Smart Avatars: using avatars to interact with objects

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ABSTRACT
This paper focuses on a new interaction system named Smart Avatars, which is based on a mixed reality environment containing virtual avatars as a medium for the interaction between the user and the smart objects of the environment. As a prototype, we introduce Flexo. With Flexo we investigate the virtues and obstacles that occur when we use an augmented reality (AR) avatar to interact with a simple smart object. Then, we conclude with the advantages and disadvantages of this kind of interaction in order to create richer interactions in future prototypes.

Author Keywords
Mixed Reality, Augmented Reality, Internet of things

General Terms
Human Factors; Design.

INTRODUCTION
Internet connection provides us a new way to access and to interact with real and tangible objects. This technology has renamed these objects as smart objects. Taking advantage of this technology we present an application that allows these smart objects to self-explain their functions. In this paper we show a way to access smart objects through a new augmented reality (AR) interface called smart avatar.

When we look for relevant projects that use AR as an interface to control Smart Objects, we have to take a look to CRISTAL [11], a project that goes a step further in this kind of interaction. In this project a collaborative interactive tabletop system is presented as a way to control all kinds of digital devices through a virtually augmented image of the surrounding environment. In this project the video stream becomes a form of interaction between the virtual devices that are connected to the network.

CHI'12, May 5–10, 2012, Austin, Texas, USA.

Another project that is related to the intelligence of the physical objects is Augmenting Sticky Notes [9]. In this project, the authors explored the way to enrich the experience of using the ubiquitous physical sticky-notes by augmenting its information and linking this to the digital world.

An improvement in the ubiquitous computing is the introduction of AR as an interface to interact with digital devices. A significant contribution is done in [7] where a single controller that uses an augmented reality (AR) interface is explored as a way to interact with several different smart objects connected to the home network. Further work would be evaluating the benefits of having real-time feedback on AR applications [8].

Finally, parallel to this investigation, Huen has been working on how to create smarter objects [6]. Through an AR application, the user can amplify the interaction of the surrounding smart objects. Also, using this AR application, the user is able to connect different smart objects. As an example, a speaker is shown with a simple interaction: go to previous or next track, and raise or reduce the volume. When the user points with the mobile device to the speaker and the AR is displayed, then an enhanced control layer appears and the user is able to add the tracks that he wants to listen to. In addition, if the user drags and drops this speaker in the display to the nearest speaker, this one will reproduce the same track that the first speaker is playing. In further steps, Huen has implemented Reality Editor [5], a system that it is able to edit the behavior and interfaces of smart objects, using an AR interface over this.

In this work we introduce an interaction system that could go further in helping to advance in the connection between tangible and digital objects. Our goal is to explore how digital information can modify the real world (and vice versa) in order to design interfaces that create new narratives between the user and technology. Here we present a digital interface which is strongly linked to a real object. The visual representation of this interface is an avatar and it only appears through a tablet device when the real object is present. Furthermore, the avatar is capable of changing the state of the object. Obviously this object must be a smart object and it needs to be connected to the tablet. This avatar is the essential part of

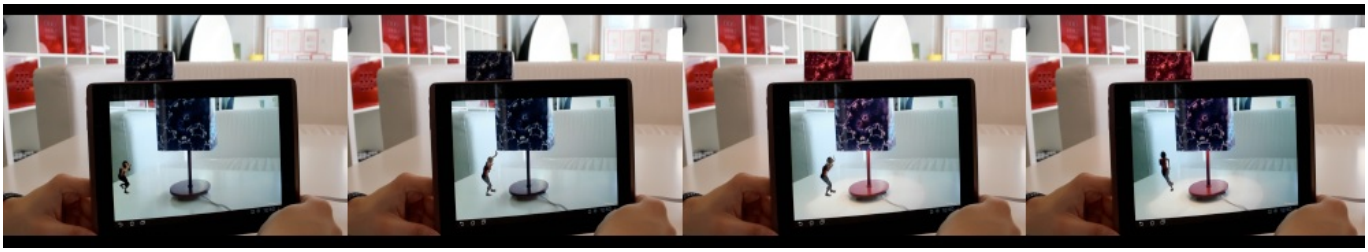

Figure 1. Sequence where a smart avatar comes close to the lamp and turns it on.

a new interface between users and real objects called Smart Avatars.

INTERACTION SYSTEM

Smart Avatars is a concept based on a mixed reality environment created using augmented reality. From the emergence of augmented reality as a new interface to interact with our environment, experts have been made great efforts to find new ways of introducing virtual data into the real world as a way of increasing the available information of tangible elements. Smart Avatars use augmented reality to create a new way of intuitive communication between the user and these tangible elements. With the mixed reality virtual objects are merged with physical objects generating a transversal environment where the virtual and the real coexist in the same layer. With this new type of interface, the advantages of the two worlds can be exploited to design improved interactions.

This interface allows the user to interact with the smart object through an augmented reality dynamic interface and can configure the functionalities of the object at each moment based on his own needs. The aim of Smart Avatars is to redefine the interfaces for these new smart objects that can be considered as robotic entities with a new approach which aims to bring down the barriers between people and complex technology. There is no longer the need to have hundreds of input devices to interact with them because every augmented reality interface will appear when needed.

Figure 2. Flexo prototype.

The interface contains human-like avatars that create a closer relation between the user and the smart object. Different research [2, 1] has shown that humans can solve problems easily when they are driven by emotions. Moreover, other researches have shown the positive value of the use of emotionally expressive avatars in virtual environments [3]. With Smart Avatars, this new narrative included in the interaction increases the implication of the user with the system, as it is generating a direct influence into user emotions.

In addition, the use of a mobile device to display this augmented reality becomes another key aspect for the hardware performance. All the operations are computed in the mobile device; hence there is no need for a high computational cost hardware. This is the fact that makes Smart Avatars a wholly multiplatform concept. Besides, being connected to the cloud at any time allows the smart object to send data and receive data whenever it is needed.

As a first example, we have developed a prototype named Flexo. Flexo applies the concept of Smart Avatars to a basic smart object, a lamp (Figure 2). Using a tablet, the user can turn on and off the lamp through the augmented reality displayed on the device. When the user performs an action (Figure 1), a virtual avatar appears next to the lamp and acts as the medium to execute that action. In this case, the avatar approaches the lamp and turns it on. The avatar becomes the interface between the user and the smart object. The user gets more involved in the interaction as the expressive avatar used to turn on the light creates this new narrative that captures the users attention. Flexo uses an extremely basic smart object with only two states. However, the idea is to use this concept into more complex smart objects where the interaction will be more intuitive and more natural than using a simple graphic layout using buttons. Moreover an interactive control of the avatar [4] could be implemented in order to interact with different smart objects.

IMPLEMENTATION

The Flexo prototype has passed through three different development stages. The first stage was to hack the lamp so that it would be recognized by a smartphone since the device would display augmented reality content. To do so, we designed a squared lampshade that had an image target in each face (Figure 3). To recognize and track the features of the image targets we used Vuforia [10].

The second stage was to give a special character to the augmented reality content. To do so, we created a 3D animated avatar. To animate the avatar in the most real way, we recorded the movement of a person using Motion Capture. We mapped the animation to the 3D model so the model performs the same actions as the actor. Throughout Unity [12] we unified the power of the rendering of a game engine for 3D content with Vuforia augmented reality.

The third stage was to make the lamp smart enough to communicate with the smartphone or the tablet device. One of our goals was to provide an easy wireless connectivity to our object. After evaluating different technologies, we decided that the Wi-Fi was the best solution - we can have a direct connection to Internet without using an intermediate device such a Bluetooth or Zigbee. Wi-fi is a versatile technology because it allows the object to connect to different devices. In order to have the wireless control of turning on/off the light, we designed an electronic circuit that is connected to a microcontroller. Through the microcontroller we can deactivate a 220 V relay that cutts off the power supply, and as a consequence, the light turns off. To achieve the control of that system and provide reliable transmission, we have created a TCP/IP communication socket to the mobile device in charge to send the state of the light. In this way, we are displaying augmented reality content according to the information we are receiving.

DISCUSSION AND FUTURE WORK

Sometimes the connection between smart objects and users must be enhanced in order to achieve a reliable experience. In this work we have developed a new digital interface that permits the interaction of smart objects through an avatar. Although part of this interaction is displayed on a mobile device a deep spatially awareness is perceived. Linking Internet of things and AR Smart Avatars go beyond the mobile display and the graphical layout of buttons.

With this new approach, the connection between the user and the smart object becomes deeper and more affective. The user gets emotionally involved in the interaction, as the medium for it is a human-like avatar. As a result, a better user experience is achieved.

This case study focuses on a lamp as the smart object to interact with. This one has been chosen as a simple object to make the concept more understandable. However, this idea has been thought out to be applied to more complex objects, where the user needs some kind of help to understand their functionalities.

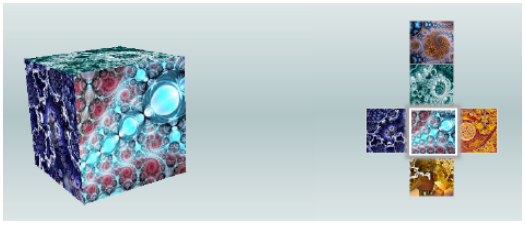

Figure 3. 3D marker used as lampshade.

Some aspects about tangibility could be improved in this kind of interface. Custom-made prototypes including some sensors within them can provide to Smart Avatars a tangible component. In this way users get more involved with smart objects.

ACKNOWLEDGMENTS

The authors would like to thank to Marc Expósito for recording the video that accompanies this paper. (https://vimeo.com/82336816)

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