

Towards a Mobile, Assistive and Intuitive Videoconferencing

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Abstract—In this paper we present TAM-TAM (Tele Assistance and Monitoring), a tool devised to provide assistive and intuitive videoconferencing. It can be used to provide social support, remote consultation, remote monitoring and training or rehabilitation group sessions through multi-user videoconferencing. TAM-TAM relies on a simple and minimalist interface based on accessible standard web technologies and open video streaming solutions. We also describe our progress for bringing TAM-TAM mobile, targeting Android and iOS tablet PCs and mobile market.

Keywords—*videoconferencing; teleconsultation; social care; nursing home; group home; elderly.*

I. INTRODUCTION

The accelerating pace of the world's population aging is remarkably changing the demographic distribution of population, as predicted by the last International Population Report issued by the U.S. National Institute on Aging [1], which foresees that the global population aged 65 and over (about 7 percent of the world's population in 2008) will rise to 14 percent of the total by 2040. In Europe, the number of Europeans aged over 65 will increase by 52.3% from 2005 to 2030, with more than 100 million people older than 80 years by 2020 [2].

The ageing of the population together with changes in lifestyle become two key factors in the growing prevalence of chronic disorders [3], which put in risk the current healthcare system since it is more focused on the treatment of acute diseases. In 2002, the World Health Organization (WHO) launched the Innovative Care for Chronic Conditions (ICCC) initiative, which formulated the basic principles and strategies to improve the management of chronic patients: disease prevention, an increasing implication of the patient and relatives in the management of the disease and a joint work between primary, secondary care and all the actors involved in healthcare.

In this context, there is a need for technological tools that help to deploy this integrated care for chronic patients, who are mainly composed by the elderly, impaired and long-term care patients. Hence, videoconferencing postulates as a very powerful technology to enhance social support, loneliness and depressive status of those collectives [4].

However, there is still a lack of intuitive applications for those collectives. According to [5], Internet technologies would be more used if they were better adapted to the elderly. On the other hand, the main reasons adduced by non-cybernauts for not using the Internet are the difficulty (71%) and the effort required for learning how to use it (60%). Among the proposals

for improving the usage of Internet technologies, price and simple interfaces are considered to be prominent.

In this paper we present TAM-TAM (Tele Assistance Monitoring), a tool that offers an intuitive interface for the elderly, impaired and long-term care people as well as for health professionals to provide social support, remote consultation, remote monitoring and training and rehabilitation group sessions through multi-user videoconferencing.

II. RELATED WORK

Although there are several initiatives and projects dealing with devices and applications devised for the aforementioned collectives, whenever a hardware device is needed but not produced in mass, it results in a relevant increase of the cost of the system, which is not affordable by public health systems. That's why TAM-TAM focuses on standard hardware such as PCs and tablet PCs, as discussed in subsequent sections. Some related projects do not include videoconferencing functionality (ALZ-AVANZA project [6]), they rely on the use of a specific set top box connected to a TV display (ATTENTIONET project [7]) or they have built their specific tactile hardware and specific software (Colabor@ project [8]).

On the other hand, there is also a wide range of videoconferencing applications, either open or proprietary that could be adopted for being integrated in a new application. In general, videoconferencing solutions can be classified into two types: dedicate systems and desktop systems.

Dedicate systems consist of an integrated equipment including all the interfaces with external devices (i.e. camera, microphone, speakers, display) and a hardware or software codec for the audiovisual digital transmission. Some examples of manufacturers are Sony, Tandberg, Polycom and Cisco, amongst others. These systems are, in general, expensive and rely on specific proprietary hardware. Moreover, changes in their interfaces are not easy to implement.

Desktop systems are applications that can be installed or run on a computer and are very diverse in nature and number. Some relevant free tools include Ekko, TokBox and Vawkr, which can be easily embedded in a web site or as part of another application. However, they lack some functionality such as recording conferences or sharing documents, and they are not open source, so they cannot be freely modified or improved to be adapted to specific medico social environments (see section III.A). Among payment solutions it is worth mentioning Adobe Acrobat Connect Pro and ViewCat, both flash-based, and Skype, which currently supports videoconferencing in iOS (4.0 or above) and a subset of Android (2.1 or above) devices. Regarding open source solutions, the most relevant is OpenMeetings, a flash-based

tool that includes shared desktop, blackboard, and multi videoconferencing. However, the complexity of the application odds with the goal of providing a very intuitive interface and makes it difficult to run it on tablet PCs.

Finally, we need not forget about HTML5, a recent standard that could be used in the next future for developing videoconferencing solutions. Currently, the specifications and implementations of HTML5 in different browsers support the rendering of video streams in the same browser without the need of external plugins. The main unsolved issue is the access to the local camera for streaming the video, although some lab experiments have already proven its feasibility [9].

III. REQUIREMENTS AND FUNCTIONALITY

A. System Requirements

TAM-TAM has been developed in the context of a working group lead by the BCDS research group [10] in coordination with the Social Services Cohesion Board depending of the Girona's Council. This working group, called "ICT, socialization and active ageing" explores and promotes new efficient ways for supporting the elderly, dependent and impaired people through the use of ICT technologies. This collaboration relies in the collection of the requirements from end users but also in testing with real users in a real environment, which includes nursing and group homes as well as particular homes involving the target collectives.

Five scenarios have been identified for the provision of videoconferencing services in medico social environments.

1) *Rendezvous*: Given an appointment, the patient accesses the application and waits until the professional is ready to assist them. Only when the professional is ready, the videoconference is started. This is the typical operation in real life, where patients wait for the doctor to be available for the consultation. The professional constantly monitors waiting patients and selects who is to be attended next.

2) *Remote camera control*: The patient is contacted by a professional or call center. This scenario is foreseen for cases where alarms are involved, where the patient's impairment is a barrier to use technology or when an intensive monitoring is needed. Since the videoconference is not started by the patient, it involves privacy issues that should be formalized in an agreement with the patient or their family.

3) *Call center*: The patient contacts an intermediary, which redirects them to the appropriate professional if needed. Here the patient may or may not have an appointment with the professional. The call center may act as the receptionist of the professional or as an integrated service that can be used to manage emergency calls and filter user requests according to the criteria of an intermediate health or social professional.

4) *Single videoconferencing*: This is the typical scenario present in most of videoconferencing tools. A user has a set of contacts with which they are able to interact as long as they are all connected at the same time. This set of contacts may be static (not modifiable by the user) or dynamic (modifiable) depending on the requirements of the application and the skills of the target user.

5) *Multi videoconferencing*: This scenario is foreseen to enable the practice of training or rehabilitation group sessions for patients (e.g. occupational therapy), improving the feeling of belonging to a group of people with similar problems and concerns. Moreover it is also useful for holding medical or training sessions among professionals and/or the members of the patient's support group, as their familiars and carers.

B. System Functionality

Current main functionalities present in TAM-TAM are described in detail next.

Videoconferencing. It is the central element in TAM-TAM, as it is needed for providing telemonitoring and teleassistance health and social services. Videoconferencing has proved to be very useful both from the medical and social perspective. On one hand, from the medical point of view, it enables a closer monitoring of the patients while improving their compliance to the prescribed treatment or therapy [11]. On the other hand, from the social perspective, it alleviates the patients' loneliness and depressive status and improves their emotional and social support thanks to their interaction with their families, social carers or psychologists [4]. TAM-TAM currently supports scenarios 1, 2, 4 and 5 from those identified in section III.A, all of which rely on the same core. This fact proves how versatile the system can be by adapting the front-end operation and interface. The video quality can be dynamically tuned to fit the available bandwidth and avoid delays in the transmission.

Calendar, messages and notifications. A relevant feature in some environments is the presence of a reminder mechanism for activities or actions that need to be carried out punctually or periodically, such as drug administration, exercises to be carried out, medical appointments (physical or by videoconference). TAM-TAM offers different interfaces for that purpose. First, it provides a calendar-like interface for editing and consulting any activity or action that is linked to a certain date, time and periodicity, what we call a notification. Each notification can be configured with an urgency degree (low, medium and high), which determines whether it will trigger a visible warning when the user accesses TAM-TAM or whether it will be kept in the calendar with no visible warning. Then, we also provide a mailbox-like interface for enabling users to send customized messages to any other user associated to them. Calendars become a very powerful tool when people belong to nursing or group homes, which are monitored by specific associations, as they can be used to manage the patient's agenda from the association itself. Edition interfaces can be configured to be accessible to all or part of the application users, depending on their profile and skills.

Instant messaging and chat. These features introduce a higher complexity in the use of telemonitoring and teleassistance applications, since they need a direct interaction of users with physical or tactile and virtual keyboards, which might be something not affordable when dealing with some types of patients. However, in some occasions when the audiovisual interaction between two parties becomes not feasible due to temporal bandwidth constraints, it may act as a backup means of communication. Moreover, for users that do not have difficulty in using technology, this may act as an added value to establish and maintain a less formal

communication with other users. Therefore, TAM-TAM can be configured to provide instant messaging and chat functionalities depending on the user profile.

User authentication. Since user authentication needs to be kept as simple as possible, a user and password approach has been adopted, offering the possibility to remind them for future accesses. In tablet PCs or if the user device is to be used by a single patient, authentication can be highly simplified by following an initial setup that bundles the application to the user.

User contacts. TAM-TAM enables bundling a set of predefined contacts to a user by the system administrator as well as adding new users by sending invitations. The user's contact list is available to determine whether a user is connected so that a communication can be started.

IV. ARCHITECTURE

A. Architecture

TAM-TAM consists of two main parts: the portal or front-end, and the server or back-end, as depicted in Fig.1.

The front-end is the application that users access, either from their web browsers or as an installed application. It offers the interface for the whole system functionality, i.e. videoconferencing, calendar, messages and notifications, instant messaging and chat, authentication, user contacts, etc.

The back-end is composed of the modules that obtain and manage the information stored in the system's databases. TAM-TAM currently uses two different relational databases, one for users, contacts and profiles and a different database for managing the calendar, messages and notifications. Regarding the modules, they provide the intelligence for the functionalities offered by TAM-TAM and the interfaces with the corresponding databases. For example, there is a module responsible for managing notifications, messages and the user's calendar. This module is implemented as a web service that offers the functions to store create new events, messages and notifications as well as to consult them for a specific user. The front-end makes use of those functions whenever a new

notification is to be created or when a user logs into the system to consult any pending urgent notification. There is also a module dealing with videoconferencing, which receives all the audio and video streams and forwards them to those users that belong to the same audiovisual single or multi videoconferencing. This module is a servlet running on the multimedia server. Fig. 2 identifies the technologies being used in TAM-TAM, described in subsequent sections.

B. Client Technology

TAM-TAM client technology is based on the Adobe Flash and Adobe AIR technologies. While the first is used for generating a Rich Internet Application (RIA) to be run on a web browser, the latter is used to build native applications for mobile and tablet devices (see section V).

RIA technologies offer in the web browser some features of traditional desktop applications, while making the update process transparent for the user, avoiding the reload of web pages and offering capabilities for designing intuitive interfaces.

Among the available frameworks used for the development of RIAs, JavaFX, Microsoft Silverlight, AJAX, Google Web Toolkit and Adobe Flash are the most relevant and adopted. Adobe Flash was chosen for TAM-TAM, since it enables the development of web applications in a simple manner by means of the Adobe Flex framework. Adobe Flex is an open source compiler and SDK based on two underlying programming languages: MXML and ActionScript (AS). While the first is used for easing the design of user interfaces, which can be based on Cascading Style Sheets (CSS), the latter offers an API that can be used for achieving interactivity and, in our case, for integrating audio and video conferencing in a simple way. AS is an open source object-oriented language that can be compiled into a SWF file to be run on the Adobe Flash Player.

The control of multimedia flows in Flex is achieved by using the NetConnection and NetStream classes offered by the AS API to create a RTMP connection to the media server and stream an audio and video transmission over that connection.

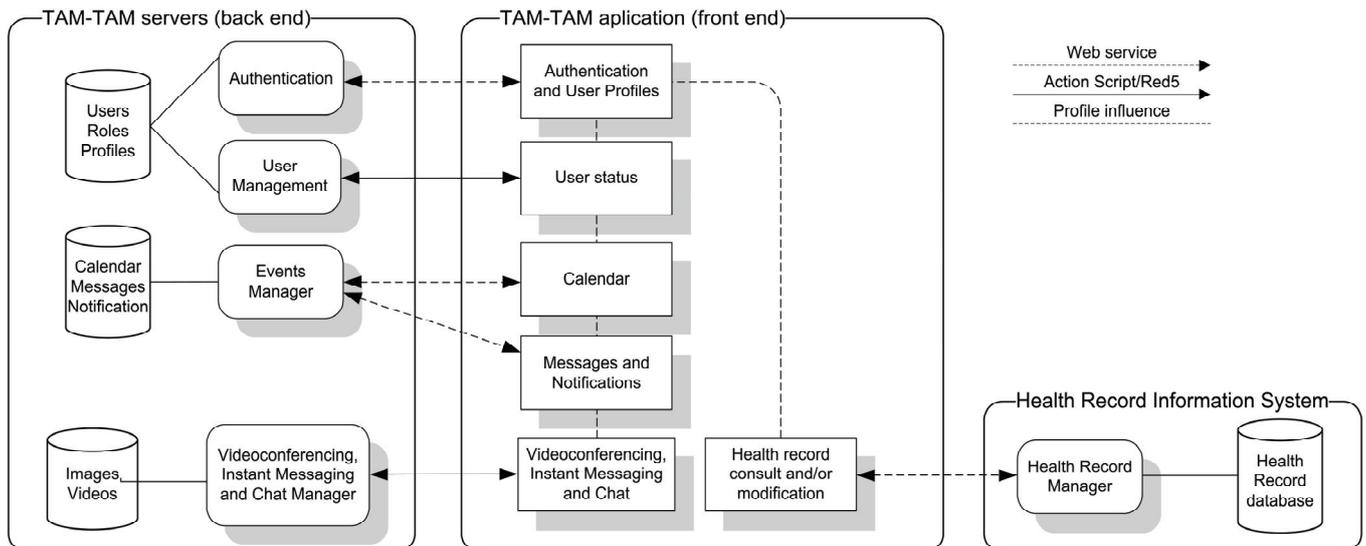


Fig. 1. TAM-TAM architecture components

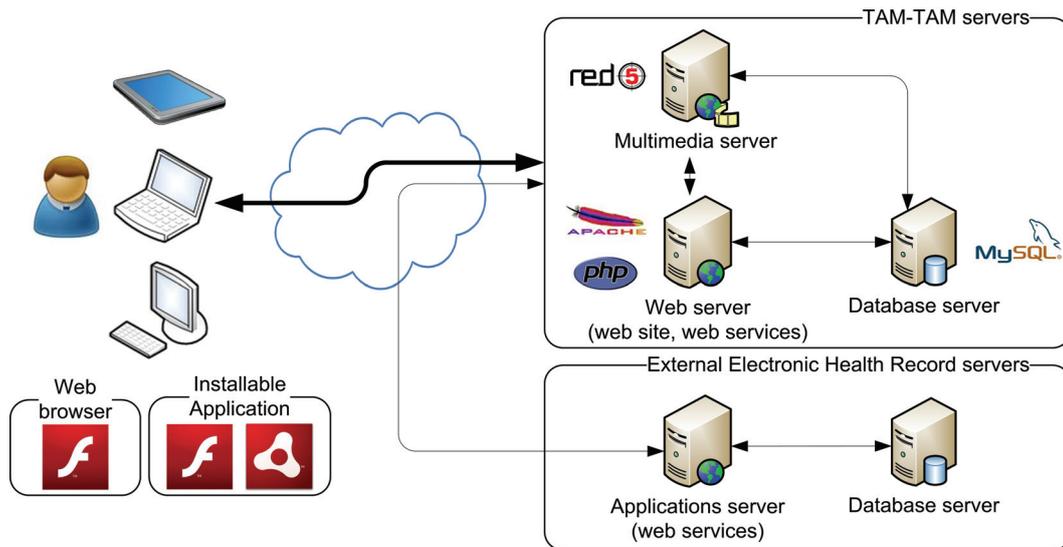


Fig. 2. TAM-TAM technologies

Moreover, the possibility of invoking web services from the AS language simplifies the extension of current functionalities and its integration with external services. This has been the approach followed to generate and consult calendar events, notifications and messages, implemented as a PHP web service. The same approach will be used to consult and modify the patient's electronic health record, presumably stored in remote Hospital Information Systems.

C. Server Technology

The multimedia server architecture is based on Red5 [12], an open source Flash server written in Java and hosted on Google Code. Red5 supports the delivery of multimedia content through the RTMP, RTMPT and RTMPS protocols, whose specification is open for the public use.

The fact that Red5 is an open source project eases the modification of the server and enables the development of cheaper and open solutions with respect to other proprietary server alternatives as Adobe Flash Media Server and Wowza.

Red5 contains an HTTP and application server that can host a custom-made servlet managing the multimedia streams and generating specific events for the connected clients to notify any change produced in the shared objects.

On the other hand, the server part also consists of an AMP server, which combines an Apache web server, a MySQL database server and PHP. Whereas the web server hosts the Flash web application, the MySQL database server is needed for the different databases regarding users, contacts and profiles and the calendar, messages and notifications.

Finally, it is important to remark that both Red5 and AMP servers are available for GNU/Linux, Windows and Mac OS X operating systems, which eases the deployment of TAM-TAM in different production environments.

V. TOWARDS MOBILE VIDEOCONFERENCING

In the last years, with the increasing development of the tablet PC market, very few companies or initiatives have taken benefit of the new capabilities provided by those devices for

developing videoconferencing applications other than video calls [13][14]. Tablet PCs have long-lasting batteries and capacitive screens that ease their use with respect to PCs and portable PCs. They can be easily transported and charged, sustained and connected to external displays by using docks. Main operating systems running on tablet PCs are iOS, Android and Windows 7, being Android the most adopted in mobile devices and tablet PCs other than the Apple iPhone and iPad.

Next, we describe the progress for bringing TAM-TAM mobile in different operating systems in the mobile context. Since TAM-TAM is to be run on the Adobe Flash Player, any operating system (OS) or device supporting Flash will be suitable for running the client application, as long as it has a microphone, a front webcam and a fixed, Wi-Fi or mobile Internet access.

Currently, the use of Adobe Flash technology enables the development of applications to be run on the browser targeting a very large part of the market, excluding iOS and some old versions of the most common OSs. In order to be run on the browser, Adobe has specific versions of the Flash Player for different OSs and browsers [15].

From our experience and tests, Flash-based videoconferencing performs well on all Windows, Linux and Mac OS X PCs, tablets and/or mobiles, but it still has some limitations when running on Android and is not compatible with iOS.

When an Adobe Flash (version 10.3 or higher) application is run in the browser on an Android 3.0 (Honeycomb) device, the execution sandbox does not allow it to access the local camera for streaming the local video and audio. While in other operating systems the Flash player asks the user for permission to get access to the local camera, in Android this feature is disabled, thus preventing the user to send his own video stream. This issue will presumably not be solved in future releases since Adobe has recently announced that the Adobe Flash player plugin for mobile browsers will not be continued.

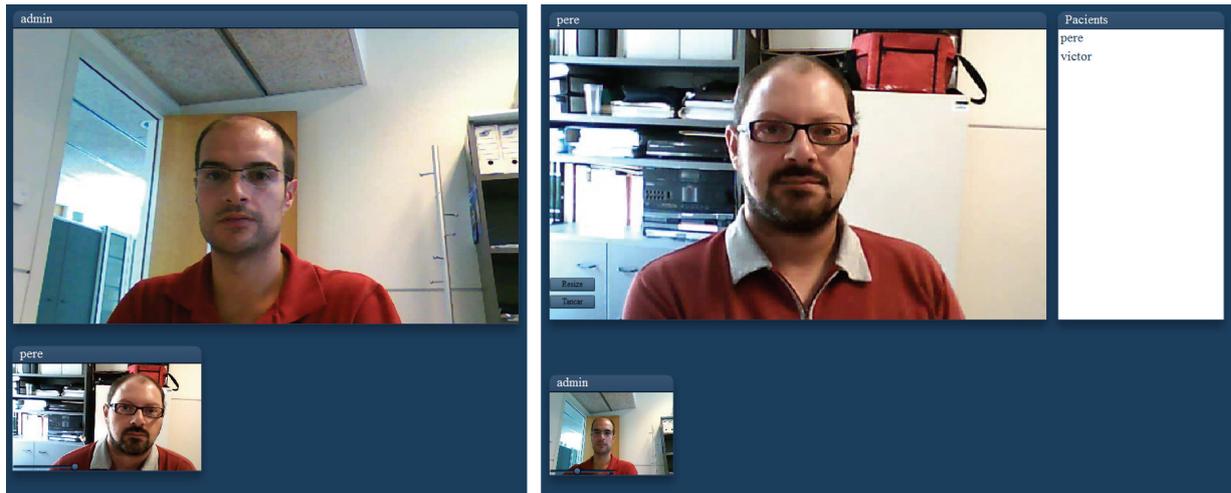


Fig. 3. TAM-TAM “Rendezvous” operation mode screenshots (left: patient view, right: professional view)

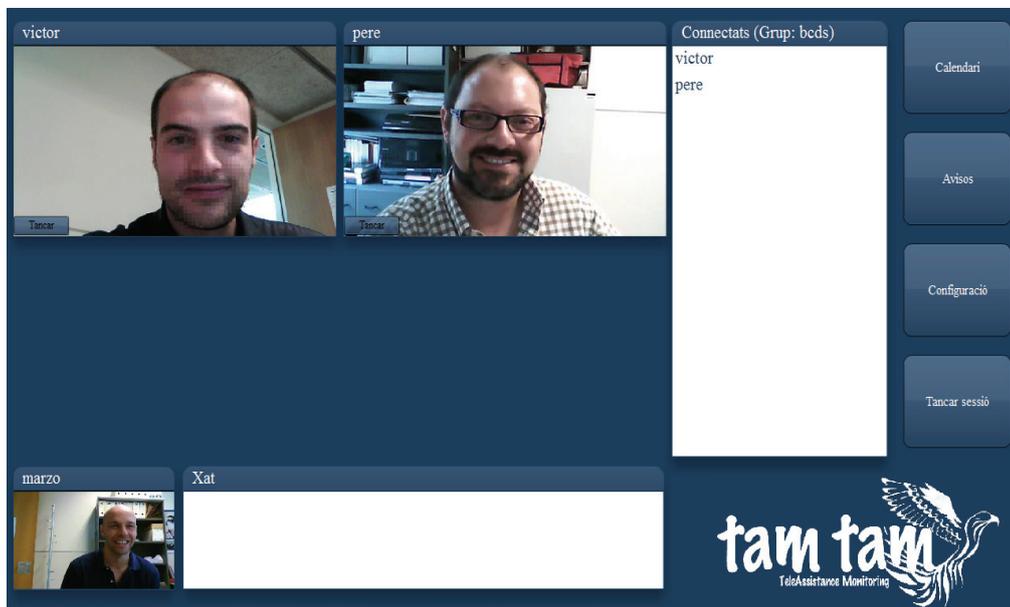


Fig. 4. TAM-TAM “Multi videoconferencing” operation mode screenshot

The solution to deal with the aforementioned limitations relies on the use of the Adobe AIR middleware, which enables to build standalone Flash-based client applications that are run like native applications. Adobe AIR is available for different operating systems, including Android and iOS. Whenever installing an AIR-based application in iOS or Android, if Adobe AIR is not installed or embedded into the application, the user will be required to do so. When developing AIR applications for Android, a manifest file needs to be configured for stating which are the local resources the application will have access to, such as the camera, microphone, contacts, etc. This step is not required for iOS applications, since applications are trusted. Whenever the user installs the AIR-based Android-enabled application, they will be asked to accept the security permissions required by the application, which, from that moment, will be capable of accessing those

resources without any further explicit authorization. Our experience and findings using Adobe AIR shows that current release (AIR 3.0) fully supports the access to the front camera in Android 3.0 or higher, which was not possible on previous releases. On the other hand, Adobe AIR is perfectly suitable for flash-based iOS videoconferencing.

A reduced version of TAM-TAM has been successfully tested as a standalone application on three tablet PCs: Acer Iconia A500 (Android 3.0), Acer Iconia W500 (Windows 7) and Apple iPad (iOS).

VI. INTUITIVE VIDEOCONFERENCING

Making videoconferencing intuitive is one of the major goals when designing medical and social applications, since they need to deal with a large diversity of users and different degrees of technology knowledge. For that purpose, TAM-

TAM has been designed to be intuitive, as in the operation modes illustrated in Fig. 3 and Fig. 4, which present different views of the rendezvous and multi videoconferencing modes implemented in TAM-TAM.

In the rendezvous operation mode, the role of the user determines the presentation and functionality being displayed to the user. On one hand, the professional has the full control over the system, since he is responsible for selecting the user to be attended from a patient's queue, controlling the video quality whenever needed and pausing or ending the consultation. The videoconference is started, paused and finalized according to the professional's decisions. On the other hand, the patient just logs into the application and waits for the professional, which will conduct the teleconsultation. When the videoconference is not active the user views notification messages like "Your doctor is online, please wait to be attended", "Your doctor is currently busy, please wait to be attended" and "Your consultation has been finalized".

In the multi videoconferencing mode, a group of users belonging to the same group interact with each other. When logged, they all can see who else in the group is already available and start videoconferencing by just a single click on the user's name or picture.

Regarding authentication, when running TAM-TAM in a browser, login information can be saved for further accesses. Additionally, when dealing with tablets, the application can operate in the same manner or even be individually bundled to a single user.

This simple user interfaces ease very much interaction for people for which technology may be an impairment. Moreover, when using tablets or mobile devices, the possibility to access videoconferencing applications by just a single touch on the screen makes the difference with respect to other type of devices.

VII. CONCLUSIONS AND FUTURE WORK

We have presented TAM-TAM functionalities, architecture and underlying technology. TAM-TAM uses the Adobe Flex framework, which enables the design of usable interfaces and provides videoconferencing support, while opening the door to the development of portable health applications on iOS and Android mobile phones and tablet PCs.

The multi videoconferencing and rendezvous operation modes of TAM-TAM are accessible for demonstration at [16], where additional videos and resources can be also found.

Currently, we have started small-scale tests with selected users who are running standard PCs in their homes. Next step will include the usage of tablet PCs. This work is being done in the context of the "ICT, socialization and active ageing" working group depending on the Girona's Council. The results are being taken into account for improving the usability of the TAM-TAM application. Additional clinical assessment as well as non-functional tests and measurements need to be carried out, including the cost-effectiveness assessment, videoconferencing performance, delay, scalability and jitter depending on the type of connectivity (WiFi, mobile, etc.).

Other relevant features that will be adopted in the future include audio and video recording, to take pictures of the patient's aspect or some types of lesions and to adopt more secure authentication mechanisms, mainly when dealing with health professionals, through the use of X.509 digital certificates. Moreover, we also foresee the integration of TAM-TAM with Hospital Information Systems, so that health professionals have access to the patient's electronic health record.

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