

Ethical Considerations in Augmented Reality Applications

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Abstract – Augmented reality (AR) is a powerful technology that has a direct effect on the end user experience. AR is a persuasive technology that is already having direct impact on the end user, all the while collecting information about them and their actions. AR is currently being used to advise, inform, track, manipulate, entertain and persuade the end user while collecting and utilizing their data. This technology raises significant ethical concerns. Some of the ethical concerns include how end users will be affected, manipulated, persuaded, or informed by the technology. Further, there are ethical concerns about the use of end user information, privacy and privacy protection. Finally, due to the immersive and persuasive nature of AR applications, the actual physical safety of end users and those around them becomes an ethical concern. Some ethical guidelines are presented for consideration.

Keywords: augmented reality, ethics, legal considerations, persuasion

1 Introduction

Augmented reality (AR) is a technology that currently utilizes visual and auditory information to instantaneously enhance the end users' experience through various digital technologies in a potentially powerful way. AR is growing at a rapid pace and will continue to become more pervasive [1]. It is a persuasive technology that is already having direct impact on the lives of end users and, potentially, bystanders as well. Because of the interactive nature of this technology, it has the potential to engage and immerse the end user, all the while collecting information about them and their actions [1, 18]. AR is already being used to advise, inform, track, manipulate, entertain and persuade the end user while collecting and utilizing their data.

While this technology provides incredible opportunities for developers, businesses, marketers, and end users, it also raises significant ethical concerns and question. Some of the ethical concerns surrounding AR include how end users will be affected, manipulated, persuaded, or informed by the technology. Further, there are ethical concerns about how information about the end user is being collected and used by the application, and ultimately those who design it, pay for the design, and pay for the information. Issues of personal privacy and privacy protection abound. Further, due to the immersive and persuasive nature of AR applications, the actual physical

safety of end users and those around them become an ethical concern.

This paper will explore various forms of augmented reality applications, and the potential ethical concerns they raise. Further, this paper will discuss ways for designers, developers, marketers and businesses interested in utilizing AR technology to determine their role in addressing ethical issues.

2 AR Applications Are Persuasive

Persuasive computing, or CAPtology (Computers As Persuasive technology) is the designing and use of technology with the specific intent of influencing or modifying behaviors, values or attitudes [1, 2]. Augmented reality (AR) falls within the definition of persuasive technology and computing [1, 3, 4]. Following this logic, the theories on ethics from the field of persuasive technology can also be applied to augmented reality.

Almost all AR applications contain some sort of persuasive element or are designed with the direct intention of persuading the end user in some way [3]. Persuasive intention in AR applications can be as simple as a prompt for the end user to click a button to move on in the application, or as complex as a series of activities and directives in the application with the intention of having the end user change a typical behavior, or develop a new attitude about a product or idea [2, 3]. AR is a powerful tool for persuasion because it can create a convincing experience that changes our thoughts and perceptions, and thus behaviors, by changing how we see, expect, interact with and experience the world around us [1, 4, 5]. It is because AR applications have the potential to be such powerful persuasive tools that ethical concerns are significant.

2.1 AR Applications Are Better Persuaders

Augmented reality applications are functionally better at persuasion than humans for many reasons and, therefore, more likely to be successful persuaders [1, 2, 3]. The main reason the applications are better persuaders is AR applications can simply do things humans cannot. AR applications are more persistent [1, 4]. When human persuaders give up on their persuasive attempts, technology can continue without such concerns as losing their voice, offending someone, taking too much time, experiencing cognitive dissonance or giving in to resistance towards their persuasive attempts [2, 3].

AR applications are anonymous [2]. When designing a persuasive AR application, those behind that application can generally remain personally anonymous. This provides an advantage over human persuaders who are likely to be directly involved and immediately identifiable with those whom they are trying to persuade. This creates an opportunity for the human persuader to be less effective based on the responses and interactions with their targets [2, 3]. AR applications have a virtually unlimited ability to store and manage data [2]. Whereas human persuaders are limited to the amount of data they can memorize and recall, AR applications can store, access and cross reference data sources with high speed and little error [2, 3].

AR applications have a virtually unlimited access to multiple modalities of influence and the ability to seamlessly switch between them [2]. While human persuaders may be familiar with many types of persuasive techniques, they may not be able to recognize when it is time to change techniques, or which is the most appropriate technique based on the present situation. AR applications can be programmed with numerous techniques and can seamlessly move between those techniques with expertise based on the situation, including end user input and feedback, geolocation information, and many other types of data [2, 3].

AR applications are easily scalable [2]. While human persuaders may not immediately recognize the need to adjust their persuasive attempts, AR applications have the ability to immediately increase, decrease, or maintain persuasive efforts based on the feedback and other information they receive from the end user [2, 3]. Finally, AR applications are better than human persuaders because the platforms that utilize AR applications, such as smartphones and tablet computers, are ubiquitous [2]. While human persuaders have to be in the right place at the right time they can certainly not always be in the right place and time. AR applications, because of the devices they are employed on, and their ability to utilize timing, user data and GPS, are able to offer persuasive opportunities at nearly always the right time and place [2, 3, 5]. Taking these abilities together, AR applications provide developers a powerful tool to persuade end users. This necessitates the need for careful scrutiny about the uses and potential ethical dilemmas that may exist.

2.2 Unique Ethical Concerns of Persuasive AR Applications

While persuasion is commonly used, the more general question remains: Can persuasion be considered unethical? The answer is yes. As a persuasive technology, AR applications have the ability to intrude into people's lives and to manipulate them [6, 9].

There are several areas of consideration when examining the ethics of an AR application. Some of these areas should lead to further review of the intentions of the application while others should cause immediate concerns to be raised. AR, as a persuasive technology, carries unique ethical implications that are described in the following subsections.

2.2.1 Novelty

AR applications are relatively new and novel. The persuasive intentions of the designers can be masked or completely hidden [2]. Frequently, because of the novelty the persuasive elements are not immediately obvious. If an end user is unaware that persuasive attempts are being directed at them in the application, then he or she is no longer an informed or willing participant. The persuasive efforts are then considered covert, questionably unethical, and potentially coercive [2, 3, 6].

2.2.2 Positive Reputation Exploitation

With literally hundreds of millions of smart phones and tablet computers being sold worldwide, and people waiting in massive lines to obtain a new product on launch day, it is safe to say that many of the devices that run AR applications have positive reputation. Due to this positive relationship, there is a built-in trust with many aspects of the devices including the applications that can be utilized on them [2]. This creates an opportunity for persuasive AR applications to exploit the trust the end users have in their devices, applications and information being delivered [2, 6]. This exploitation opens possibilities for persuasion to be carried out covertly, or in other unethical fashions such as the use of deception [2, 3].

2.2.3 Persistence

As previously discussed, AR applications have the ability for unlimited persistence [2]. Long after human persuaders have lost their voice, run out of ideas, or simply lost the attention of the target, AR applications can endlessly prompt the end user for action and attention. This can be done through pop-ups, reminder alerts, continuation prompts, texts, and emails [3]. The ethical concern arises when the end user is repeatedly bombarded with persuasive elements that are difficult to avoid [2]. Because AR applications can utilize user patterns, GPS, and crucial timing, the repeated persuasive efforts can be extremely effective, but must be examined carefully for potentially unethical effects it has on the end user [3].

2.2.4 AR in Control

When dealing with human persuaders, people have the ability to question, recant, debate, and argue with the persuader. This ability for a truly interactive encounter allows for an element of control by both parties involved [2]. When dealing with a persuasive AR application, however, there is limited or no ability for the end user to engage in such opportunities. The only engagement available is what is programmed into the application. This makes the persuasive intent one sided and takes a significant element of control away from the end user [2, 3]. The lack of control is potentially unethical, particularly if the end user is unaware that they have no true control in the situation.

2.2.5 Emotions

AR applications have a tremendous ability to utilize persuasive techniques that can affect the emotions of the end user; however, the reverse is impossible [2]. Human persuaders are able to observe various cues displayed by those they are interacting with, including physical, emotional and verbal cues, and thus modify their techniques to ensure a more ethical exchange and outcome [2]. AR applications are at a significant disadvantage as they currently are unable to observe these types of cues without direct end user input, and are therefore unable to adjust their techniques in the face of these cues [3]. If an end user is uncomfortable with the techniques being used at that moment by the AR application and has no ability to modify it, then it is potentially unethical [2]. As technology continues to evolve, AR applications may gain the ability to observe, read, and react to physical cues such as facial changes, eye movement and pupil dilation, which signal an emotional response, thus allowing it to modify the persuasive techniques being utilized.

2.2.6 Responsibility

The ability to take responsibility for one's own persuasive actions creates an interesting dilemma for AR applications [3]. A human persuader is clearly able to take responsibility, or at least to be held accountable, for their persuasive actions [2]. Human persuaders can make adjustments, apologize, and make restitutions for any unethical actions they may engage in. AR applications, on the other hand, have no ability to accept personal responsibility, which creates potential for an ethical dilemma [2]. Designers of AR applications can face legal responsibility for any damages their product causes [7, 8, 9, 10]. However, there have been no product liability cases as of the writing of this paper [8, 9, 10, 11]. Fogg states it may be difficult to seek accountability from those who develop the applications as they may have absolved themselves from the application, or the company may be out of business [2]. To complicate matters, because the Internet can perpetuate software applications long after a developer is out of business, it creates further dilemma for assigning responsibility and seeking restitution for someone who has suffered some sort of harm from the persuasive application long after the company has closed [2].

2.3 Questionable, Concerning, and Dangerous Persuasive Techniques

While persuasive techniques are commonly used without significant concern, and have significant positive outcomes, there are several types of techniques that can be utilized in persuasive AR applications that require attention. When these techniques are observed, they should cause concern for end users, and developers alike [3]. Though these techniques should raise attention and scrutiny it does not necessarily mean they are being used in unethical ways, so caution is required when utilizing and interacting with them [4]. Finally, there are some techniques that should always be

considered to be unethical and should be avoided [2]. Examples of these techniques are presented in the following subsections.

2.3.1 Operant Conditioning

Noted behaviorist B. F. Skinner developed the theory known as Operant Conditioning. Briefly, it is the theory that you can modify behavior (persuade) through repetition paired with reward and punishment. It is generally acceptable, and common, to reward an end user of a persuasive AR application for completing a requested task, following directions, or modifying a targeted behavior. However, the use of punishments in an attempt to modify behaviors, or force an end user action, is typically considered to be unethical [2, 3]. Such use of punishments, or negative reinforcements should be avoided.

2.3.2 Surveillance

Surveillance is another persuasive technique available to an AR application that should raise suspicion, depending on the context and purpose for its use [2]. Fogg states that as long as surveillance is being used in a way that positively reinforces or is helpful, then it can generally be considered to be positive [2]. However, if it used in order to covertly observe, collect private information, or to punish, then it should be considered unethical and should be avoided [2, 7].

2.3.3 Vulnerable Groups

Another use of persuasive AR applications that should be scrutinized is any use that attempts to persuade members of a vulnerable group [2]. Such groups include children, the elderly, those in poverty or of a low socio-economic status, the developmentally disabled, the intellectually challenged, and the mentally ill. This technique should be examined for its persuasive intent. If the intention is to reward or positively reinforce the actions of an end user in a vulnerable group, then it is generally not considered to be unethical. However, if the intention appears to attempt to exploit or punish, then it should be considered unethical and should be avoided. In some cases where exploitation is obvious, reports should be made to advocacy groups, and in some cases, such as child pornography, the police, to ensure the safety of those being exploited.

2.3.4 Coercion, Punishment and Deception

While some persuasive techniques are open to debate and scrutiny as to their ethical use, coercion, punishment and deception are considered taboo [2]. These types of persuasion involve forcing end users to make a choice, usually with a threat of a negative consequence, or by blatantly lying to them, which ultimately only benefits the application developer, or advertisers. These techniques force end users to do things they normally would not do, and something they likely do not want to do. Techniques involving coercion, punishment and deception are always unethical and could

potentially be dangerous and illegal depending on the outcomes of their use.

3 Privacy

In the limited number of published articles on AR and ethics the topic that appears most frequently is that of privacy [3, 6, 7, 9, 11, 12, 13]. Privacy in the United States is protected by federal law under the Constitution. When it comes to mobile technology privacy remains a key concern to consumers [7, 8]. Many anecdotal reports in the media claim that most consumers, especially those younger than 30, are less concerned about their privacy rights, and are willing to increasingly give them up for improved access to mobile and online content and applications [14]. However, in one of the first scholarly articles written on the subject the opposite was found to be true. While younger consumers are more active users of mobile applications, and participants in online networks, they continue to have similar views to those of consumers over 30 when it comes to their privacy, norms, and policies. Further, they report their privacy continues to be of great value to them and of significant concern for protection [14].

Even if younger consumers are not as concerned about private data, applications developers must be. Personal and private data collection of the end user remains a significant point of ethical concern in AR applications. With developers, advertisers, and retailers trying to figure out the most effective way to gain consumer attention, end user data becomes very valuable [7]. Developers of AR applications are often eager to obtain as much hard data as possible on how to effectively engage, maintain, and persuade their end users with their product [7]. Such data allows products to be better tailored to such end goals, and can ultimately lead to increase revenues [7]. These desires must be tempered by ethical considerations such as privacy protection, informed release of information, informed consent, and user safety.

3.1 Types of Privacy That Raise Ethical Concerns

Consumers' public reaction to perceived and real violations of privacy remain strong, and they hold negative opinions of companies that track their movement and activities online [7]. This is true for consumers of augmented reality applications as well [7]. While it is clear that privacy remains a key concern to consumers, and information remains a target of interest for developers, advertisers and retailers, most of the online information tracking and gathering is lawful [7]. Consumer concern and reaction has led to recurring calls for action across both the US and Europe, resulting in multiple laws and regulations across various jurisdictions and municipalities [7]. Wassom calls this "patchwork legislation and regulation," and states it leaves developers confused about what information they are allowed to gather [7].

3.1.1 Personal Information and Data

The collection of personal information poses ethical concerns. With applications asking for blanket permission to

access user data, ethical concerns are raised about how that information is used, how it is protected, and who has access to the information. For example, when using an AR web browser, does the application track users' every move, and what types of locations a user visits based on GPS data? Does it track how long they stay, or how many times they frequent the locations? With the increased proliferation of being able to make purchases with a smartphone, are all of the end user's purchases being tracked? If applications are tracking such information, how is that information being stored? Is it secured or is it being sold to marketers and advertisers? Are the end users aware of the information being derived from their using the applications? What control, if any do they have over what information is retrievable and disseminated?

Further, what if the information was being used in an effort to survey the end user? Could the information be used to target the person based on their religious affiliation because their data shows them visiting a specific house of worship such as a mosque? In 2006 the US government disclosed that they had obtained literally hundreds of millions of phone calls and cellphone data from telecom companies in the name of fighting terrorism without warrants or disclosure to the public. When raw information is accessible to others, they are able to make assumptions about the users that might be good, bad, or simply incorrect without the end user's knowledge or ability to correct or defend against those assumptions [13]. This creates a significant ethical dilemma, and AR application designers can look to this series of questions as a template for the types of issues they must address in their application design.

3.1.2 Facial Recognition

Perhaps no other development in AR holds as much excitement, anticipation and concern as facial recognition software. Current technology is being developed by major computing and online companies that would allow public, and potentially private, data and information to be displayed through facial recognition AR applications. The ethical concerns over privacy violations for such ability are great [7, 12, 13, 15, 16]. The use of AR data including GPS and other data mined information, when combined with the facial recognition will lead to a seamless blending of online, and offline, as well as public and private lives [17].

AR facial recognition applications are currently being developed that will scan a person's face, and then go online in an attempt to compare the unique facial features of that person to photos posted on public social sites in an effort to identify that person. When applications like this become available, concerns for how that information will be used are significant. If a person is interested in someone they randomly encounter, it will be possible to find personal information about that person, potentially without their knowledge and without their permission, if they are unaware the application was being used on them [12]. Their friends, marital status, general interests, personal contact information, political and religious affiliations, and other private data might all be available at the push of a button and on display for anyone who uses the application to see. This can lead to serious concerns over

privacy, stalking, being targeted by misleading advertisements and scams, social stereotyping and profiling [3, 17]. Ethical concerns are further raised by the abilities of the person who is being identified by the applications. Does the person have the ability to opt in or out of the recognition? If they opt in, do they have any control over what information is allowed to be shared? Do they have any ability to know where, when and who has used the applications to identify them? Is there any disclosure that the technology will be deployed and therefore give them the opportunity to opt in or out?

Further, concerns have been raised about this particular application because the company developing it has total control over what information is presented about an identified person in the application. Potentially, the company could present only negative information that could damage a person's reputation. While there is market excitement surrounding facial recognition, the risks of ethical violations concerning privacy are significant.

4 Safety

There are real ethical concerns regarding safety for people who use AR applications and for those around them. This holds especially true for AR games and navigation applications, as they require an end user's attention and focus. Human beings have limited capacity to focus on multiple activities. This is due to the brain's limited capacity to process multiple actions and to handle the processing and memorizing of the activities and stimulus [3]. When a person is focused on using an AR application, they tend to be focused on the screen of their smartphone or tablet (and in the very near future, on glasses as well on car windshields), as well as the information that is being presented on the devices [3]. This leaves limited ability to focus on the rest of the world around them.

4.1 Potential Pitfalls of Immersive AR

AR applications can provide an immersive experience [7, 9, 18]. The utilization of visual and auditory elements, while demanding the user's focus, creates the immersive potential [3]. When an application becomes immersive and commands the continued attention from the end user, it creates the potential for the end user to become so engaged in the experience that they become completely engrossed in the activity, and lose awareness of time and what is happening around them. This is referred to as a "flow state" [3, 18].

When users of an AR application enters a flow state, they are at risk for real injury. If they are walking down the street holding their phone in front of their faces playing the latest AR scavenger hunt game, will they be able to pay attention to other pedestrians sharing the sidewalk? Will they be able to notice the broken concrete, or other obstacles, and avoid tripping and falling? Will they be so engrossed that they step off the curb into oncoming traffic because they are so focused on the latest rating tagged on a nearby restaurant?

The potential injury from intense focus on AR applications goes beyond a simple trip and fall. Applications, such as navigation, and games, rely on GPS information and user input to guide an end user to a goal or target. What if the

information listed in the application is bad, or the developer is unaware of the general safety of the location? For example, a developer creates an AR game that requires users to travel from location to location in the real world while using their mobile device. If the developer was unaware of the true nature of the area the game was directing the user to, the user may find him or herself in a bad neighborhood, or trespassing on private property [9]. Both scenarios could put the user in actual danger.

With car windshields with AR capability on the near horizon, ethical concerns for real harm to occur begin to surface. If simply walking down the street while engaged in an AR application can lead to injury because a person trips and falls, imagine the potential for serious damage and injuries that can occur by a driver distracted by information displayed on their windshield! Accidents while driving with distractions such as talking on the phone, eating, putting on make up, texting, adjusting the radio, having conversations, have all led to accidents. In fact many states have banned the use of cellphones and texting while driving because of the increased risk for accidents these activities pose [20]. With AR applications being immersive and attention grabbing, AR windshields (depending on the type, amount and placement of information displayed) have the potential to create a further distraction to the driver, thus placing them at increased risk for an accident.

4.2 Liability and Avoidance

The potential for actual harm, both physical and emotional, should be of serious concern for application developers and those who fund them [3, 7, 9, 10]. While no litigation has yet been filed for injuries sustained while engaged with an AR application, it is just a matter of time [11]. Wassom predicts that litigation due to injuries is unavoidable, and states that other liability cases have already laid the groundwork for AR cases to be tried [9, 11].

While the desire for many AR developers is to keep the user engaged and engrossed in their applications, considerations should be given to ways to limit the potential for injury from using their products. Some simple measures can be taken to limit the potential for harm. First, while an immersive experience is optimal for maintaining a user's attention, it is not optimal for avoiding the potential for injuries. In mobile AR applications a simple "time out" feature could be placed in the program that pauses the game and thus gives the user an opportunity to be aware of their surroundings. Second, a warning disclosure could be placed at the launch of the application that briefly informs the user of the potential for immersion and injury. Lastly, for all AR applications, limiting the amount of information displayed will limit the potential for distraction of the user. This is especially important for AR windshields and AR glasses and goggles.

5 What To Do?

So how do developers, advertisers, investors, marketers, and retailers determine what is ethical and what is not when it

comes to their AR applications? There is no one clear answer for this. While seemingly obvious to many, ethics are personal and individual. Ethics involving augmented reality are based on the views of the individual of developers, designers, investors, end users, bystanders, researchers, lawyers, judges and legislators. One person's serious ethical dilemma brought on by the ability of an application can be another person's glowing success of that same application! Each individual involved must determine their own ethical standards and how they will apply, adapt, or abandon those ethics based on the needs of others. One ethicist states that in order to limit ethical dilemmas of technology, personal data should always be ultimately owned by the individual, and he should have final say on how, and if, the personal data is to be used, any use of the individual's personal information without their consent is a violation of their free will, and thus highly unethical [13]. However, data that is obtained that is generalizable and not tied directly to an individual should be considered fair use [13].

5.1 The Ethical Decision Tree

When developers are creating persuasive AR applications they should critically examine their design, the ability and intention of the technology, and their desired outcomes [2]. This can help them determine what potential ethical concerns surround their design. Fogg developed the "stakeholder analysis" to help developers truly examine their application and the implications it has. It helps a developer determine ethical concerns by examining who will be potentially involved with all levels of the application, who has the most to gain or lose, what they have to gain or lose, and then determining the ethics of the gains and losses based on the values of those developing the application [2]. This analysis is completed prior to the development of the application, but can be used upon its completion.

5.2 Ethical Codes of Conduct and Review Boards

While not all involved in the development, funding and delivery of AR applications are members of formal organizations that provide ethical standards for members, such organizations and codes exist to provide guidance. Most importantly for the developers of AR applications is the ACM Software Engineering Code of Ethics and Professional Practice [19]. The code provides an excellent standard for professionals to adhere to, or at least be advised by this code.

For those who plan to research AR applications and their effects, they will most likely have to present their research proposal to a review board. A board examines the potential research and determines what, if any, potential harm the research could pose. Further, those who seek any governmental funding for research typically have to present to a review board [10]. Any ethical violations during research done through governmental funding in the US is potentially actionable [10].

5.3 Disclosure

Another way AR developers can limit ethical concerns is to simply provide full, accessible, and understandable disclosure to the end user. This disclosure should include what information the application uses, how it is used, and any options the users may have to adjust how this information is used. Further, as discussed previously, disclosures can be placed at the beginning of the application to indicate the potential for immersion and the risks it poses. While simple upfront disclosures can never suffice for full legal disclosure as to limit exposure to liability, it will at least provide some limitations of ethical dilemma.

6 Future Research

Future research is needed in many areas of AR but especially those in cognitive psychology [1, 3, 21]. This research will help developers have a better understanding of how the technology is used, understood, processed, and engaged with by users [21]. Further, more scholarly studies should be conducted on the ethics of privacy in AR applications.

7 Conclusions

While AR applications present exciting opportunities for developers, advertisers, retailers and end users alike, they also raise serious ethical concerns. Concerns over persuasive ability, manipulation, user privacy, and safety abound. As AR applications continue to invade the market place they are likely to face legal tests in the near future on the grounds of liability, and copyright [11]. While there are no agreed upon set of ethical guidelines and standards for those developing and designing AR applications, other formal ethical standards, such as those set out by ACM Software Engineering Code of Ethics and Professional Practice can be utilized by professionals. Another tool for determining the ethical nature of an application is that of the ethical decision tree [2]. Future research is needed in many areas of AR but this is especially true for the ethics of AR applications.

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