
Towards Building Augmented Social Cyber Physical Systems for Pediatric Patients

Jorge Montaner-Marco

Polytechnic University of
València
València, Spain
jormonm5@dsic.upv.es

Javier Jaén

Polytechnic University of
València
València, Spain
fjaen@upv.es

Elena Navarro

University of Castilla-La
Mancha
Albacete, Spain
Elena.Navarro@uclm.es

Patricia Pons

Instituto Tecnológico de
Informática
Valencia, Spain
ppons@iti.es

Abstract

Hospitalization is usually a difficult experience for many children, as there are many situations that might cause them fear and anxiety. Besides, another problem these pediatric patients face is isolation, not being able to interact with other people while in hospital. In this context, children need the right tools that enable them to establish social bounds with other hospitalized

children, hospital teachers, physicians and nurses making their hospitalization a much friendlier experience. In this respect we are convinced that converting the physical hospital environment into an augmented cyber-physical world where social interactions are promoted could have a great impact on children's psychological wellbeing. In this position paper we propose how the use of Augmented Reality and gamification techniques could play an important role in the implementation of a Cyber-Physical Social System to reduce anxiety and isolation experienced by pediatric patients. We believe this scenario opens big opportunities for AR in the future, but also raises many problems that must be addressed in many areas: psychology, technology, privacy and ethics, among others, that need the participation and perspectives of experts from multiple disciplines.

Author Keywords

Pediatric social apps; Cyber-Physical Social Systems, Human-computer interaction; Augmented reality; Computer Supported Collaborative Work.

CSS Concepts

●**Human-centered computing**
~**Collaborative and social computing**
~**Empirical studies in collaborative and social computing**

Introduction

Hospitalization is usually a difficult experience for many children, as there are many situations that might cause them fear and anxiety. In this respect, many gamification approaches have been proposed in the past to address this problem as we have analyzed in a previous systematic review [3]. However, as we

concluded in this review, only a small part of the gaming technologies developed for pediatric patients had socialization as their goal, as most of them were produced as a distraction tool for medical procedures or to help with motivation for treatments or rehabilitation. We have developed in the past some gamification environments to improve socialization by involving multiple hospitalized children on collaborative activities. These environments consider the social dimension of the hospital internment period, an aspect that could be improved [2] and that brings benefits to their recovery process [6]. Three examples of this approach are Tangibot [5], a co-located gaming activity designed to foster socialization through coordination by means of an interactive robot that must be controlled co-jointly to solve a problem; HabitApp [1], a biological observation tool that allows children to participate in co-located observation activities of animals located at remote places (zoos and wildlife environments), this tool has been evaluated by oncological patients and their caregivers and by hemodialysis patients who spend many hours together in hemodialysis rooms; and ConectaDogs [7], a tool for hospitalized children to play with animals located at a remote dog daycare facility by means of a camera and a remote-controlled robot. These examples have resulted in significant benefits in the psychological well-being of hospitalized children but require the synchronous physical co-location of participants and leave aside other stakeholders such as nurses, physicians and hospital teachers who are not involved in the ludo-therapy activities. A different promising approach is that of converting any place, person or object in the physical hospital space to be augmented with digital gamified elements that support or motivate collaboration (synchronous or asynchronous, co-located or not) among different

hospital stakeholders. Our hypothesis is that the use of such an augmented space (an example of Cyber-Physical Social System as defined in [8]) can improve the psychological state of pediatric patients by helping them to establish social bonds with other stakeholders (children, nurses, physicians and teachers) who are present in the hospital.

How do our ideas relate to the workshop's aspects?

We believe that the use of Augmented Reality Cyber-Physical-Social Systems (ARCPSS) can provide a huge benefit to the youngest pediatric patients, as the hospital (which is their physical space for long periods of time) can become an augmented space offering many new opportunities to play and socialize that can have an important and positive emotional impact. In this context there are many challenges to be faced that are related to the workshop's aspects including how hospitalized children can create digital content and augment the available physical objects, spaces and persons by means of easy to use editing tools; what gamification strategies are most effective to foster socialization in this pediatric context; how other stakeholders who see the physical space as a workplace can be motivated to use it as a ludo-therapy space in which they are active participants; how adaptation mechanisms can be implemented in the ARCPSS so that the augmented space is tailored to the specific needs of each user; what social UX quality metrics should be used to evaluate the effectiveness of the proposed AR spaces; what architectural designs should these applications follow to accommodate requirements such as scalability, flexibility and maintainability; and, finally, what are the devices that are best suited to be used by young children and people in their workplace to

have a non-intrusive AR experience. We would like to discuss with other practitioners these and other aspects that may also be challenging in other domain areas.

What role does social AR play in face-to-face interactions?

The use of AR in face-to-face situations opens many opportunities. For instance, in our context AR may be used in face to face interactions involving physicians and children where the pediatric patients may access the digitally augmented space of physicians to know more about their interests, work practices, or engage with them in short AR gamified experiences before a clinical intervention to reduce children's anxiety levels.

In other contexts, ARCPSS would be a great tool for group gaming, with new, more motivating games that will complement those that we already use with physical elements. Playing with friends, acquaintances or family is usually a funny experience, but is limited to the physical possibilities of the space in which the activity takes place. It is easy to imagine a group of people playing a board game while they are meeting in someone's home, for instance, but it is even easier to imagine them playing in scenarios in which they have to use social abilities. This is especially interesting with young people who may be affected by bullying [4], isolation or forced immersion in unwelcoming environments, as is the case of the hospital's environment who would need tools to learn emotional intelligence features.

But it is not only in the context of playing in which AR can improve the social aspect. In environments such as the workplace or commercial spaces there are possibilities in which the use of AR could be useful. For

instance, in the workplace, the usage of virtual elements integrated in the environment during meetings or during the whole workday in general could make the environment more friendly and improve interpersonal relationships, while, in the commercial areas, it could help making the experience less tedious when physically going to the shops, which could also help with the sales numbers. We also envision in the hospital context that ARCPSS can be used to motivate adults to collaborate to produce digital content that is engaging for children and, thus, motivate adults to socialize themselves in the hospital workplace.

There are many other possible uses. For instance, someone could use AR to enlarge and decorate themselves digitally, so that anyone who meets them could know about their interests or personality, which could help meeting new people. A situation could be someone using a digital distinctive from a hobby he or she has, who walks in front of another person who has a similar interest and that could trigger casual conversation (this would be of application as well in our pediatric hospitalization context).

In the specific case of our research lines, the use of AR technologies with a social approach could help to reduce the isolation of pediatric patients thanks to being able to meet other people in the hospital, offering both co-located collaborative games and personal-amplification tools like the ones described above that could help fostering face-to-face interactions of the children both with other patients or with hospital staff.

Thinking big: the future of social AR

One of the biggest problems in the current state of AR technology is that its implementation is mostly done

through mobile devices. Although there have been recent developments in what should be the next AR generation systems (that is, using devices such as the HoloLens 2), the use of these devices is not still widely extended.

However, in the future, the maximum potential of AR could be achieved when all human sensory capacities can be augmented. This could completely change the way we have to socially relate with our environment and with each other. With a technology that allowed us to do this by fully emulating a person, and doing this pervasively anywhere or at any time, our social model could completely change. Even the possibility of “being” with people who are no longer with us through virtual representations in a physical space could be a reality.

Regarding hospital pediatric patients, they might even have a normal relation with their usual outside-the-hospital classmates and “be” with them while they are in the hospital receiving treatment. Certainly, this is nowadays completely utopic but surely the upcoming technological advancements will make this possible in the future.

The questions: ethical aspects, privacy, or social restrictions

This future, however, brings new problems that must be resolved in many different areas. Of course, there are many technological questions that must be resolved, but there are also social concerns regarding privacy, security and ethical aspects.

For instance, augmenting people involves getting data from them, and not only personal data, but also monitoring physical information as well. This raises

privacy and security concerns that will have to be addressed.

There are ethical questions as well related to the ownership of the digital information that is shared in ARCPSS: e.g. if a person passed away, would it be right to interact with the virtual representation of that person or with his/her augmented spaces? Would it be right that there is a virtual representation of that person? How much information should people give about themselves to achieve that representation?

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