Augmented Reality Card System for Emergency Medical Services

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Abstract. This paper shows the description of the development of the Augmented Reality Card System for Emergency Medical Services (ARCSEMS). The aim of this system is to speed up assistance time and facilitate a person's relevant medical data in an emergency that has taken place on the street. Its use is focused within the context of the social web (currently called web 2.0) within the frame of augmented reality, allowing both the civilian population and medical staff to use this tool.

Keywords: medical records, first aid, health card, augmented reality, medical informatics

1 Introduction

At present there are different cards whose aim is to identify a person univocally, providing at the same time information about personal medical data. Cards such as the "Tarjeta de Obra Social" [1] or the "Tarjeta Sanitaria Individual" [2] complement their scope with electronic medical records. In the field of health applications we come across “Assistència Sanitària” [3], which is an augmented reality application that allows us to search for doctors, medical centers and clinical laboratories following different parameters. “My Medical Info” [4] and “Medref” [5] allow us to keep a record of diseases and possible pathologies of a patient. Finally, the “Simple Medical Information” [6] is used to obtain an early diagnosis depending on the symptoms that we may indicate. However, this study shows differential functionalities considering the use of Augmented Reality (AR) to contribute with medical assistance in an emergency. AR is able to merge data and virtual objects with the physical world, thus enriching our perception of reality [7]. It is common for AR to be compared with

Virtual Reality but they do not represent the same concept. There is a main difference between Augmented Reality and Virtual Reality. The latter involves immersing the individual in a completely virtual world, while in AR the individual is in the real world with virtual additions superimposed [8]. As a result of the great technological breakthroughs in recent years in the field of mobile devices, such as smartphones, tablets, PCs and wearables (some examples of these are the intelligent lenses of Google Glass [9], HoloLens [10] and the smartwatches like Apple Watch [11] and Band by Microsoft [12], among others) a group of companies focused on the creation of several tools for the development of AR applications like Metaio [13], Layar [14], Vuforia [15], AR Tool Kit [16], Mixare [17] and Unity3D [18].

This design is introduced and developed in the context of AR technologies. It is a software solution that allows us to obtain information about an individual who has an accident on the street or who is in a critical health condition, so that they can be assisted as soon as possible thus helping to safeguard thier life. Table 1 shows a comparison between card applications and/or systems used in the health field according to search features such as medical services, personal data, relevant medical information such as allergies, diseases and surgeries, medical records display and other technical features. These can include external interfaces of use that may be needed, operating system used, internet use and price.

Cards/Systems / **Features**	Medref	Asistencia Sanitaria	Electronic Medical Records	My Medical Info	**ARCSEMS**
Medical services search	No	Yes	No	No	No
Contact data	No	No	No	Yes	Yes
Personal data	No	No	Yes	Yes	Yes
Relevant medical data	No	No	Yes	No	Yes
Price	€1,00	Free	Free	€2,00	Free
Facilitates augmentation	Yes	Yes	No	No	Yes
External interface required	Yes (Google Glass)	No	No	No	No
Operating system	Android	IOS/Android	N/A	Android	Android
User type	Unrestricted	Unrestricted	Doctors	Unrestricted	Unrestricted
Internet use	Yes	Yes	Yes	No	Yes
Records display	Yes	No	Yes	Yes	Yes

Table 1. Medical services comparison chart

While there exist health oriented clinical information management applications for people, this study presents the development of a system that applies Augmented Reality together with the use of a cell phone or tablet, thus providing information quickly by enhancing the individual's physical ID card with vital information about the person, contact data and personal data, in order to contribute in an emergency situation to the person's best and prompt assistance.

2 Proposal: Augmented Reality Card System for Emergency Medical Services

The Augmented Reality Card System for Emergency Medical Services (ARCSEMS) consists of an application with Augmented Reality capabilities for mobile devices, which provides the user with relevant information about an individual. This characteristic is used to decide what to do in an emergency in which, for instance, the patient is unconscious. Even in that situation, it is still possible, through the card, to obtain the patient's medical records containing information about health, past medical conditions, medication used, surgeries, allergies or disabilities.

Figure 1 shows a diagram of the conceptual architecture of ARCSEMS, consisting of three functional modules (Main Module, Web Module, Mobile Module). The Main Module acts as a Server between the Web Module and the Mobile Module. These last two load data and operate content both static and enriched by the Augmented Reality technology. They will be later described in detail.

The Web Module was developed under HTML standards, together with JavaScript and public libraries such as JQUERY [19] and Bootstrap [20]. It is supported by a Java backend [21] through Apache Tomcat [22] and Spring platform IO [23], which gave us the possibility to obtain flexibility. We also reused mainstream tools that allowed us to make a low coding effort.

The Main Module includes a REST API [24] which is also served by a Java environment using Spring IO and Apache Tomcat. The storage support is implemented with a relational database with JDBC [25] support, used in the MySQL [26] development environment. Finally, the Mobile Module includes a compiled application for mobile devices with Android operating system using the Multimedia Unity3D Engine and Vuforia recognition system.

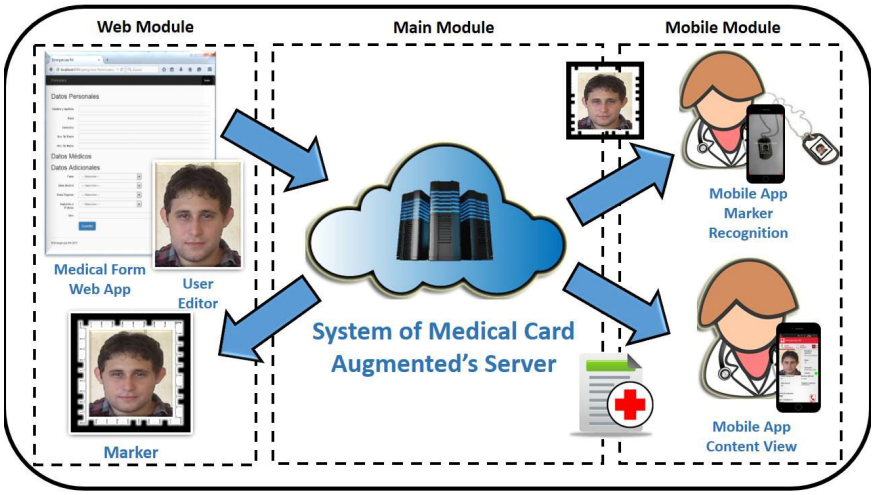

Fig. 1. Conceptual diagram of conformation of ARCSEMS in a set of modules

Figure 2 shows the mobile application at work. Please note the photo of the user being assisted. The augmented content can be seen on the screen of the device which in this case is comprised of a set of red buttons on top. From left to right, they represent the options of emergency call, augmented content display, personal contacts call and static content display respectively. Below the buttons we can see the person's relevant medical data.

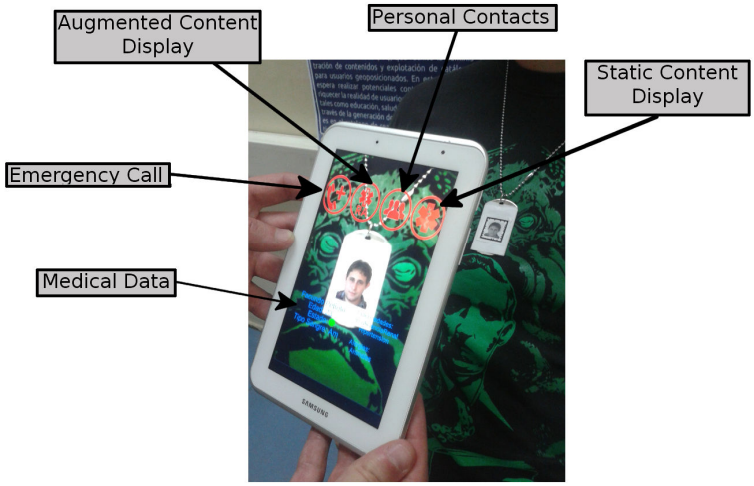

Fig. 2. Photo of ARCSEMS at work.

2.1 Main Module – Server Application

This Module is comprised of a RESTful API that acts as a backend providing creation services, editing, serialization, compression and web forms storage with user's relevant medical and personal information, which make the core part of the ARCSEMS. Figure 3 shows diagram components. The ARCSEMS can operate in two modes. In one of them the emergency service is connected to a server via the internet. In the other, ambulances may have their own server in each unit and use it as an intranet.

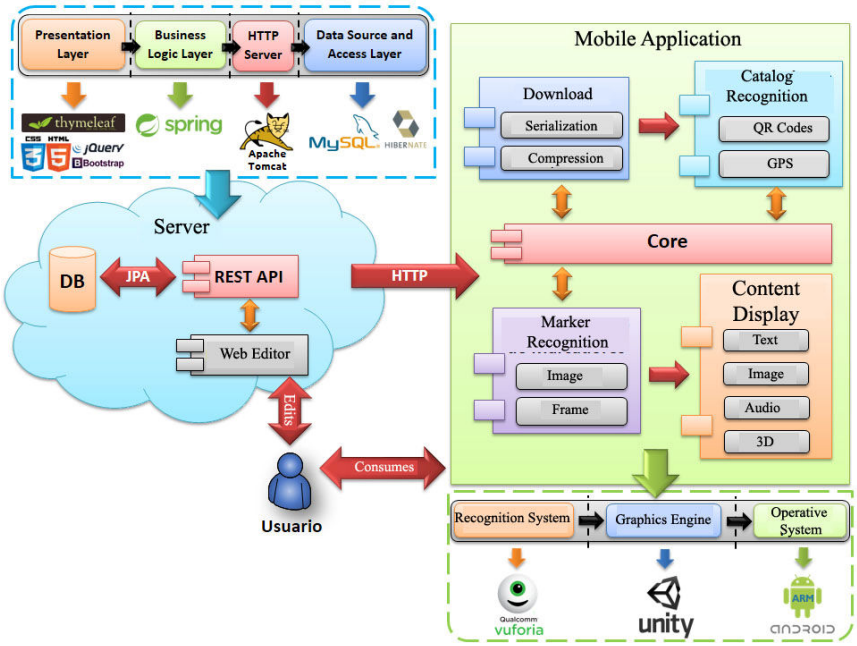

Fig. 3. ARCSEMS components diagram

After having described the previous modules, we will now show the WebApp interaction with the server through a class diagram, see Figure 4. The most important classes the system has are: Core, BusinessDTO, 7zip and ControllerWebApp. The Core class contains the business logic of the system, allowing to control the other modules. BusinessDTO handles the conversion of metadata between the application and the server. This process will take place through the 7zip class which will perform the serialization of data so that they can be transmitted and the deserialization of data received. Finally, the ControllerWebApp class controls all the requests that come from the website.

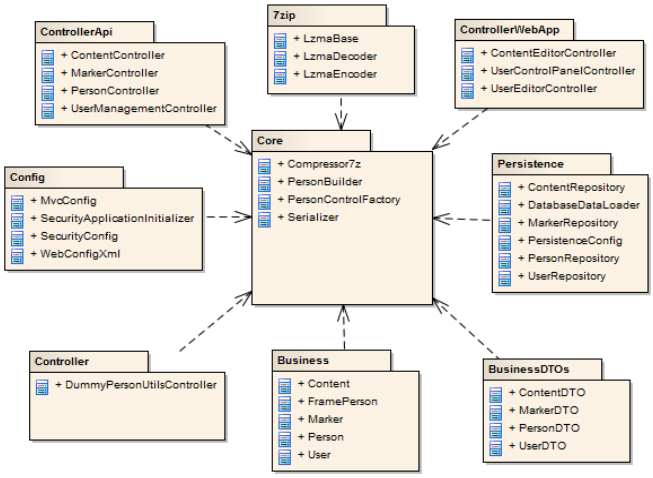

Fig. 4. WebApp-Server class diagram

2.2 Web Module – Data Loading Application

This module serves as system data entry and provides a web form where the user enters relevant personal medical information to create their own medical records. This form will be sent to the Server, which will record it in the database and will send a FrameMarker[1] with a certain code which must be printed and placed in a pendant. This pendant, together with the marker, will represent the activator of the mobile application, see Figure 5.

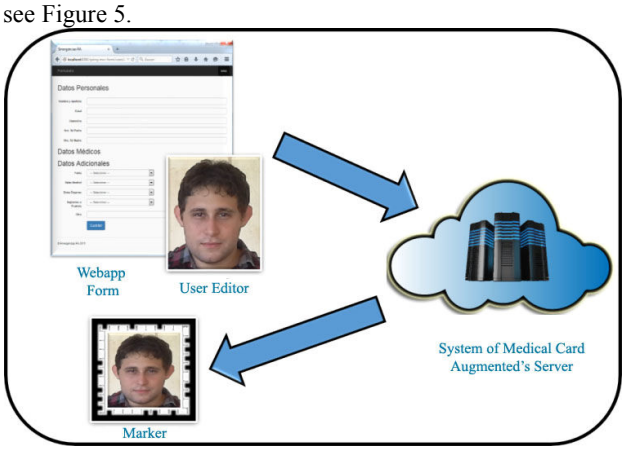

Fig. 5. User's data loading cycle

[1] Printed image that provides a spatial reference, allowing the device to print virtual information in the captured real environment, known as "marker".

2.3 Mobile Module – Augmented content exploitation application

The aim of this module is to exploit the augmented content of the application. The person must previously register their relevant medical data through the web application. Once the person is registered, scan the marker on the patient's pendant. Once the reconnaissance operation is run, the application will send a request to the Augmented Reality Card System for Emergency Medical Services Server to download the appropriate information. If the FrameMarker is deemed valid, the main module will respond with a form associated to the person's medical record. Then, the mobile application will turn that form into content, which will be displayed on the mobile device screen. See Figure 6.

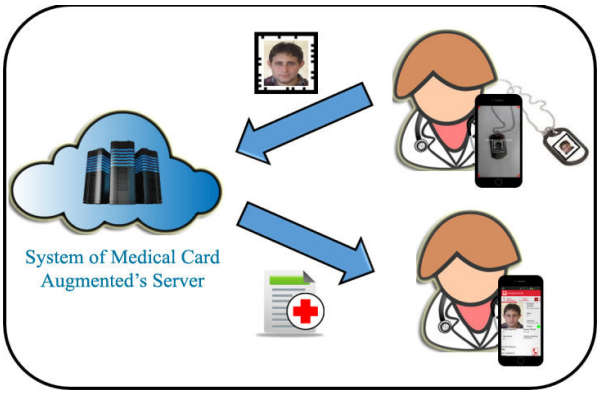

Fig. 6. Diagram of the augmented content exploitation cycle

This content has two views. The initial view is performed with AR, and it has options to dial 911 to show relevant information (name, age, blood type, allergies, health condition and diseases), and to call relatives. Finally, it allows you to go to normal view, see Figure 7.

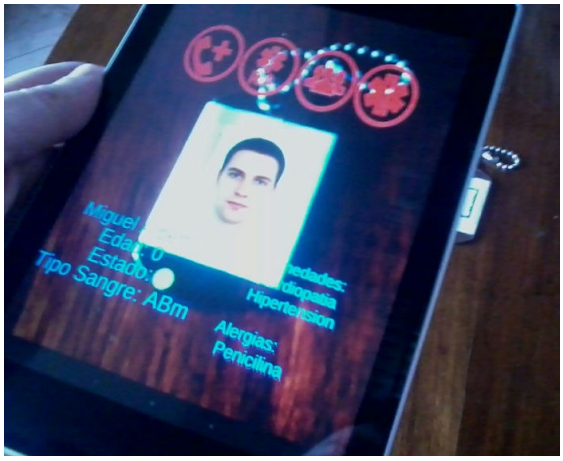

Fig. 7. AR visualization of the mobile module

The normal view comes before the AR view. It is shown in three different sections within the application, see Figure 8. The first one gives information about personal data. The following application covers the person's medical record, where you can see details about diseases, surgeries, allergies, etc. Finally, the last section contains complementary data, for instance: if the person is an organ donor, if he/she is an alcoholic or a smoker, if he/she has a phobia, among others.

Fig. 8. Normal visualization of mobile module

The mobile module was developed based on the following class diagram shown in Figure 9. The mobile application's most important classes are: Core, 7zip, Container and GUI. The Core class has the mobile application's logic and acts as link among the other classes allowing the management of said classes. The 7zip class serializes the data so that they can be transmitted and it deserializes the received data, as it happens in the WebApp. The Container class is in charge of keeping the data referred to the FrameMarker and its associated information, which will be the patient's medical data.

Finally, the GUI class controls all the requests that the mobile application receives from the graphic interface.

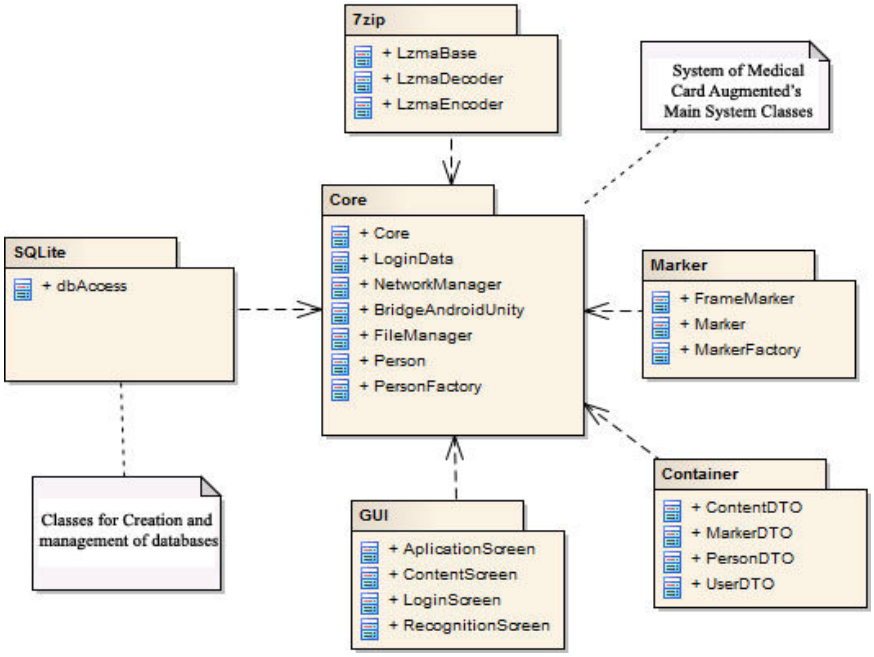

Fig. 9. Mobile module class diagram

The mobile application operation can be represented in the sequence diagram shown in Figure 10. In the case described, the user starts the application and the graphic interface. Core, in turn, starts the marker reconnaissance system. When the marker is recognized, the identification number is retrieved and used to obtain the database. Then, the system prepares the augmented content for its operation and finally the graphic interface shows the content on the device.

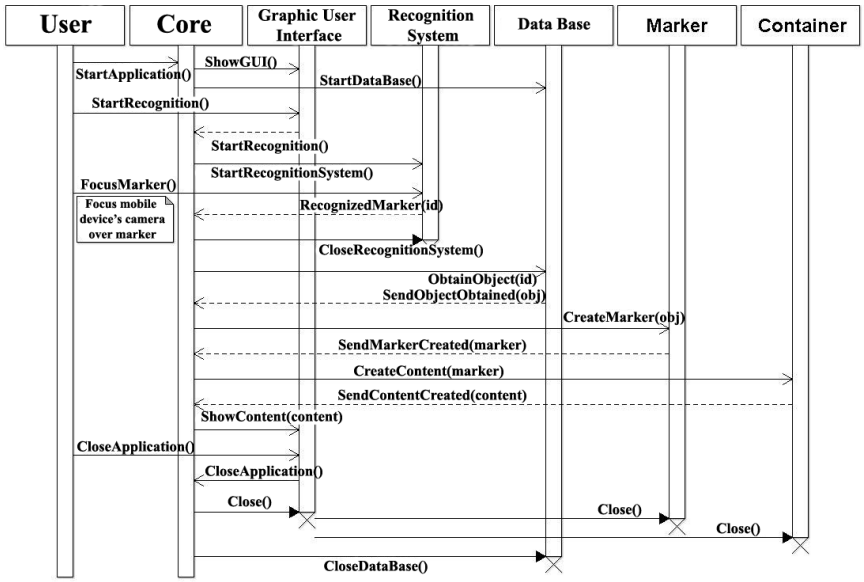

Fig. 10. Mobile Application Sequence Diagram

Figure 11 shows the integration of the components, which includes the mobile application. Please note the following modules. The module in charge of the marker reconnaissance through the Vuforia framework; the download module that serializes and compresses the contents to be transferred on the web; and finally the content display module that shows the virtual objects on the screen of the devices. The multimedia graphic engine Unity 3d facilitates that functionality.

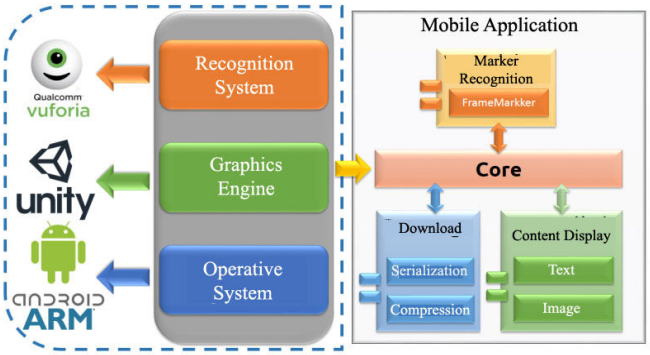

Fig. 11. Mobile module component diagram

3 Preliminary Results

Two groups of college students took part in ARCSEMS tests: one of the groups belonged to the medicine program, see Figure 13. The other group belonged to IT related programs, see Figure 12. The following application scenarios were carried out: actual cases drill, review of each of the application sections and use of the ARCSEMS functionalities. At the end of the tests, each student had to fill in a satisfaction survey indicating whether the ARCSEMS had been Very Good, Good, Average, or Bad, in terms of Intuitive, Speed, Usefulness, and Innovative.

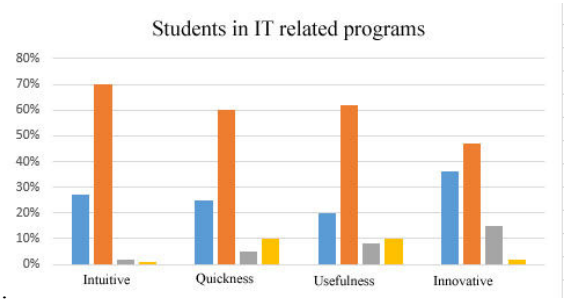

Fig.12. Graph showing related programs user evaluation

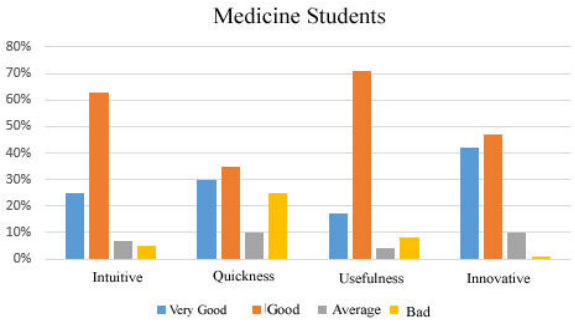

Fig.13. Graph showing medicine program user evaluation

4 Conclusion and Future Research

The Augmented Reality Card System (ARCSEMS) contributes to the patient assistance in emergency situations. The tests carried out when using the cards were satisfactory, increasing the information when compared to the classic physical identification of a person, contributing to improve people's information availability they are in an emergency. Future research is focused on widening the ARCSEMS functionality with biometric sources of identification, which would add the possibility

of obtaining patient data using the mobile device camera for face recognition and fingerprint recognition using a digital scanner incorporated in mobile devices. Within the framework of systems based on knowledge, the possibility of including a classification of patients according to their medical record is being analyzed. This classification would give the medical staff an immediate categorization of the person in an emergency.

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