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Safety Risks in Location-Based Augmented Reality Games

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Abstract. Location-based augmented reality games occur with a player moving through public spaces, which carries risks. The inattention of the player is one such hazard. Additionally, as seen in many news reports, players of these games have also engaged in trespassing, playing while driving, playing in places of worship, etc. These actions have led to public outrage, and in some well-known cases, arrest and legal consequences. These instances bring forward issues for developers to consider to ensure players' ethical development and safety while using modern location-based AR games. To evaluate the current safety problems of these games, we provide a comparison of popular AR games.

Keywords: Augmented reality · Location-based games · Safe games.

1 Introduction

The world is an inherently dangerous place. We learn this from a young age, and we protect ourselves via risk mitigation, such as wearing a seat belt in a car. This is problematic for new technologies, as technological development moves faster than a risk assessment and mitigation is put in place. Further, there are the *unknown unknowns*, which only become apparent over the life cycle. Over the past few years, augmented reality (AR) technology made a giant leap in development. Such developments have not been well examined in terms of risks, leading to incidences of arrests, detainment, potential physical harm, and emotional damage for both users and non-participants, which we will examine later in this article. AR is the environment with the addition of digital data to the physical world employing digital devices. The scope of AR is rather extensive, and it includes mobile technology, medicine, military, computer games, etc. AR applications and limitations are described in detail in [32].

In 2018, the global law firm *Perkins Coie LLP* issued the report comparing Augmented Reality and Virtual Reality (VR) in 2016 and 2018 [4]. About 39% of respondents indicated that AR and VR technologies are more prevalent in game development. In 2016, only 18% of respondents were concerned about safety issues. However, in 2018, the number of respondents concerned about safety issues has increased to 42%, which shows that the AR and VR markets require a solution for this problem. This growth portrays the relevance of the study about

safety issues in AR games. Later in 2020, *Perkins Coie LLP* issued the newer report, where the safety issues in AR and VR games are of concern to 41% of respondents, which participated in this survey [5]. This survey was conducted with startups, established tech firms, advisers, and outside consultants.

In his book Wassom raises questions about the ethical side of AR technologies [33]. The author states that the AR may change our relation to privacy and ethics [29]. This is already happening, and cases of arrests and fines because of AR games demonstrate that this process is not smooth (see Section 2). AR provides the extension of different parts of reality. This paper focuses on game content generation based on location and aims to discuss safety and ethical problems.

2 Background

One of the pioneers of mobile multiplayer location-based AR games (LBGs) is *Ingress* released in 2012 by *Niantic Labs*. This game's main idea is to join one of two existing teams and, on the real-world map, conquer game objects linked to specific locations, which are called portals. To conquer portals, players must physically reach them. The players were allowed to create new portals. However, some players created portals in unethical and unsafe places, including cemeteries, temples, dangerous places, etc. To prevent it, developers have forbidden the creation of new portals in 2015. Later in 2017, this functionality was returned to players with some limitations: high-level players had to approve new portals. It does not imply that all high-level players are highly educated people who understand ethical problems, which some players can cause. The game's positive side is that it allowed people to get a new playing experience, pushing them to go outside. More extensive research about *Ingress* can be read in [3, 12].

In 2016 *Niantic Labs* released a new LBG called *Pokémon GO*, which became the most popular AR game in the world. The idea of this game is to catch imaginary creatures called *pokémon* located on the map, upgrade them and fight with other *pokémon*. Similarly to *Ingress* *Pokémon GO* pushes players to move. The *Pokémon GO* has *pokéstops* and gyms located on map. Their locations are taken from *Ingress* portal locations. *Pokémon GO* revealed the ethical and safety problems of this game concept. Some of the locations resulted in people questioning the ethics of a specific location being integrated into the game space.

It is impolite to see someone playing games in temples during prayers. This can distract and make worshipers feel uncomfortable. The world contains many places where playing games may be considered inappropriate and even illegal. For example, the director of public affairs at the Holocaust museum states that it is unacceptable to play *Pokémon GO* in a memorial to the victims of Nazism [27]. After such incidents, *Niantic Labs* had to exclude some of the museums from possible places of *pokémon* generation. Nevertheless, the problem did not disappear. More discussion about catching *pokémon* is provided in [15].

Mobile application stores allow publishing games separately for different countries. This will enable developers to focus on chosen markets. Also, some games and applications are not authorized by governments to be published. In

some cases, games and apps can even be blocked [18] in those countries' mobile application stores. One of the possible reasons for it is a conflict with the laws of those countries. For example, *Pokémon GO* remains blocked in Iran, Kuwait, etc.

Sometimes illegal behaviour caused by AR games may lead to jail. Players can be officially arrested for playing in some territories; this happened to Ruslan Sokolovsky while playing in Russia in Yekaterinburg's Orthodox church [29]. Therefore, it is imperative to know the country's laws while playing LBGs.

Generation of game content in water, near volcanoes, and other places can endanger life. In [16] authors consider five LBGs and claim that in *The Walking Dead: Our World* content can be generated in the water and in *Draconius GO* even on high traffic motorways. Unfortunately, dangerous areas can be everywhere if players are too distracted by the game. There are plenty of situations when *Pokémon GO* players died or were traumatized while playing [11, 19].

In their paper, Colley et al. [6] reported the results of a mixed-methods study of the geography of *Pokémon GO*. It includes a five-country field survey of 375 *Pokémon GO* players and a large-scale geostatistical analysis of game elements. Authors claim that *Pokémon GO* has geographically-linked safety risks. The authors found out that *Pokémon GO* causes people to visit new locations on an unprecedented scale with some degree of distraction-related risk. The results have shown that more in-game content is generated in urban places than in rural areas. Over one-third of respondents reported some form of near-miss or actual collision with an object while playing the game. Mainly those players reported bumping into signs, poles and other people. The most severe awareness problem is raised when they come into conflict with road traffic. In this respect, 11% of participants recalled situations in which they had put their safety at risk by, for example, crossing the street without looking. About 13% of respondents did report feeling unsafe in an unknown place while playing *Pokémon GO*. Authors reported that three approaches could be used to increase the safety of AR game players: notification about dangerous areas, avoidance of game content appearing across a road from the player's location and stricter game prohibitions while driving. Also, the authors state that movements are more dangerous than places in LBGs. Some gamers' carelessness and indifference will always be a problem in LBGs. Still, there is a chance to reduce the deaths and traumas using some universal rules for forbidding game content generation in dangerous areas. Thus, this paper should examine hazardous locations for game content generation.

The popularity of *Ingress* and *Pokémon GO* led to the greater interest of gamers in LBGs; it has been claimed that these games created a new game genre [30]. And this stimulates the market to develop a more considerable amount of new LBGs in the nearest future. It can be assumed that future games should somehow change game content generation to prevent problems with laws in different countries and issues with dangerous places. Therefore, game developers should pay attention to laws. Some countries considered *Pokémon GO* inappropriate from a religious point of view. Some countries were afraid of revealing military object locations, etc. We believe that the lack of algorithms preventing

the generation of game content in dangerous and inappropriate places increases the risk of traumatizing people and breaking the laws in LBGs.

According to [16] generation of content in LBGs happens in points of interest (PoIs), which can be created manually or automatically. Authors claim that in *Draconius GO* automatically generated PoIs may appear in restricted areas making the game unsafe because of trespassing to forbidden territories. Millard et al. discuss the responsibilities of mixed reality designers for using places in their applications [20]. These responsibilities include avoiding physical trespass, respecting cultural norms of behaviour, etc. The application of the automatically generated PoIs can lead to ignoring those two responsibilities because virtual objects may occur in private territories or unethical places.

Some safety issues can be solved by using audio cues [26]. *Songs of North* is a LBG released in 2004, where users can get a sound notification while playing in a dangerous situation. The audio cues are more deeply discussed in Ekman et al. [7]. The sounds in *Songs of North* emphasize the surroundings, which allows a player to percept the game and other players without staring at the phone.

Other problems may arise while playing LBG with a specific device on the head, as described in the paper of Broll et al. [2]. The authors describe the head-mounted AR system with monocular or binocular for the augmented view of the world. Even though the system can superimpose the real world with virtual objects, using such a system outdoors risks a malfunction and wearing a sizeable head-mounted unit in many places in a church might not be appropriate.

In 2019, a new COVID-19 virus emerged [31]. Due to this, countries were obliged to maintain social distancing and self-isolation, which almost excluded playing outside. It has been widely publicized that some players of *Pokémon GO* were fined for playing outdoors [8]. In 2020, *Niantic Labs* announced the changes in their games to encourage home AR gaming [23, 25]: walking inside home began counting as the achievements progress; the paid pass to participate in *Pokémon GO* raids was introduced; the amount of content for *Harry Potter: Wizards Unite* was increased; the need of interaction with *Ingress* portals was reduced.

3 Comparison of LBGs

To understand the advantages and disadvantages of LBGs in terms of safe and ethical content, we provide a comparison of several popular games: *Ingress*, *Pokémon GO*, *Jurassic World Alive* and *Harry Potter: Wizards Unite*. All of those games were released in different years, which allows for a focus on LBGs evolution. Other LBGs are omitted in comparison because it is work-in-progress. *Ingress* is chosen for comparison as a pioneer in the field of LBGs. The *Pokémon GO* is chosen for being the most popular LBG. *Jurassic World Alive* was released in 2018 by *Ludia Inc.* This game's idea is close to *Pokémon GO*. Another setting and game content differs from *Pokémon GO*. Visually *Jurassic World* looks different from *Pokémon GO*, mechanics of catching of dinosaurs do not copy the mechanics of *pokémon* catching. In 2019 *Niantic Labs* and *WB Games*

San Francisco released *Harry Potter: Wizards Unite*. It has the same backbone as *Pokémon GO*. As a result, the game suffers from the same problems: generation of the game content depends on the time of the day and weather, the neighbourhood’s density, which results in a lack of content in rural areas.

People tend to overcome their opponents by reaching generated content faster than others. However, it could lead to traumas while using vehicles [14]. Therefore, all the abovementioned games have a speed limit for players. We believe that the speed limit may differ for the compared games, affecting the safety level.

The number of extreme weather conditions rises exponentially year over year [9]. However, with the current quality of life, the amount of people suffering from the consequences of extreme weather conditions is decreasing. From 2006 until 2010, in the United States, 10649 deaths were related to adverse weather conditions such as heat and cold [1]. The LBGs may be played outdoors, so they impose restrictions on movement in extreme weather conditions.

Due to the lack of visibility, a human makes more mistakes at nighttime than daytime [28]. The street robbery rate is higher at night, as stated by the US Department of Justice [21]. Moreover, the night also worsens the visual perception of obstacles, which can lead to traumas. Gold mentions that some people were awakened at 3 AM by crowds of *pokémon* catchers bumping into things [10]. Therefore, playing LBGs during the night may be unsafe and unethical.

By trespassing private, unethical, and unsafe areas, players put themselves and people around at risk [22]. The LBGs should prevent the generation of in-game content in such areas. The experience of *Ingress* shows that two or more players competing nearby can negatively affect their health [13]. Thus, Player vs. Player (PvP) distance is vital for the safety of the players.

Since the developers of considered games have not provided the exact information about the speed limit for playing, all of the measurements were done empirically. Information about other criteria was gathered from considered games’ safety rules, community guidelines, terms of service and observed game features. The results of our observations are collected in Table 1. Previously described games are compared according to the criteria: speed limits, extreme weather conditions, nighttime, trespassing alerts, and PvP distance.

Table 1. Comparison of Chosen LBGs

	Ingress	Pokémon GO	Jurassic World Alive	Harry Potter: Wizards Unite
Speed limit alert	50 km/h	50 km/h	15 km/h	15 km/h
Extreme weather alert	Weather	Weather	General	Weather
Nighttime alert	No	No	No	No
Trespassing alert	General	General	General	General
PvP distance	Proximity	No matter	No matter	N/A

It can be seen that *Jurassic World Alive*, and *Harry Potter: Wizards Unite* have the lowest speed limit for playing the game, which makes driving during the game almost useless. Therefore, these two games are better for the safety of drivers. However, all games allow skipping the warning by answering that they are passengers. We believe that more strict rules have to be applied for players exceeding the speed limit, whether they are drivers or passengers. The game should be locked in such cases to prevent cheating by playing drivers.

Each compared game gives a general warning to avoid private and unsafe areas. Nevertheless, notification during trespassing is not provided. We assume that the detection of such a variety of spaces can work better than a general warning. In the ideal case, games should not generate content in such areas or close to them. This should become an essential direction for LBGs to make them safer and protect players from breaking the laws. Currently, all considered games allow sending reports about unsafe and inappropriate places.

Extreme weather conditions are differently processed in considered games. All games of *Niantic Labs* give extreme weather condition warnings while *Jurassic World Alive* gives only a general notice, which is less safe. We believe that warnings can help some players to stop playing. For others, they may be ineffective. The ultimate solution is locking the game during extreme weather conditions.

None of the considered games notifies players about increased danger during the night. The presence of this feature could allow preventing playing outdoors at night. Moreover, *Pokémon GO* has unique creatures appearing during nights, pushing some players to go outdoors. We assume that night game content generation in LBGs has to be minimized or even excluded to make games safer.

PvP was added to *Pokémon GO* in 2020, and developers claim that the opponents for PvP are chosen from the entire world [24]. We may assume that this decreases the chance of matches between players located nearby. According to claims of developers, the choice of opponents for PvP in *Jurassic World Alive* does not depend on distance [17], which prevents physical contact between players because of game conflicts. Currently, PvP in *Harry Potter: Wizards Unite* does not exist. Therefore, *Ingress* has the highest safety risk among others because of possible conflicts between players located near to each other.

Thus, it can be said that games of *Niantic Labs* have partially evolved in terms of safety because of having lower speed limit alert in their last published game *Harry Potter: Wizards Unite* and because of not having proximity condition for PvP in *Pokémon GO*. Supposedly, developers of *Jurassic World Alive* have considered the experience of *Niantic Labs* with playing drivers and also used a lower speed limit. However, they did not pay that much attention to extreme weather condition warnings and used only general warnings.

4 Conclusions

This study has considered the ethical and safety problems of content generation in LBGs. The comparison of modern LBGs was done. This paper demonstrates that the current state of LBGs contains many safety risks related to playing while

driving, in extreme weather conditions, during nights, on private territories, etc. Therefore, it requires changes to motivate players to enjoy the game safely. Specific actions could decrease this.

Future work would be to develop and test the LBG following the provided recommendations and contain safe content generation algorithms that can exclude hazardous places. Furthermore, surveys should be conducted to understand how effective risk warnings are for the user and if they will be heeded.

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