

## M-Learning and Chatting using Indexed Arabic Sign Language

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### Abstract

*Sign language is a language that uses hand and body gestures and movements, lip movements and facial expressions to express words and meanings. It was developed in deaf communities to help deaf and hard of hearing people to communicate with each other and with ordinary people. This paper describes a mobile application with several features which can be used to teach Arabic sign language and to communicate using it. These features include translating from Arabic text to Arabic sign language, video chatting where two users can use the application to chat in Arabic sign language, SMS messaging and translating SMS messages to Arabic sign language, in addition to other features such as easy indexing for Arabic words and recording own sentence. The system is evaluated in terms of performance and cost against other similar systems.*

### 1. Introduction

Although handicapped people are minority in the world societies but they deserve, as humans, to get all the help needed to live an ordinary life. One way to help them is by using the advance technology to overcome some of the difficulties they face. The handicapped people consist of many types such as deaf people and speech-impaired (dumb) people. These deaf and speech-impaired people have problems in communicating with ordinary people. This is because most ordinary people do not know the sign language which the deaf people use. In addition, some deaf/speech-impaired people, especially in the Arabic world, have difficulties in communicating with each other. This is because some of them do not use the standard Arabic sign language; instead, they use their own developed sign language. Additionally, what if two deaf persons want to communicate while they are far from each other? The Arabic sign language application that this paper describes aims and tries to solve these problems by providing means for teaching the standard Arabic sign language and communicating using the standard Arabic sign language. By using the developed mobile application, ordinary people can learn the standard Arabic sign language and then can use what they learned to communicate with deaf people. Moreover, deaf people can use the application to communicate while they are far from

each other. In general, this application aims to improve the quality of life of deaf/speech impaired people.

### 2. Related work

Translation of sign language to different formats is an important issue that many researchers have worked on. One effort [1] was done to translate English speech to British sign language. This system was developed for use in the post office. Its functionalities and vocabulary were limited to the post office use. The system uses an avatar for displaying the sign language words. The system has achieved a good rate of accuracy for both phrases and single words.

Another system [2] was implemented by describing the architecture of an English text to sign language translation system. This system can translate the English text to other sign languages like German and Dutch. The process of translation was divided into two parts. The first part was to convert the English text to a semantic-based form. After that, the semantic-based form is translated to a graphic representation which can be performed by an avatar.

One more system [3] was developed to translate from American English speech to American Sign Language. The American Sign Language words were in video format and stored in the database. The speech recognition was done using a MAC operating system speech recognition engine. The problem with this system is that it only recognizes a pre-defined set of words.

A system that can recognize Arabic sign language words using an instrumented glove was developed in [4]. The user of this system has to wear a glove and then make an Arabic sign language word. The glove is connected to a computer system that takes the readings of the glove's three-dimensional position. Based on these readings, the computer system can detect the Arabic sign language words.

Another recognition system for Arabic sign language was developed in [5]. This system can detect visual sign language without using gloves or input devices. In addition, the system is signer-independent and it can recognize isolated signs. The operation of this system begins by capturing a video of a person making a sign language word. The next stages include segmentation, background and feature extraction, and end with sign recognition.

Other work done in this area includes a teaching system of Japanese sign language [6], text to British sign language translation system [7], database for automatic recognition of American sign language [8] and progress in automated computer recognition of sign language [9,10].

### 3. System Design

Many considerations were taken into account while developing the application presented here. For instance, the application was developed to be portable, extensible, easy to use, and efficient. It was developed using Java Micro Edition as a programming language that ensures the portability of the application.

The application has six features as follow:

- 1) *Translation from Arabic text to Arabic sign language:* The user can use this feature either to learn the sign language or to communicate with deaf people. The application takes the input text and searches in the database for a matching word in sign language. If the word is found, then it displays a video representing the word. The user can enter more than one word and the application will show a sequence of videos that represent the words.
- 2) *Index of Arabic sign language words:* The Application provides an index of all the sign language words that are stored in the database located in the server as will be explained later. The words are categorized into many categories such as family, food, transportation, commerce, etc. Once the user chooses a specific category, he will be able to choose from many words that belong to that category. When a specific word is chosen, a video representing that word will be played.
- 3) *Translation from Arabic sign language to Arabic text:* This feature can be used by the deaf people to communicate with ordinary people. It can also be used by ordinary people to learn the alphabet of the Arabic sign language. The application provides an Arabic sign language keyboard (as can be seen in Figure 5). The user can form words and sentences using the sign language keyboard. Then, the application translates them into Arabic text.
- 4) *Sending and receiving SMS:* The user of the application can use the Arabic sign language keyboard to write words and sentences, or can write text using other input methods provided by the mobile phone such as the keypad. Then, he can send the written text as an SMS message to another mobile phone after specifying the recipient mobile phone number. The recipient mobile phone will receive the SMS message in

the application SMS inbox. The received text message can be translated to Arabic sign language videos.

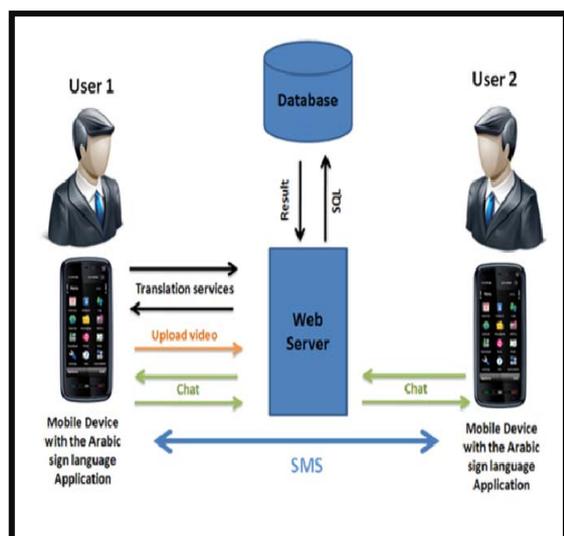
- 5) *Chatting using Arabic sign language:* Two users can use the application to chat in Arabic sign language using the video capture/send facility which is available in many mobile phones. The first user will have to capture a video of him/herself making a sign language sentence and then send it to the second user. The second user will receive the video and view it. Then, he can also capture a video of himself making a sign language sentence and send it to the first user.
- 6) *Adding new Arabic sign language words and sentences:* This feature represents the users' contribution to the database of Arabic sign language words and sentences. The user of the application can record a video of him/herself doing a sign language sentence, then he can upload this video to the web server of the application. However, these videos will not be added to the database directly. The database manager will have to verify the content of the new videos before adding them to the database.

### 4. System architecture

The System Architecture is shown in Figure 1. The system follows a three tier architecture design and it is basically a client server model. The three main components of the system are the mobile device with the Arabic sign language application installed on it (the client), the web server, and the database.

#### 4.1. Mobile device

The mobile device represents the client in this system. It has the Arabic sign language application installed on it. The application has several features that require the use of internet connection in order to connect with the web server. The internet connection can be provided by Wi-Fi or GPRS. The application can use the translation services to translate Arabic text to Arabic sign language. It can also upload new recorded videos of Arabic sign language words to the web server. Moreover, video chatting between two users is done through the web server, as the recorded videos are stored on the web server. Additionally, the application can send SMS messages to other mobile devices without the need to use the web server. This application will run on mobile devices that support Java Micro Edition, and have Arabic language support, a camera and an internet connection.



**Figure 1. System Architecture**

## 4.2. Web server

The web server contains the PHP files and the Java Servlet application. The web server also stores the videos of Arabic sign language words. It also stores the chatting videos and the new recorded videos of Arabic sign language words. The PHP files main task is to retrieve the URL of the Arabic sign language videos from the database. After receiving a query from a mobile device, the PHP files search the database for a matching word, and then they send back the URL of the video to the mobile device. The Java Servlet application task is to store the videos received from the mobile devices in the web server. It can also send back these stored videos to the mobile devices.

## 4.3. Database

The database basically contains the URLs of the Arabic sign language videos. When the database receives a query from the web server, it returns the URLs of a video if the query word is found in the database.

## 5. System validation

The system is validated against some of the most important requirements: Efficiency, extensibility, performance, portability, reliability, and usability.

### 5.1. Efficiency

The mobile application was tested to measure its efficiency. The application runs smoothly during various testing of its features. Moreover, when running the application in the background, other applications on the mobile phone can still be run

normally. Thus, the consumption of the mobile device resources by the application is acceptable.

### 5.2. Extensibility

The application development was done using Java Micro Edition. Each feature of the application has its own classes and these classes are arranged in folders. The main class has the control over the features of the application by calling their constructor functions. This means that adding new features to the application can be easily done by creating new classes and adding their constructor functions to the main class.

### 5.3. Performance

The response time for moving between the forms of the application was fast. Additionally, the results and outputs of the application were received quickly from the web server, and these results were the correct results. This means that the application has a high throughput. Performance testing results are presented in section 7.1.

### 5.4. Portability

Using Java Micro Edition as a programming language has increased the portability of the application. The application was installed and tested on several mobile phones such as Nokia 5800, Nokia N85, Nokia N95, Nokia N97 and BlackBerry Bold 9700. It was running properly on these mobile phones with all of its features functioning correctly.

### 5.5. Reliability

Efforts have been made to minimize application failures and crashes. Special considerations were taken to make sure that the inputs to the application are valid. Alert messages have been added to the application to warn the user from inputting invalid inputs.

### 5.6. Usability

The application was designed to be user friendly. The main menu of the application has clear titles that indicate the feature of the application. Moreover, several icons have been added in the application to make it easier to use. The commands that are in the application are concise and indicative.

## 6. System description and testing

System testing was done in order to evaluate the system and make sure that the system met its requirements. Each feature of the system was tested

and the results are shown in the screenshots in the next subsections.

### 6.1. Main menu

The main menu of the application was tested to ensure that it works properly. The testing was done by moving from the main menu screen to the other screens of the application. Examples of the test can be seen in Figure 2.

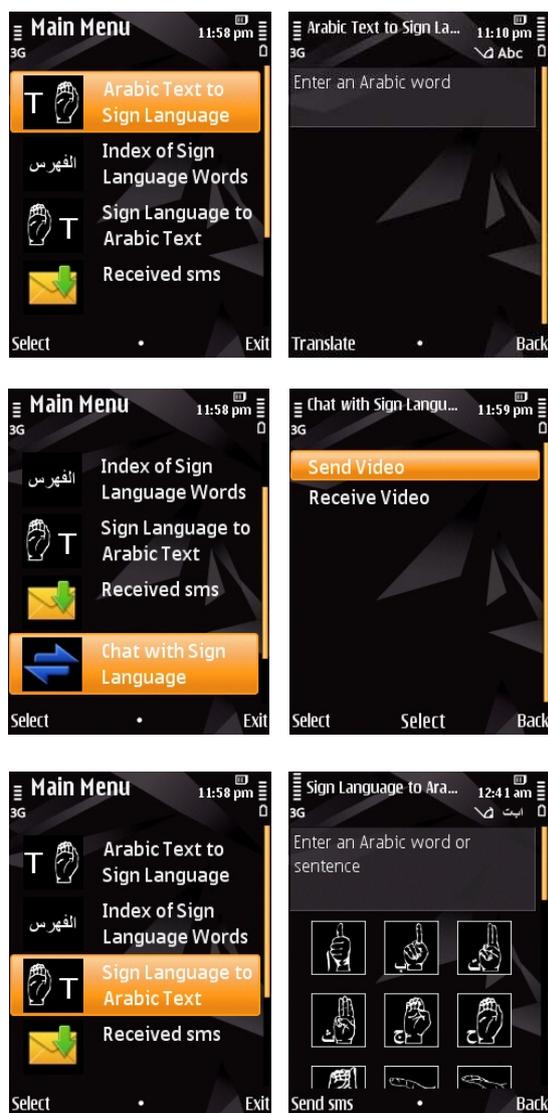


Figure 2. Main menu testing

### 6.2. Arabic text to sign language

When the user chooses the Arabic Text to Sign Language feature, he will be provided with a text field to enter an Arabic text. After entering the text and choosing the “Translate” command, the user will be asked for an internet connection (if not already connected). After successfully connecting to the internet, a video will be displayed on the screen. This

video is the translation of the sign language word that the user entered. This can be seen in Figure 3.

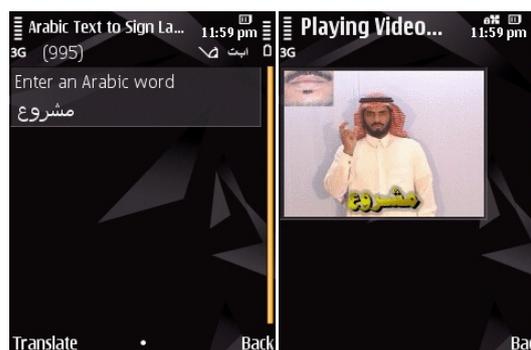


Figure 3. Arabic text to sign language

### 6.3. Index of sign language words

A categorized index of the sign language words will be shown in this form. The user can select a specific category and then choose a word from the list of the category. An example can be seen in Figure 4 where the user chooses to translate the word "أب" (father). This feature requires an internet connection. In these examples, the application is already connected to the internet.

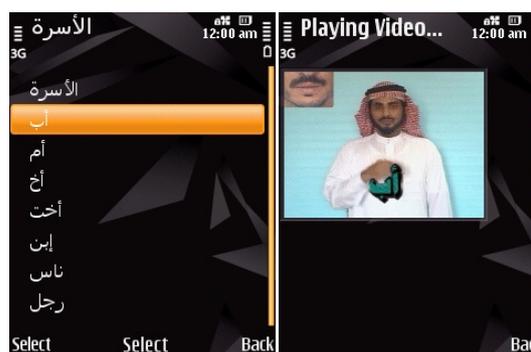


Figure 4. Translating the word "أب" (father) from the index

### 6.4. Sign language to Arabic text

A keyboard that represents the alphabet of the Arabic sign language will be shown in this form alongside a text field for inputting Arabic Text. When the user clicks or presses on a letter of the keyboard, the letter will be appended to the text field. Figure 5 illustrates an example of using this feature where the user clicked on the letters "أ", "ن", "أ" to form the word "أنا" (Me).

After that, the user can send an SMS message using the entered text. As in Figure 5, there are two text fields in the Send SMS form which are the phone number and the message. The message field is filled with the text entered from the Arabic sign language keyboard. The phone number can be entered manually or can be entered by choosing a number

from the contact list of the phone. The final step is to choose the command “Send SMS” to send the message. An alert screen will be displayed when the message is sent successfully.

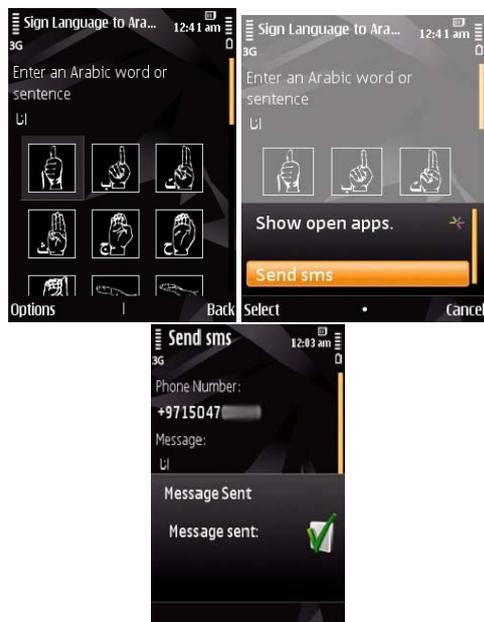


Figure 5. Using the Arabic sign language keyboard and sending an SMS

### 6.5. Receiving SMS

An Alert will be displayed to notify the user of receiving a new SMS message. The user will have to choose the “Received SMS” feature to view the SMS message. Then, the message can be translated by choosing the command “Translate”. This can be seen in Figure 6.

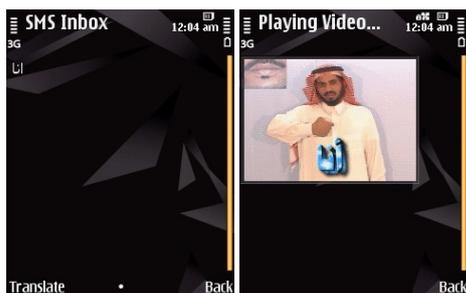


Figure 6. Receiving and translating an SMS message

### 6.6. Sign language chatting

When choosing this feature, there are two options to choose from. These two options are “Send Video” and “Receive Video” (see Figure 7).

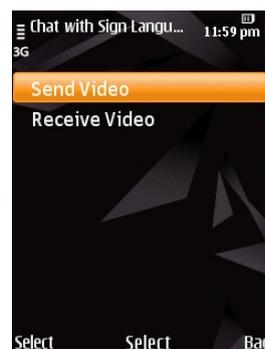


Figure 7. Chatting with sign language main screen

When choosing the “Send Video” option, the user will be able to record a video by choosing the command “Record”. To stop recording the video, the command “Stop Recording” should be chosen. Then, the recorded video can be either sent to the server or viewed again. If the video is sent successfully to the server, an alert will be shown to confirm that (Figure 8).



Figure 8. Sending a video

If the user wants to receive the sent video, then he should choose the “Receive Video” option. The user will be able to view the received video file, as shown in Figure 9.



Figure 9. Viewing the received video

### 6.7. Recording new sentence

After choosing this feature, the user can record a new video of a sign language word or sentence. To start recording the video, the user should choose the

“Record” command. To stop recording, the user should choose the “Stop Recording” command. After that, the user will have the option to view the recorded video or upload the video to the server. This is illustrated in Figure 10. If the video is uploaded successfully, an alert will be shown for confirmation.



Figure 10. Recording a new video

## 7. System evaluation

### 7.1. Performance

Performance testing was conducted in order to evaluate the system response time and the needed time to show results. Table 1 shows the result of the performance testing. The testing was done by connecting to the server using a Wi-Fi connection with 2 Mb/s speed. The fast response time obtained in translating words is a result of the Arabic sign language videos being small in size. The Average file size of these videos is around 150 KB. This also applies to the uploading and downloading video files test results. These files, which are used for the video chatting feature, are small in size. The size of the five seconds video is 60 KB while the size of the ten seconds video is 115 KB.

Table 1. Performance testing results

Operation	Average Time (seconds)
Translate a word	1.1 second
Upload a 5 second video	1.6 seconds
Upload a 10 second video	1.8 seconds
Download a 5 second video	1 second
Download a 10 second video	1.4 seconds

### 7.2. Cost evaluation

Cost evaluation testing was carried out for measuring the cost of using the application. Since the application requires an internet connection for connecting with the web server, the user can choose from connecting with a Wi-Fi connection or with a GPRS connection. The Wi-Fi connection can reduce the cost of using the application, especially if a free Wi-Fi hotspot is available at the user’s home,

university or company. Commercial Wi-Fi hotspots are also cheaper than GPRS connection. Table 2 illustrates the results obtained when testing the application using a GPRS connection, where the cost of the GPRS connection is 1 Fils/KB. In addition, the cost of SMS messages is obtained. Each SMS message can contain up to 70 Arabic characters.

Table 2. Cost evaluation testing results

Operation	Average File Size	Cost in AED	Cost in USD
Sending SMS	Up to 70 characters (Arabic)	0.18	0.05
Translating a word	150 KB	1.5	0.41
Downloading a five seconds video	60 KB	0.6	0.163
Downloading a ten seconds video	115 KB	1.15	0.313

### 7.3. Comparing with other systems

The developed system can be compared to other related systems. One system that can be compared to is the system developed for translating English text to sign language [2]. A good aspect of this system is that it can translate the English text to other sign languages like German and Dutch and that it uses an avatar to represent sign language words. However, this system runs on a normal computer system, while the application developed here is a mobile application. This gives the Arabic sign language application an advantage of being small in size, portable and that it can be used anywhere, since most people tend to carry their mobile phones with them all the time.

Another comparable system is the video calling feature offered by telecommunications services providers such as Etisalat Company in the UAE. This feature is comparable to the video chatting feature in the Arabic sign language application. The advantage of the video calling system is that it offers live video streaming between two mobile phones using 3G networks. However, the quality of the video is relatively low compared to the videos that the Arabic sign language application uses. In addition, video calling is quite expensive to use. For example, Etisalat Company charges 0.6 Dirham/minute for local video calls, and more expensive rates for international video calls. The video chat using the Arabic sign language application is free to use when using Wi-Fi connection.

The system developed in [5] is actually one of desired features that can be added to this project. This system can detect visual sign language and translate it into Arabic text. It takes video files as an

input to the system. This makes integrating this system with the application developed in this project fairly easy. That is because the Arabic sign language application can capture a video of a person making a sign language word and send this video to the visual sign language recognition system. The visual sign language recognition system can then send the results back to the Arabic sign language application.

## 8. Conclusion and future work

This paper describes an application that is developed in order to teach the Arabic sign language and to communicate using Arabic sign language. The system was developed to be portable, extensible, easy to use and efficient. The developed application has six features that provide different functions for learning and communicating using Arabic sign language.

The system was developed using a three tier architecture design where the mobile application represents the client tier, the web server represents the server tier and the database represents the database tier. The system was evaluated against other similar system in terms of performance and cost.

There are several recommendations and ideas that can be suggested to further improve this system. One idea is porting this project to other mobile phone operating systems such as the Android OS and the iOS. This can help in distributing the application among a larger percentage of people.

Another proposed idea is the translation from vocal Arabic to Arabic sign language videos. The application takes vocal Arabic words as an input and translates the words into Arabic sign language videos. This feature has many benefits such as making the learning process easier where the user of the application does not have to type the Arabic words manually. Another benefit of this feature is that it can ease the communication between a normal person and a deaf person. The normal person will just have to say an Arabic sentence which will then be translated to Arabic sign language video. Then, he can show the video to the deaf person who will understand it.

An additional good idea is the translation from visual sign language to Arabic text using systems such as the ones in [5, 11]. Image processing techniques can be used to recognize visual sign language and translate them into Arabic text. For example, a normal person who has the application can use it on a deaf person who is using the sign language to say a word or sentence. This can help normal people communicate better with deaf people as it becomes easier to understand what they are trying to say. The mobile device must be equipped with a camera in order to capture the visual sign language.

Extending the application by adding new languages support can also be considered. Adding new languages can help the application in spreading in more countries and cultures, thus, benefiting larger number of people.

Additionally, tests will be done to evaluate the effectiveness of this software as learning and chatting tool.

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