A health-based use case of the Connected Vitality project: the Yooom in the sterile room

Lóránt Vajda[*], András Tóth[*], Péter Hanák[*], Achilleas P. Achilleos[†], Christos Mettouris[†], George A. Papadopoulos[†], Katja Neureiter[§], Claudia Rappold[§], Christiane Moser[§], Manfred Tscheligi[§], Omar Jimenez[‡] and Robbert Smit[‡]

[*] HTK Center, Budapest University of Technology and Economics, Budapest, Hungary
E-mail(s): {vajda, toth, hanak}@emt.bme.hu

[†] SEIT Laboratory, Dept. of Computer Science, University of Cyprus, Nicosia, Cyprus
E-mail(s): {achilleas, mettour, george}@cs.ucy.ac.cy

[§] ICT&S Center, University of Salzburg, Salzburg, Austria
E-mail(s): {katja.neureiter, claudia.rappold, christiane.moser2, manfred.tscheligi}@sbg.ac.at

[‡] PresenceDisplays, Delft, Netherlands
E-mail(s): {omar, robbert.smit}@presencedisplays.com

Abstract — The social isolation of people with immunology problems after (or before) transplant operation or immunology illness (e.g. different phases of AIDS, child-cancer, etc.) is a constant issue in Europe and Worldwide that demands immediate attention. Such people are intended to use a clean/sterile room for a period of time while they might feel isolated because of their situation. In this period they cannot have any physical contact with other people, family and friends. For each person this period of time is a hard time to spend without the beloved ones. Moreover, before or after a medical intervention or an illness with possible sad outcome the psychical condition of the person is deplorable. These people, these situations need social connections, they need the family and friends, and they need the personal presence of beloved ones. In this paper a telepresence system is presented, which enables social presence and facilitates social interaction contributing to e-Inclusion of people living in clean/sterile rooms for a period of time. The solutions and facts given by this paper are supported by the Connected Vitality project in the AAL programme: the YoooM device and system.

Keywords—Social presence; e-Inclusion; human-computer interaction; multimedia systems.

I. INTRODUCTION

The modern medicine demands in special situations to develop clean/sterile rooms for the patient having immunology illnesses or after/before transplant operation when the immune system of the person is weakened for medical reasons. The period of time to stay in such isolated situation can vary from one to several months, while they might feel lonely. In this period they cannot have any direct physical contact with other people, including family and friends. For each person this is a hard time to spend without contact with beloved ones. Moreover, before or after a medical intervention or an illness with possible sad outcome the psychical condition of the person is deplorable. In the case a child needs to use the sterile room environment, it is very difficult to understand and cope with the fact that he/she cannot hug and/or kiss his/her parents.

It is needed to mention that the solution itself is developed in the AAL Program, by an international R&D research project consortium called the Connected Vitality (CVN). The technical solutions and description presented in this paper are based on the scientific dissemination activity and already published at the 12th International Conference on Telecommunications – ConTEL 2013 (Zagreb, Croatia) [1].

Nowadays, ICTs offer a variety of possibilities to communicate with family and friends (e.g., via Skype), which can be used in a clean room environment too. Existing systems allow persons to communicate with family and friends, and thus contribute in overcoming social isolation and feeling lonely. They do lack though in terms of providing the sense of social presence improving thus e-Inclusion. The term ***social presence*** has no unique definition within the literature, but it is rather continuously re-defined [2] [3]. In one of the initial definitions social presence is defined as: "*The degree to which people are perceived as 'real'*" [4]. In this work we consider social presence as "*the perceived user experience of being together when communicating and interacting over distance, enabled through a system's capabilities that allow conveying a variety of non-verbal cues such as facial expressions, postures and gestures, thus offering a realistic animation of human behaviour.*" On the other hand, e-Inclusion "*refers and aims to achieve that "no one is left behind" in enjoying the benefits of ICT. It focuses on participation of all individuals and communities in all aspects of the information society, reducing gaps in ICT usage and promotion, to overcome exclusion, improve economic performance, employment opportunities, quality of life, social participation and cohesion"* [5].

*The **C**onnected**V**itality – the Personal Telepresence **N**etwork (CVN)* project delivers a novel device and a high-quality (i.e., H264, VP8) audio and video communication system. The device is powered by a personal computer, it has two monitors (lower is touchscreen capable) positioned together at a certain angle, two high definition web cameras for a multidimensional and panoramic view of the other person including body language, a high fidelity microphone for optimal sound experience and two side-attached speakers. This system addresses the aforesaid key issues of (i) social presence and (ii) e-Inclusion by fully noticing the importance of social connections, as attested also in [6], and delivering via the use of ICTs the appropriate social activities that enable the experience of being connected, offer lifelikeness and the feeling of being part of a community. This allows creating small-scale networks that link family of the suffering person in the sterile room, offering communication capabilities and multimedia-enabled social activities of shared interest.

Moreover, the CVN system proposed for sterile room situations is using specific user interfaces (UIs) of one-button interface, which refers to providing simple and clearly comprehensible and identifiable "click-to-perform" user

actions, offering the optimal information feedback, user control and freedom. Need to mention that the CVN system and the developed device concept was mainly designed and developed to be used by older (elderly) people. All the tests, field studies and questionnaires mentioned in the present paper were therefore performed with the help of older adults and the care personnel.

The CVN system identified three main communication and activity formats: ***Meet, Club*** and ***Classroom***.

The central requirements with respect to the ***Meet*** format are outlined in the following:

1. One-to-one high quality audio/video calls enabling displaying an almost real-life sized picture of the other party, which makes it possible to experience being present within a remote communication. This could be especially good for the clean/sterile room situation.
2. An opportunity to easily contact family or friends, in order to enable regular contact.
3. Opportunities to be in contact with health care experts, seeking advice and medical guidance providing a sense of safety.

The central requirements with respect to the ***Club format*** are outlined in the following:

1. Communication between groups of people familiar to each other.
2. Possibilities to participate in a club or association, so as to engage in social activities together with others.
3. An opportunity to engage in physical and mental activities.

The central requirements with respect to the ***Classroom format*** are outlined in the following:

1. Activities that promote social interaction and enable to exchange and discuss interests (e.g., hobbies).
2. An opportunity to engage in voluntary activities (e.g., teaching).

Apart from these individual requirements, the ***key user requirement*** that was considered imperative in all three formats was the ability to enable ***social presence*** and as a result ***e-Inclusion***, which called for the provision of suitable technical capabilities that enable users to mimic real-life face-to-face interactions. This called for ***a device and a system that enriches audio and video communication by auditory and visual signals that animate real-life behaviour***; i.e., body language.

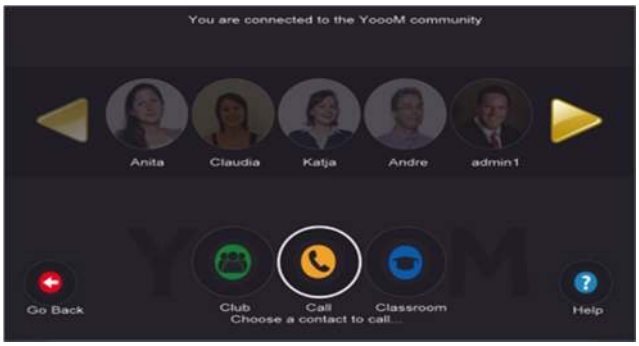

Fig. 1. One Button User Interface: The three communication formats

The formats are delivered through the implemented system modules and enabled by high-quality H.264 and VP8 implementations [9] [10], so as to enable social presence via audio and video conferencing. Fig. 1 illustrates the one button user interface that shows the implemented system modules, namely the ***Meet, Club and Classroom***. The design of the one button UI aims at providing large, clearly visible and instantly comprehensible user controls, to enable simplicity in interaction and communication.

II. Background Study

A. One-to-One and Multiparty Communication

In this project an important background research was conducted, considering projects and services in the areas of telepresence and audio/video conferencing. The aim was to identify the types of telepresence systems currently available at the market and understand the issues and challenges in the area, so as to establish a communication system required to serve the project's objectives. Although proprietary, closed-source systems were examined, these systems were excluded, since the target (even at the proposal stage) was an open source, extensible and modular system.

BigBlueButton [11], [12] is an open, web conferencing system, distributed under the GNU GPL v3. The system offers video conferencing, text-based chat, screen sharing and document sharing (e.g., presentations). It is mainly marketed as an e-learning solution (e.g., conducting online lectures in real-time). It is not a hosted service: users must run their own BigBlueButton (BBB) server and clients use their web browsers (or Flash player enabled software) to connect to the BBB service. The system uses Flash media for video conferencing and includes an integrated VoIP solution. BBB is composed of many open-source sub-components such as the "Red5" Flash media server, "MySQL" as a database, "Tomcat" as a Java Application server and many others. There also exists an active developers' community and a hosted demo service of the BBB system is available, which provides an easily accessible overview of the main features [11].

Openmeetings [13] is an open-source, web-based video-conferencing system with similar functionality to BBB; offering audio/video, text chat, screen sharing and collaboration via a whiteboard or shared documents. As with BBB the Openmeetings system uses Flash media as the medium for conferencing. Thus, clients use their own web browser to connect to the Openmeetings service (i.e., either their own service or via the hosted Openmeetings demo service). Other important projects are Opentok [14] and Scenic [15].

A new project is WebRTC [16] is also an open solution, which aims to provide an API to application developers to develop web-based real-time multimedia applications. This project is under development providing currently only the core WebRTC components. Thus, the Web API is still in an early stage of development and cannot be used at the moment for developing pure web-based applications. Therefore, this project was considered for the implementation of the YoooMRTC module, which is an extended version of WebRTC and implements one-to-one communication; i.e., the Meet format. It provides also the UIs (see Fig. 1), used by the users interacting with the CVN System. WebRTC was selected because it enables scalability, performance and flexibility because of its peer-to-peer communication model; in contrast to the others. However, WebRTC does not support multiparty communication at this stage. Hence, on the basis of

the requirement analysis [7] [8] and the background study an open-source and modular multi-party communication system was selected for the development of the Club and Classroom formats.

The following criteria were taken into account when selecting BBB over its counterparts: (i) the key advantage of the BBB system is the modular architecture that allows developers to implement new modules, in order to extend it based on their business requirements, (ii) BBB has a highly active developer community fully committed to the project, which continuously upgrades the system with new features and resolves system issues, (iii) audio and video communication critically improved since high definition audio and video codecs are currently supported (i.e., H.264 since Flash 10.3), providing echo cancellation algorithms, reduction in audio and video delays, etc. (iv) it offers a client-server architecture for exchanging and storing information between clients (session creation, messages, etc.) and (v) it can be integrated with widely accepted Content Management Systems (CMS), such as Moodle.

B. Interactive Multiuser Applications

In addition to the multimedia communication provided by the system, which aims at enabling social inclusion and social presence to avoid isolation of users living in a clean/sterile room, the system aims at fostering physical and mental social activities that keep these persons active.

On the basis of the design considerations of the CVN system (see Section C), it was considered important that the system's applications should follow the philosophy of today's mobile and tablet applications. Therefore, an essential background study was performed that involved tablet application design methods and considerations of appropriate multiplayer activities; i.e., activities performed in multi-party communication.

Activities such as movement games (e.g., handball, pong, bubble shooter) and entertaining games (e.g., taking virtual tours together via shared panoramic imagery or browsing together the Internet) was considered during the design phase of the CVN project. Thus, a selection of these activities was made and activities were designed in a way that revealed their concept and functionality.

In particular, based on evaluation results, the conclusion was made that a device is required that is able to capture a wide range of movements (push of buttons, movement of head, hands, etc.). It should also provide proper feedback on facial expressions, movements, hand gestures, promoting physical activity and entertainment, while communicating at the same time. Hence, the system needs to allow the user to focus on and be involved in the social activity. As a result, it was intended to implement interactive multiuser applications that consider the need for feedback and movement control, promoting mental and physical health.

Garrido et al. [17] point out that an intelligent application and its UI should provide two methods in order to avoid users getting bored or frustrated with a kinetic application. As shown in Fig. 2, the methods involve: (i) feedback control and (ii) level control. Feedback is an important part in the CVN system to provide an interactive experience. In specific, feedback can be presented in several ways to the user such as visual, audio, action, etc. Changhoon and Park [18] claim that several alternative types of feedback should be offered from the use of multimodal interfaces, so as to suit a higher number of people. The other key element refers to the possibility of dynamically changing the difficulty level, in order to avoid overstraining or under-challenging a user. Consequently, applications of the CVN system need to detect the difficulty users are facing at any given moment. This is performed through a challenge function, which converts an explicit game state into a value that specifies the game difficulty perceived by the user.

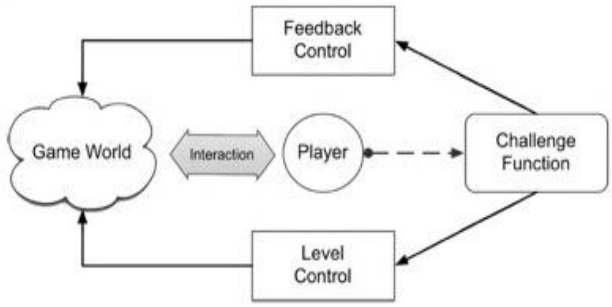

Fig. 2. Kinetic module design principle [18]

In the CVN system the following multi-user applications: (i) Bubble Shooter, (ii) Pong, (iii) Ludo, (iv) Browser Sharing and Excursion (i.e., virtual sightseeing tours).

C. Device Physical and User Perspective

Based on the aforementioned results of the initial user-oriented research [7] [8], we concluded that a social presence system aiming to provide enriched physical experience and social interaction requires focusing on the following key aspects:

1. Enrich media by auditory and visual cues.
2. Mimic face to face communication.
3. Provide realistic animation of human behaviour.

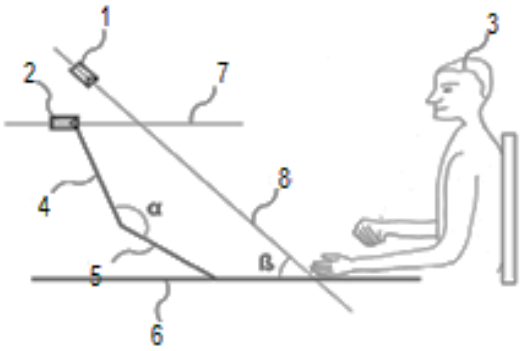

Fig. 3. The design of the device – enabling social presence

In order to deliver a system that supports the aforesaid critical aspects, it was deemed important to manufacture a novel device. Fig. 3 presents the design of the new device, which shows the positioning of two webcams on the top of the device. The primary webcam (2) provides a view of the upper part of the user sitting in front of the device; i.e., the face view (3). The second webcam (1) provides a view of the user's acting perspective (8), which shows user's activity; e.g., writing. Moreover, the two screens of the device (4, 5) are arranged at an angle of $\alpha = 135^{o}$, enabling the feeling of presence displaying the communicating user almost life-sized. Thus, a digitally shared face view and acting area is enabled through the cameras positioning and allows the transportation of a variety of auditory and visual cues (e.g., face expressions, gestures), improving natural communication and mutual

understanding, providing a realistic animation of human behaviour; e.g., see Fig. 5.

III. CVN: A SOCIAL PRESENCE SYSTEM

A. System Architecture

The CVN system architecture is defined on the basis of a hybrid communication model, which combines the client-server and the peer-to-peer communication models. This hybrid model is defined as a result of the study and analysis of existing multimedia communication systems (e.g., WebRTC, BBB, OpenMeetings), in an effort to exploit, modify or extend their technical features and resolve any weaknesses in order to support the objectives of the CVN project. The hybrid communication model serves as the basis for the definition and implementation of the system modules. It also allows addressing quality, scalability and performance requirements for the three key categories of communication formats. These categories refer to the one-to-one, one-to-many and many-to-many communication formats, which are delivered by the implemented CVN system modules.

Fig. 4 presents the CVN system architecture that includes the three modules developed by adapting and extending the open WebRTC and BBB projects. As part of the Club module, the Kinetic sub-module implements the interactive multiuser applications enabling the users' physical and social activities.

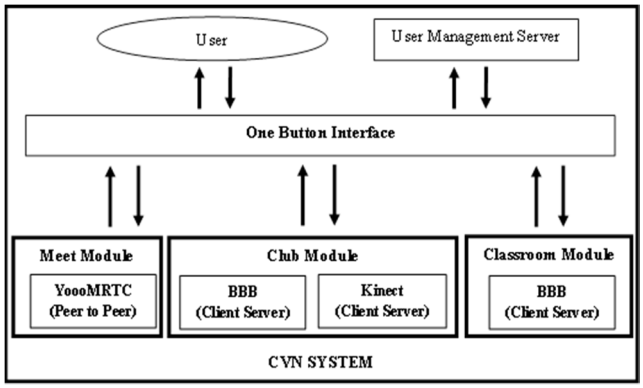

Fig. 4. The CVN System Architecture

The CVN system is implemented as a Windows application using the C and C++ programming languages. This was performed since the technical analysis revealed a straightforward approach in integrating the desktop-based ***Meet*** module (i.e., WebRTC based) with the web-based ***Club*** and ***Classroom*** modules. The Meet module main user interface allows launching an MSDN WebBrowser control that hosts the Club or the Classroom web-based module within the C++ application. The system's main interface is tightly coupled with the Meet module, while it is loosely coupled with the Club and Classroom modules. For the Club and Classroom modules the integration is declared as loosely coupled, since when the WebBrowser control is invoked the handle is passed to the implementation of the web-based modules. This means that the WebBrowser control hosts the web-based modules but the functionality of multiparty communication and the interactive multiuser applications are executed via the Flash implementation. The following subsection provides details on CVN system modules implementation.

B. System Developments

B1. Meet Module

The one-to-one communication format is implemented by extending the WebRTC technology [9]. The WebRTC-enabled module offers quality, performance and scalability to the CVN system. It conforms to the peer-to-peer communication model, the implementation of the VP8 high-quality video codec and the iSAC and iLBC high-quality audio codecs. The WebRTC libraries that could be embedded into well-known browsers are currently in the development stage. Hence, the ***Meet module*** illustrated in Fig. 5 was implemented as a C++ application.

Fig. 5. The Meet Communication Format

B2. Club Module

The ***Club*** module (i.e., many-to-many communication format) is realised by two sub-activities that enhance the communication and social interaction of possible clean/sterile room users with their family and friends. Specifically, the upper screen of the YoooM device hosts the application that facilitates multi-party communication, while on the lower touchscreen the users are provided with interactive multi-user applications (e.g., Browser Sharing, Pong). While interacting with the communication partners on the lower screen, social presence is supported through the upper screen, providing a realistic animation of the users' behaviour. This simulates a real-life situation by enriching ICT-based communication and interaction with auditory and visual cues, mimicking real-life face-to-face communication.

The BBB Flash-based, Red5 media server was modified and extended in order to support many-to-many, high-quality audio/video communication in the Club format. Initial implementation involved enabling H.264 support, since this feature was in beta phase and not enabled by default. The Flash official release that supported H.264 was planned to be released at a later stage. Thus, the needed functionality was implemented, so as to enable the compilation and testing with high-quality audio and video. The next development step involved the implementation of the functionality for streaming and displaying two adjacent streams per participant, which is not provided by BBB, so as to enable the feeling of social presence. Fig. 6 illustrates on the upper screen the extended functionality of the BBB media server, which displays four participants that are communicating with high-quality audio and video, while at the same time they interact by navigating and sightseeing different places using the synchronized view of the same map.

Initial tests were also performed to determine the optimal number of participants in a communication session, which

were limited to four participants for the Club format and five participants for the Classroom format. This decision was a result of the technical tests (e.g. latency, packet loss, audio-video synchronisation) conducted, so as to provide a smooth communication experience that resembles near real-life conditions, taking also into consideration UI design. For the experience it was deemed essential to avoid video streams delays, while at the same time keeping the voice communication quality at an optimal level. Consequently, the bandwidth and quality parameters were fine-tuned via the implementation based on the results of several testing sessions.

Fig. 6. The Club Communication Format

Overall, the principal goal was to define the accurate balance between audio and video quality and bandwidth consumption. For instance, providing high quality video streams during the testing revealed the high consumption of bandwidth, which typically caused problems such as audio delays, blocking of the video streams, stalling and synchronization issues. In contrast, setting parameters to low quality provided pixelated video streams but limited greatly bandwidth problems. Thus, the process aimed at testing and defining the optimal settings for the purposes of the CVN system, which resulted to tuning these settings so as to use the maximum bandwidth available for streaming two videos feeds with 87% quality in terms of the H.264 standard, at a frame rate of 15fps.

The next stage involved the implementation of the Club format UI client functionality and the functionality at the BBB server side that allows detecting if the Club format was selected. This enables management of the video windows, when clients log in and out of an activity. Finally, the C++ application was implemented that hosts two WebBrowser controls of the MSDN library. This was critical in order to permit executing the multi-party audio and video call as a Flash-based application on the upper WebBrowser control, while loading and running on the lower WebBrowser control one of the multi-user, Flash-based interactive social applications. As aforementioned, the WebBrowser application allowed integrating the Club and Classroom formats with the Meet format, and allowed to take advantage of the entire UI space of the device.

The interactive multiuser social applications of the Club format were implemented as an individual Kinetic sub-module based on the modular architecture of the CVN system (see Fig. 4). This sub-module is also implemented using Flash-based technologies on the client-side, which communicates and exchanges information with the socket server over the network. At the server, the required management actions are implemented (e.g., user, room management) that facilitate the coordination of multiuser interactive social activities. The developed applications of the Kinetic sub-module are presented as follows.

Ludo, Balloon Shooter and Pong

If children are in the view, games are an important point of the system. In the CVN system games are also developed and described in this section. Need to mention that these developed games are multiuser/multiplayer applications extended with video-conferencing solution to achieve the aforementioned presence feeling.

The Ludo[1], Balloon Shooter and Pong games are developed in the form of Flash-based client applications that need to be loaded via a web browser. Due to Flash security restrictions (i.e., file system access permissions) it was required to store the games executable and all assets on the server, from where they can be accessed and downloaded by the client when the Club module loads. In particular, each game is downloaded and loaded via an URL that includes the location of the Flash-based media application (i.e., compiled SWF file) and specific start-up parameters. These parameters aid server actions such as determining the room the user is joining, the username needed for updating the UI of other users when a new user joins, etc. In the integrated CVN system each game is loaded in the second lower WebBrowser control of the implemented C++ application. Fig. 7 shows the Flash multimedia communication loaded on the upper control and the Balloon Shooter game on the lower control.

Fig. 7. The Club Format – Balloon Shooter Application

Browser Sharing and Excursion

This application is also based on the same client-server architecture as the games. It is executed on the lower WebBrowser control and has practically two modes: (i) it

[1] Ludo has been developed by a sub-contracted team led by V. Páli in Budapest.

allows navigating and viewing the same synchronized webpages with other users in the session and (ii) it allows navigating and viewing the same synchronized view of a map with other users, simulating a real-life sightseeing in the form of a virtual tour. In specific, a transparent layer is implemented on top of the WebBrowser control, which listens for click events generated by the lower touchscreen (e.g., clicking a hyperlink, clicking the implemented zoom and scroll buttons) and broadcasts through the server the events to all client applications in the current session. This enables users in a specific virtual room to navigate the same webpages or watch the same places on a map. The application includes parameters that aid server actions, such as determining the room the user is joining.

B3. Classroom Module

Finally, the implementation of the ***Classroom*** module (i.e., one-to-many communication) is considering one of the room participants in each session as the "teacher", and thus in a central position, while the rest of the participants and placed in the four corners of the lower touchscreen (Fig. 8). This participant is playing a key role in the session and is positioned enlarged in the centre, so as to be clearly visible by all other participants. Hence, one user is considered as the coordinator of the communication session, who teaches other users, e.g., how to knit. The central enlarged position of the "teacher" is necessary in order to enable a clear understanding of what the lead participant is showing, so that participants can follow the activity.

Fig. 8. The Classroom Format – CVN Demo at EU Parliament

Therefore, in terms of the developments it was critical to implement the functionality that allows identifying at the server side that the classroom format is selected and be able to distinguish between the "teacher" and "students" in a session. This allows setting accordingly the video stream resolutions and the position of the UI windows. In addition, during the HCI and UI experts' evaluation of the initial version of the CVN system, it was considered important to provide the capability to resize "student" participants and actively move them directly to the centre position. This allowed observing and having a clear view of a specific participant at any point, which is useful since the "teacher" might want to observe if a "student" is performing the activity correctly. It is also very important for other "students" to be able to look clearly at another participant when speaking or showing something to the rest of the group. Hence, a participant is able to double-click using the touchscreen on another user to resize and position that participant in the centre. This action is only affecting and changing the view of the user that initiated it, and does not affect the views of other users in the session.

IV. User-Oriented Evaluation Of The CVN System

During the whole development process, the system was iteratively evaluated together with potential end users and HCI experts, in order to actually meet the target group's needs. The evaluation steps and the most important insights on the results are outlined in the next paragraphs.

The major goal within the first user studies was to gain preliminary insights to what extent the first prototype of the device actually meets the target group's needs. Within workshops participants got the opportunity to try out the Meet format and first ideas on the activities the system provides (e.g., Club games, Reading a book using the Classroom format) were presented. The majority of participants appreciated the different formats and activities, especially the opportunity for the one-to-many communication, enabling, e.g., to participate in courses. With respect to social presence and as a result e-Inclusion, the majority of participants were impressed by the system quality, allowing an almost natural conversation and pointed out that it provides a great sense of realism.

Based on the results, the technical implementation of the activities was performed. In a second step, focusing more on improving the usability of the system, a heuristic evaluation was carried out. Ten experts were invited: four HCI researchers with general knowledge on usability, four experts working in the area of adult education (i.e. teaching them in working with computers) and two experts working in the care area. This evaluation revealed a variety of different usability problems essentially concerning consistency and feedback issues. Experts mainly advised to highlight clearly important UI areas, provide explicit and clear feedback for all actions. Additionally, the SUS[2] (system usability scale) was used in order to assess effectiveness, efficiency and satisfaction when operating the system. A score of 63 indicated that users accept the system but that there is a tendency that they did not like it, making it necessary to improve usability aspects.

Within the additional development process the identified problems were addressed. Lab tests were carried out, so as to bring in again the user perspective. The major goal was to evaluate the usability and gain insights into end users' experiences and attitudes towards the system, as well as gather information about likes, dislikes and suggestions for improvements. Overall 30 possible users took part in the study. The results indicate that social presence was rated high by almost all participants and interviews at the end of the study showed that most of them especially appreciated communicating via the Meet format, pointing out that it provides a great sense of realism.

With respect to the usability, the SUS score substantially increased from 63 to a score of 78 indicating that participants accept now the system and that there is a tendency that they like the system. Nevertheless, a variety of problems were found and needed to be addressed before the field tests could

[2] A score from 80-100 indicates that users like the system from 60-79 that they accept the system and a score below 60 indicates that the user does not like the system.

take place, in order to actually ensure that participants will use the CVN system and that the system will adhere to their expectations and to the need to provide easily usable, comprehensible and interactive social activities. Most of the problems concerned the operation of the Club format. Participants, for example, were not sure how to play the games, how to use browser sharing and what to do if system fails. Therefore, help functions were included, feedback on the system status was further improved and remedial actions were implemented to bring the system to a stable state (e.g., in the rare occasion of system failure).

Within the iterative evaluation process a second heuristic evaluation was conducted. Although a variety of problems were addressed, this expert evaluation revealed further usability problems. Several issues concerned the information architecture, user control and freedom. Experts pointed out that feedback on the system status was lacking or even missing (e.g., when the Internet connection breaks or when a user is not available). Again these issues were addressed and resolved in the development process.

V. Conclusion And Next Steps

Summing up, as described in the abstract and introduction, there is a clear need for people using sterile room scenarios to have an ICT based solution which gives possibility to communicate with family and friends. Moreover, besides simple communication methods, provision of the sense of social presence improving e-Inclusion is welcomed.

The CVN system and the developed YoooM device presented in this paper provides an opportunity to interact over distance while supporting at the same time social presence (i.e., the experience of "being together"). In this way it allows addressing e-Inclusion key aspects like the participation of users in communities, reducing gaps in ICT usage and promotion, contributing to their wellbeing and quality of life and achieving the "no one is left behind" vision by fully exploiting ICT benefits. Overall, the CVN system can offer a solution for people in sterile/clean room who face restrictions (e.g., in mobility) and thus, might be in danger of getting isolated.

At this point next steps need to be taken by contacting specialists in the field to develop a sterilization method of the YoooM device developed by the CVN system. The actual device consists of a personal computer, two monitors, microphone, two HD camera and speakers in a special metallic case. As it is now it is hard to sterilize and to be used in sterile/clean environment.

One option to control the YoooM device is the usage of gesture control. With this mode it is not needed any physical contact, which can reduce the chances of any infections, therefore the need of complex sterilization method for a full clean device is not needed.

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