

Toward a mobile service for hard of hearing people to make information accessible anywhere

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Abstract— Deaf and hard of hearing people can find it difficult to follow the rapid pace of our daily life. This problem is due to the lack of services that increase access to information. Regarding hearing impairment there is no specific solutions to make information accessible anywhere. Although this community has very specific needs related to the learning and understanding process of any written language. However, hearing impairment is an invisible disability which is quite frequent: it is estimated that more than 8% of world's population suffers from hearing loss. According to many studies reading level of hearing impaired students is lower than reading level of hearing students. In fact many deaf people have difficulties with reading and writing; they cannot read and understand all the information found in a newspaper, in vending machine to take a conveyance, in instruction leaflet etc ... Mainly all visual textual information are not accessible for this category of people with disabilities. However, a number of obstacles still have to be removed to make the information really accessible for all and this is crucial for their personal development and their successful integration.

In this paper we propose a solution to this problem by providing a mobile translation system using the great technological advances in smart phones to improve the information accessibility anywhere. We rely on text image processing, virtual reality 3D modeling and cloud computing to generate a real-time sign language interpretation by using high virtual character quality.

Keywords— Cloud Computing, Android, Sign Language, Virtual Reality.

I. INTRODUCTION

According to many linguistic researches it turned out that sign language is a non derivative language it is a complete language with its own unique grammar [1, 2]. In other words the learning process of hard of hearing people differs compared to the classical learning process. In 1996 Marschark and Harris [12] confirmed that the hard of hearing people's learning progress is extremely slow. Furthermore, the gain of experience collected by deaf children in four years is equivalent to the gain of one year for hearing children. This

deficiency causes illiteracy among the deaf person; they are in a situation where textual information is not accessible to them.

Say you want for example to read news so you buy a newspaper and information will be accessible for you, this would be impossible for a hearing impaired person with low English literacy. You want to take a train ticket for example is a breeze for someone who has no hearing impairment but for a deaf person it very difficult due to the interaction with an ATM¹ that does may not provide accessible information to this category. Many deaf people in the world have difficulties with reading and writing; in fact some of them do not read. A text-based system would make it impossible for the people to follow and understand a conversation in real-time. Using ict we can improve the accessibility to information anywhere by new mobile service based on cloud computing, sign language and multimedia content.

In this paper, we present a new approach developed in our Research Laboratory which can provide benefits for deaf people with low English literacy to improve their social integration and communication. As a first step we focus on the relationship between deaf people and the technological progress, and based on experimental study we try to identify some specific needs related to accessibility to information by this community. This new approach uses mainly a web-based interpreter of sign language developed in our research laboratory and called WebSign [5]. It is a tool which permits to interpret automatically written texts in visual-gestured-spatial language using avatar technology. Otherwise we have developed another layer around the WebSign core to provide a real-time translation service using cloud computing approach, multimedia content and a client mobile solution on Android OS to enjoy the Smartphone qualities and to ensure access to information anywhere.

¹ An automated teller machine (ATM) is a computerised telecommunications device that provides the clients of a financial institution with access to financial transactions in a public.

II. TECHNOLOGICAL PROGRESS AND HEARING IMPAIRMENT PERSONS

Nowadays we heavily rely on solutions which follow technological progress and which greatly facilitates everyday tasks such as electronic payment, ATMs and other systems that rely on automated processes and machine human interaction. The question is, are all these systems truly accessible by all? Unfortunately the answer is no, most of systems are inaccessible and unusable by a person who has a specific needs. In other words, the necessity to provide efficient solutions to this problem is quickly felt.

A. Earlier works

Before discussing this latest study, we will first survey briefly some earlier works. Following the technological revolution in communication field, people who suffer from hearing impairment can use smart phone to communicate with each other by video transmission in real time. However, this alternative based on Video phones is quickly widespread as the preferred method of communicating for the deaf and hard-of-hearing community. Video phones require significant computer processing power to compress and decompress video in real-time. Nevertheless, this alternative still has to overcome the various technological challenges associated with utilizing video

phone technology, especially with low bandwidth network. Also this solution has a restricted access to other types of information that depend on human machine interaction like ATMs.

B. MMS Sign

Mobiles do pose some potential difficulties for the deaf and hard of hearing. Text messages are short, clipped and often incomplete sentences - so they carry a built-in potential for misinterpretation. Texting quickly becomes expensive, and SMS messages cannot always be counted on to be immediately received. However, many deaf people having sign language as their first or preferred language, the inputting and reading of written text messages can become even more difficult. In this context mms sign [6] was created to make available to people who are suffering from hearing impairment a service to facilitate communication using mobile phones. This service is mainly based on the transformation of SMS-Text to MMS containing the video sequence of translated text in sign language in a format which can be sent to deaf via MMS. This transformation is realized first with a generation of 3D animation using virtual character [5] then will be transformed to an MMS containing a 3GP video sequence as shown in figure 1.

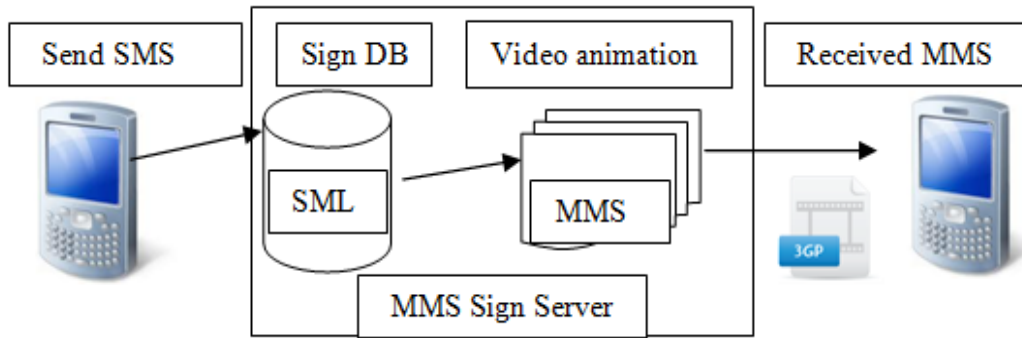


Fig. 1 MMS Sign Server Architecture

C. Evaluation study

In our laboratory, we conducted a study to determine whether there is a comprehension benefit when many services will be accessible to deaf people. We designed some questions according to services that will be useful in everyday life. However, issues are related to ATMs interaction or the ability to read a newspaper or an informative panel in train, bus station or even in airport. Our sign language expert interprets these questions and gives us the view of ten deaf persons. There was a statistically significant difference in accessibility scores between hearing impairment and no hearing impairment persons.

Furthermore, we find that the majority of hard of hearing participants avoid using ATMs, they have difficulties to read a newspaper and they have difficulties to access to information panel. As results to this study we deduce that the majority of participants who suffer from hearing impairment either, they

never use this technology or they have handling difficulties. In other words, they have problems to access to visual textual information. For this reason we focus on visual textual information accessibility problem in order to find a solution which improves the accessibility level. Accordingly, they can be quickly informed and they have an easier access to new technologies of information and communication.

III. TECHNICAL CONSIDERATIONS

The objective of our project is to develop a mobile based interpreter of Sign Language (SL). This tool would enable people who do not know SL [13, 16] to communicate with deaf individuals. Therefore, it would contribute to reduce the language barrier between deaf and hearing people. Also our objective is to give the opportunity to the deaf to handle the new technologies of communication and information. The developing team has adopted Web 3D technologies [3, 5, 7, 9, 15] which have surpassed traditional approaches such as real video and still images [14]. We use the Sign Modeling

Language SML [5, 6] as transcript language to animate our 3D humanoid interpreter.

SML is based on XML structure to describe animation such as X3D2 format. Actually our system is based on automatic translation from the written text with considering the sign language specificities [10, 13, 16] to generate the appropriate animation. In this work we focus on two principal aspects. The first one is to build service that translates the text to sign language using cloud computing and the second aspect is to offer mobile anywhere access to this service.

A. Translation system architecture

Our transcription system architecture is based on sign modeling language data base. The system sends the input text as a request to Google translator service. This service gives us English translation to be an input to the Text Adapted Sign Modeling Language module. After this operation we obtain a text form adapted to the sign language specificities [4, 10, 13] and which represent an input to Web Sign kernel [5][17][18][19][20][21][22]. Finally this engine generates the sign modeling language SML [5] according to this text form to be interpreted by our virtual character as shown in figure 2.

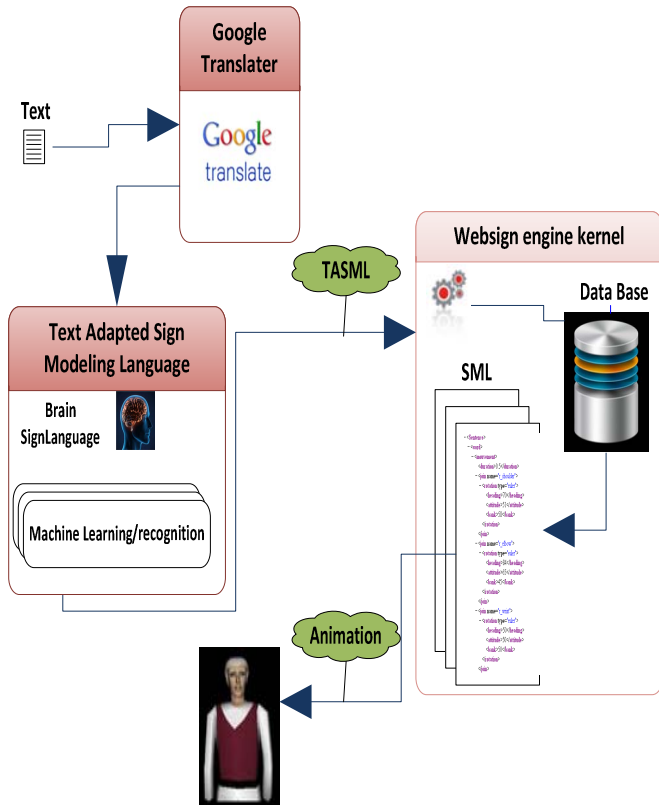


Fig. 2 Translation system architecture

²X3D is the ISO standard XML-based file format for representing 3D computer graphics

IV. OUR APPROACH

Based on cloud computing, virtual reality modeling and mobile solution. We have built approach to make available a mobile sign language translation service. We use a virtual character for sign language interpretation in animated 3D video rendering format. Indeed, we adopt this solution to generate animation on demand using a collaborative approach [5] through our signs design tool.

Furthermore, this tool gives opportunity to a large community of users to add themselves signs that will be saved on database in SML format to be subsequently transformed to a 3D video animation. This solution is more efficient compared to the classical sign video, because, first the process is independent of human interpreter, the multiple community criterion of signs and the possibility to combine several signs to interpret sentences while preserving a smooth movement.

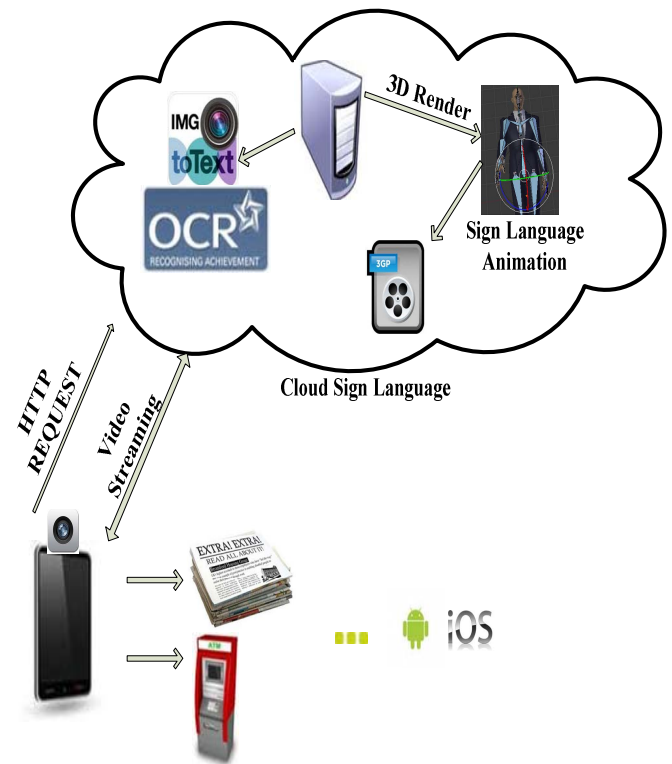


Fig. 3 Cloud Sign Language translation system architecture

A. Cloud computing

Cloud computing refers to the on-demand provision of computational resources (data, software) via a computer network, rather than from a local computer. This approach is adapted to be used by minimal computational resource terminal. The idea is to interconnect many dedicated computer on high bandwidth network allowed for a system in which multiple CPUs and storage devices may be organized to increase the performance of the entire system. Users or clients can submit task to our service provider without knowing either

the location or the type of background processing. In our context the computational resource are dedicated to sign language computational processing. However, our service depends mainly on 3D rendering and this kind of processing is closely related to CPU computing power. As shown in figure 3 this approach gives us opportunity to use Smartphone as client and to take advantage of computing power offered by this service.

The idea is based on textual information extracted from image. Furthermore, User with his Smartphone takes a picture that will be sent to the cloud. Our service integrates a specialized Optical Character Recognition OCR that detects and extracts automatically all textual information. In the next step the extracted text will be sent as input to our 3D rendering server to generate animation which contains the translation of input text to sign language using virtual character technology.

Finally the animation will be generated in 3GP format and the streaming video link will be sent as HTTP REQUEST to client to view the result. For now we have only Android OS version and as a future works we try to cover Apple IOS and other mobile operating systems.

B. Optical Character Recognition

Our approach is based largely on the client alleviation. In addition, all heavy treatments will be forwarded to other specialized entities such as Character Recognition Service on the cloud. Using this solution we optimize the global response time of this application compared to the embedded Optical character Recognition. The error rate of OCR [8], depends a lot of image quality. If the image has a good resolution the error rate of our OCR is limited to 4% except that the image may have noise information and a bad resolution so we may have to improve the rate in this case.

C. Android client

We developed a mobile client application under android operating system. This application uses mainly Smartphone camera and video streaming technology. Indeed, the video streaming choice is based on hardware constraint related to mobile phones. We all know that 3D rendering depends closely on good computing, graphics processor and virtual memory configuration and our aim is a maximum optimization of the response time. Using embedded 3D render system, the service response time becomes very slow. In other words, we used specialized powerful machines to ensure a 3D rendering in an acceptable response time.

D. Virtual character animation and video streaming

Regards to the generation of 3D animation we developed a module that transforms an SML animation to video animation which contains the interpretation of text into sign language using virtual character. The transition from SML animation to video animation is based on firstly the choice of the

collaborative and multi community approach to feed the signs dictionary [5] so we must manipulate the 3D virtual character in real-time and create signs through our web 3D modeling interface. Secondly the real time rendering approach depends closely on hardware configuration. After the video generation, the linker maker module generates links streaming to be sent in HTTP request to client.

V. CONCLUSION

This research has identified a solution to improve the accessibility to some important information of hard of hearing community when using the automatic text interpretation into sign language and video streaming service. In this work we are based on cloud computing technology to alleviate the client treatment. This project is classified among the first studies to improve access to information anywhere and we prove that deaf perceives a big difference when he will be able to access to more information and more technology such as ATMs. This application has very good results, however we can improve the response time if we use the distributed parallel 3D rendering on multiple machines. In future work, we will focus on parallel 3D rendering. We will improve the virtual character quality and optical character recognition and we will develop other client versions on other mobile operating systems such as IOS and BlackBerry OS.

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