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Humorous and Playful Social Interactions in Augmented Reality[1]

1 Introduction

We can't live without play and humor. We smile and laugh during our daily activities and interactions, whether we are at home, traveling, or in our workplace. When we are alone and experience or remember a particular humorous event we enjoy it, maybe not necessarily with an explicitly displayed genuine smile or laugh, but certainly with a kind of inner smile or laugh that is produced from the same felt comic amusement emotion that we experience with a real humorous event. Instead of real and experienced humorous events, we can also consider events that in itself are not humorous at all, but in our imagination, we can give such an event a twist that makes it humorous. This 'twist' does not affect the real situation, it happens in our mind. We imagine someone in front of us slipping on a banana peel, we come aware that something happening in front of us can be given an ambiguous or incongruent interpretation, probably leading to a humorous event. This imagined humorous event does not have to happen after being imagined, it is sufficient that we can imagine it to happen.

Current humor research does not cover such situations. Humor research usually focuses on jokes. That is short verbal descriptions of events that turn from a stereotypical interpretation of such an event to a contrasting and unexpected interpretation. This unexpected view arises because the listener has been fed with information that allows different interpretations, with cues that support a wrong interpretation, and in a punchline, you are made aware of a contrasting but acceptable interpretation that surprises and causes a smile or a laugh. An incongruity is detected and accepted. Laughter and smiles are not always caused by humorous events. There can be social reasons to laugh or smile. Hence, from laughter and smiles, we cannot conclude that there was an anticipated, imagined, or real humorous event. Neither can we conclude that any incongruity will be considered humorous. An incongruity can be threatening or confusing as well. Nevertheless, in humor theory, it is usually assumed that an incongruity needs to be present to appreciate an event as humorous. There is of course the danger of circle definitions, both humor and incongruity lack a precise definition, but that should never prevent a practical and engineering approach to understanding and generating humor with smart digital technology.

In many countries, we already live in a world that is full of smart digital technology. We know the terms: pervasive computing, ubiquitous computing, and disappearing computers. But also smart environments, smart public spaces, and smart cities. Broadband networks and cheap smart devices, sensors, and actuators are becoming available. We have web-based applications and e-services in sectors such as business, health care, education, and transportation. User interface research profits from advancements in image, speech, language, and touch processing. Recent research also addresses digital smell and taste processing and mediating smell and taste through the Internet. Multisensorial processing of human behavior information and use the results to adapt the smartness of sensors, actuators, and, more generally, the environment, is a research theme that draws much interest. There is supporting research on cognition, artificial intelligence (deep learning, reasoning, knowledge representation), also to be able to generate interaction behavior by smart devices that will be considered as natural and maybe 'human-like', in particular when interacting with social agents such as embodied virtual agents and chatbots, or physical social robots. Users, or rather inhabitants of smart environments, are being monitored by sensors embedded in the environment and also because of their wearables (smartphones, fitness watches, smart glasses) become living sensors (and actuators) in the Internet of Things. Social media (Twitter, Facebook, Instagram, et cetera) can be considered as 'soft' sensors. Soft sensors collect and interpret a user's intentionally and unintentionally reported activities and opinions. Moods and emotions can be extracted even when they are not reported explicitly.

Augmented Reality technology is now becoming available for consumers. In Augmented Reality, a virtual layer is superimposed on the real world. The virtual layer can contain visuals, that is, computer-generated images and animations, but it is also possible to overlay the real world with virtual content that can be experienced with our other sensory organs (touch, smell, taste, sound) and that can be experienced in a multi-sensory way, just as we have our experiences in the real world. Artificially generated content needs to be integrated with the real world. Moreover, we need augmented reality devices that allow us to perceive this mix of the real and the virtual world, and that allows us to interact with both the real world and the objects in the virtual layer. Various types of augmented reality and devices have been introduced and will be discussed in section 2 of this paper.

Humor, as it is experienced in the physical world, is based on incongruities. This is well-known for jokes and it is a well-researched approach to joke analysis [1]. Less well-known is the incongruity approach to humor for physical environments and human activities, although this approach has a history that is longer than that of joke analysis [2]. We can, as mentioned above, have situations, activities, and human interactions in urban environments that are considered humorous or potentially humorous, for human observers [3][4]. Elements of incongruity and incongruity humor are unexpected events, inappropriate situations, unusual activity, strange behavior, and interactions, and these events, situations, activity, behavior, and interactions can be compared to what is considered ordinary and often when they are sufficiently opposed in these comparisons, humor emerges.

[1] Keynote speech in this congress.

Augmented Reality allows us to introduce these potentially humorous situations. Augmented Reality allows us to integrate artificially generated virtual content with the real world that that is in contrast with what is already present. In this way, we can confront the user with artificially generated humorous situations. We can also deceive the user or let her have – not necessarily humorous – illusory experiences. Section 3 of this paper will be devoted to playful and humorous experiences that can be realized with augmented reality and some examples of existing playful augmented reality applications will be presented. A short section with conclusions ends this article.

2. Interacting in Augmented, Diminished, and Smart Reality

How can digitally enhanced physical environments help us to detect and appreciate possible humorous events and how can such smart environments help us to generate humorous events? Can we detect situations that should make us smile, can we generate situations using digital technology, that causes us to smile? These questions are at the core of humor research, rather than questions about syntactical, semantical, or pragmatical ambiguities in language research that only looks at non-spontaneous humor such as jokes, puns, and other linguistic humor that is far from what we encounter as humor in our daily activities and encounters. Augmented Reality has the potential to introduce humor in our daily activities and encounters.

Augmented Reality was first surveyed in an influential paper in 1997 by Ronald Azuma [5]. In this and other papers, we find with some slight variations the following definition. Augmented Reality (AR) (1) combines real and virtual objects in a real environment, (2) registers (aligns) real and virtual objects, (3) and runs interactively, in three dimensions, and in real-time. Usually, it is also mentioned that AR should not be limited to specific technologies and that it does not address sight only. From [6]: "Azuma's definition doesn't play any limitations on the type of technology used, nor is it specific to visual information …" AR applies to all senses. Hence, we have AR systems that provide visual, auditory, tactile, olfactory, and gustatory experiences or combinations of these experiences.

To perceive the augmented world the user may need an AR display. Vision is our dominant sense, hence we often see devices that are meant to augment our visual perception of the world, hence, a virtual layer that contains computer-generated visual content is superimposed on the real world. This vision-oriented AR can be displayed on a regular computer screen (monitor), a wearable (head-mounted display, e.g., smart glasses), on a smartphone's screen, or it can be displayed on objects and walls. The visual content has to be aligned with the real world and the interface to the augmented world should allow real-time interaction. Usually, we expect to interact with the virtual content in such a way that the interactions are plausible, they reflect interactions that can be considered plausible if the virtual content had been real. But, as can be understood, AR in a medical education application will make different demands to plausibility then AR in a theme park or an artistic installation. As mentioned in [7] in the context of audio-augmented reality, alignment and interaction in AR can be perceptually implausible with our experience in the real world, while it nevertheless is consistent with a particular application scenario. We can extend this observation to other experiences than sight and sound experiences in AR.

Before having a look at other experiences we give a brief introduction to the different types of AR that are distinguished in the visual domain. There are several types of video-supported AR. In 'video see-through' AR video images are overlaid with computer-generated visuals. The combined images can be displayed on a fixed monitor, e.g., a computer screen, a handheld's screen, or on an opaque display of a head-mounted device. In Figure 1 (left) we illustrate a video see-through system. The display can be a monitor that is in a fixed position in the environment, and so is the camera. It becomes interesting when monitor and camera are used in a mobile setting, for example in a vehicle. The camera should be able to recognize interesting objects, including moving objects, and interesting positions and virtual content (information) is superimposed on the objects or in the positions that are recognized in the video. Video see-through can also be used when the user is not mobile but is sitting or standing while performing a task in a fixed location such as his workplace or a desk and the virtual content helps to perform this task. In this case, the position of the user and his head orientation needs to be tracked by the head-mounted device to display the virtual content in accordance with his head movements. In this paper, we do not go into detail how the virtual content can be registered (aligned) in the real world view that is recorded by the video (see [6]). Pokémon GO! Is an example of an AR game that provides the gamer with both a map-based and a video-see through view of the environment in which virtual characters are superimposed on the real world.

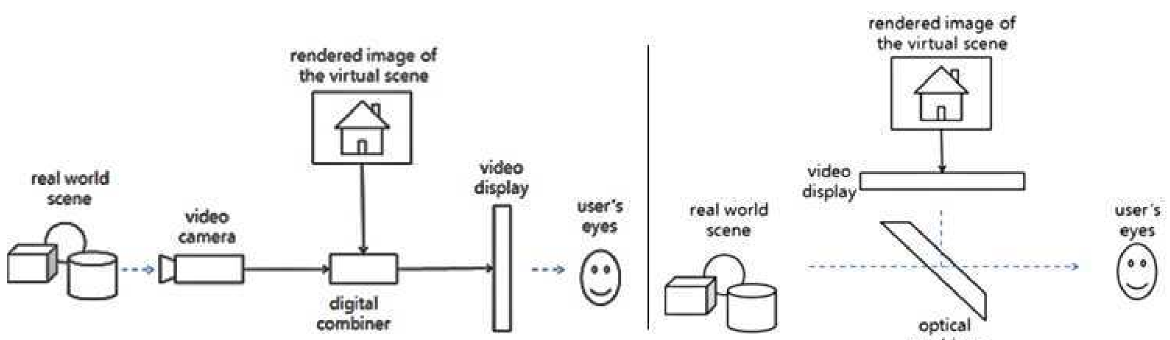

Figure 1 Video see-through AR (left) and optical see-through AR (right).

In 'optical see-through' AR (see Figure 1, right) we view the real world through a transparent combiner on which the digital information is projected and integrated. The alignment of the digital and the real world requires a video camera that provides the device with information about what the user sees (computer vision) and what computer-generated content has to be projected to present the user with an integrated view. The device, usually a wearable headset, also monitors the head orientation of the user to adapt the display of the virtual content to the user's estimated gaze direction. Well-known examples of optical see-through devices are Microsoft's HoloLens, Magic Leap, and various types of smart glasses such as have been designed by Google and Intel. The transparency of the glasses allows the mobile use of these devices. Optical see-through glasses allow a user more freedom of movement than a video-see through a head-mounted device.

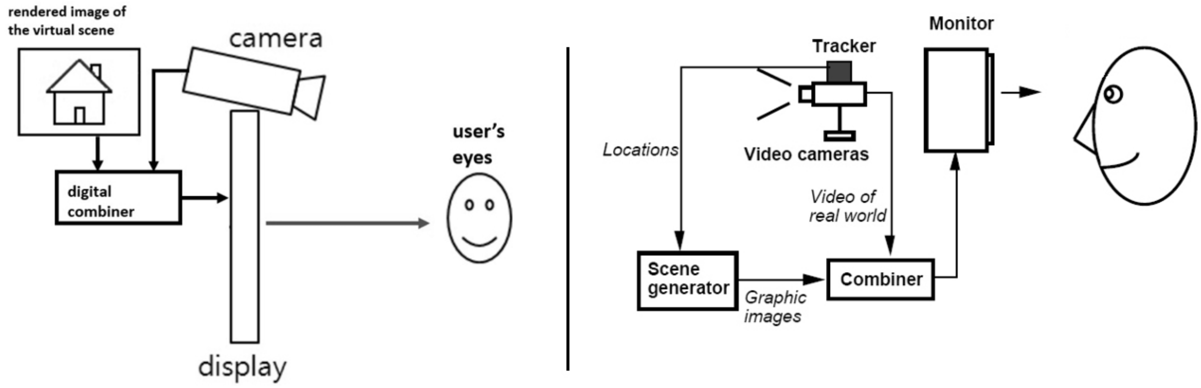

Figure 2. Mirror-based AR (left) and monitor-based (video see-through) Spatial AR (right).

Interfaces to optical and video see-through AR devices can make use of buttons, touchpads, and gestures, and speech recognition. A smartphone or a tablet can also serve as a control device. Similar interaction options are possible with Mirror AR (Figure 2, left). In this type of video-supported AR, the camera is aimed at the user and an image of the user (not necessarily realistic) is projected in a computer-generated virtual world. The user can see herself moving in the virtual world. The virtual world can be inhabited with animated objects, including virtual animals and humans, or virtual objects, for example, clothes can be superimposed on the user. There are applications in retail and entertainment. Large screens for entertainment Mirror AR can sometimes be found at exhibitions, in museums or station halls. This kind of Mirror AR is an example of what can be referred to as Spatial AR (SAR), AR where graphical information is displayed on spatial displays, rather than on handhelds or head-mounted displays. We already mentioned screen or monitor-based video see-through (Figure 2, right) where we use standard PC equipment or have such equipment embedded in a billboard, a shop window, or a kiosk. Optical see-through with a spatial display is also possible. The generated images need to be aligned with the physical environment.

A special case of vision-based SAR is AR where graphical information is directly projected onto surfaces of physical objects. Shape, location, reflection, and orientation of objects and other geometric information about the physical scene that is the subject of the projection need to be considered. Interaction with the virtual content can be done with gestures and body movements, or, when the surface is close, with touching. In a stationary system, projectors are fixed in the environment. Cameras can be used for scene recognition, for example, where to project on a workbench, and detecting interaction activity. If the user can change his position relative to the objects then the projection needs to take into account the user's viewing directions. No special eye-wear is needed.

There are examples of mobile projection-based AR where the user wears a head-mounted device that includes a camera for tracking the position and the orientation of the 3D objects in the real world and a projector for the display on these objects [8]. A building's façade can also act as a surface. In that case, the projection should take into account the particular architectural elements of that building [9]. Hence, geometric information about the façade needs to be known and is preferably obtained automatically. Projection-based AR offers can offer an AR experience to multiple users at the same time.

It should already be clear from the above observations on vision-oriented AR that augmented reality has the potential to introduce playful and humorous events in our daily activities. More opportunities can be offered. In addition to adding virtual content to the real world, we can introduce distortions in a video recorded view of the real world. A human, face, body, or body movements can be distorted in funny ways to create more attractive interaction with the virtual elements. Another example of this so-called 'mediated reality' is diminished reality. In diminished reality [10], objects are removed from reality. This can be done by overlaying virtual ones, but it may also require 'inpainting', that is when an object is removed the diminished area needs to be filled in such that it fits the scene.

In the text above, we have almost exclusively talked about vision-based augmented reality. What about the tactile, auditory, gustatory, and olfactory sensory organs? Different kinds of flavors and smells can be produced artificially, that is, chemically or electronically. For objects in the real world, in particular food, of course, we can have augmented taste and smell. In his foreword to a book on augmented taste and smell, world owned chef Andoni Luis Aduriz Mugaritz [11] tells us that we need 'glasses' for the mouth and perhaps in the future, they become as common as spectacle glasses. So we can think of a virtual layer superimposed on the real world that contains artificial tastes and smells and there are devices to produce and perceive these augmentations. Artificial touch addresses our tactile sensory organ. Real objects when manipulated with tactile gloves can produce different sensations of texture or shape. Visual objects in a virtual visual layer can produce tactile sensations that have been added in the virtual tactile layer. Similar observations can be made for sound. In a virtual auditory layer, the sound of a moving object in the real world can be manipulated. With binaural microphones integrated into earphones, users can be given a hear-through experience. Objects in a visual layer of an augmented reality world can be provided with artificial sounds.

Especially in the non-vision-oriented AR worlds, multisensory experiences play an important role. For example, flavor is an experience that involves, taste, smell, and texture (mouthfeel [12]. Tactual perception (active touch) requires not only touch but also kinesthetic sensibility. With ultrasound, we can introduce invisible 'objects' in mid-air or near surfaces that nevertheless can give the experience of touch. The appearance of an object or food can have an impact on the weight or flavor experience. We can augment the intrinsic elements of a particular experience (for example, smell and taste in the case of food), but also design crossmodal stimuli by augmenting, among other things, color, shape, or sound [13].

Augmented reality research has so far been fairly isolated from developments in artificial intelligence, intelligent (virtual) agents, and pervasive computing (Internet of Things). As mentioned in [14], in recent years we are beginning to see the convergence of these distinct research fields. AR applications will appear in smart domestic, work, recreative and urban environments. Sensors and actuators are embedded in these environments and are connected to sensors and actuators in the wearables worn by humans and animals [15]. In our smartphones and the AR HMDs, we already have a variety of sensors: camera and microphone sensors, but also magnetometers, proximity sensors, gyroscopes, accelerometers, light sensors, and fingerprint sensors. Above we also mentioned data gloves, binaural microphones, and projectors as part of our wearables. Research from artificial intelligence and intelligent virtual agents can help to make virtual characters in AR more aware of their environment, it can learn them how to behave and how to interact. The research area affective computing offers results that can be used to make characters in AR exhibit emotional behavior where necessary. AR displays can show information derived from sensors in locations that are not necessarily visible for the user or near. In fact, we are already used to it. In navigation systems, we have a 'reduced' (GPS-based) view of the real world and they show us long in advance where we can expect a traffic jam and what to do to avoid them. From the same application area, consider a windshield on which navigation and traffic information is displayed, in real-time and in an interactive way. This is an example of optical see-through spatial augmented reality. Cameras can capture information about a car not yet in sight, for example, because it is occluded from view by buildings. When wirelessly connected to these cameras the moving car can be made visible by overlaying the windshield's real world view with a see-through view of the buildings and the moving car made visible behind them [16]. It is just one of the many applications that can be realized when we embed AR in smart urban environments.

3. Interacting with Playful and Humorous Augmented Reality

In this section, we show some examples of playful and humorous augmented reality. The examples show various types of augmented reality. A short discussion in which we consider these examples in the context of playful and humorous social interactions will follow these examples.

An example of (spatial) video see-through AR comes from London, New Oxford Street, London, 2014. It is called the Unbelievable Bus Shelter [17] (Figure 3). One of the bus shelter's wall had a fake window. The real view from that window was captured by a camera installed near the top of the bus shelter. This makes it possible to have virtual computer-generated activity overlaid on the real world street view in the fake window. People waiting for the bus and looking at the window see people and cars passing by and buses arrive. But suddenly they can be confronted with a prowling tiger as well. The designers need to model the animal's movements in a 3D model of the environment to make its behavior natural, that is, fitting in the video-captured and displayed physical environment. Passers-by, once they understood the installation, entered the camera-captured space and had their friends take pictures of them while being chased by the (virtual) tiger. In addition to the prowling tiger, there was a giant laser-shooting robot and passers-by abducted by flying saucers.

Figure 3. 'Prowling Tiger' video see-through AR in a London bus shelter.

Another example of video see-through AR is in marketing. In Brazil, fast-food chain Burger King invited consumers to download an augmented reality app on their smartphones that allowed them to 'burn' adds of rival fast-food chains. If a mobile user points his smartphone's camera at a billboard ad from a competitor he sees the billboard ad engulfed in flames, a play on Burger King's flame-grilling cooking technique [18]. You are rewarded with a mobile coupon for a free whopper sandwich from the chain's nearest location. See Figure 4 (left). In Figure 4 (right) we see a HoloLens user walking an animated virtual dog that is displayed on her HoloLens optical see-through head-mounted device. This research aims at providing virtual animated characters in AR with the capability to act 'naturally' when walking in an urban environment and interacting with human passers-by [19].

Figure 4. 'Burn that Add' smartphone video see-through and 'Walking the Dog' HoloLens optical see-through.

There are many examples of entertaining mirror-based AR. Big screens in station halls or museums the possibility to 'interact' with computer-generated graphics, for example, virtual animals or humans. Users have to stand on marked positions on the floor and they are projected in a virtual world. Depending on the built-in computer vision intelligence (detecting presence, position, posture, orientation) and possible scripts of user behavior the animation of the virtual characters can be influenced. Users observe themselves in relation to AR content and start to 'interact' with the virtual content. In [20] this has been called 'pretend interaction'. It is some kind of exploration of the virtual content. In Figure 5 we illustrate this type of AR with some pictures from a 'Designers against AIDS' campaign in Antwerp's Central Station, 2011. Travelers were invited to join a virtual pillow fight with Belgian top model Hannelore Knuts. As mentioned in [21]: "Virtual feathers fly around the scene as she smashes a pillow on the person's head."

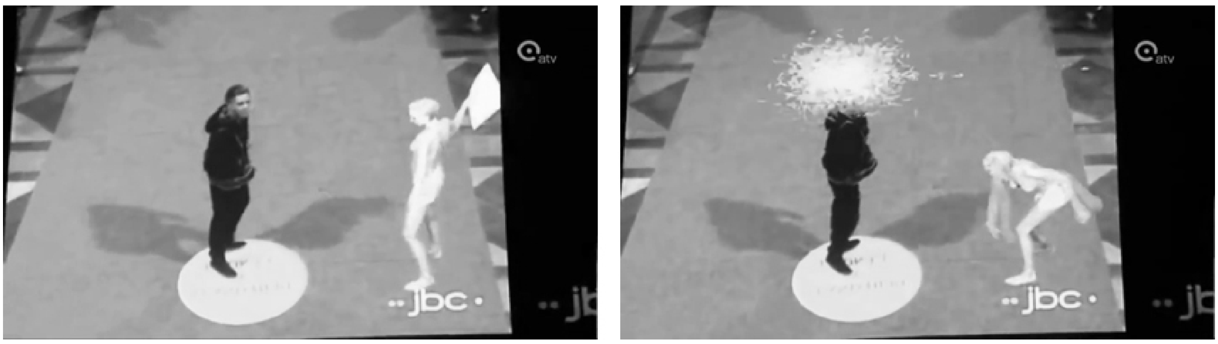

Figure 5 Mirror AR. Passers-by are invited to participate in a virtual pillow fight.

A nice example of projection-based AR is the Urbanimals project [22]. In this project animated virtual animals are projected on walls and street surfaces, passers-by are tracked with Kinect cameras, and there are scripted interactions between animals and passers-by. The application requires the 3D modeling of the environment in which the interactions take place so that the virtual animals can move around with knowledge about the environment, avoiding collisions with street furniture, walls, and ceilings and taking care of irregularities in the environment. The Urbanimals have been present in Bristol (UK) as a 'Playable City' project. Among the animals is a jumping kangaroo that climbs the stairs, a beetle that plays with a ball and invites passers-by to join him, a dolphin that invites you to jump the highest, and a rabbit with whom you can run a race. See Figure 6.

Figure 6. Projection-based AR in Brighton, UK. Competing with a virtual rabbit (left) or a dolphin (right).

All examples above include playful and humorous activity based on augmented reality. Spatial augmented reality, whether it happens on the street, in museums, or station halls, often allows multiple users and their activities can be watched by bystanders. Smiles and laughs naturally arise in these situations. There is play and there is humor because of the unexpected situations and events one is confronted with and the playful incongruities that are involved.

4. Conclusions

In [23] we gave examples of accidental humorous situations that occurred during play with the smartphone augmented reality game Pokémon GO! In [24] we discussed the various ways in which humor theory can guide the introduction of incongruities in augmented reality applications. More examples of augmented reality applications with animals can be found in [15]. In the current paper, we focused on already existing playful and humorous applications with different kinds of augmented reality technology. Humor and play are inextricably linked to social relationships and social events. In our AR examples, there is play with virtual characters (humans and animals) and with other people experiencing AR (as co-participant or bystander).

In a recent paper, AR pioneer Ronald T. Azuma [25] predicts that AR will become the dominant platform and interface, supplanting the smartphone, for accessing digital information. In his view, optical see-through glasses is the most likely approach for success. They are seen as having "... the best chance of achieving the long-term vision of ubiquitous consumer AR displays." Further progress in computer vision techniques, comprehensive modeling of the real world, and natural AR interface technology is needed. Perhaps Azuma's views are too biased on current mobile applications. It nevertheless is interesting to investigate how the AR examples we introduced in this paper and similar but more sophisticated applications involving intelligent virtual characters should be realized with optical see-through AR and if not yet feasible, what kinds of developments are needed to achieve them. Finally, Azuma's observations on the future of consumer AR are fully vision-oriented. no attention is paid to the other senses that humans cannot do without.

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