Humor in Human-Computer Interaction: A Short Survey

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Abstract. This paper is a short survey on humor in human-computer interaction. It describes how humor is designed and interacted with in social media, virtual agents, social robots and smart environments. Benefits and future use of humor in interactions with artificial entities are discussed based on literature reviews.

Keywords. Humor · Social Media . Embodied Agents . Smart Environments

5 Introduction

Humor is a complex cognitive process that frequently, but not necessarily, leads to laughter [53]. The Oxford English dictionary defines humor as "the faculty of observing what is ludicrous or amusing or of expressing it" [62]. The fact that even a simple joke uses simultaneously language skills, theory-of-mind, symbolism, abstract thinking, and social perception, makes humor arguably the most complex cognitive attribute humankind may have [34].

Humor is consistently found in all cultures around the world [69]: people of all ages and backgrounds seem to have an instinctive ability to perceive humor attempts, a fact suggesting humor has an evolutionary basis. Researchers found close ties between humor and playfulness: humor appears to be the very complex ability of the mind to be playful with thoughts [34]. Further, researchers also found that mock aggression usually exhibited in playful behavior was a way to resolve social conflict, relieve tension [34] and facilitate cooperation by transferring information on sympathy levels through recipients laughter [26].

Along the history, humor has played an important role in our cultural and social life as it manifested in literature, poetry, arts, and theater. Taking various ways of expression and functionalities, humor appears in the performances of native North American tribal clowns [53], Arabic storyteller tradition [20], Indonesian Wayankulit puppet shows [59], Polynesian clowning wedding traditions [24], modern television comedies or more classic stand-up comedy in cafes around the world [15].

Although the use of humor is universal, what is held to be funny is relative and may vary from culture to culture: for example, jokes that provoke laughter in Indian popular theaters would hardly draw a smile from a Dutch observer [15]; Americans seem to prefer aggressive humor more than Belgians, Hong-Kongese [12], Senegalese or Japanese [60] do while native Hungarians show more appreciation for jokes featuring ethnic stereotypes as compared to their bilingual English-Hungarians counterparts [19] [33]. Such differences explain why many jokes or ironic remarks often go unremarked, misunderstood or perceived as offensive [56]. As such, creating humor seems to be a very challenging task: one needs to be aware of social norms and culture-specific conventions, share a common background with the audience, master language subtleties and sense the appropriate context for spinning a good story [56].

Humor is also found to be an attractive characteristic in people increasing the interpersonal attraction [9], strengthen friendship and boosting trust among peers [21] and business partners [30]. Also, in learning environments humor proved to be an excellent tool for promoting content retention and student motivation [72].

In this paper, we explore the benefits humor can bring in human-computer interaction (HCI). More specific, we look at how humorous interaction can be created in social media, virtual agents, social robots and smart environments with the goal of ultimately achieving a better user experience (UX). It is a fact that humor continues to evolve in our modern times through memes, YouTube clips, funny tweets and other playful interactions.

Since humor has always shown positive influences in our lives, we can expect similar beneficial consequences in interaction with technology. However, the HCI field holds rather an undecided view on humor in task-oriented interactions: on one side, the traditional view considers humor to increase overall competition time by distracting users and causing them to take the task less seriously; on the other side, research studies have found task competition time and amount of effort to be mainly unaffected by incorporating humor in interaction [38].

Concerning non task-oriented interactions, HCI has a rather neutral view: neither are humor interactions recommended nor discouraged. As technology started moving from our work environment to our home and less goal-directed interactions are starting to become predominant [48], we believe humor can positively affect the interaction.

This paper has four sections each one corresponding to a technology under review, namely social media, virtual agents and social robots and smart environments - smart environments is given special consideration in our paper due to the relative importance it has in nowadays context. The survey ends with conclusions and a future work outline.

6 Humor and Social Media

Since humor is a social phenomenon, it is not surprising to find plenty of humorous events occurring in mobile and web-based dialogue. For example, it a is a common experience to type unintentionally funny texts by using the auto correction feature of instant messaging systems. This situation happens so often that there are websites where users share the humorous messages they consider mostly hilarious[11]. One of the strategies employed in computational humor consists of identifying these sources of unintentional humor and recreating them intentionally. In the case of the above example, previous attempts have been performed to model short texts containing humorous mistakes, using forms of lexical similarity to produce funny puns [66][64].

During the last decade, social media enabled people to produce and share a vast amount of multimodal material, including humorous texts, images, and videos. For instance, YouTube hosts a large number of videos showing pranks or funny mistakes. Humorous comments are commonly posted on Facebook as well as Twitter and YouTube. Internet memes, generally consisting of a picture and a short message, are one of the most common types of potentially viral content. Despite their simple structure, internet memes are enough complex to combine linguistic and visual creativity and thus achieve forms of multimodal humor that have been modeled computationally[31][49].

Social media not only give the opportunity to share content between members of an online community but also allow them to provide feedback, rate what is posted and select the posts they like most. The feedback can be explicit, such as Facebook likes or Reddit upvotes or downvotes, or implicit, as in the case of Twitter's retweet or Facebook's share features (where

[11] www.damnyouautocorrect.com

reposting some content may be used as an indirect indicator of humor appreciation). Web sites such as Sickipedia[12] collects jokes posted by the users and rank them according to the users' feedback (as either up-votes or down-votes). It may happen that some users provide a new version, possibly more successful, of an already posted joke. In this way, a form of evolutionary selection promotes the creation and transformation of jokes. This process achieves, at a higher speed, the same type of collective creativity underlying the creation of jokes communicated in oral, face-to-face, channels. In the case of media environments where comments can be nested (e.g., comments on comments, etc.), such as Reddit [14], the repartee generated by this feature produces original and funny conversational traces.

A particularly interesting research line is about computational analysis and generation of verbal irony in tweets. Irony and sarcasm typically have a double audience. They are used both "laugh at someone" and "laugh with someone" [61]. Sarcastic tweets, in particular, express a negative opinion about some target (e.g. a politician) and, at the same time, are meant to amuse the readers and to make them willing to retweet them. This explains the explosion of interest in automated sarcasm detection, on which recent advancements has been performed using various machine-learning techniques [22][57][5][51]. Moreover, there have been first attempts to generate irony automatically and provide Twitter bots with ironic capabilities [67].

One of the main advantages in the study of humor in social media is the possibility to analyze the ongoing collective response of users to humorous messages. For instance, an empirical study shows that practical jokes, performed by brands as a way to attract the attention of consumers, are not particularly useful as a marketing strategy [27]. Pranks are a kind of disparagement humor, relying on the induction of negative emotions such as fear or other negative stimuli such as derision or aggression. According to this study, people often tend to empathize with the victim of the prank and thus associate negative sentiments to the brand.

In summary, we envision two stages in the computational treatment of humor in social media. The first phase would consist of the development of computational resources for modeling humor expressed by events, social behaviors, shared knowledge and its rating by online communities. In a second stage, computational humor researchers will hopefully be able to build systems proactively able to create humorous events and adapt their humorous behavior according to the individual and collective responses.

[12]www.sickipedia.ne

7 Humor, Embodied Agents, and Robotics

Humor underlies a highly complex cognitive process that clearly distinguishes humans from other species in the animal kingdom: it is a sign of intelligence, an ice-breaker in social gathering, a way to relieve stress and to induce good mood. And yet until recently from the HCI point of view, humor has received little attention.

However, why virtual agents and machines should use humor? Through their visual appearance, speech and gesture, virtual agents and social robots try to mimic the style of human interaction. On one side, this human-likeliness brings familiarity; on the other side, it could lead to unfulfilled expectations and feelings of uncanniness [37]. A way of dealing with such shortcomings could be to lower the user expectations, decrease the degree of striking human resemblance and improve the user experience by making the interaction less tensioned. Perhaps, humor could induce a key change of perspective, making users laugh at a yet imperfect technology and, thus, accept it.

This hypothesis seems to be confirmed by early studies on humor in HCI re-port on similar beneficial effects as encountered in human-human interaction. For example, Morkes and colleagues [38] studied the effects of humor in task-oriented interactions and found that users rated significantly better the system that gave humorous comments. He found no evidence of users wasting task completion time as previously thought in the HCI community but rather an overall improved perception of systems qualities. Similarly, the study by Huan and Szafir [25] found positive effects of humor in education: students interacting with a humorous teacher - robot or human - gave more positive comments about the instructor than otherwise. Also, a later study by Niculescu and colleagues [42] demonstrated that humor increases the likeliness of a social robot's speaking style and personality, as well as it contributes towards increasing the overall task enjoyment.

Expressing humor gives the machine the ultimate human touch: the study by Dybala et al. [17] showed that users evaluated a humorous agent as more human-like and consequently rated it as more likable and funny. Babu and colleagues [4] also found that social conversations increased up to 50% when a virtual receptionist used jokes in interaction with human users.

Humor in non-verbal form of expression (e.g. gestures, facial expressions, whole body movements) was studied by Wend and Berg [68] in interaction with a service robot. Their study showed that non-verbal humor has

significant positive effects on the way different robot characteristics were perceived, as well as on the entire interaction quality evaluation.

Another study by Katevas and colleagues [28] investigates social dynamics between a robot performing stand-up comedy and a human audience. Results showed that people respond more positively when the robot looks at them while performing. Also, robot's gestures seemed to contribute to different patterns in the audience response. The study provides good insights on how humor and stand-up comedy should be designed in a multimodal interaction context.

Further, the study by Niculescu and Banchs [41] shows how humor can be used to help chatbots recovering from errors: in situations of failures, i.e. when the system is unable to retrieve the correct answer, it may use humorous responses to prompt the user to reformulate the query and consequently recover from failure.

Humor also seems to be a successful tool to persuade people to change bad habits. Started as an initiative of the Volkswagen Group Sweden, the so-called 'fun theory' explores how fun, playfulness and humor can change user behavior for the better. Within a competition organized for the best fun idea, several interactive 'ideas' were developed - such as an interactive piano staircase, an noise making garbage bin, a playful recycling automaton, rewarding speed camera etc. These devices were used to persuade people to do more sport, throw garbage in the bins, recycle more and reduce speed while driving. Empirical results confirmed that more people tended to change their behavior as a result of experiencing fun in interaction [1].

Implementing humor however, given its subtleties and nuanced facets is one of the major challenges in computer science. There are three important steps for a successful deployment of humor in autonomous systems: firstly, humor needs to be detected and semantically understood. Secondly, it needs to be generated. Thirdly, humor needs to be delivered at the right moment and appropriate situation; the last one is perhaps, the most challenging task, as background knowledge, emotional intelligence, context and culture awareness are needed. While notable advancements in the area of detection [50][13] [45] [23], understanding [55], generation [65], appropriate delivery [16] [3] were made, the development of fully automatic humorous machines capable of recognizing, generating and using humor appropriately is still in its infancy.

Recognizing the value of humor in interaction, big corporations such as Apple, Microsoft and Amazon started investing in creating virtual agents having gender, level of education, personality, political opinions and of course their very own style of humor. Siri, Cortana and Alexa are already famous for

their funny responses. Interestingly, here is that behind the answers stand not carefully designed algorithms but rather teams of novelists hired by the corporations to give the audience the best possible responses [18].

In the future, we expect humor to be used on a large scale in interaction with virtual agents and social robots for an increased number of purposes. This could be learning tasks, i.e. to help retain content more easily, motivate people pursuing a specific goal, change people's behavior and improve system usability in case of errors. At the moment, artificial devices still struggle with understanding natural language semantics and as such, mastering humor will be - with no doubt - a huge technological step forward to be probably accomplished not in a few years' time.

8 Humor in Smart Environments

Sensor technology is about devices that obtain information from pressure (touch: screen, button, mat), movement (camera), identification (intelligent vision), gesture (intelligent vision), temperature (thermometer, infrared camera), tags (RFID scanners), sound and speech, (neuro-) physical sensors, and even implants that provide information about brain activity. Actuators are computer controlled devices that make physical changes to the environment (movements, replacements, appearances, volumes, sound, temperature, pressure, light, humidity, smell, taste, ...). In smart environments these actuators, fed by computing devices (embedded micro-processors) that assess sensor information, take care of communication, control of heating, lighting, humidity, safety, and other issues that deal with efficiency and sustainability. Sensors and actuators are in our wearables: smart phones, smart watches, smart textile. Smart materials [36] act as sensors and actuators at the same time.

Thanks to sensor technology our environments become smart. We are used to doors that open when we approach or escalators that start moving when we get close. Air conditioning or heating devices in our rooms know about the temperature and know about our preferences. Sprinkler installations can detect smoke and actuate sprinkling. Home security systems guard our houses. Our activities are monitored. Audio-visual and haptic information can be sensed, manipulated, and distributed, and can become input to actuators that can make changes to the environment. Our smartphones sense and are sensed, they are context-aware and allow implicit interactions with the environment. In our homes we can talk with domestic digital assistants that control devices in our house.

Embedded smartness in our environments, our wearables and bodies will penetrate all our activities, including our home, recreational, travel and office activities. Will it also penetrate our ways of generating and appreciating humor in verbal and non-verbal contexts? In this section we are interested in generating and experiencing humor that involves digital technology in real world environments. Hence, digitally enhanced real world environments, in which we live (smart domestic environments), work (smart workplaces), travel (smart public transport, smart cars) or do shopping and recreate (smart public spaces).

How can the design of humorous and playful events make use of digital technology? Can we have spontaneous use of digital technology, by on the fly changing and reconfiguring sensors and actuators, to create a humorous situation? Can smart technology and Artificial Intelligence autonomously decide what to do in order to create a humorous situation? And, finally, does the presence of smart technology increase the chance of unintentional humor?

8.1 Humor: From the Language Domain to the Physical World

Humor research is usually focused on the use of humor in texts and in verbal interaction. Theories of verbal humor, for example the so-called "General Theory of Verbal Humor" developed by Victor Raskin and Salvatore Attardo [2], provide an analysis of jokes, where jokes are represented as conflicting scripts. That is, when someone is telling a joke usually, at first, a stereotypical situation is introduced. But, this set-up allows ambiguity that we become aware of when there is an unexpected change in the story (in a joke, the punch line). The change makes us clear that we gave a wrong interpretation to the set-up, and we are surprised and confused, especially when the new situation is opposing the original one. But our confusion is changed to understanding once we have resolved the incongruity we were experiencing.

Although not all jokes follow this pattern, we can certainly learn from this incongruity view on humor when investigating non-language humor, including nonverbal aspects of interaction, cartoons, comedies, sitcoms, stand-up comedy, movies, video games, and the real, physical world. We can use this view when investigating the creation and experiencing of humor in our daily activities, when we intentionally or unintentionally take part in humorous events or witness events that make us laugh. Again, incongruities, unexpected but forced deviations from stereotypical interpretations of how things should appear or be done are the key elements of humor in real-life situations. But we need to add two other viewpoints.

The first one is that when we abandon the language domain, incongruities can become cross-modal incongruities. There can be incongruity between appearance and behavior, between language use and behavior, or more detailed, between gestures and eye gaze behavior, et cetera. When sufficiently conflicting, these cross-modal incongruities can help to let a humorous situation appear.

The second viewpoint we need to mention is that speech, conversations, and text present humor in a sequential way. There is the explicit possibility to mislead a reader or listener by presenting story elements in a particular order. This can also happen in a real-life situation, we see events happening sequentially, we change our physical viewpoint, we understand what's going on after seeing the reaction of bystanders. But it can also be the case that two conflicting interpretations are presented at the same time. For example, in a cartoon, where the visual information conflicts with the text balloon or the caption, or when in "The Goldrush" Charlie Chaplin is eating his shoelaces pretending they are spaghetti strings (a literal and metaphorical interpretation appearing at the same time). We have two concurrent, but opposing meanings. At a more global level, behavior that is expected in one social context can become inappropriate and potentially humorous in another. In real life we can observe pets and children acting in ways that are non-stereotypical from the point of view of grown-ups. Hence we can observe incongruities and humor that follows from them.

8.2 Humor Research beyond Jokes and Conversations

There is an enormous amount of humor research in psychology. There is research on the appreciation of humor, the various types of humor, functions of humor or the cultural aspects of humor. There is research on humor in sitcoms, movies, and video games. There are numerous books on comedy writing. In applications such as advertising, healthcare and education the persuasive role of humor is investigated. Collections of chapters on fundamental and applied studies of humor can be found for example, in [35] and [54].

We are interested in how humor can be created, rather than in its functioning, its various roles and possible ways of appreciation. Moreover, we are interested in humor as it appears in the physical world, rather than in language. And, because of the digital enhancement of our physical world, we are interested what role digital technology can play in creating non-language humor. Since our aim is to study opportunities for humor to appear in

digitally enhanced real-life environments it is useful to see what has been said - before the advent of digital technology about generating humorous events in real-life environments.

Unfortunately, although there are typologies of humor and descriptions of basic techniques, the viewpoint that is usually taken is the characterization or the analysis of humor. Nevertheless, knowing about characterizations of humorous events should help us to design humorous events in smart environments or to design conditions that can help in creating humorous events, whether de-signed in advance, or created spontaneously, on the spur of the moment when an opportunity arises and humor seems to be appropriate.

There is another shortcoming of these typologies, they hardly address humorous situations in real life. In the tradition of Bergson [7] who was very much influenced by French theater play in his and previous centuries, more recent re-searchers usually make references to events that occur in movies, rather than in the real world. Noël Carroll [10] investigated 'sight gags' in movies from an incongruity point of view. Most examples are taken from silent movies. In Morreall [40] categories of humor are introduced as it can appear in objects, persons, or situations. These categories are: 'Deficiency in an object or person', 'One thing/situation seeming to be another', 'Coincidence in things/situations', 'Incongruous juxtaposition', and 'Presence of things in inappropriate situations'. We notice that in all these categories incongruity plays an important role. In Berger [6] forty-five basic techniques of humor are distinguished. The techniques were obtained by studying jokes and humorous texts (jokes, comedies, short stories). Hence we can find many linguistic, logic and style related techniques. They have been used in comedy writing and the analysis of jokes. But, interestingly, the techniques have also been used in the analysis of TV commercials [8]. In jokes, humorous texts, in comedy and in TV commercials the humor is designed.

Situations differ from what we experience in real life, human behavior is more exaggerated and events are not always plausible or even possible. Nevertheless, the characterizations of incongruities that are made available by the various categories are useful for thinking about the creation of humor in the physical world.

Physical objects can be found in domestic and public environments. Research on humorous products usually addresses products that are used in our homes, such as furniture, door mats, vases, mugs, writing material, kitchen and bath products, et cetera. Products have texture, appearance weight, volume. Sometimes a product can emit, absorb or reflect sound, light or heat. It means, as discussed in [32], that there are many possibilities to

introduce cross-modal in-congruities in the design of humorous products. Rather than having cross-modal or cross-sensorial incongruities based on appearance and product properties (for example, a visual-auditory incongruity is present in a rubber duck that roars like a lion when it is squeezed).

It is also possible to have product incongruities with characteristics similar to those we can recognize in the categories of Morreall [40]. For example, in [70] representational aspects, operational aspects and aspects of context of use incongruities are introduced. An example of a representational (shape) incongruity is a floor lamp with the form of a match stick. There is a clear relation between a floor lamp and a match stick (they both give light), but they are certainly opposed in size. An example of an operational incongruity is a balloon that is used as a business card of a chest physician. When the balloon is inflated the address of the physician becomes visible. Again, there is a clear relation between the balloon and the profession of the business card holder, but of course it is an unexpected use of a balloon. The results of their research have been used in the design of interactive humorous (indoor) water fountains [71]. Categories of techniques for humorous product design are also introduced in [58] and [29]. There is overlap between the categories, expected versus unexpected is of course a common viewpoint, but this viewpoint can be approached from different directions and in different detail, such as function, representation, and context, or product properties, or more concrete suggestions concerning the use of irony, parody, visual puns, anthropomorphization and zoomorphization.

Our observations in this subsection help to make clear what conditions play a role in order to perceive behavior, an event or a product as humorous. A further systematic differentiation between incongruities in order to obtain more comprehensive design guidelines for introducing incongruities in the physical, non-language world seems to be useful. The typologies that have been introduced are about observing humorous events, they donot mention how to introduce humorous events or how to invite humorous interactions. Moreover, what is missing in these typologies is a possible role of digital technology to introduce humorous products in a smart home or public space environment or to introduce or what role digital technology can play in making environments not only smart, but also playful and humorous. Can we use smart technology to design environments that have a sense of humor?

8.3 Creating rather than Interpreting Humor

Humans are able to create humor. That is, a remark, a joke or text, a gesture, a behavior, an object, or an event that provides us with the emotion of comic amusement [11]. Traditional humor research is about analyzing humor, rather than on creating humor. Humor can be created, that is, intentionally. Humor can also appear unintentionally.

If we would have necessary and sufficient conditions for humor to be created or to appear, we would understand humor. That is not yet the case. But, we can at least try to find necessary conditions for humor to appear. Conditions include the introduction of incongruities that surprise us, maybe confuse and challenge us, but are not threatening. A humorous event can also be suggested. Someone can comment on a particular situation, drawing our attention to a particular viewpoint that makes it humorous. Hence, complementing the event with the necessary conditions that are missing.

For humor as it appears in the real world or in the digitally enhanced real world we need to distinguish the various roles that human actors play. Let us first look at how we have a role in joke telling.

In the case of a joke we have a speaker (the joker) and one or more listeners (the audience). The joker plays with the audience, he or she is misleading the audience with the set-up of the joke and then introduces an incongruity for the audience to resolve. A joke is usually about a human activity and involves human actors. For them there is no incongruity in their behavior or the situation. The incongruity is in the different viewpoints that are introduced by the joker and have to be understood by the audience in order to get the joke. We can laugh about the way we have been fooled and misunderstood the event that is described in the joke. However, often a joke involves a human actor who is doing stupid things, who is fooled or is made ridiculous. And we laugh about the misfortune of this person.

What about the roles of human actors in the real world? We smile a lot, particularly while face-to-face interacting with other people, but not necessarily because there is humor involved. But, more importantly for this section, we also often smile about events that happen in our environment and that we experience as humorous. Laughing aloud happens when we see an event is seriously humorous or changes from mildly humorous to seriously humorous. We smile or laugh when someone is fooled, when someone acts stupidly or completely misunderstands a particular situation. A person can act in a way that is inappropriate in a social setting. When confronted with an unknown situation or with unfamiliar technology, someone can fall back on

previous experiences, but they may not be valid anymore. Similarly, we can laugh about the behavior of pets and children that are confused by changes in their environment.

Taking these observations into account, in real life humorous situations we can distinguish various roles for the human `participants. We can have observers of humorous situations (the audience). We can have creators of humorous situations. Here we need to make a distinction between intentional and unintentional humor creation. In intentional humor creation we have a creator. The creator has planned the humor in advance. An artist can make a humorous interactive installation. An interactive fountain can be designed in such a way that it makes a difference between an adult and a child when squirting water upon them. An urban game designer can introduce different roles for the players of the game.

Hence, we can have persons that introduce, knowingly or unknowingly, humorous events or add to events in order to make them humorous. We can be observers of such humorous events. We can be actors that are involved in humorous events. In the latter case we can help, knowingly or unknowingly, to make the event possible, or we can be the target and the 'victim' of the humor. We have humorous event creators, we have observers (the audience) and we have actors that are part of the humorous event, including 'actors' that are the butt of joke making.

8.4 Smart Humor in Smart Environments

The typologies and incongruity distinctions we mentioned earlier do not take into account digital technology. They were mainly composed before the advent of personal computers, the Internet and the World Wide Web. Apart from observations on humorous product design, examples that illustrate these categories are usually taken from 'artificial' worlds, that is, stage plays and movies. There are exceptions, but usually we find these exceptions also artificial (how often see you someone slipping over a banana peel?) or childish (playing keek-a-boo). Obviously, whether it is about comedy or movies, humorous events in real life, or real or imagined events in children's play, in many such situations we have events that are blown out of all proportion if we compare it with the mild humor that we experience in our daily routines and activities. We nevertheless think we can learn how to introduce humorous events in the digitally enhanced real world by looking at the principles of the techniques that are used to generate humorous products or at humor as it appears in theater play, sitcoms or movies in more extreme forms.

We provide two views on creating humor in smart environments. The first one is a traditional one. Civic authorities can ask artists or media studios to de-sign humorous and playful interactive installations in public spaces. This is not necessarily different from designing objects using digital technology in amusement parks. In public spaces these installations are meant to be available for an audience during a particular period of time, an exhibition, a celebration or some other kind of festivity. In certain locations, for example an amusement park, they can be available for a longer time. But an interesting difference can be that in public spaces use is made of objects that are natural (rather than artificial objects in an amusement park) in the public space. Such objects can include lamp posts, buildings, statues, street signs, traffic lights, metro entrances, billboards, et cetera. Many examples where sensors and actuators make use of such city objects in order to create smart humor exist [44][43]. In these projects sensors and actuators are added to existing street furniture in order to create playful and humorous situations. Incongruities are introduced because it turns out that we can interact with lampposts and mailboxes (anthropomorphization) in a conversational (chatbot) way or because when we pass a lamppost equipped with an infrared camera and projector we see not only our own shadow on the street, but also see shadows that have been recorded from previous passers-by. Although at first this leads to confusion, we can also see that people become amused and start playing with their own and projected shadows [47].

Unfortunately, despite the availability of playful and humorous installations, in public spaces, museums, and workplaces, such projects are not really integrated into a local community, let alone that a local community can decide to use available IoT technology to introduce playful technology in its environment. The latter has been done and can expected to be done when more people involved in the Do-It-Yourselves (DIY) and makers communities start using their and civic hackers knowledge to 'attack' existing smart street furniture or to add community sensor technology to already existing Internet of Things (IoT) technology. In the 'shadowing' project mentioned above we have a top-down approach, future and potential users have not been involved in the design and implementation of the project.

Our second viewpoint is a more visionary one. When smart digital technology is available we have the possibility to make the real world more look like the worlds we know from movies, stage plays, TV serials, video games, and virtual reality. Making use of (IoT) technology there is the possibility to make changes to physical environment, the appearance of an environment can change, objects can occupy different positions, light and

other environmental conditions can change, sensors and actuators can be given different functions or different access can be allowed. New sensors and actuators can be introduced and configured to serve particular purposes. Humans participating in these IoT networks are becoming nodes in the IoT. They are both sensors and actuators because of their possibility to interact in traditional ways (speech, facial expression, eye gaze, body language) with the IoT, but also because their sensorial and intellectual capabilities will be amplified with smart technology, such as smart wearables (smart phones, glasses, watches, neuro-physiological sensors, electronic tattoos, implants, brain stimulation). Moreover, their taste, touch and smell senses can be amplified. Artificial Intelligence can be used to make us smarter and to make the environment smarter. Augmented reality should be mentioned as a technology that allows us to integrate the physical with any digital world. Hence, in this second viewpoint humans become smarter and have digitally enhanced sensorial capabilities, and their environments become smarter. It is unclear yet what consequences this has for new kinds of humor. Evgeny Morozov [39] suggests that those who control the IoT will control humor.

As mentioned in section 2, in humor research we usually distinguish three viewpoints, the superiority, the relief, and the incongruity (resolution) viewpoint. The first two viewpoints are about the functional and the emotional aspects of humor. The incongruity viewpoint is about the cognitive aspects of humor and how we can give different interpretations to a particular situation, how we can make a shift from one interpretation to another and how we can integrate different interpretations into one. Smart technology makes it possible to change an environment and to manipulate the perception of an environment. For that reason we are interested in the incongruity viewpoint. How can smart technology introduce incongruities that can become humor, that is, that become the object of comic amusement?

We introduce four categories of intentional humor creation in smart environments. There can be other, unintentional ways that humor appears in a smart environment. There can be bugs in the technology and it may also be the case that humor appears because of not being able to handle the technology, making errors, and clumsy behavior. In [47][46][63] more can be found about this kind of humor in smart environments.

- The objects of humor are generated autonomously by the smart technology. This requires that the smart technology has a sense of humor and uses it, whenever it is appropriate, to generate an event that will be considered humorous by someone present in the

environment. There can be unwanted 'participation' of an actor that is the 'butt' of the humor. Other participants can have a passive role (audience) or be involved in the use of smart technology to see this event happen.

- Smart technology allows us to perceive different views on a particular situation. We can be persuaded to perceive these views at the same time (con-currently) or sequentially. This can be done using audio-visual media, augmented reality, or virtual reality technology. An incongruity can be there when we have a metaphorical versus a literal interpretation of a particular scene in our real world. Augmented reality provides us with different views on the same event. Rather than having the environment decide about the creation of humor, we can leave it to the human participant to use this in-formation to create a humorous event, making use of sensors and actuators available in the environment.
- We can have autonomous generation of humor by a smart environment, we can have smart technology that suggest how to use this technology in or-der to create such events. There are other possibilities to use the smart technology to introduce humor. One of them is auto completion or, rather, prediction. Machine learning methods will make it possible to complete certain activities in a humorous way, suggesting, persuading, or forcing the user to complete his or her activities in a way that leads to a humorous situation. The environment becomes a digital humor adviser. The adviser can become embodied (a virtual agent or a social robot) to make it more convincing.
- Rather than having agents that help in creating humorous situations we can also think of agents that give humorous comments on events that are happening in a smart environment. The events are not necessarily humorous. A humorous comment can be constructed by providing an alternative and op-posing view on a particular event. In this case there is no need to implement such a humorous view using available technology. Such an agent role can be compared with the Agneta and Frida personas introduced in [52] who have ironic comments on the websites a user is visiting.

9 Conclusions and Future Work

In this paper we have presented a short survey on the specific role and use of humor in human-computer interaction. Although humor has received increasing attention in computer science areas such as natural language processing and artificial intelligence, it appears to be a neglected research topic in the field of human-computer interaction. Given the significantly important role humor has played in human social behavior and relations since the origins of society, we assert that the proper understanding and study of humor in human-computer interaction should be consider strategically important to research and practice in this field. This paper is an attempt to draw special attention towards the importance of studying humor in human-computer interaction, with special attention to humor creation, rather to humor interpretation, as well as to the programmatic use of humor to support and improve the user experience.

With the advent of new technologies, human social and cultural activities have expanded from interpersonal interactions within the natural and urban environments to new environments: the cyberspace and the augmented and smart physical spaces. Regardless of the virtual or physical world settings, the use of humor in artificial agents (either virtual agents in the cyberspace or robots in the physical world) is of fundamental importance to make human-computer interaction more natural and inviting in terms of similarity to human-human interaction. The current trend of human-computer interaction is on "humanization", although it is still debated in the research community. However, we rather emphasize the focus on "humorization" of human-computer interaction, since we believe it could improve the user experience in terms of acceptance, engagement and collaboration.

The future work in this area should focus on strategies and mechanisms to generate humor in different human-computer interaction settings (social networks, virtual agents, robots and smart physical spaces) with the objective of improving the overall user experience. Some of the interesting research questions to be addressed in future agenda on humor in HCI must include, but should not be restricted to, at least the following:

- What are the most effective mechanisms for humor generation in the different human-computer interaction settings?
- What are the social and cultural contexts in which different types of humor are proper and acceptable?

- How to use humor with the objective of minimizing system failure effects and/or augment user tolerance to failure?
- How to use humor in human-computer interaction to increase acceptability and reduce/mediate social friction and social divide?
- What are the most effective ways of using humor for maximizing the use and utility of public spaces?
- What is the impact of using humor in human-computer interaction towards the treatment or prevention of mental health diseases?
- How to use humor in human-computer interaction to improve on-line education and self-paced learning?

Human-computer interaction is becoming pervasive and ubiquitous in the physical world and the cyberspace. It is progressively and dangerously replacing most of our traditional human-human interactions. Humor is a paramount indicator of socially desirable and positive interrelationships. The increasing use of human-computer interfaces seems to projecting us into a dark era of human isolation. Providing them with humor, instead, they will likely enhance our humanity.

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