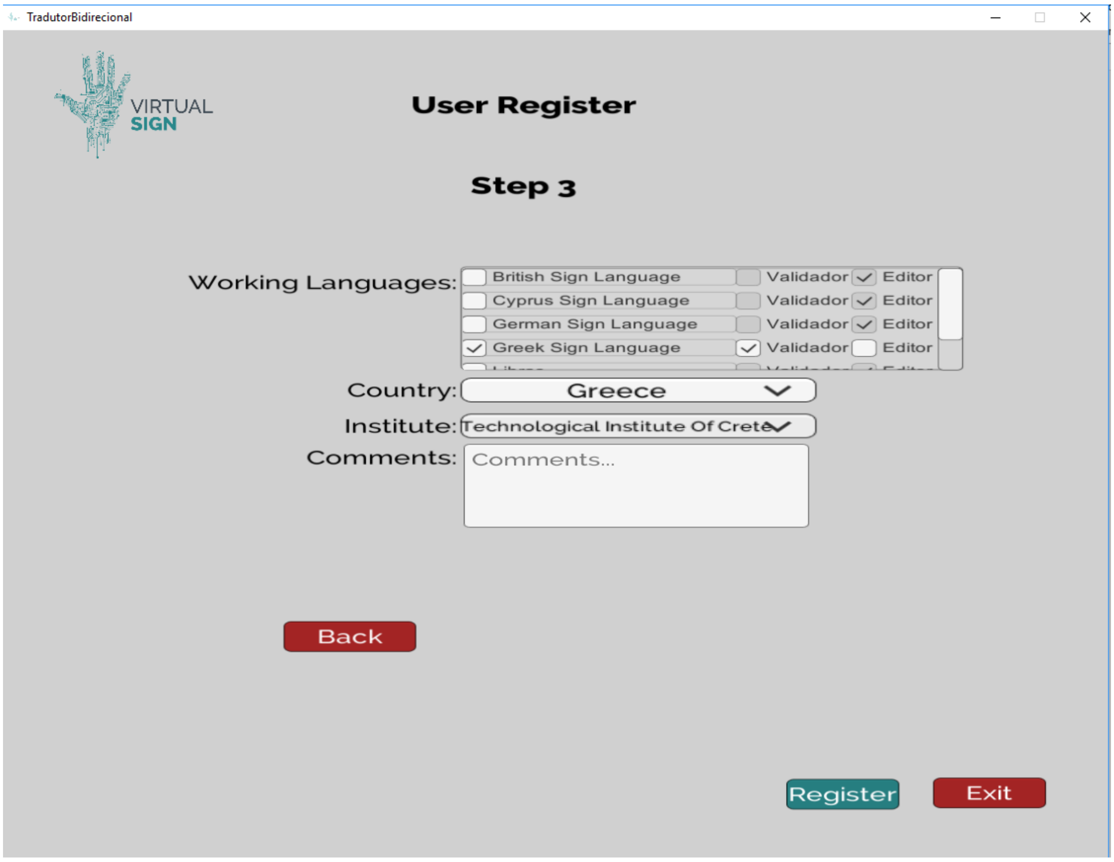

FIGURE 5.4: CREATING AN ACCOUNT – STEP 3

The account is not active until an administrator accepts it. Until then the account is inactive, and we cannot work with the program. The administrator enters his credentials in the welcome screen and press the "Accept Accounts" button (Figure 5.5).

FIGURE 5.5: ACCEPTING AN ACCOUNT- STEP 1

The accounts created and awaiting approval are shown in Figure 5.6 and the administrator has to accept or reject them. Once an account is accepted the respective person can work with the program according to the role selected upon registration (editor/validator).

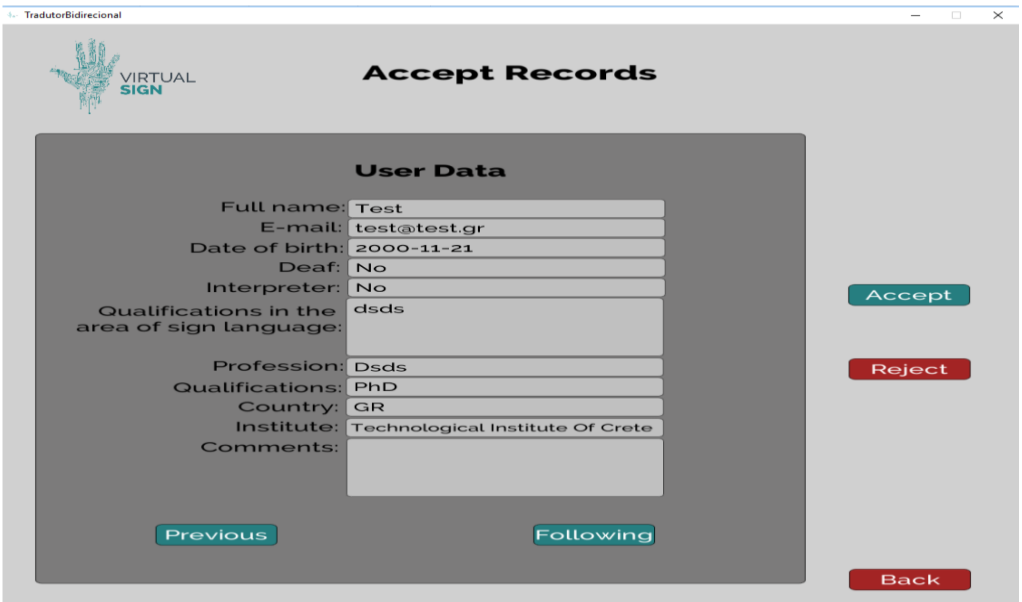

FIGURE 5.6: ACCEPTING AN ACCOUNT – STEP 2

5.2 Importing hand configurations

The first and most significant thing to do is import all the necessary hand configurations to the program. Figure 5.7 shows the initial screen of the program.

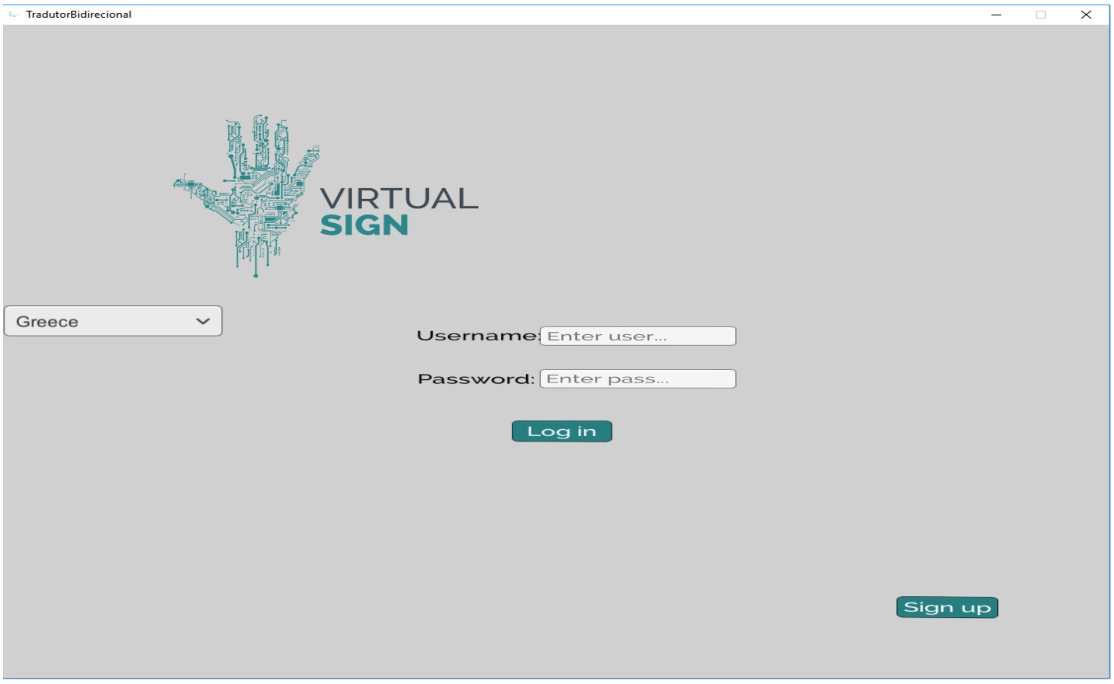

FIGURE 5.7: BACKEND OF THE PROGRAM

In the dropdown menu on the left, we choose Greece as the sign language to be edited and we provide our credentials. It is important to say that only people with administrative rights can import hand configurations to the program.

Administrators, besides importing hand configurations, can also perform other procedures such as (Figure 5.8):

- ✓ Create a new Institute
- ✓ Create a new user account
- ✓ Create a new country
- ✓ Create a new language.

An account may have the following rights:

- ✓ Administrator. An administrator has access to all menus, can create or delete languages, countries users, add hand configurations etc.

✓ Editor. An editor has access only to the part of the program that let him creates words

✓ Validator. A validator sees the words created by an editor and decides whether the word is right and validate it or can perform some corrections to the avatar.

In our case primarily the country (Greece) was created, then the Technological Educational Institute of Crete was added, a new user account was created and accepted and finally we were able to add configurations to the program.

FIGURE 5.8: ADMINISTRATIVE MENU

When we press the button "Add Configurations", we face the next screen where we can choose the language where we want to import the hand configurations (Figure 5.9):

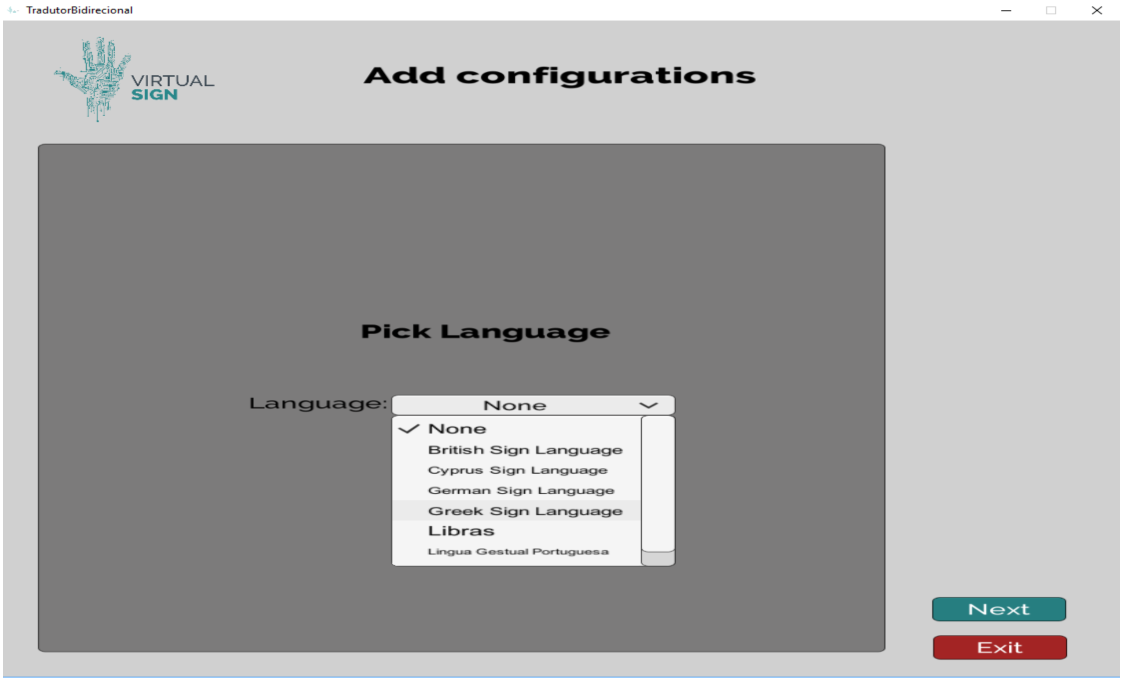

FIGURE 5.9: MENU TO CHOOSE SIGN LANGUAGE

A typical paradigm of the available hand configurations is shown in Figure 5.10. They are divided into groups (1-13) and each group contains a number (not necessarily the same) of hand configurations. All the available hand configurations from every group are presented in Appendix A. In the same Appendix are also presented the hand configurations used for the Greek Sign Language.

Next, we must select the hand configuration we want to import to the program. Let us suppose we want to import hand configuration 15 from Group 1. We choose it and press the "Next" button. The result is the one in Figure 5.11. There we enter the meaning of the specific hand configuration and save it.

The same procedure is repeated until all the necessary hand configurations for the Greek Sign Language are inserted to the program.

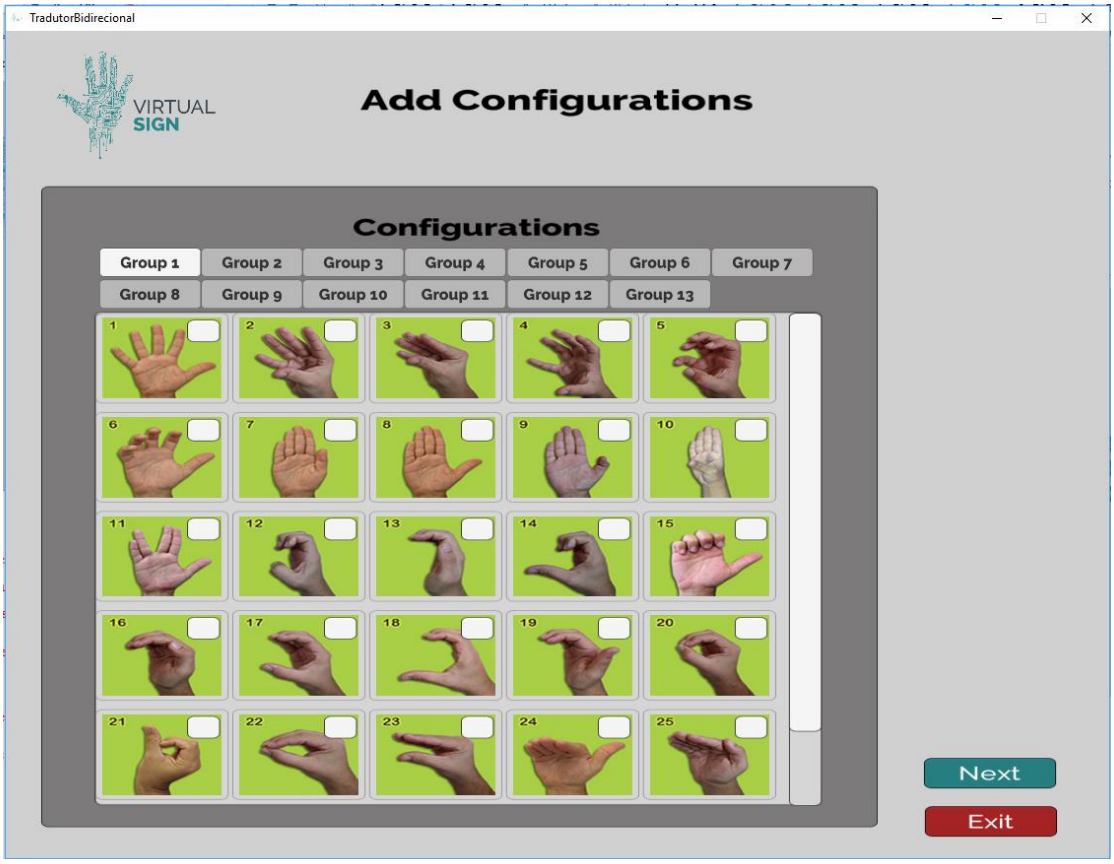

FIGURE 5.10: THE AVAILABLE HAND CONFIGURATIONS

FIGURE 5.11: SAVING A HAND CONFIGURATION

5.2 Entering words

The next step was to “train” the Avatar to learn a specific text. This means that we had to enter words from a given text, originally written in Portuguese. The text was translated to Greek and a python script was used to identify the unique words in an ascending order. After this we were able to enter the words to the program. A total of 500 words was inserted to the program. To do this we login to the program, but this time as editors (Figure 5.12).

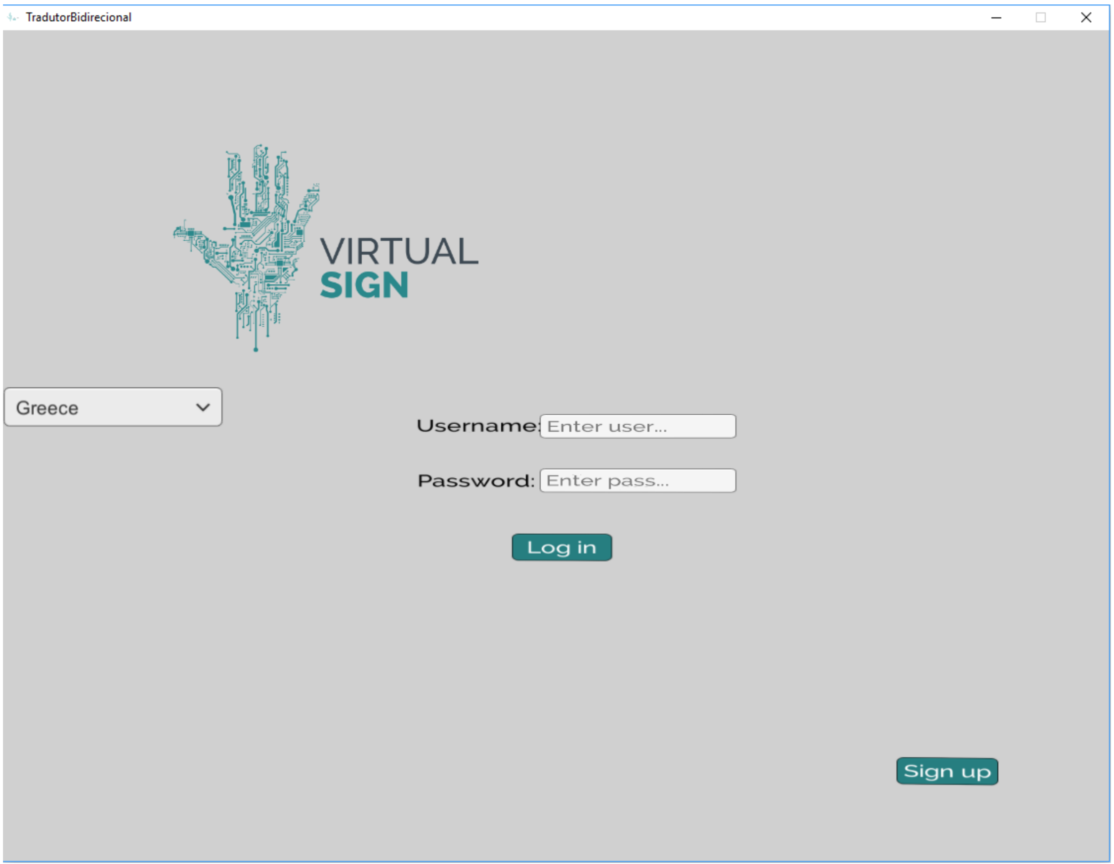

FIGURE 5.12: ENTERING THE BACKEND AS EDITOR

When we login we see the next screen (Figure 5.13). It shows the screen we face as an editor. The screen for the validator has minor changes which will be examined in another section.

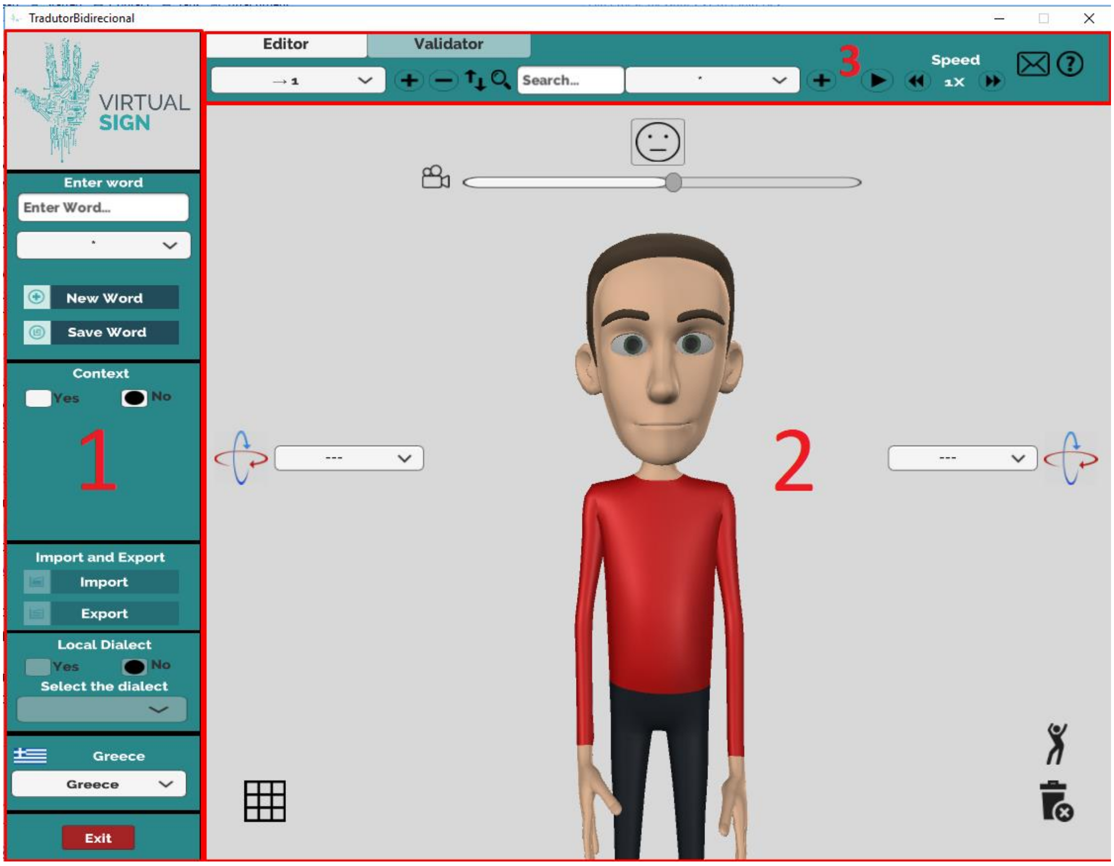

FIGURE 5.13: ENTERING THE BACKEND AS EDITOR

We have split the window in Figure 5.13 into three (3) areas. We will have a closer look to each area. First, in area 1 we see some options an editor may find:

- *Enter Word*: Here the editor enters the word the avatar must "learn". The dropdown menu just below this option shows similar words when the editor starts entering text.
- *New Word*: The editor must press this button every time he wants we enter a new word. A popup window will arise asking us if we are sure because all the unsaved changes will be lost.
- *Save Word*: After "training" the avatar the editor must press this button, otherwise the word will not be saved.
- *Context*: If the word the editor enters means many things in the spoken language, by pressing this button the right meaning is chosen. Figure 5.14 shows an example for word "route" when the editor presses the button "context". There are all the available meanings from which he chooses the appropriate one.

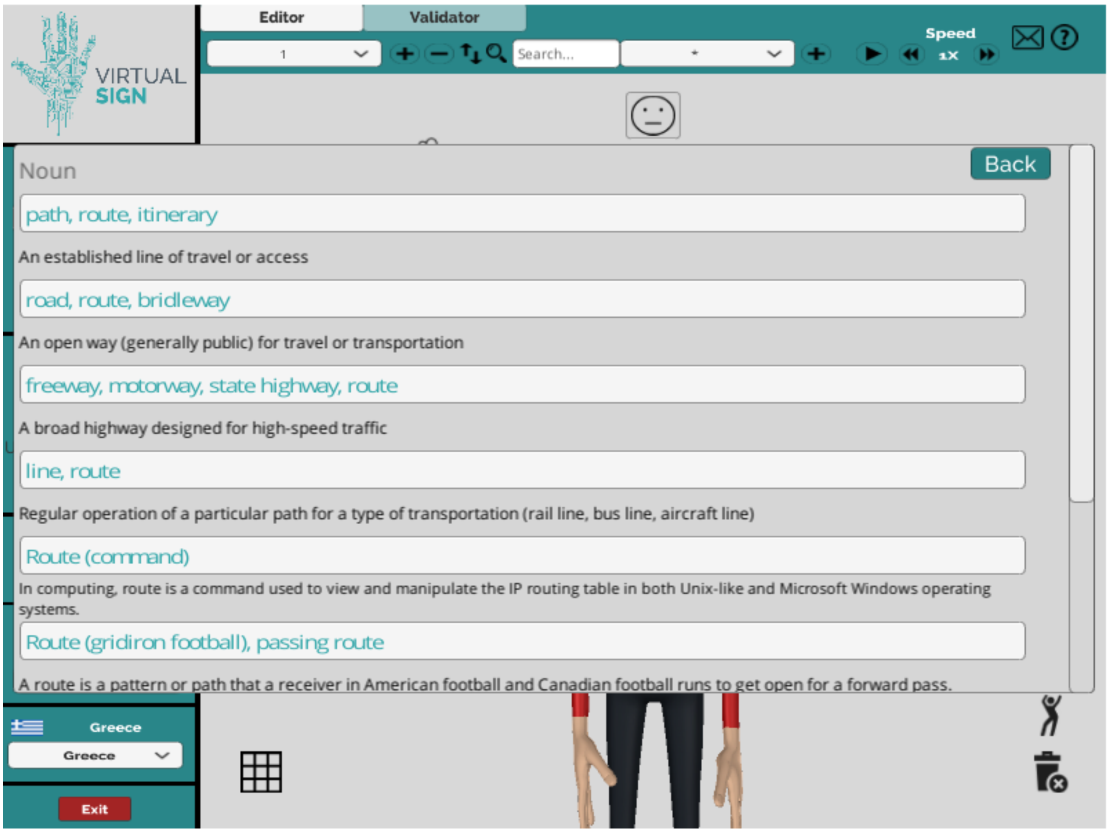

FIGURE 5.14: CONTEXT FOR WORD "ROUTE"

Import and Export: These buttons are intended for future use

Local Dialect: This button allows us to choose whether the entered word comes from a local dialect or not. Default value is "No".

Finally, the last dropdown menu shows the current language, the one selected when entering the backend.

In Area 2 the important thing to notice is the avatar. The first and most significant thing to do is to choose the correct hand configuration. This is done by selecting one hand configuration from the dropdown menu on the left or the right of the avatar (Figure 5.15). Depending on the word we want to "train" the avatar we may use one or two hand configurations.

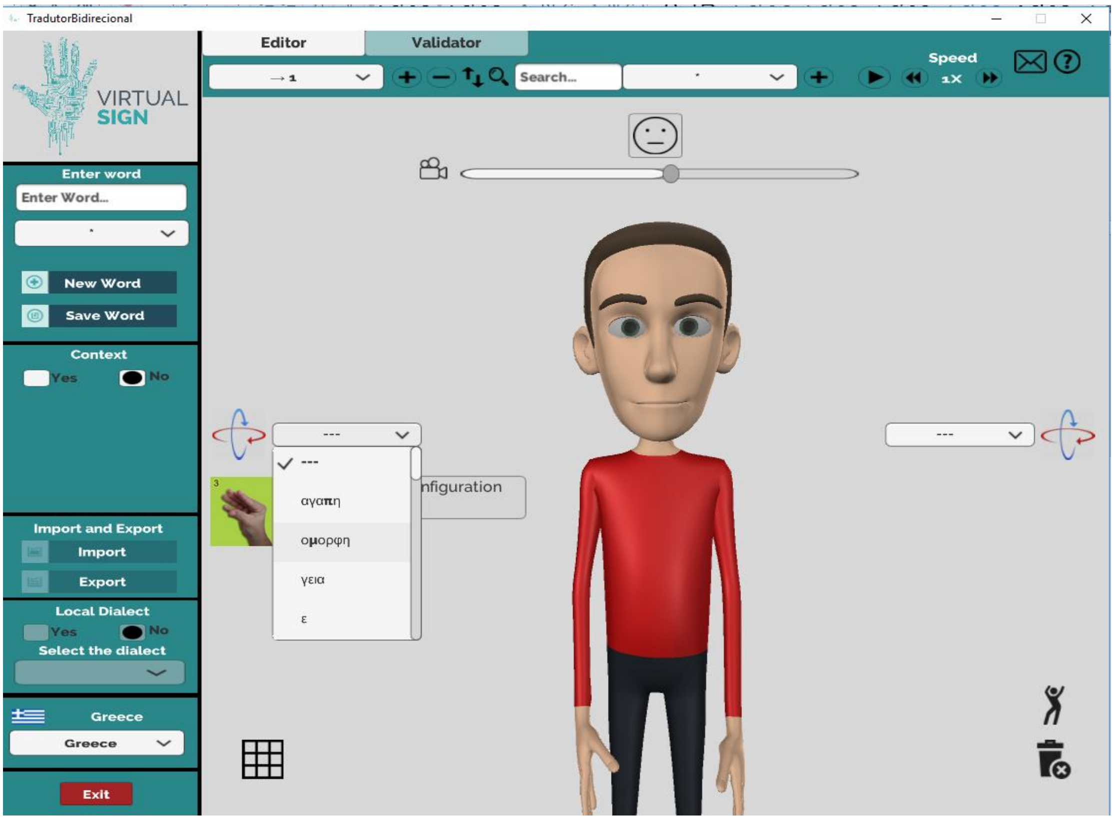

FIGURE 5.15 CHOOSING THE CORRECT HAND CONFIGURATION

The slider above the head of the avatar allows us to see it from the left or the right side, in order to adjust any move (Figure 5.16). The camera button resets the avatar to its default position.

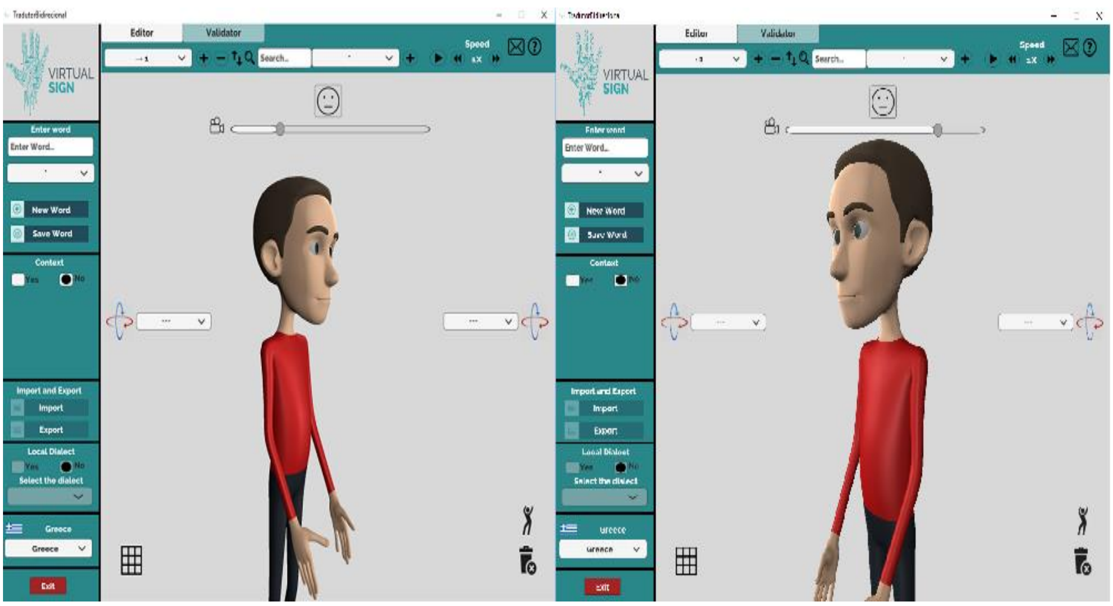

FIGURE 5.16: ADJUSTING THE VIEWING ANGLE OF THE AVATAR

The face button above the slider allows us to change the facial expression i.e. whether the avatar is happy or sad etc. and the head rotation (Figure 5.17).

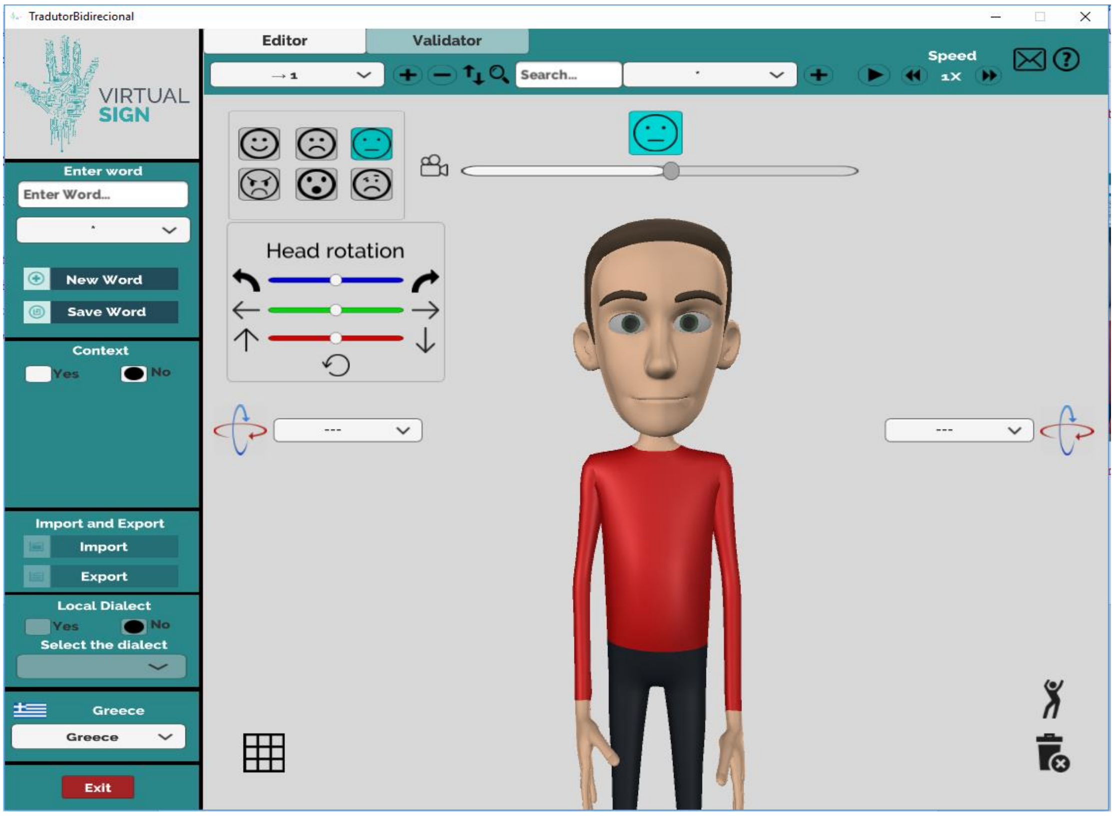

FIGURE 5.17: EXPRESSING FEELINGS – HEAD ROTATION

We can also display a grid in the main window (area 2) in order to make adjustments easier (Figure 5.18).

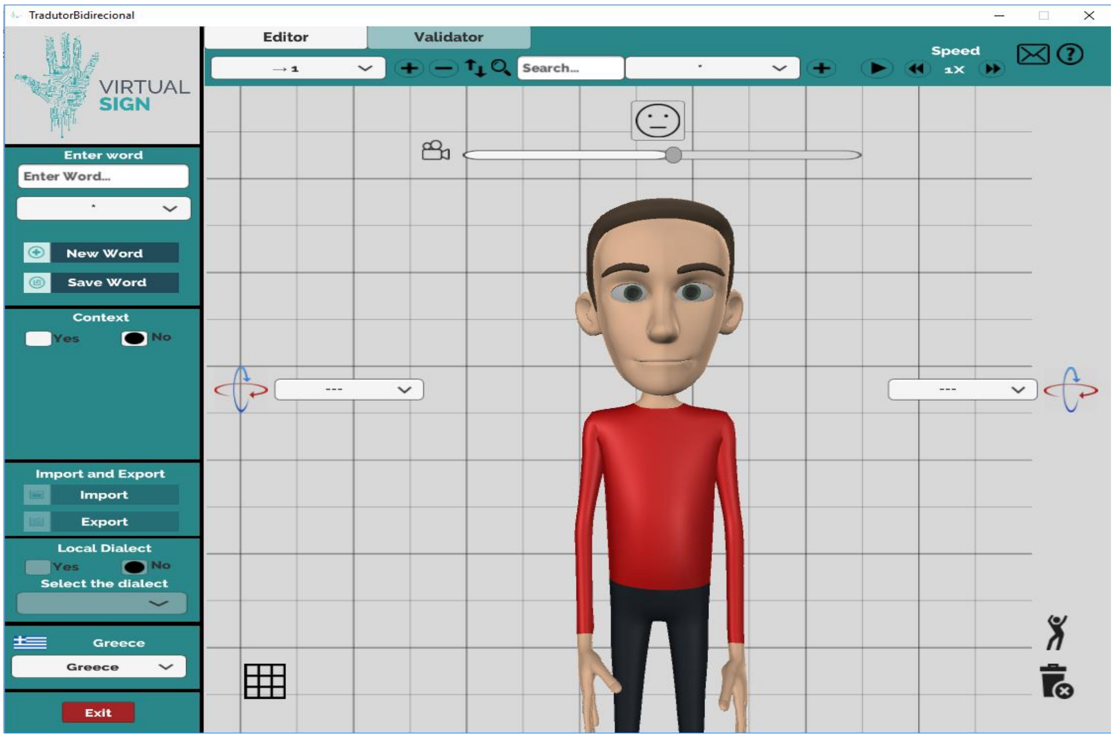

FIGURE 5.18: THE AVATAR WITH THE GRID ON

In area 3, there are the two tabs which allow us to act as an editor or a validator. Just below this option there is a dropdown menu with numbers. These are the moments. It is obvious that a word in a sign language is consisted of more than one moments and each moment may use a different hand configuration.

An editor must choose the correct hand configuration for each moment, the correct body position, the appropriate face expression and head rotation for each moment. The plus (+) button adds a new moment to the word while the minus (-) button deletes a moment.

Figure 5.19 shows how an editor can copy a moment if a movement is repeated (the file icon next to number in the dropdown menu) or change the order of a moment (the up and down arrows).

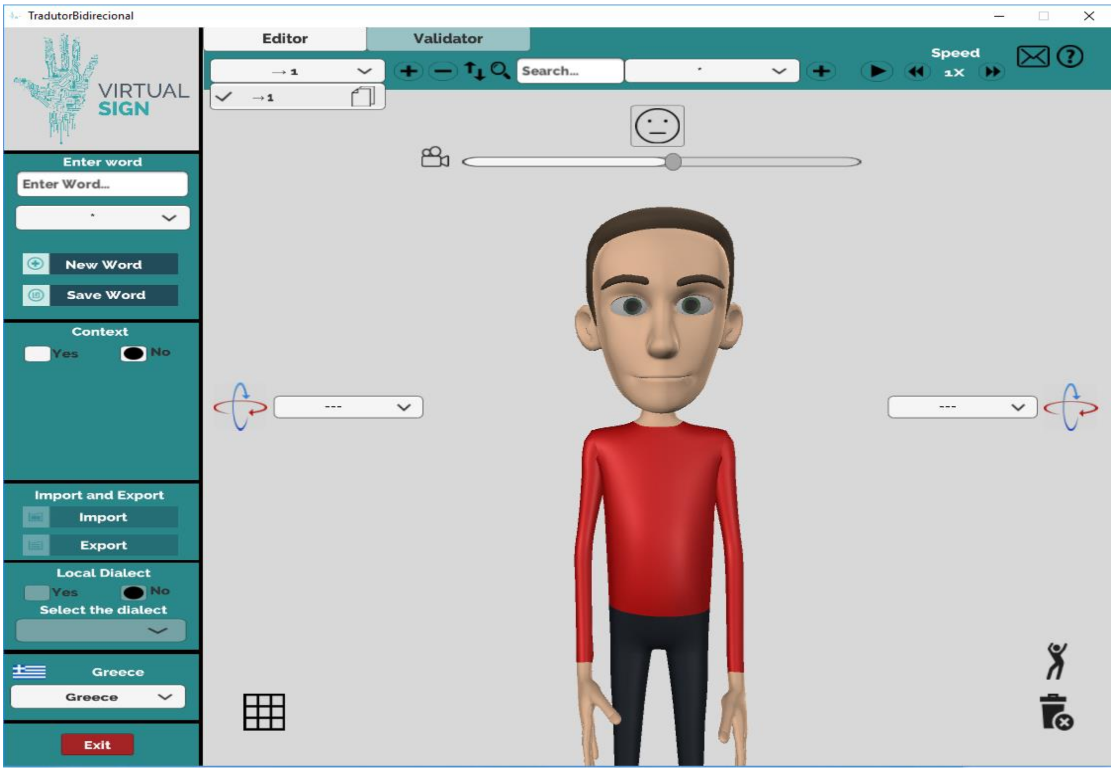

FIGURE 5.19: COPY A MOMENT OR CHANGE ITS ORDER

If we want to change the orientation of the hands, their distance from the body we must press the button next to the dropdown menus showing the utilized hand configuration (Figure 5.20).

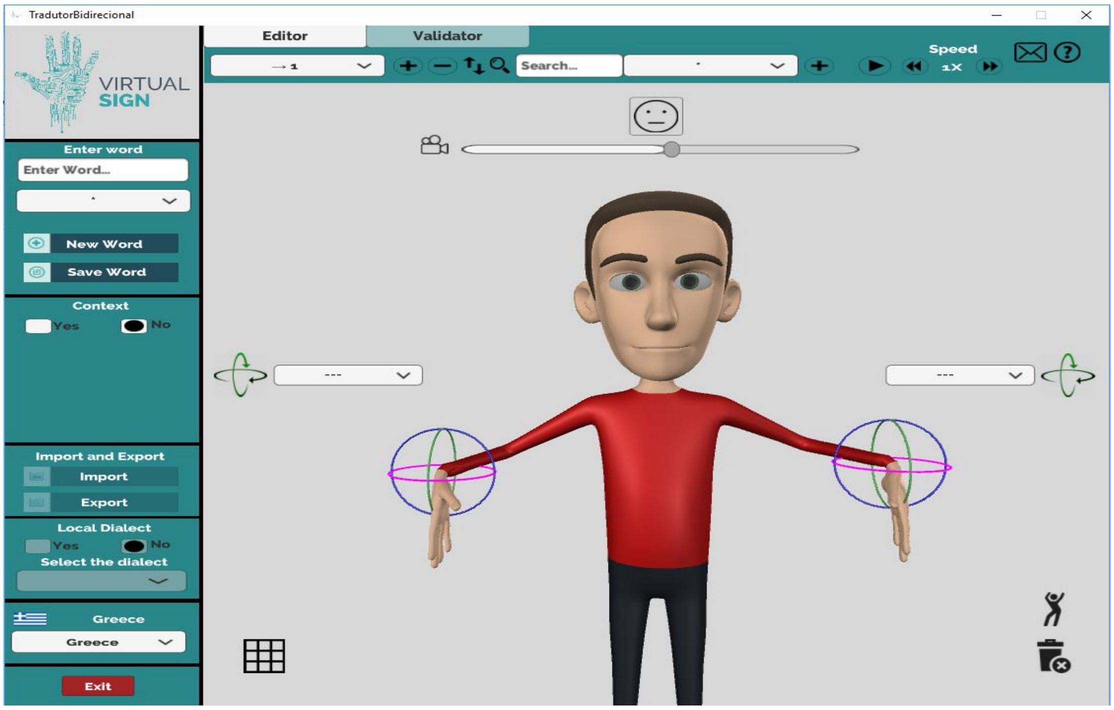

FIGURE 5.20: CHANGING ORIENTATION OF THE HANDS

The text box next to the magnifying lens allow us to import a word. This is extremely helpful as some words are similar to the Greek Sign Language. By this method we can copy some or all the moments of the imported word and use them in the new one. For example, let's suppose we want to import «αγορά» ("market" in English). We will write the word «αγορά» in the text box and the result is shown in Figure 5.21. The we press the plus (+) button next to the word and the all the moments of the word «αγορά» are imported to the program.

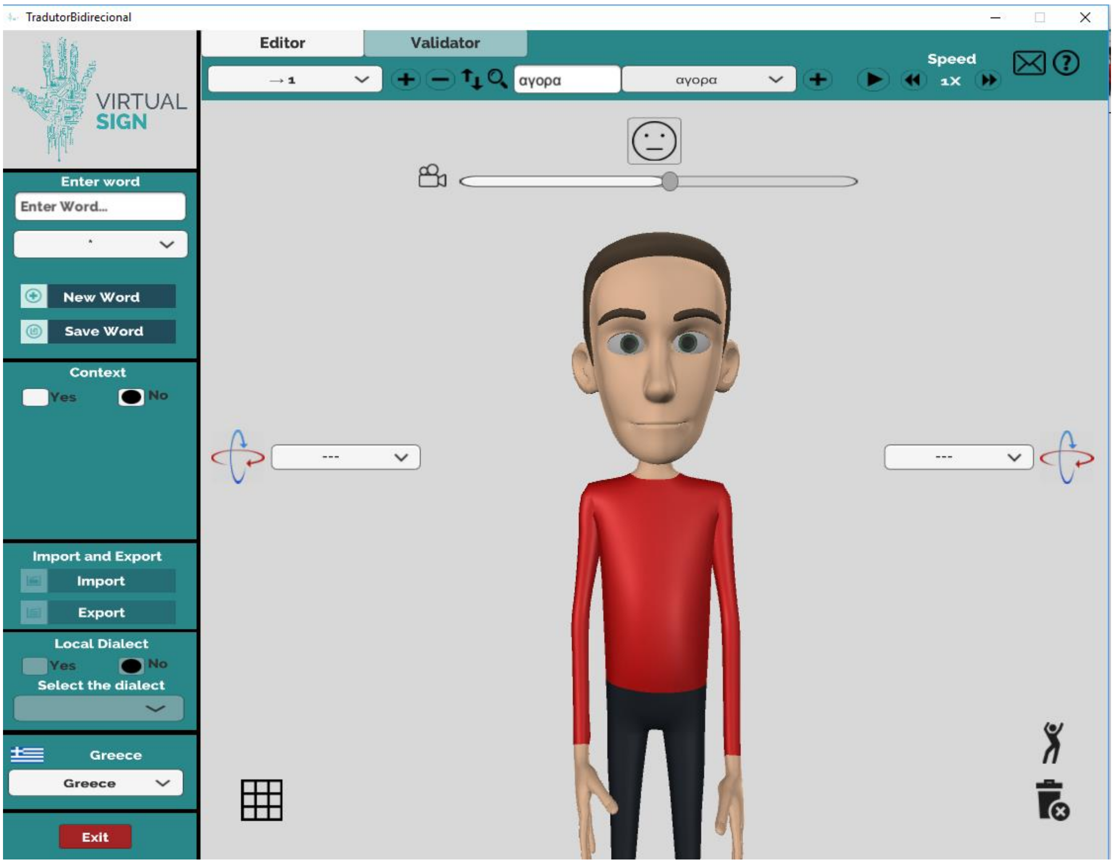

FIGURE 5.21: IMPORTING MOMENTS OF A WORD TO THE PROGRAM

The "play" button allow us to see how the avatar corresponds when all the moments are combined as one unique word. We can also change the speed and make it "play" faster or slower by changing the value. Finally, through the "letter" button we can check if we have any messages and the "?" button can activate or deactivate the help.

5.3 Validating a word

To validate a word someone has to enter the program as a validator or if he has both roles (editor/validator) to press the appropriate tab. The screen a validator sees is shown on Figure 5.22.

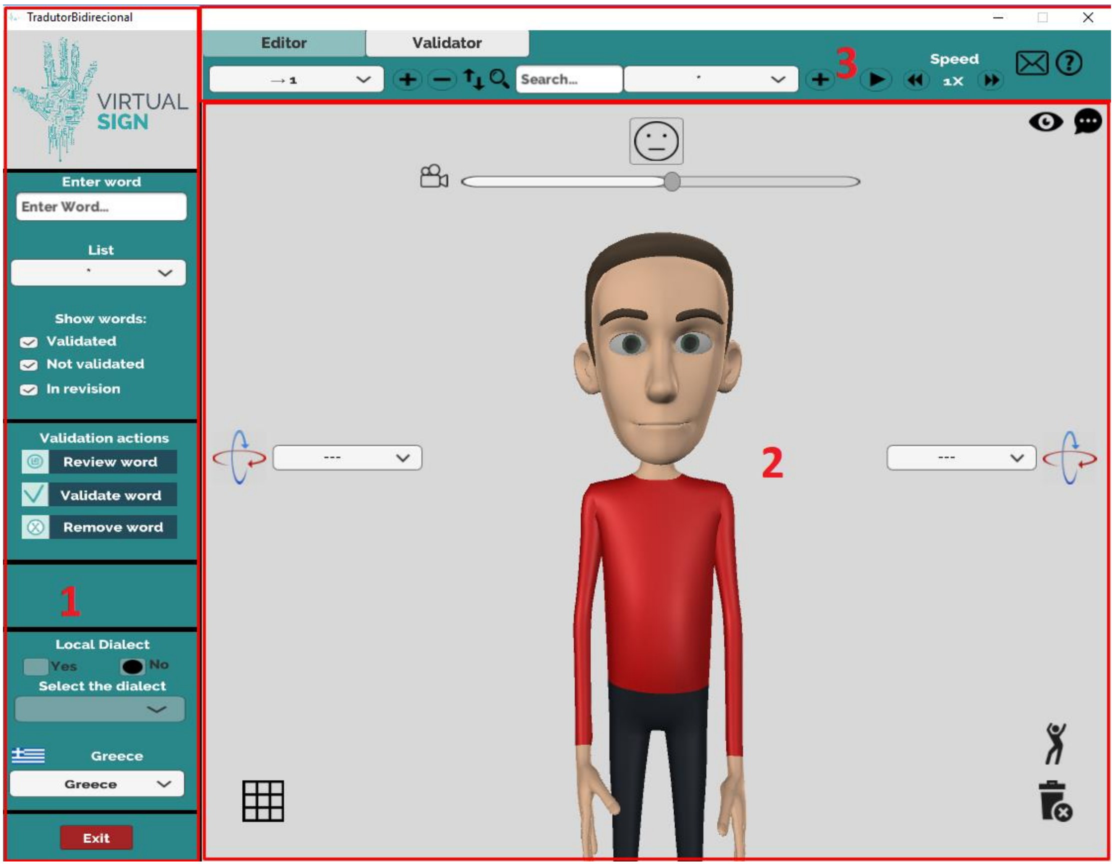

FIGURE 5.22: VALIDATING A WORD

If we compare Figure 5.22 and Figure 5.13, we see that the only differences are in area 1. Moreover, the dropdown menu named "List" can show:

- Validated words
- Not validated words
- In revision words

Let's suppose that a validator wants to check if a word an editor inserted to the program is correct. He must choose the "Not validated" option. This will show him in the "List" dropdown menu all the words which are inserted but not validated. He then chooses an unvalidated word, checks if it is accurate and if not, he corrects it in area 2 just as described above. He then presses the button “Validate word” and the word is permanently saved in the database. The other option a validator has is to remove a word.

Chapter 6 - The Translator

After importing the Greek model, the rest is easy. The avatar is now considered "trained", therefore he can translate Greek text to Greek Sign Language. Figure 6.1 shows the European Sign Translator.

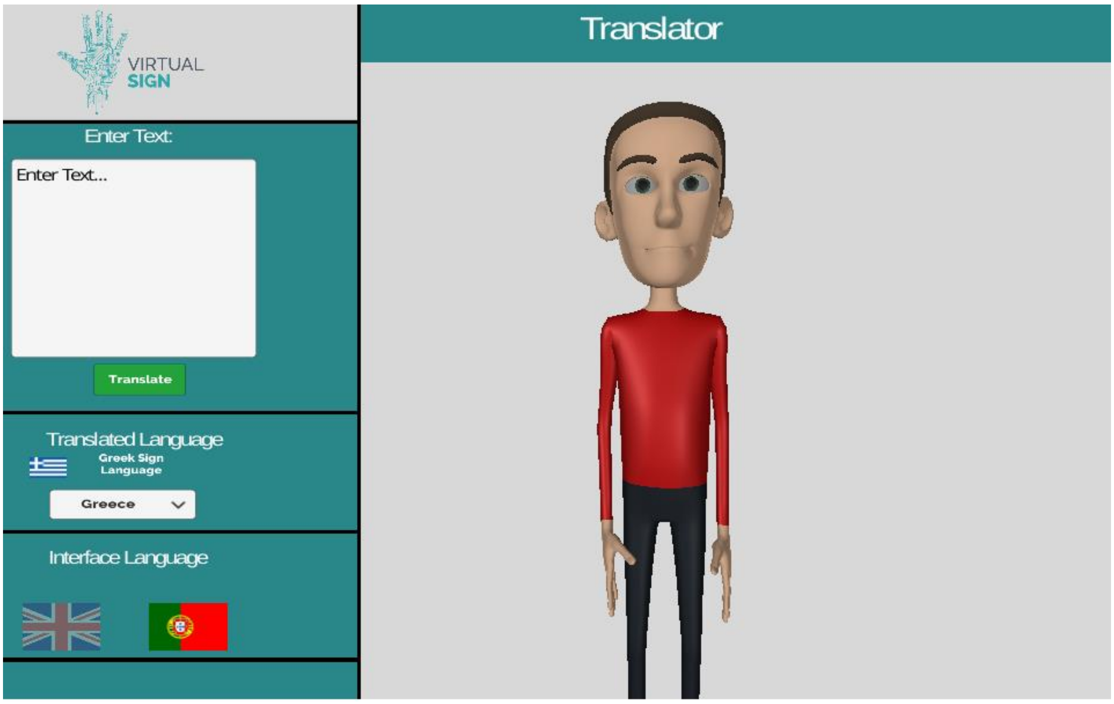

FIGURE 6.1: THE EUROPEAN SIGN TRANSLATOR

In the textbox we enter the text we want the avatar to translate to GSL and we press the button "Translate". We can change the desired sign language by changing the value of the dropdown menu named "Translated Language". Finally, the two flags on the bottom left allow us to choose the interface language. English and Portuguese are the two-interface language right now, but more will be added.

Chapter 7 - Conclusion and Future work

The I-ACE research program is a breakthrough technology that brings together the deaf community and the hearing people. It reduces the educational gap a deaf student faces when he enters school and give him the opportunity to participate to the school procedures as an equal member of the community. Although I-ACE research program is a huge step towards, there are many improvements that should be done in future revisions:

- ✓ Speech to text. There should be the possibility a microphone to capture teacher's voice and convert it to text. Then according to the prementioned procedure the translation to the sign language will be done.
- ✓ There should be added the capability an editor to move not only the hand of the 3d avatar, but its fingers also. This should finetune the movement and make the formed word more realistic.
- ✓ The option to express feelings and rotate the head should be further redesigned as with its current state it is not represented well.
- ✓ The online version of the program should be faster especially when working to full screen.
- ✓ There should be more interface languages to the translator and not only English and Portuguese.
- ✓ Other aesthetic improvements such as choice of different themes should be considered.
- ✓ There should be a stop / pause button in Translator. This could be useful when someone wants to pause temporarily or stop the avatar translating for some reason.

Although there is a lot of work that should be done in order an automated translator to "replace" a human, I-ACE research program could be a milestone to deaf education. An automated tool that reduces the lack of communication between deaf students and hearing ones, is remarkable and should be further supported and evolved.

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Appendix A

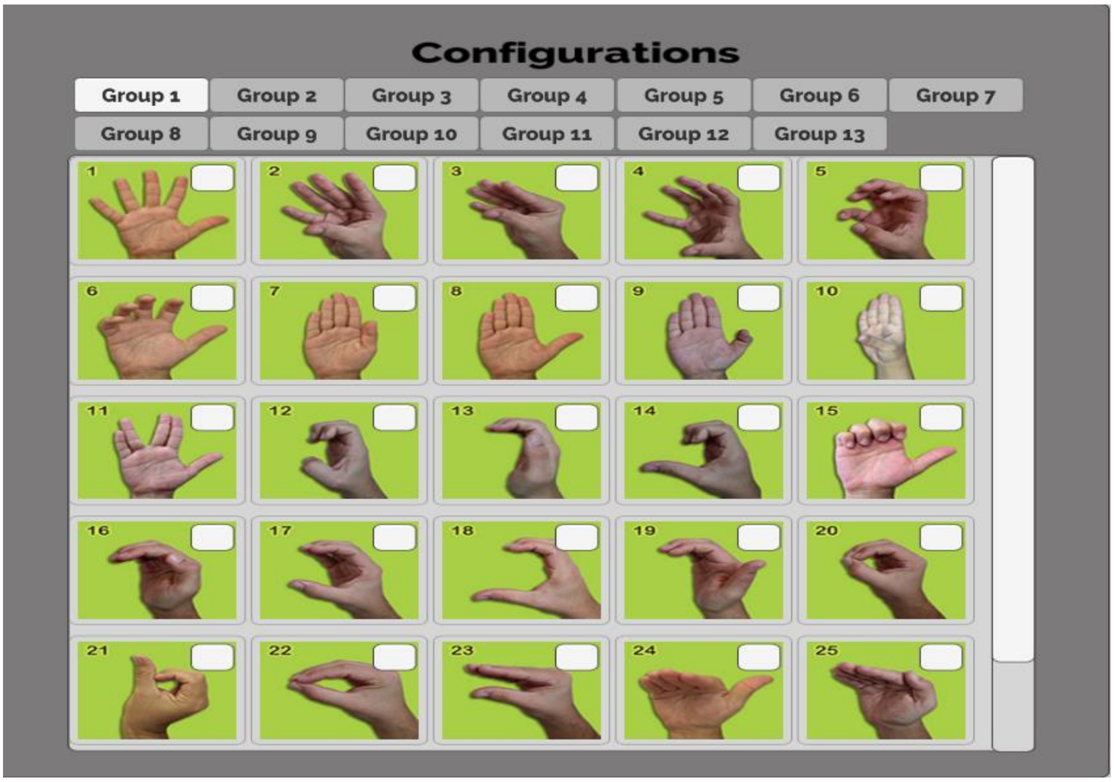

FIGURE A.1: HAND CONFIGURATIONS OF GROUP 1

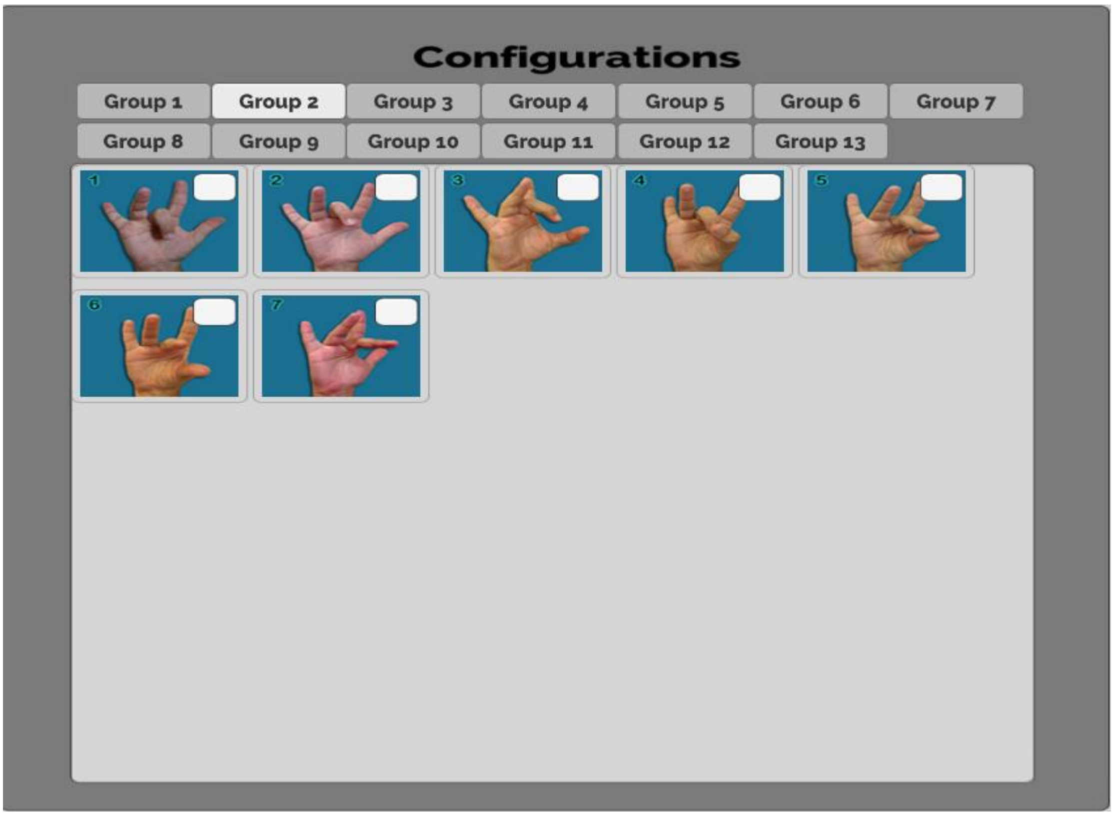

FIGURE A.2: HAND CONFIGURATIONS OF GROUP 2

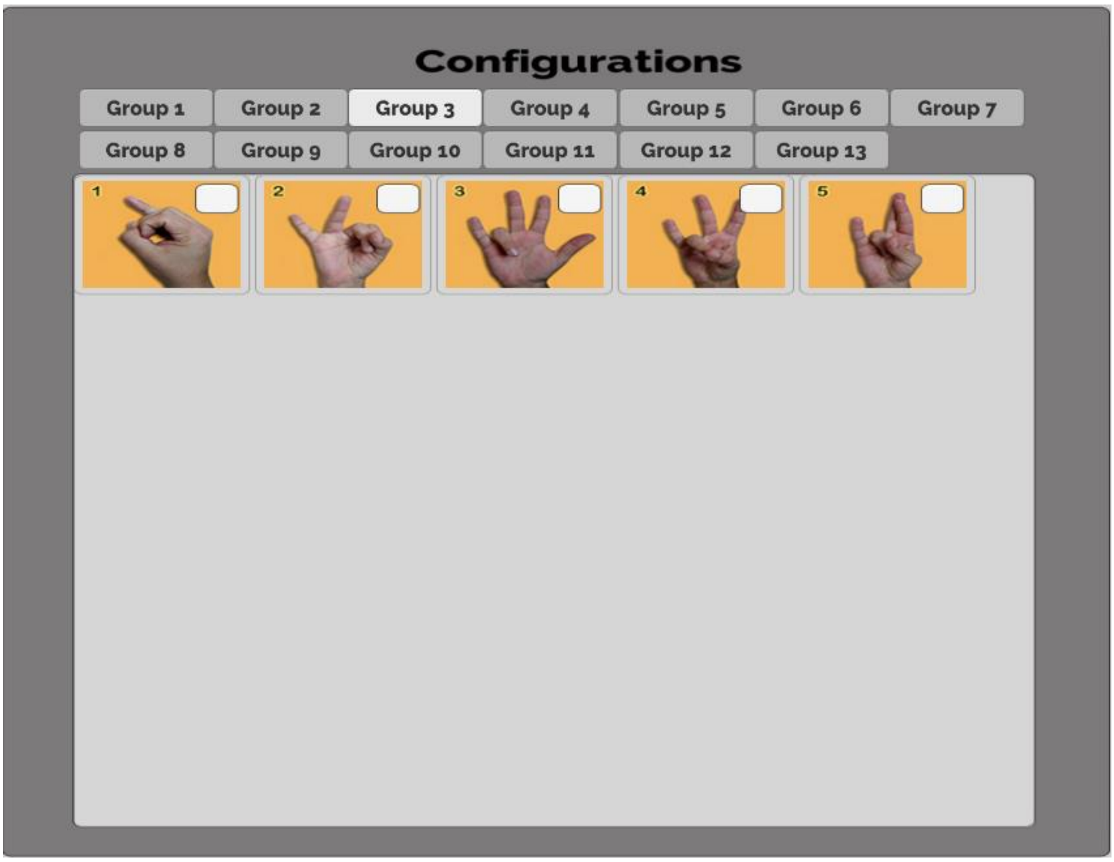

FIGURE A.3: HAND CONFIGURATIONS OF GROUP 3

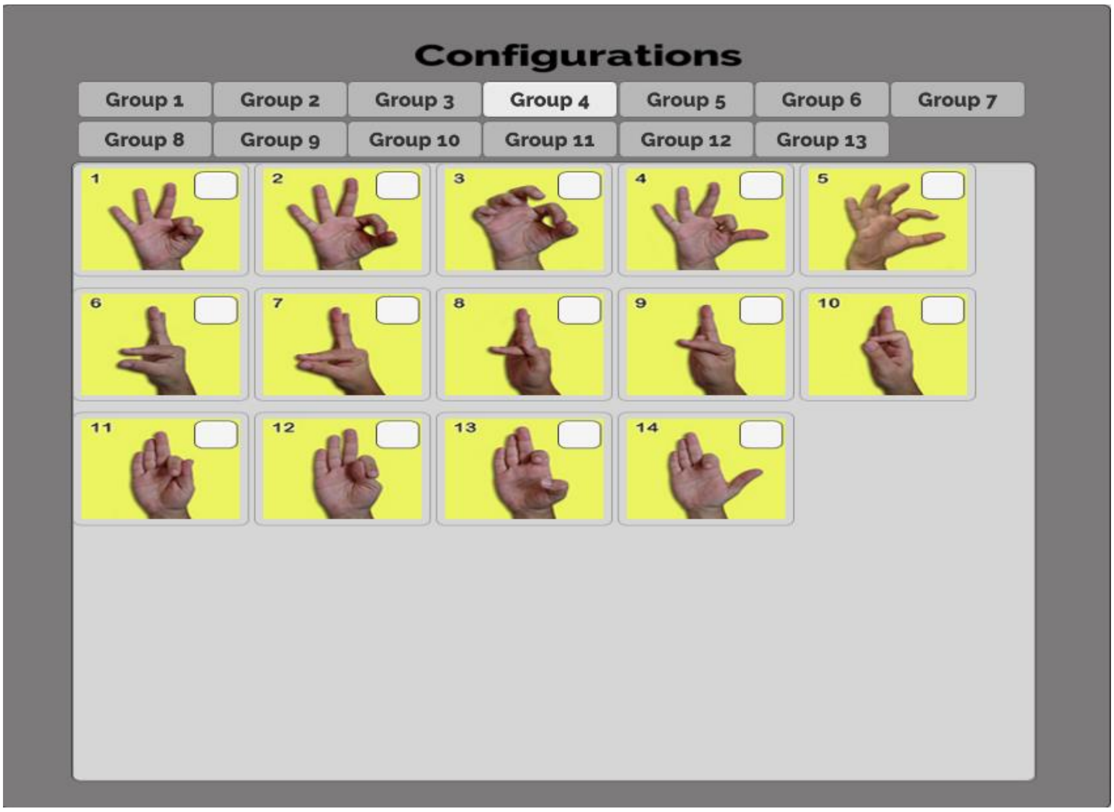

FIGURE A.4: HAND CONFIGURATIONS OF GROUP 4

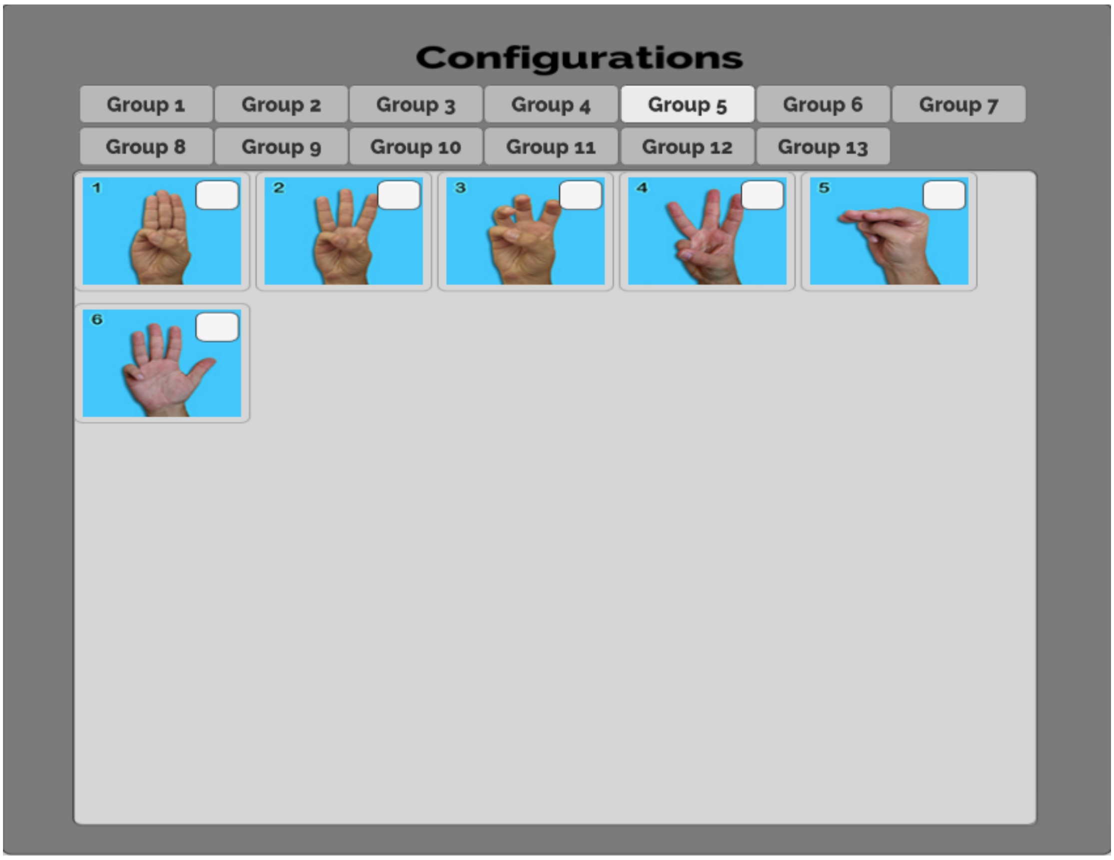

FIGURE A.5: HAND CONFIGURATIONS OF GROUP 5

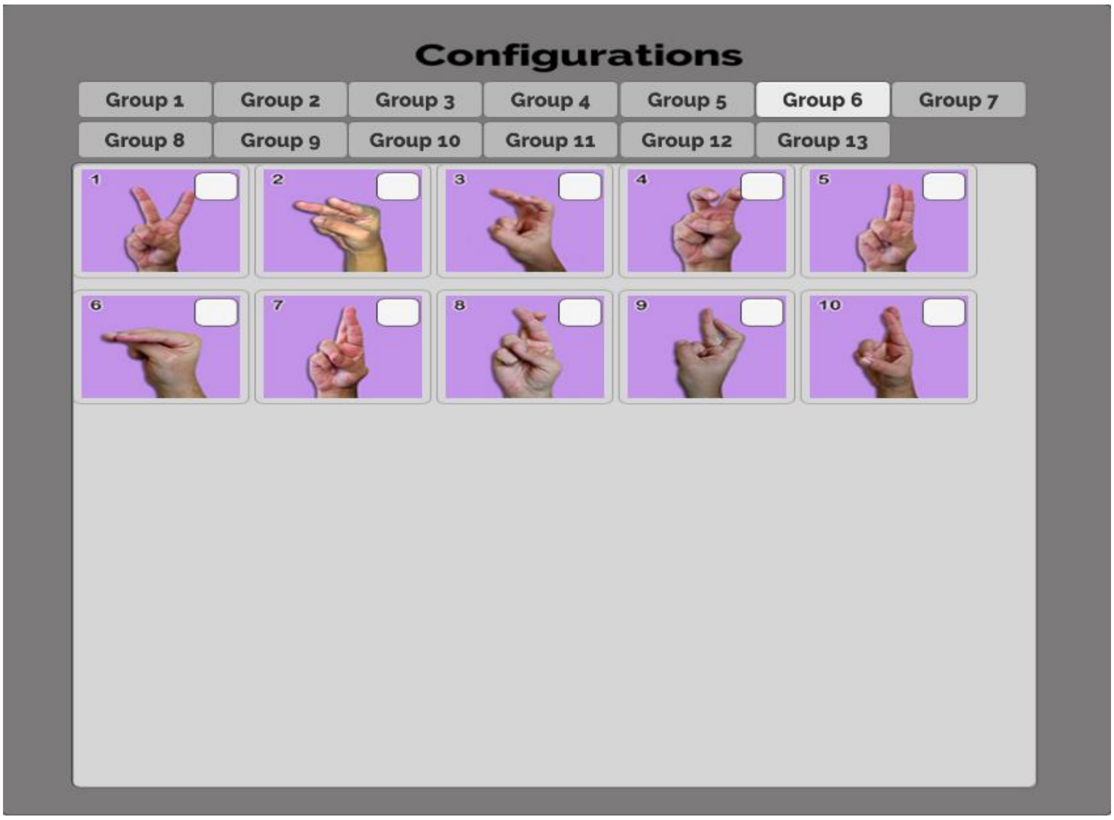

FIGURE A.6: HAND CONFIGURATIONS OF GROUP 6

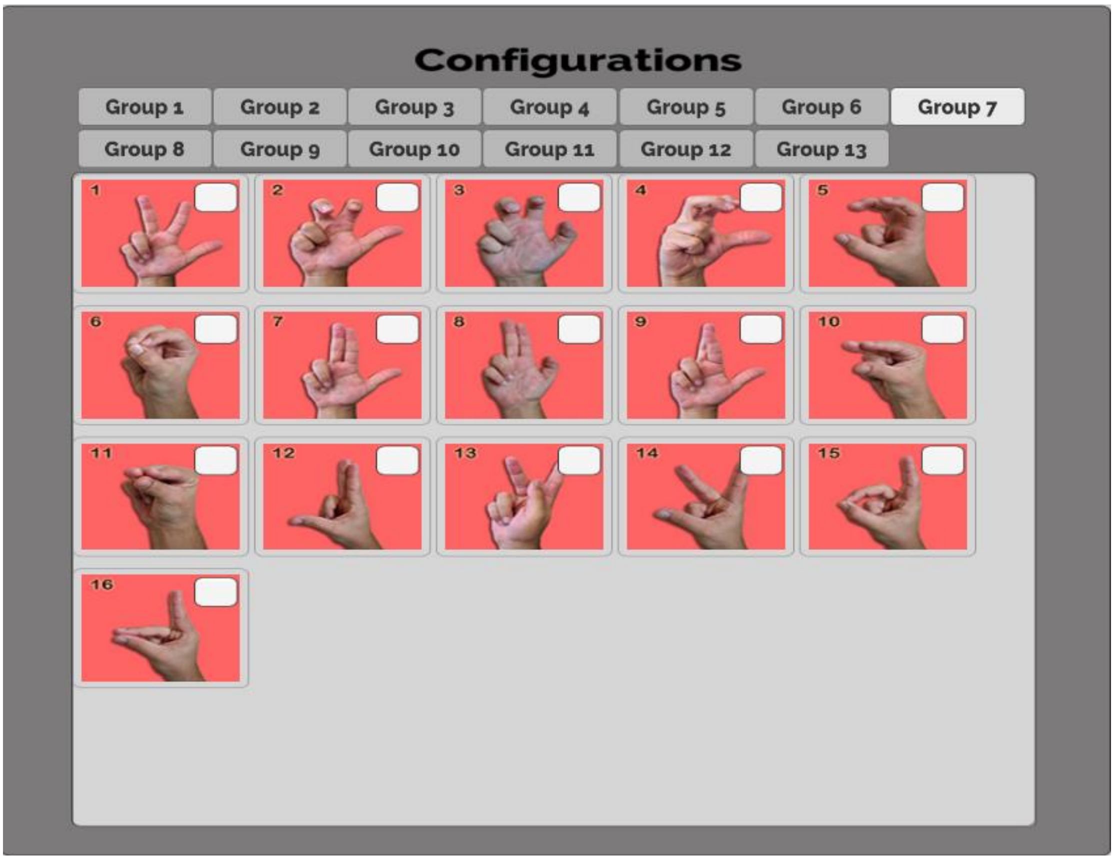

FIGURE A.7: HAND CONFIGURATIONS OF GROUP 7

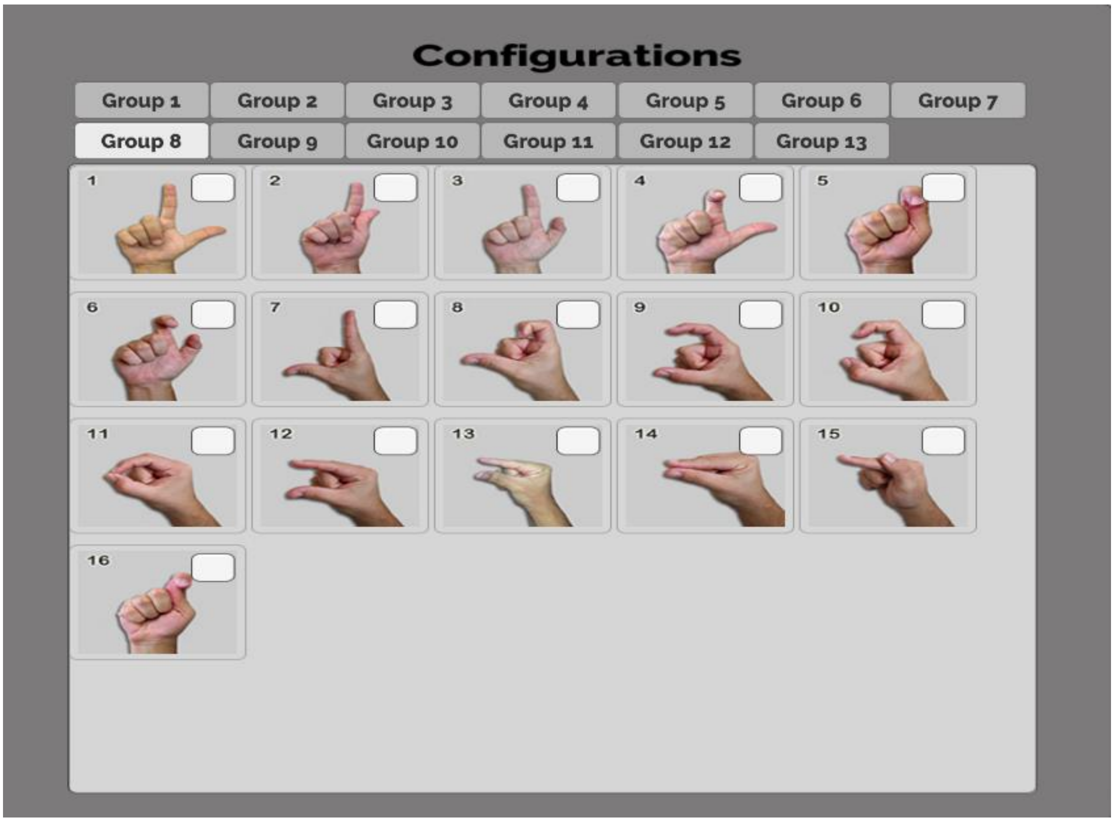

FIGURE A.8: HAND CONFIGURATIONS OF GROUP 8

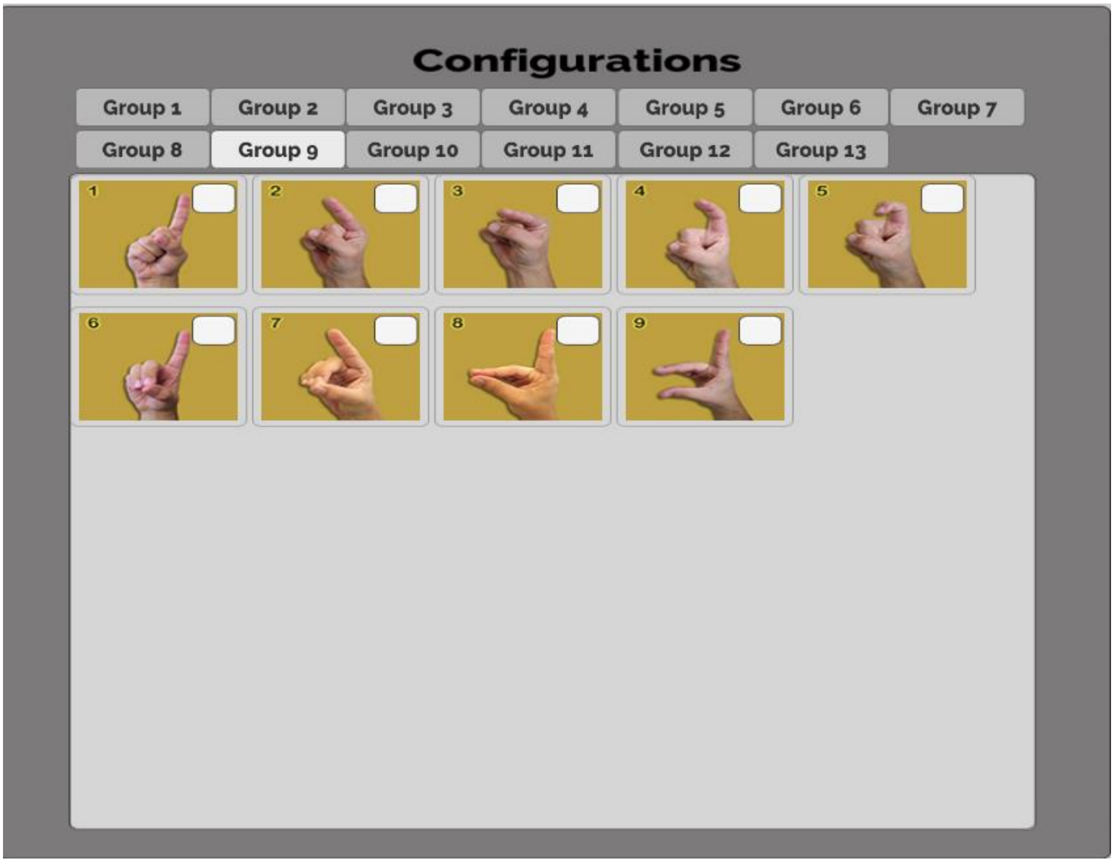

FIGURE A.9: HAND CONFIGURATIONS OF GROUP 9

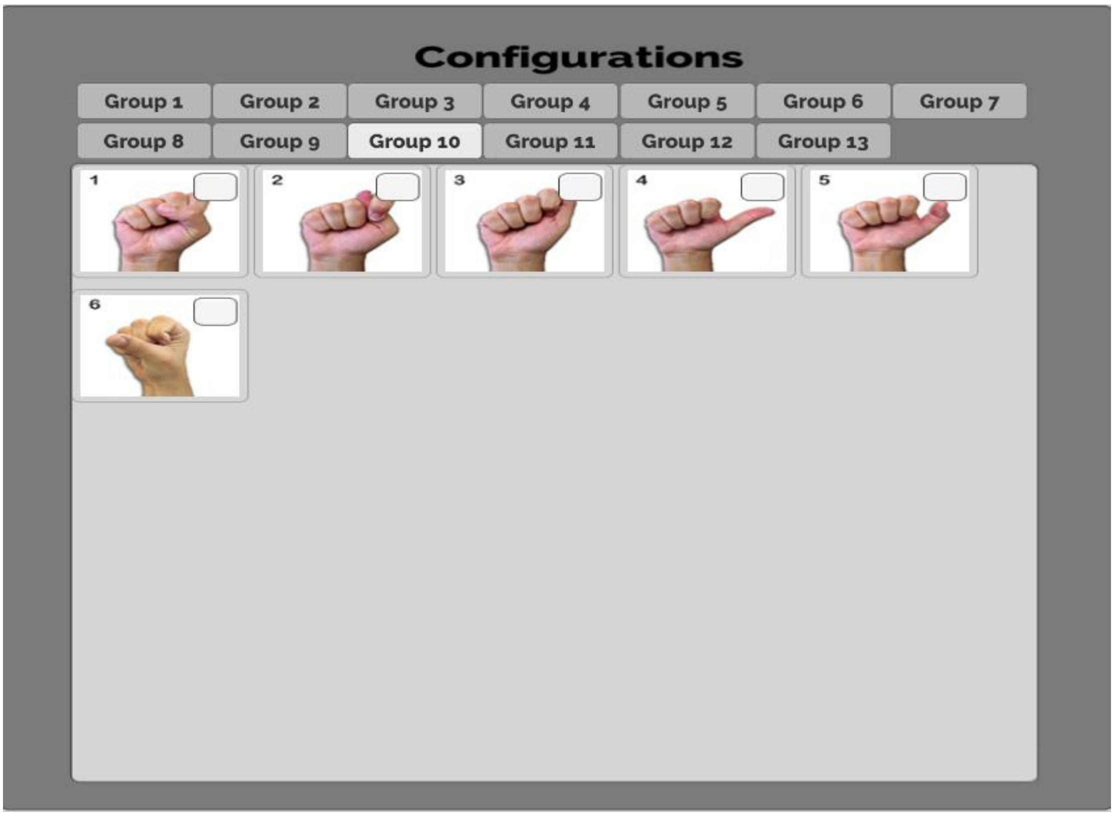

FIGURE A.10: HAND CONFIGURATIONS OF GROUP 10

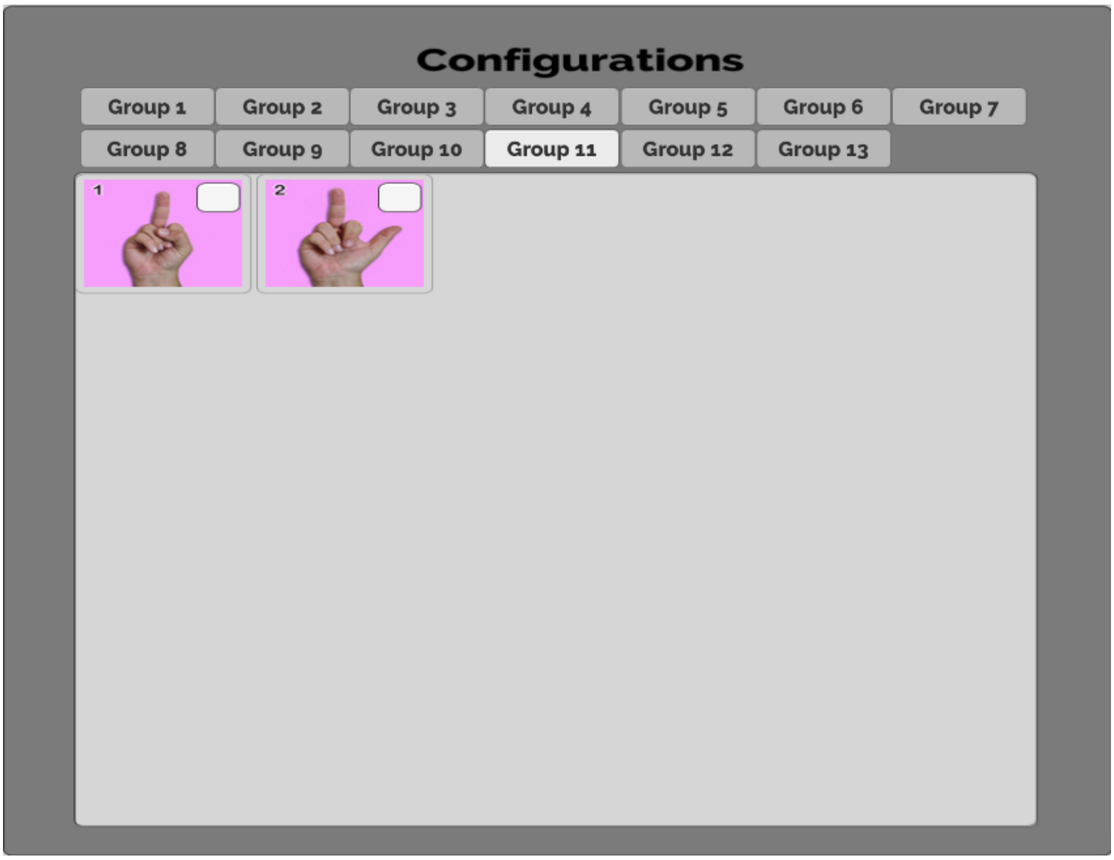

FIGURE A.11: HAND CONFIGURATIONS OF GROUP 11

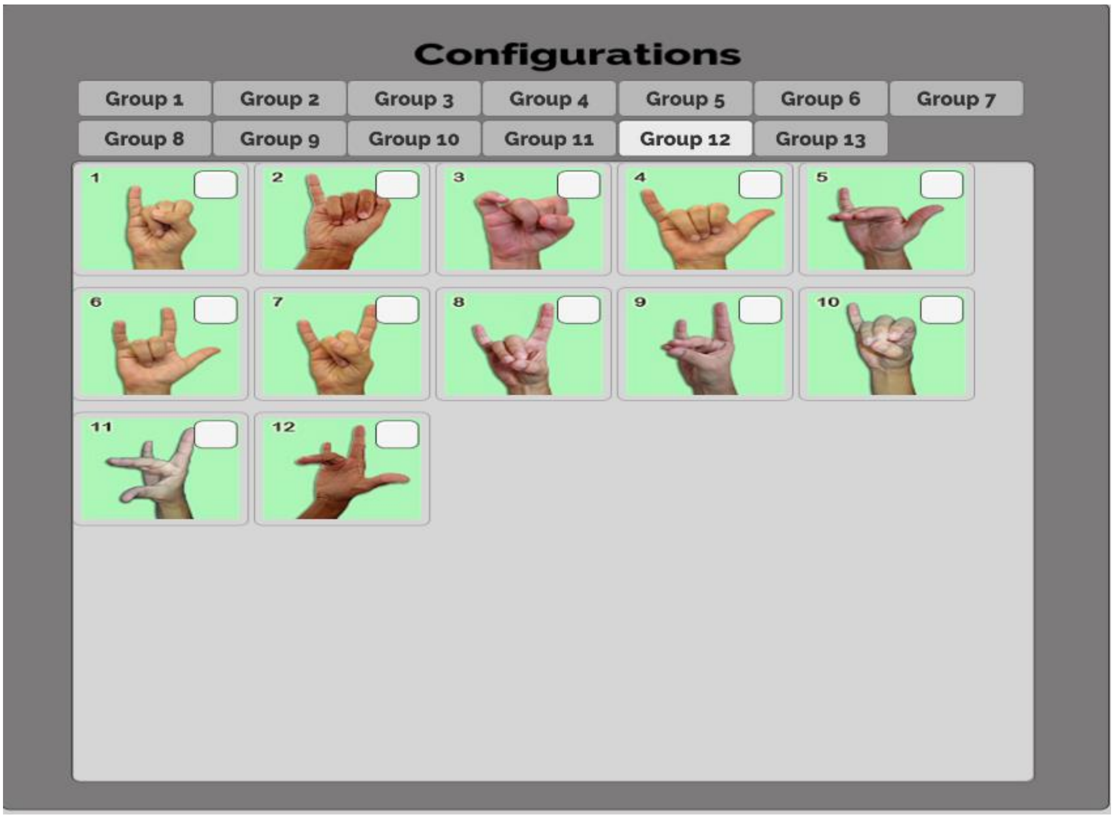

FIGURE A.12: HAND CONFIGURATIONS OF GROUP 12

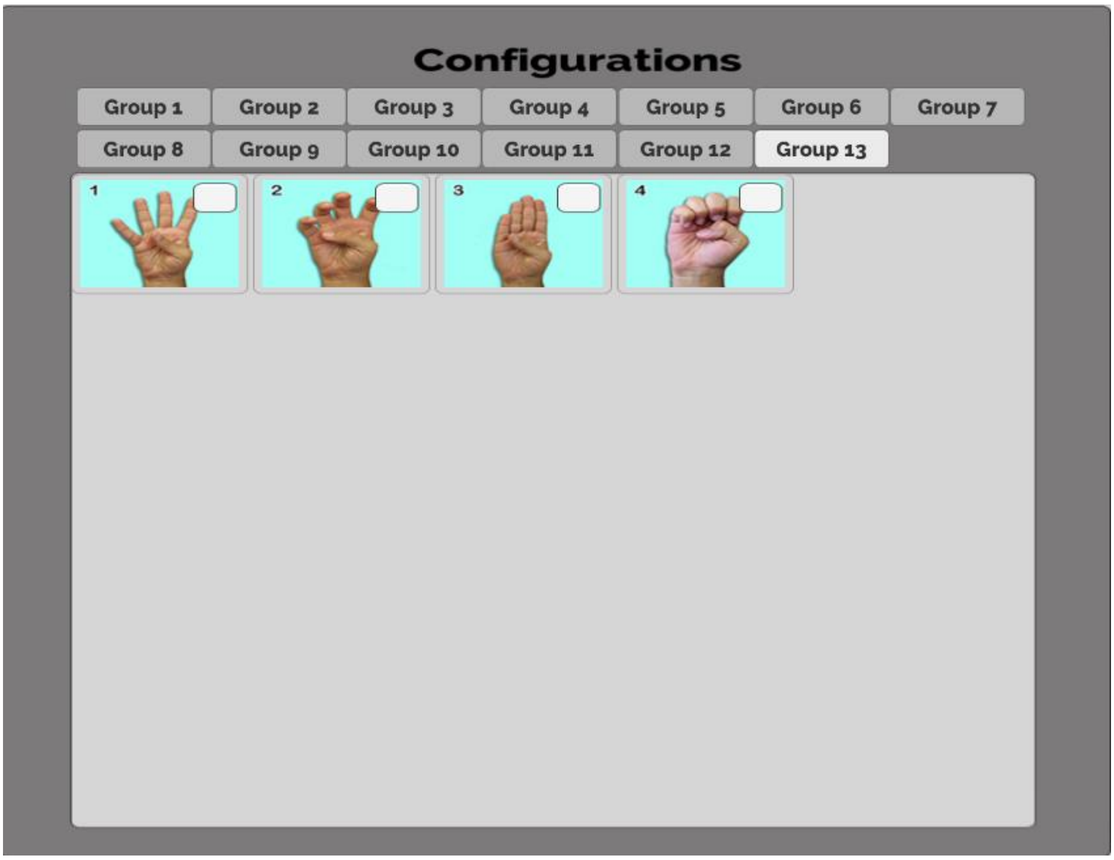

FIGURE A.13: HAND CONFIGURATIONS OF GROUP 13

TABLE A.1: HAND CONFIGURATIONS USED FOR GSL FROM GROUP 1

Table A.2: Hand configurations used for GSL from Group 2

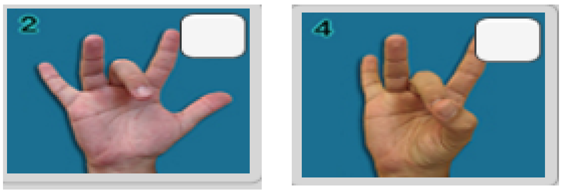

Table A.3: Hand configurations used for GSL from Group 4

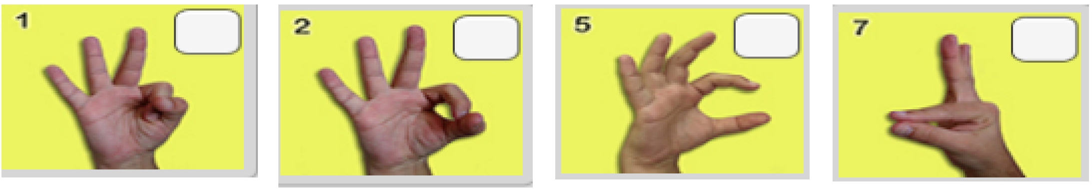

Table A.4: Hand configurations used for GSL from Group 5

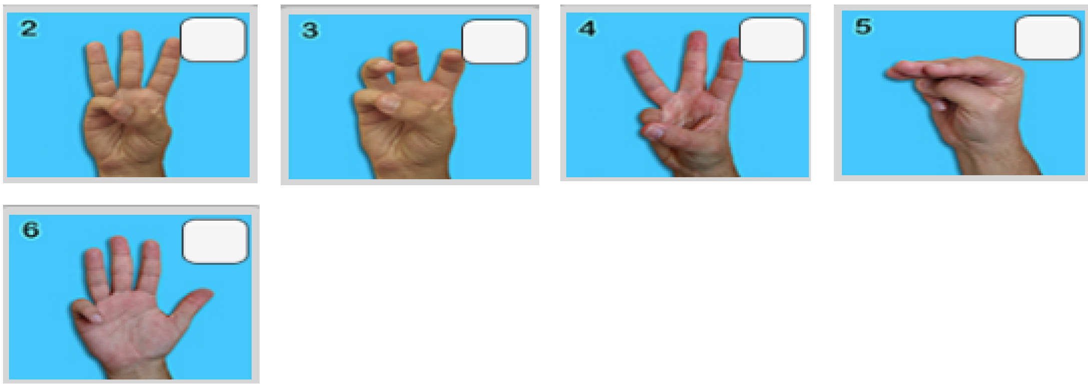

Table A.5: Hand configurations used for GSL from Group 6

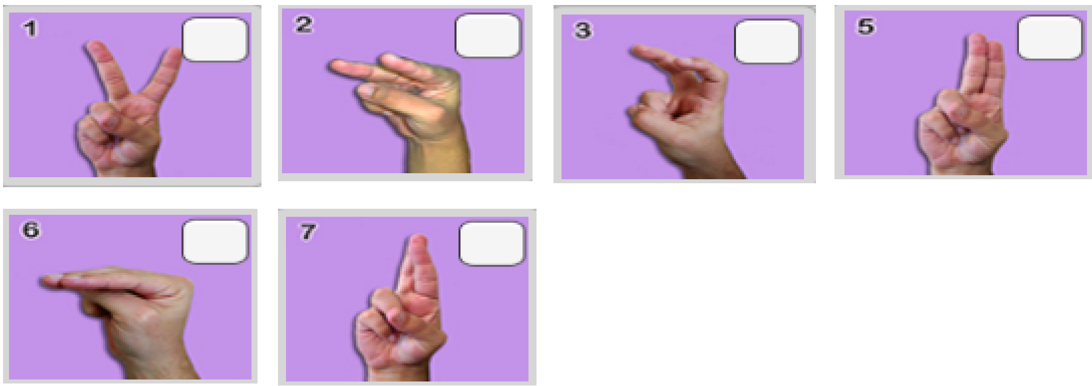

TABLE A.6: HAND CONFIGURATIONS USED FOR GSL FROM GROUP 7

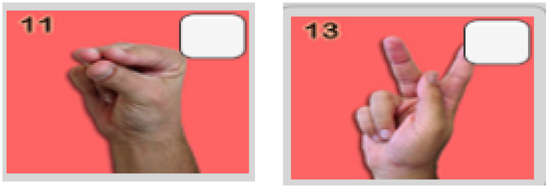

TABLE A.7: HAND CONFIGURATIONS USED FOR GSL FROM GROUP 8

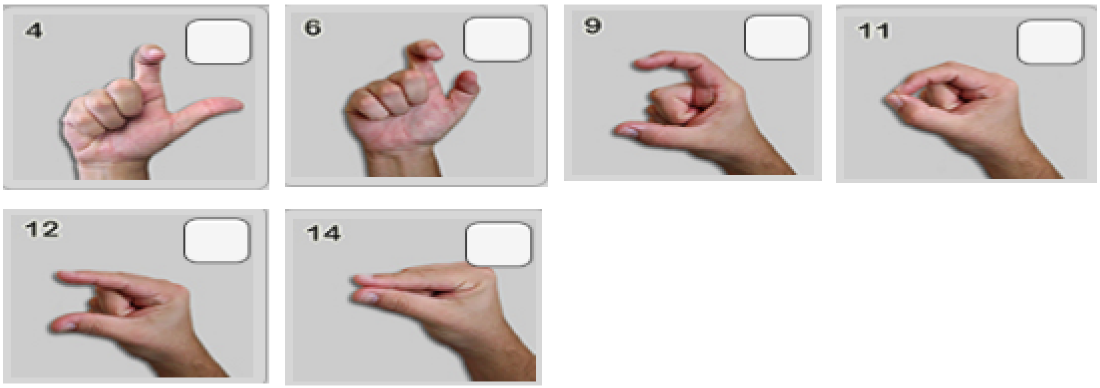

TABLE A.8: HAND CONFIGURATIONS USED FOR GSL FROM GROUP 9

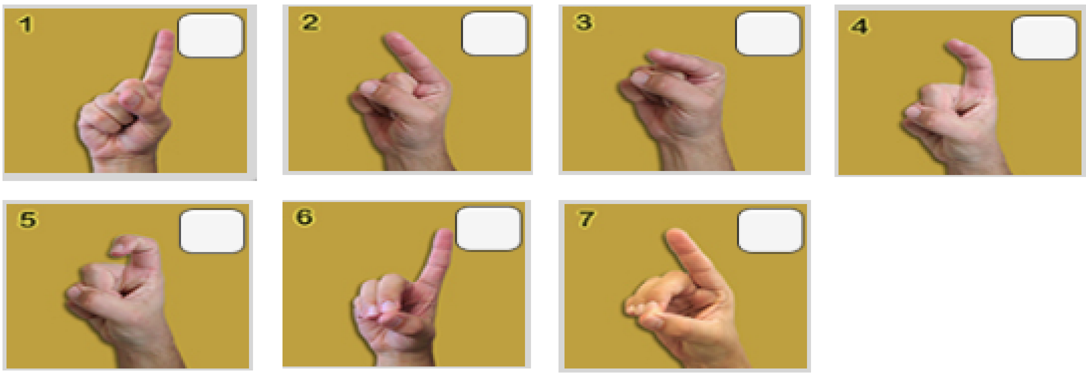

TABLE A.9: HAND CONFIGURATIONS USED FOR GSL FROM GROUP 10

TABLE A.10: HAND CONFIGURATIONS USED FOR GSL FROM GROUP 12

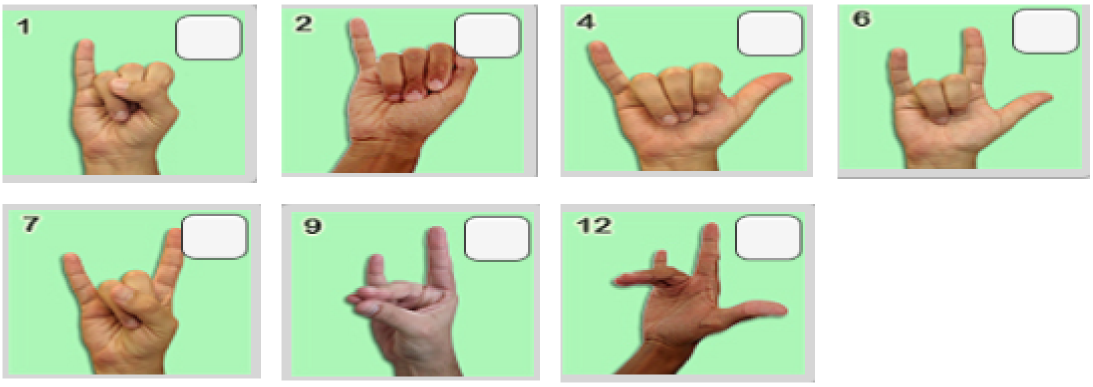

TABLE A.11: HAND CONFIGURATIONS USED FOR GSL FROM GROUP 13