Exploring the use of mobile AR to aid decision-making on-the-go

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ABSTRACT

Extended reality adaptation is gaining traction across a broad spectrum of disciplines. Mobile phones and markerless augmented reality (AR) are fascinating methods for retrieving information because they enable content to be rendered in the user's immediate environment while they are on the move. This method of rendering virtual content within a physical environment will be accessible to a large audience that, for the most part, does not have access to high-end equipment such as head-mounted displays. Along with a large audience, augmented reality on mobile devices can display dynamic content in real time, even in outdoor settings, providing users with information about physical artifacts that is both immediate and contextually relevant. The purpose of this paper is to discuss the development of a mobile application that will assist users in making on-the-spot decisions based on online content displayed nearby. Along with developing an application that assists users in locating nearby restaurants, a strong emphasis is placed on architecture, user interface, and experience design, as the application will be used in environments with limited focus (e.g., traffic noise or occlusion with real objects). The study concludes with a discussion of the application's user experience and future research directions in this field. With the rapid evolution of mobile devices, it is critical to understand some of the challenges and design constraints inherent in developing better user experiences for applications that support on-the-go decision-making.

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1 INTRODUCTION

Recent research on mobile HCI is putting more attention on design problems associated with new technologies and services. Traditionally, AR applications have relied on components designed for native mobile development, which, while effective, increase development costs and introduce various deployment requirements. The mobile AR app described in this paper is called RestoViews [1]:. The application assists users in locating restaurants on the fly, meeting the following set of criteria: first, we want to provide on-the-spot information retrieval; second, we want to provide this information quickly and accurately; and third, we want to design the application for environments with scattered attention. Making decisions via traditional web applications can be perplexing and frustrating for users, even more so when navigating a real-world situation. RestoViews aims to combine the best of both worlds by providing access to digital information while facilitating a more seamless transition from virtual to physical content via a personal handheld device.

2 SYSTEM ARCHITECTURE AND INTERACTION DESIGN

2.1 Progressive Web Application

Advances in web technologies allow RestoViews to be built as a Progressive Web Application (PWA), enhancing the convenience to users. By being a PWA, users need only to enter in a url in their browser and do not need to go to a device specific app store and download a new application before using. By utilizing PWA features, RestoViews is able to take advantage of a smart device's hardware similar to how a native application can and in ways that are typically not associated with a standard website. This includes such sensors as:

- The GPS, which is used for determining the geolocation of the user as they move about the real world
- The accelerometer, which is used to determine the current orientation of the mobile device and the direction that it is facing
- The compass, which is used to determine the user's current orientation in relation to the space itself

[1] github link with the instructions, demo page, and all necessary details will be provided here. The code will be under MIT licence.

- The camera, which is used to stream the real world surroundings for which the augmented reality scene will be placed in

Together these sensors work as the core features that make it possible for RestoViews to provide its augmented reality experience. RestoViews utilizes HTTPS to serve files and data to the user. Without this secure connection, most browsers would reject the applications request to access the sensors that are necessary for the app to build and run the augmented reality scene.

2.2 Mobile Augmented Reality

Enabling augmented reality in a web environment is made possible via two libraries, AR.js and A-Frame. Together they are able to take in the necessary sensor data and output a dynamic augmented reality scene. AR.js is the library that is responsible for melding the real-world sensor data with the RestoViews application. It utilizes the mobile device's GPS, accelerometer, and compass to continually process the device's location and orientation. This data is then used by A-Frame to build an augmented reality scene that is superimposed over a livestream being pulled from the device's camera. The React side of the RestoViews application processes the restaurant location data and hands the relevant information (i.e. restaurant name, latitude, longitude) to A-Frame. Using A-Frame, we are able to design and render objects within this 3D space that are then placed in relation to the user thanks to AR.js. Additionally, user interactions are defined with A-Frame, and callbacks are provided that allow data about state to be passed back and forth between the augmented reality scene and the React user-interface.

Backing the Client software as described above, is a microservices API built using the Flask micro-framework and Python. The goal of this service layer is to abstract the Google Places API and optimize restaurant data returned to the client. Google Places is the primary data source for RestoViews. The Flask framework provides an adequate feature set to support our basic API needs for the app today but is also extensible enough to support future versions of the RestoViews app. Python offers excellent support for JSON manipulation and http request/response handling which is used quite heavily in this software. The Google Maps platform and specifically the Google Places service is how the RestoViews app gains knowledge of the real world. The Google data set has the appropriate location granularity to fit our "up-close" view of restaurants that often exist side by side or even stacked on top of each other. Google also allows filtering by data elements that our users find relevant and useful when they are deciding on a restaurant. The Google dataset and especially the data analysis tools available in Google Cloud will be instrumental in future versions of RestoViews.

2.3 User-Experience Design

The simplicity, symbolics, and one-handed thumb-based gestures used with RestoViews are intended to help users quickly grasp the user interface and experience discovery rather than instruction. These characteristics are critical when designing user interfaces for "on-the-go" applications. This keeps the interface simple and straightforward to use, while still providing ample information to the user in a mobile-friendly format [de Sá and Churchill 2012]. Numerous one-handed interaction strategies have been developed for mobile phones [Hakka et al. 2019]. When users interact with their smartphone solely with one hand, however, inaccessible regions of the screen appear. Due to the nature of these techniques, which are used to select unreachable targets, one-touch movements may limit design options [Kostic et al. 2020]. When an object becomes inaccessible, certain techniques include the appearance of a pointer [Hakka et al. 2019]. Measuring the speed and accuracy of the single-handed direct touch demonstrates that the proposed technique is a viable one-handed interaction strategy, and RestoViews app also examines its potential in this paper.

The ergonomics of holding a phone in order to "look through it" to see the AR content might be challenging [MacIntyre et al. 2013]. In creating a mobile experience meant to improve the ease at which a user connects real world information with their device, a lot of thought was put into optimizing the user-interface for simplicity. One of the main ways this is accomplished is by implementing a gesture based design.

The ability for the user to filter the results is a critical component of any search-based application. RestoViews presents results in a non-traditional manner by superimposing them within the environment rather than sorting them into a list, grid, or other more conventional method of displaying data. This method necessitated a novel way of filtering the results, but one that was also natural and easy to infer.

3 CONCLUSIONS AND FUTURE WORK

The purpose of this paper is to discuss the design and development of the RestoView app. The research begins by posing the following question: how can we leverage augmented reality and mobile technology to create an intuitive application for on-the-go information retrieval? RestoViews is a fully functional, high-fidelity proof-of-concept application that was created with this motivation in mind. Despite significant technological advancements, mobile augmented reality applications remain relatively underutilized for this purpose (here, we are solely focusing on the cell-phone based applications for large audience; there is a plethora of amazing AR applications and research projects in the HCI, Computer Vision, and Information Visualizations domains). RestoViews' future development has three potential directions: application architecture, user interface design, or user experience and interaction design.

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