Simplified Mobile AR Platform Design for Augmented Tourism

Eric Hawkinson, Edgaras Artemciukas

Abstract**—**This study outlines iterations of designing mobile augmented reality (MAR) applications for tourism specific contexts. Using a design based research model, several cycles of development to implementation were analyzed and refined upon with the goal of building a MAR platform that would facilitate the creation of augmented tours and environments by non-technical users. The project took on several stages, and through the process, a simple framework was begun to be established that can inform the design and use of MAR applications for tourism contexts. As a result of these iterations of development, a platform was developed that can allow novice computer users to create augmented tourism environments. This system was able to connect existing tools in widespread use such as Google Forms and connect them to computer vision algorithms needed for more advanced augmented tourism environments. The study concludes with a discussion of this MAR platform and reveals design elements that have implications for tourism contexts. The study also points to future case uses and design approaches for augmented tourism.

Keywords**—**Augmented tourism, augmented reality, user experience, mobile design, etourism.

I. Design Goals

THIS study employs design based research and an iterative approach to create and analyze user interfaces for tourism contexts, mainly in destination tourism such as augmented tours and informal learning environments. MAR has shown to have many affordances in tourism applications [1]–[3]. Uses that have already shown promise have risen in location based marketing, geocaching, and massive augmented reality games like Pokèmon GO [4]–[6]. Many of these uses have pointed out design choices that have impacted the experience of their use in tourism contexts. These past implementations guide as well as a series of field tests have yielded in an evolving set of principles for the design of MAR experiences, both in the creation of the environments and in their use [21]–[25]. This study outlines iterations of designing MAR applications for tourism specific contexts. The goal is to form an overall framework of design principles to build on these technologies for tourism. To accomplish this goal this study will follow the evolution of the design of an MAR application through several iterations, showing how feedback and new technologies influenced this design-based research.

Eric Hawkinson is with The University of Fukuchiyama, Japan (e-mail: erichawkinson@gmail.com, website: http://erichawkinson.com).
Edgaras Artemciukas is with Klaipeda State University of Applied Sciences, Lithuania (e-mail: e.artemciukas@kvk.lt website: https://ourtechart.com).

II. AR in Tourism

Tourism is well suited for implementations of AR due to many factors. Users are moving around and in new locations and makes getting contextualized information about where you are and what you are looking at very useful. Tourism settings benefit from connecting expert and curated content to places, people and objects. It also allows the creation of individually customized experiences that connect user preferences to possible differentiated tours and options. AR has already been used in museums as interactive guides that provide contextualized information about where visitors wonder [9]–[11]. AR is also seen in libraries to orientate visitors to facilities and available periodicals [12]. AR has also been used in events of many kinds including live sporting events [13], concerts, and international conferences [14], [25].

The most notable use in tourism is that related to navigation and how it connects to user preferences. Most mobile devices have equipped with Global Positioning Service (GPS) receivers that allow the device to know where in the world it is. This has allowed for large scale adoption of AR-like tourism applications. An early version of GPS gaming is geocaching. Geocaching is where public lockboxes are placed at specific GPS coordinates, so explorers equipped with GPS radios. It has been great for nature enthusiasts and park administration to add fun and engaging elements to visitors [15]. One great example of this is a location-based check-in platform known as Foursquare. Foursquare took the GPS coordinates from your mobile device and gave you a list of nearby places to eat, drink, rest or play. It also allowed users to ‘check-in’ to a location while they were physically there. Users add the ability to rate and review quality of product and service when they checked-in. It quickly became a convenient and powerful tool for travelers and locals alike to find high quality food and service in their current area. Business models around the platform began to form. Business offered discounts and other perks for check-ins and favorable reviews. A major system was made to denote the user who has the longest streak of daily check-ins. Starbucks coffee gave free coffee to the mayor of their establishments, another way to reward brand loyalty and encourage social sharing. The data generated from the Foursquare platform can inform us how the technology can offer a new level of customer behavior understanding for marketing and promotion [16], [17]. This is an important understanding to the design of AR environments and what makes the use of this technology to attractive to marketers. To overlay digital content in and on the physical world requires a device to search for triggers and that requires the acquisition of a lot of data. In the case of Foursquare it has facilitated the collection and analysis of the movements of large amounts of people with very large sets of GPS coordinates. It has allowed for a detailed breakdown of consumer movements and preferences in local areas, and has even been used to track urban activity and growth [15], [18].

More sophisticated large-scale AR experiences became popular in large scale social GPS gaming. Software developer Niantic created the hit mobile gaming platform Ingress, which pitted two teams in a battle over control of physical locations. The game enjoyed great success and inspired city-wide campaigns all over the world mobilizing hundreds of thousands of players. The game requires players to go out and explore physical locations, and the game's popularity was harnessed to create connections between local populations and local tourist points of interest [19]. This game was very important, as it showed design challenges and opportunities in AR environments. The designers knew that they could not possibly create the needed catalog of physical locations around the world from which players would battle to control, so they built a submission tool into the game that allowed users to add their favorite local statutes, stations, and other interesting neighborhood locations. This became very important because over the course of 10 years of gameplay, the company cataloged millions of locations around the world. Those locations were the basis from which Niantic built their next AR gaming platform, Pokémon GO. Pokémon GO could possibly be the most important AR platform to date in terms of learning design principles. The platform had record breaking success in terms of user base and in game purchases, but there were also a host of unforeseen problems, both legal and social with the game's large-scale use. Users went into private and dangerous place, they overcrowded areas, and got into accidents from being distracted to what was digitally there instead of what was really there [20]. Many local municipalities as well as local businesses have tried to harness the power of Pokémon GO to get consumers moving around and engaging in commerce. Kyoto, Japan which is the home of Nintendo, the holder of the Pokémon intellectual property, have tried to broker deals to incorporate the platform to serve local tourism, but the initiative has not shown any traction as the game had little connection to the corporate headquarters. This did not stop local businesses and municipalities from creating maps of Pokémon GO world items and locations and how they relate to local attractions. Pokémon GO showed us some hints into the future of digitally augmented environments.

III. Design Principles

There are many factors that influence design choices of mobile augmented experiences, many of them come from factors related to the physical environment for which the experience will take place [7], [8]. This is due to the fact that the physical space(s) and the purposes they serve are greatly varied. Attributes of the space that can greatly impact MAR design are internet bandwidth, wireless signal strength, lighting, freedom of movement, and public access [1], [9]. The users also are a big part of design choices. The users can have different levels of experiences using AR, they can have different expectations of technology, and they can have varied levels of technical expertise [10]. All of these lead to different levels of 'buy in' or motivation to engage in AR enhancements for tourism contexts [11]. Another concept important to design choices is the level of digital enhancement. Past examples such as geocaching have a minimal level of digital enhancement as in that activities most basic form the only digital information being added to a user's experience is a set of GPS coordinates. As AR related technologies evolve such as computer vision and other sensors they will combine and aggregate more data and add more content into the experience. These ideas have been explored in classroom settings for learning environments and are influenced by the devices being deployed and the capabilities of those devices [23], [26]. Some capabilities may include depth sensing cameras, motion sensors, and powerful image processing power [1], [12].

IV. Methodology

Design-based research (DBR) is the chosen method of inquiry for this study. DBR is a method of inquiry that attempts to blend rigorous research methods with practical implementation [27], [28]. DBR is appropriate for this study for a variety of reasons. The quickly evolving technology means tools and equipment can change as research is taking place. The seasonality and repetitive nature of tourism lends itself to a series of trails [27], [28]. DBR is also fitting as it allows the discovery and shifting of research focus between cycles as new data emerges from each trail. The study looks back to past case studies and prototypes then moves to field tests and user trails. The iterations will stop when there has been enough evidence gathered to sufficiently declare overall themes and principles. As a secondary goal, application will reach a stage worthy of public consumption. If that is accomplished, it is possible that research may continue with a new focus based on large scale use.

V. Past Iterations and Case Uses

First stages of this research involved looking to implement commercially available augmented reality platforms in tourism contexts. Trails using mobile applications such as Blippar, Layar, Wikitude, Entiti, Aurasma, Junaio, and others were used to create simple marker based tours and learning aids for informal learning environments. During these stages lists of functions, business models, and deployment strategies were created to start to categorize these products for tourism use. One notable categorization technique came about by focusing on the instrument utilized for collecting data for augmentation. From this a table was created to help inform design considerations of MAR elements as they relate to how environments can and should be augmented with digital information. Separating visual, audio, GPS, and motion data as they are collected by different instruments on a mobile device proved to be very helpful in thinking about how tours can best be enhanced with MAR [1].

Next stages looked to users and more specifically adoption levels of MAR for first time users. A series of activities was introduced to participants at international conferences to observe reactions to and interactions with augmented reality. A three-tiered system of connected activities was devised from low to high tech. Data was collected about the participants' engagement and how far they progressed into deeper and more complex use of AR at the event. The results showed high interest but low tolerance to give the time required to learn to use more complex tools [11].

Environments for larger groups of people were designed and were largely informed from the experiences introducing AR in the more controlled environments at conferences. An AR rally was designed and implemented for a group of about 200 participants. It took groups of 8-12 participants on a gamified tour of a city in Japan and was designed to orientate new residents to the city and its community. The results showed that AR lends itself to group dynamics as content can be individualized to teams and team members, creating information gaps and conflicts to resolve as a team. From these experiences and collected data the research turned to focus on creating a new AR platform that might enable tourism industry non-technical professionals create and implement their own augmented tourism environments. Augmented tourism is the blending of digital content in and on physical environments to enhance and add affordance to travel experiences. This process started with designing a prototype mobile application which used a set of pre-programmed images as markers and a web-based system to connect those images to web content dynamically. The design was based on some features from commercial apps and previous attempts to have students create their own AR content in higher education tourism-based courses. The design of the platform started to combine principles of use from earlier iterations in terms of implementation, use, and creation of AR environments.

VI. Current Iteration

The stages from which the current version of this project is melding of a case study research from earlier iterations, and include data from the end users, implementers in tourism contexts, and designers of AR environments. Each stage of the study evolved in scope and focus, starting with usability of single users, to managing and creating AR enhanced environments with large numbers of users. This stage of the research seeks to combine past design principles and create a platform where tourism non-technical professionals can create and implement new MAR environments.

The platform consists of a mobile application and a web-based database that houses data for user created MAR environments. Elements of both the web-based database and the mobile application were designed with ease of use for creators and end users. Design elements were also chosen to boost affordances for tourism contexts. The platform uses a computer vision algorithm to locate and overlay digital information over a set of predefined trigger images. The images are a specially designed set of playing cards, 52 cards in all. Each card has a unique design and illustration that allows vision to easily recognize each card and distinguish them from each other.

The trigger cards simplify the creation of MAR environments. In most all AR tools that employ visual data, both a trigger and an overlay are required. The trigger is usually an image that a computer vision algorithm and camera use to find and execute an overlay. An overlay is some digital content that is displayed or a set of instructions that is started when it is triggered. Having a predefined set of triggers takes half of the design process out of creating MARs in this way. Having the trigger be playing cards gives designers and users a set of numbers and sequences they already are familiar with. To connect the trigger images dynamically to user defined overlays, Google Forms was used. It allows users to simply enter a URL to online content for each of the trigger cards.

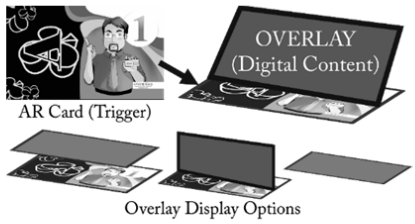

Fig. 1 AR platform trigger cards and MAR application overlay display

Fig. 2 (a) Mobile Application Screenshot of Card Overlay

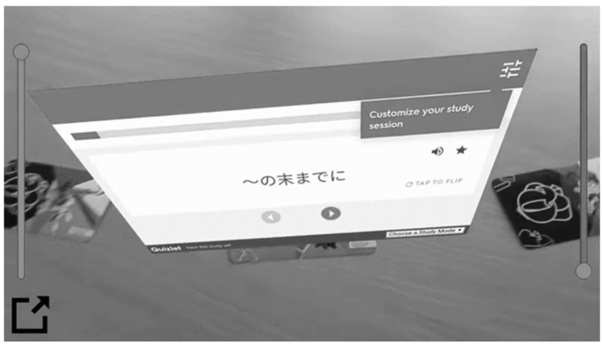

Fig. 2 (b) Mobile Application Screenshot of Card Overlay

In analyzing commercial AR toolkits, they rely on proprietary software or web-based design tools to create MAR environments. In some cases, it means you need coding skills and others mastery of software much like Photoshop or Maya.

By using Google Forms users are already familiar with the platform to input overlay information, and that coupled with a predefined set of triggers, streamlines the creation of MAR content extensively. The Google Form allows users to create a 'Project' which is a collection of internet content connected to the trigger cards. The Google Form asks for a title, description, keywords, and author email of a 'Project' before allowing users to enter URL information for each of the 52 trigger cards. The URLs can be websites, YouTube videos, or direct links to any online content such as images, audio, and other interactive content. Google Forms takes the input from the user when the form is completed and adds it to an online spreadsheet. This Google Sheet document is a list of all the 'Projects' now available to the mobile application to access to then associate trigger cards to online content.

The mobile application was built using the Unity3D game development environment and an augmented reality plugin called Vuforia. These tools allowed the use of a predefined database of images of AR playing cards that are used as triggers. The approach used in this design does not depend on a large number of images stored in the cloud for recognition. Using Google Sheets as an online database to house data helps to avoid costly cloud services. The approach used in the Mobile AR application connects the app to web services hosted on a Google Drive. Google Forms are used to collect user content and those contents are stored in a Google Sheet. This effectively creates a stable and simple cloud-based solution that is cost effective and reliable. Google provides a series of APIs and other web services to customize Google applications such as Google Sheets and Forms. Using these APIs and web services, a system was devised to connect the Google Apps to our mobile application. The web service is a simple script developed using a javascript-based language, making use of online Google APIs. The current version of the mobile applications has the ability to retrieve data from Google Spreadsheets at runtime, but it is not necessarily has to be limited the data as it is accessed – saving, updating and deleting records/objects is not an issue. In general, the mobile application employs a mobile device as a visual sensor for scanning for cards and uses Google applications to gather and house online data to augment those cards.

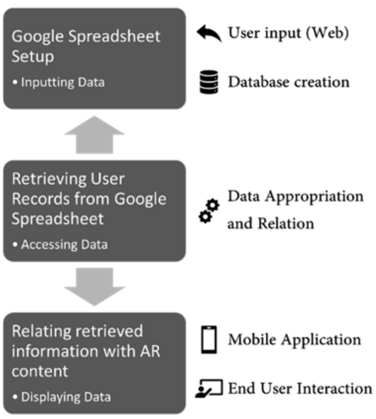

Fig. 3 Accessing and relating data

Using Google Applications such as Google Sheets and Forms in this manner has a few requirements. The first is the ability to provide access to Google Sheets, these services have security and authentication layers that must be accessed by a mobile application. The second is the ability to allow other users to put content on Google Sheets using Google Forms. To access the Google Sheet from within the developed application web service URL, spreadsheet ID and password are required.

VII. Forming Framework

The design choices made at the various stages of this project point to a forming set of principles that give augmented reality affordance to tourism. Simplifying design processes, using existing tools in widespread use like Google Forms, and examples for creating group experiences all start to create a picture of augmented tourism. As MAR grows in technology and users, these principles can guide the design of MAR applications and implementations for tourism contexts. Through these efforts to simplify the creation of MAR environments for the tourism context, we hope to help extend both the use of MAR in tourism and allow larger scale research into the role it will play in tourism contexts.

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