

System for People with Hearing Impairment to Solve their Social Integration

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Abstract

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I. INTRODUCTION

The deaf have the right to live a fair life and do their tasks without any difficulty exactly like everyone else. There are 360 million people (328 million adults and 32 million children) worldwide who have disabling hearing loss (Over 5% of the world's population) (WHO, 2015). Disabling hearing loss refers to hearing loss greater than 40 decibels (dB) in the better hearing ear in adults and a hearing loss greater than 30 dB in the better hearing ear in children (WHO, 2015). The majority of people with disabling hearing loss live in low- and middle-income countries (WHO, 2015).

There are two main obstacles facing the deaf; first, difficulties when contacting normal people and people with hearing impairment, because people lack the knowledge of sign language and deaf life style; second and most importantly, the deaf are often separate from their surroundings: they may not listen to radio, watch TV, or review YouTube. When they read a newspaper or an internet article, they may not understand it, a thing that makes them more isolated.

Driven by these obstacles, this work presents a mobile application that aims to make the communication between the deaf and other people easy, thus helping them to be more productive and better integrated into their communities. We can identify three channels of communication that relates to deaf:

- 1- Normal people contacting people with hearing impairment (ex: Deaf, hard listen, ...etc.) and vice versa.
- 2- The deaf contacting other people who have hearing impairment (Deaf to Deaf), because sign language and deaf culture is different from town to town.
- 3- The deaf integrating with society by letting them know what is going around them.

To solve these problems, we need first to understand the world and the culture of the deaf. Deaf people often build their own lives and develop their own life styles. They have less knowledge about their surroundings. While people with no hearing problems gain their knowledge and emotions by interacting with people, media, or the family, a deaf person

creates his own private world because he cannot listen to media, interact with people in the street or have friends. This life style often leads the deaf person to be isolated and to have little knowledge about the social inclusion and the integration in their communities.

The deaf can read, but they cannot understand everything they read; for example, we may learn the letters of Japanese language, but when we read a literary Japanese book, we will not understand what we read, and that what happens with the deaf people. They can read, but they cannot understand the full meaning of what they read.

You can imagine what is the effect of that on a person in this world, a world full of knowledge and news. While a group of people are unable to cope with such technologies. No good use of smartphones, books, SMSs, internet articles, stories, advertisements, movies, discussion shows, songs, even more, our emotional feelings are coming from literature, poetry, and society, which deaf has no understanding of any of them. The deaf person will not be able to make phone calls, express himself /herself or understand the trick of words.

Deaf people often perceive the structure of sentences in a way that different from that of normal people. Every sentence needs to be restructured in a way they can understand the meaning of it (it will be explained), which we considered is the essence of the whole problem. People can't hear, and lose the emotional knowledge, so they need to restore it with other ways to be normal again. We believe that someday they will feel the environment around, and be more productive, which will be done if normal people took hands of the deaf and create a fair technological solution.

II. PREVIOUS WORK

There are some previous studies focusing on English language, but a few studies on Arabic language, the most relevant study by (Mohandes, 2006) focusing on converting Arabic language to sign language, it depends on work matching, which is not effective in translation, because such system needs to be built on NLP processor, there is a good tool called websign (lattice.rnu.tn) which converts predefined English language using SML to a 3d character (Avatar), SML is an XML based descriptive language that the team have developed to annotate gestures in Websign, it is a useful solution, but it mentioned for web only, and to be more specific it's a plugin for Internet Explorer only, it does not combine all the NLP process we intended to do on our system to reach a complete

solution for deaf communications in real world situations because converting predefined language like (SML) to avatar sign is not what deaf need, they need to convert any written peace of text to sign language.

III. THE STUDY

We created hope system for the deaf (HSD) which is a mobile app with many integrated services. We believe that hope will be able to fill the communication gap between the normal and deaf. It will be achieved by introducing a complete solution starting by fixing the small problems in daily life, to more complex real world problems like phone calls and reading language and more.

A. The System

Specifications:

The system focuses on Arabic language process, and try to fix Arab deaf problems. After being done with Arabic language, it can be applied to other languages with some modulations (Mohandes, 2006).

After great endeavours, we found that there are little or no software for Arabic language that helps the deaf in real world life, the apps in market vary from apps that view a word and its sign (dictionary) in pictures (which depends on Menasy website), or apps that show rules for the deaf, or converting letters to finger sign language. All these apps are not helpful in the factual situations. They only introduce one limited service. Even the Unified Arabic Sign Language Dictionary (UASL), created by Qatar, does not have its own app in Android and iOS (which we proposed many times to create on).

On the other hand, English apps for the deaf are more mature. There is the American Sign Language Dictionary (ASL), and Britch Sign Language Dictionary (BSL), and there is a newly app that converts text to sign language.

We created our system using Windows Phone 8.0 OS, with C# and VB.NET language, and we created the Morphological Translator using SQL Server Database, with WPF software build with C#.

System Components:

The system consists of many services that work as Complex Adaptive system (CAS). These small components are integrated to create the whole system to reach its goal.

There are two main components

- a) Peripheral services.
- b) Central services.

A. Peripheral services: these services are mentioned to be complementally services. They have no effect on the text to sign language converting process, but it will help the deaf or normal people to know each other, these services are

1. Deaf Tube: which is a list of channels of youtube.com for many life fields (culture,

economic, news and politics) so that deaf can be in touch with the world. These channels are selected carefully with 10 different languages, hoping that their owner keeps publishing videos for the deaf. we found that supporters of the deaf (organizations or individuals) stop their support after a short time. It might be due to the lack of financial support, or searching for another field.

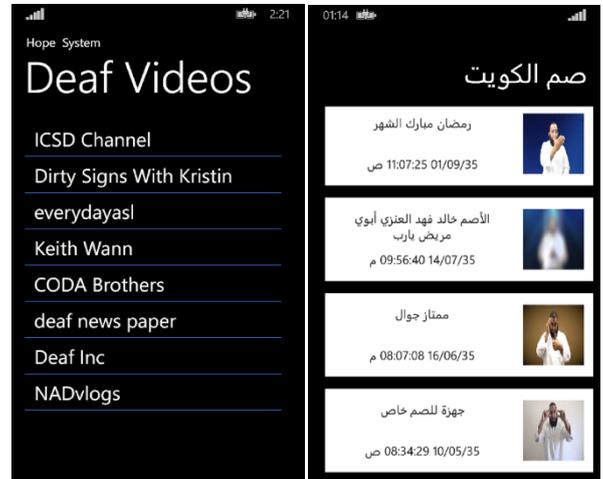


Fig. 1 Deaf tune in Arabic and English

2. Deaf Culture: instructions and rules for normal people about the culture of the deaf, and how they can communicate with them, this is helpful for any people new to this matter.
3. Sign Language Grammar: the grammar of sign language and finger sign language.
4. Deaf News: a collection of Useful RSS news from websites concerned with the deaf. (We were shocked to find only one website for the Arab deaf introducing news, and they usually do not respond to us.)
5. Enlarge and speak: a useful service for the deaf's daily life. When a deaf person wants to use transportation to go somewhere, he/she must carry small paper cards, on which the address is written. This service allows them to carry the use the address, enlarge the font, and let the mobile articulates and repeats the word.

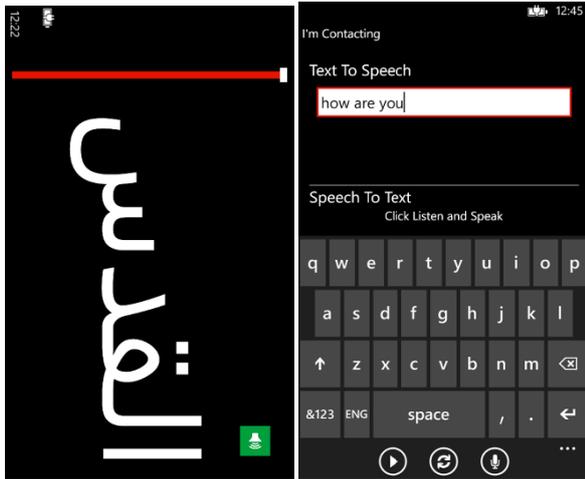


Fig. 2 Enlarge and speak and I'm Contacting

6. I'm Contacting: Converts 'Text' to 'Speech' when the deaf speaks with the normal, and it converts speech to text when the normal speak with the deaf. The result is listed in a chat conversation like border. This service is not available in Arabic, however, is available for the speech languages supported by Windows Phone OS.



Fig. 3 Hope main screen and services in Arabic UI

- B. Central services: the heart of the system that make all the real job for the deaf. As we mentioned, the final goal of the system is to make the deaf read and understand books, newspapers, SMS and make phone calls. They depend on Natural Language Processing (NLP) and Text Mining algorithms. These services are discussed in the next sections.

IV. SIGN LANGUAGE TRANSLATOR

The system's goal is convert text or speech to sign language. This goal can be reached by reading the text and pass it to sign language translator.

The process focuses on converting a text to sign language, converting speech to a text done by special software, which is another part of the system that we can buy and install any time, because speech to text is a separate science that needs special algorithms. It's far from our research, and yes there is a software for converting Arabic speech to text, but we didn't examine it in a real environment with noise and low sound etc, this part can be installed any time, because the main problem the deaf want to fix is text reading (Abdel-Fattah, 2005).

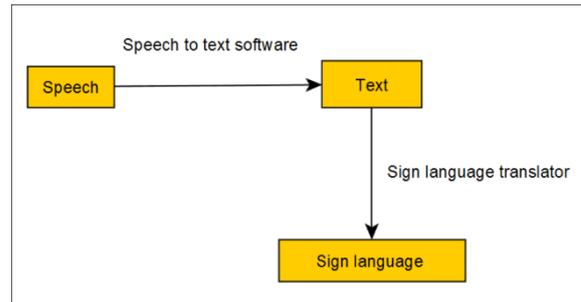


Fig. 1 Example of an unacceptable low-resolution image

A. Sign Language Sentence, Grammar & Structure

"Grammar" is a set of rules for using a language. These rules guide users in the correct speaking or signing of a language (lifepoint.com, 2015).

The grammar of a language is created by the group of people who use the language. New grammar rules come into existence when enough members of the group have spoken (signed) their language a particular way often enough and long enough that it would seem odd to speak the language in some other way (lifepoint.com, 2015).

Sign Language (SL) has its own grammar system, separate from that of Natural Language. What this means is SL grammar has its own rules for phonology, morphology, syntax, and pragmatics. It follows several different "word order" depending on what is needed. Which word order you choose depends on your audience's familiarity with the topic and what you are trying to do: explain, remind, confirm, negate, cause to consider.

Normal conversations tend to follow Subject-Verb-Object or Subject-Verb order (Stokoe, 2005). Some people might confuse this as to mean English word order (Stokoe, 1978). SL does not use BE verbs (am, is, are, was, were) or anything to indicate the state of "being," nor does it use articles (the). These are some distinctions to keep in mind, eg:

ذهب الرجل إلى العمل
 it must convert to
 رجل + ذهب + عمل
 Then

(ذهب + إشارة الماضي) رجل عمل
Then
رجل (ذهب + إشارة الماضي) عمل

Another example is

أكل محمد التفاحة؟

The final sentence must be

إشارة استفهام + محمد + (أكل + إشارة الماضي) + تفاحة

The structure and grammar difference in sign language is very huge, and we can say that it's the creation of a new language translator. The Arabic sign language grammar is described in *قواعد لغة الإشارة القطرية العربية الموحدة* book, in our research we took all the rules and grammar from this book (2010) (سمير & محمد) which may considered another research, these rules are specified and listed.

B. Arabic Morphological Analyser (AMA)

Due to the difference in syntax in our normal spoken patterns and in the deaf sign pattern, we had to overcome this challenge. so after working daily with the deaf for one year, we created Arabic morphological patterns that can be easily translated to the deaf sign patterns depending on the list of rules and grammar we extracted from *قواعد لغة الإشارة القطرية الموحدة العربية* book.

Its seems impossible at the beginning, because creating NLP algorithm is too big for one team (which will be discussed in briefly).

To create our AMA, we need NLP algorithms that define part of speech (POS) of the sentences (Feldman & Sanger, 2007; Weiss, Indurkha, & Zhang, 2010), so that we can specify the verb, adverb, adjective, preposition ..etc. (Stokoe, 1978).

We used a free source algorithm called Mansour (a-abuzaid, 2012), which is created by AbdRahman ElHefny. It can POS any sentences and the results are very good.

Mansour has some limitations and these are

- 1- Wrong words: Mansour can't handle wrong words, so we used another open source project that can fix the wrong words. It gives an acceptable result but not a great one, and it needs more development because of the different usage of Arabic accents; not all people speak formal and standard Arabic.
- 2- Pointing: some words Mansour can't give the right POS in the sentence due to lack on Pointing Formulation. There are also open source projects like Mishkaal (2013) (مشكال), it gives a great result, but it needs to recombine with Mansour algorithm.
- 3- Stemming: As some words do not return to their right stem, we found a good open source project called Qutrub (qutrub, 2012). It is very handy, and it also needs to recombine with Mansour.

We admit that there is little Arabic text mining software and algorithms, which makes Arabic language text mining

delayed over other languages; this delay affects many fields of technology, and there must be more job done here (aci.health.nsw.gov.au).

We started pretreatment for text before entering it to Mansour algorithm then we add many information to Mansour Database; for example we added:

- 1- More stop words.
- 2- More adjacent phrases or words, like السلطة الفلسطينية ، فلسطين المحتلة، ضواحي المدينة، كثافة نابلسية
- 3- More root stems.
- 4- More Proper noun ex: ميسي، الشيخة موزة، محمد ، الفاتح، انتوني كوين ...etc.
- 5- More Arabized Words: جوجل، انترنت، ميغا، آسيا، بنك
- 6- Word Department
- 7- More Grammar Rules
- 8- Words of special meaning, eg: الأضحية، البرزخ، الحج، أسطورة، أولمبياد
- 9- Places, Cities and countries
- 10- Question prepositions: آ ، أنى ، هل ، ما هذا ، كم
- 11- Negation prepositions: لا، لات، ليس، لن، لم
- 12- Negation and Question prepositions: ألا، ألم، أليس
- 13- Non-Arabic words: there must be list of non-Arabic words and their meaning in Arabic because many texts have English words within.

The final result of AMA can be modified any time, adding more words to our Database. This will make the results more accurate and more useful for next morphological analysis (Berry & Kogan, 2010) .

Our AMA needs more specifications, more departments, and more rules. This may be done by the help of a community or organization looking for the deaf, specifically, Arabic support. Explaining more about our Morphological analysis is not a part of this research, it's a separated paper (Farghaly & Shaalan, 2009).



Fig. 4 Sample result from AMA.

This Agent must be hosted on a cloud service for many reasons; first: it will have a huge database. Let's assume that

the text has the word *الشيخة موزة* or *ميسي*, AMA must return their photo and description, and imagine how much video for sign language must the system have (more than 7000 videos) so that the deaf can understand the meaning, second it will need processing effort as mobile cannot handle this effort. Last but not least, this database will be updated daily, and users cannot handle daily update on their smart phones, so the best solution is to host this part on the cloud and call it from mobile, and the suggested platform is Microsoft Azure Cloud Services.

C. Other System Components

To complete *Hope* system, we need to add more features on the central services, and these are:

- a- Sign Language Dictionary (SLD): there are more than important 7000 words for the deaf's daily use. The problem is that the sign of these words differs from country to country and even from town to town, but there is a surprising job done by Qatar that creates the first regional sign language dictionary for Arabic language, which is a marked sign around the world. This dictionary contains almost 2600 words and their video sign language, upon which we build our AMA, hoping that this dictionary will contain more words in the future.

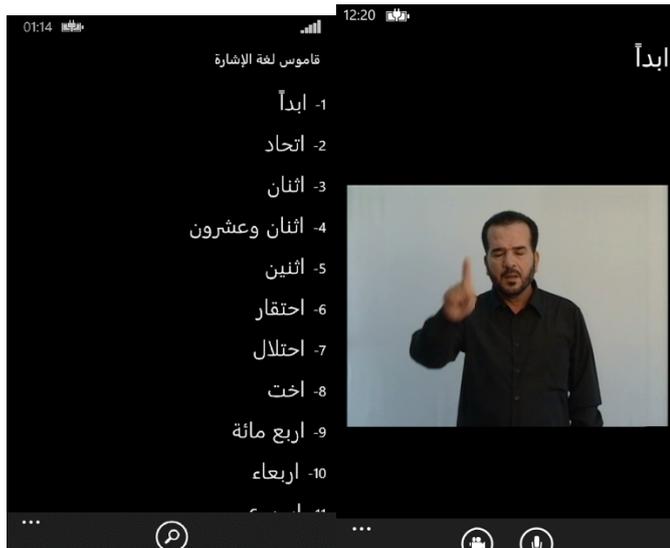


Fig. 5 Sign Language Video

- b- Finger Sign Language Converter: when we try to convert a text that contains names (محمد، حسن، محمود) or locations (غزة، القدس، فلسطين), we need to convert it to Finger sign language, which is mainly used in the deaf's culture to pronounce names and locations (El-Bendary, Zawbaa, Daoud, Hassanien, & Nakamatsu, 2010).



Fig. 6 Finger Sign Language Converter

D. What's done, what's next:

Hope version 2.0 is now available on Windows Phone Store. We get a lot of useful feedback. Noting that the AMA service (Syntax analyser) is not published yet. It's still in research and development mode. More efforts are needed to be done. You can download it and please check it out, but it lacks.

We have two goals, *Hope* is coming with 14 GUI language but Arabic language is the main language for services, some services support English language, and others.

We are looking forward to the completion of the system by:

- 1- Completing the morphological Analyser.
- 2- Adding more words to dictionary.
- 3- Crating 3D characters for videos instead of current video character (Avatar), which will have a remarkable effect on performance and development, because now if we want to include videos in the app, we will face the problem of size, the current size of app is 500 MB and is contains only 2600 word, at least we need 7000 word and more than that pictures for famous people characteristics, the other solution is sending videos over web, and it's not a sufficient solution, our avatar may build by reversing Microsoft Kinect Sign Language Translator (research, 2013), which is a system converts any sign language to text, it contains an avatar for simulation, it can be used to convert written singes motions to visual signs, so that system can be an automatic translation system, and signs can entered in saved written motions, which will reduce the size for every sign from megabytes to kilobytes, development of such translator is not difficult, also there is more close solution called websign, which converts Text to Avatar.
- 4- Add more languages.
- 5- Develop current services.

We hope that we reach our final two goals:

- First: Ability for the deaf to read everything, by adding the morphological analysis to hope.
- Second: Convert incoming calls to sign language so that the deaf can answer any voice call, even reply to the call.

V. CONCLUSIONS

We believe that *Hope* will help the deaf to integrate with society and make them more helpful to their families. *Hope* introduces many services in Arabic varying from lonely services to integrated ones; for example, Sign language dictionary can be used alone search for words, or can be used in converting a text to sign language. To conclude, all *Hope* system components create CAS, to reach its goal.

ACKNOWLEDGMENT

We are very thankful to Qatar institutions for supporting the Arab deaf. We are also thankful for the people who created an open source software and algorithms for Arabic language, top of them prof. Taha Zerrokly from Tunisia.

We also hope to add these recommendations after our research:

- 1- Create a blog related to the deaf, so that they can know their updated news.
- 2- Create a reference between research centers or universities for the deaf researches.
- 3- Create a reference between research centers or universities for Arabic Natural Language process and Text Mining researches.
- 4- Follow up the development of deaf projects from interested institutions, not only a financing one.
- 5- Create 3D (Avatar) character or characters that can be used to create full body sign language.
- 6- Create an online website for the deaf learning materials
- 7- Help the deaf to know more about Technology and smartphone services.

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