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Augmented Reality Navigation

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Category Research

ABSTRACT

Navigation is a popular field of research in both science and industry. Combined with maps and various localization technologies, navigation systems have become more robust and user-friendly. In this paper, the design and implementation of augmented reality systems are discussed. It will use a well-designed smartphone camera and GPS to display user-centric information in real time on a smartphone. The proposed app will combine G.P.S location technology with tracking technology to provide the user with basic information about the building they want or one they are close to.

Index Terms:

Augmented Reality—Navigation systems—Indoor —Tracking—Campus Navigation—Android

1 INTRODUCTION

In today's world, reality and virtuality are increasingly mixing together. This event is called Mixed Reality (MR). MR is divided into two categories. The first category is about a computer-created world without real objects. This category is called Virtual Reality (VR). It is a creation of an apparent world in which the user can immerse himself, move around and realize his fantasies and ideas. Virtual Reality forms a high-quality user interface that is controlled by head and hand movements, by speech or by the sense of touch. In the second category, it is specifically about providing the user with additional information that is directly related to the real perceptions. The interesting thing here is that there is real-time interaction between the real environment and the projected additional information. In the first AR applications, live videos were enriched by computer graphics and animations. For centuries, people have been trying to find ways to improve navigation. Navigation systems play a major role in our daily lives.

This paper is mainly about AR technology in smart navigation system, which can strive to mix the real world with the physical world in such a way that both physical and abstract objects are visible to the user in the same space. An augmented reality navigation system is a system that uses augmented reality technology to navigate the users. In essence, the system combines explicit navigation information with real-world objects. [1]

2 STATE OF THE ART

This chapter is about the current state of AR technology, the current user field and the navigation.

2.1 Related Work and Problems

In this chapter, the existing applications and the problems associated with these applications and the problems with the Present Navigation applications will be discussed.

2.1.1 Similar Applications

- **Arizona Mobile**

Arizona Mobile is the first official application and one-click Experience in everything at the University of Arizona, including a navigation system. Arizona Mobile not only makes life it's easier for current students, but the surrounding past/present students. The world can be kept up to date with functions such as an event calendar and video tour, so that every user feels immersive Campus- no matter where they are.[2]

Features: some main features included in this system are Maps, Phonebook and campus directory, Course listings, U-Access Student, UA-news, Event listings, Social Media, Videos, Library, Tours, Photos, Alumni, Emergency contacts.[2]

Review and Comparison: This mobile application has few unique features, for example: the user's social interaction features. Students can update at the university News and headlines through this application, but the map is not works with newer versions of Android phones. [2]

- **Oregon State University Mobile**

This application comes in both iPhone version and Android supportive Plattforms. [3]

Features: Offers an optimized experience for a variety of web phones and devices can access this site from any mobile web browser with real-time data, can find buildings on campus or track down phone numbers just using your thumb: the auto-populating people finder will even complete user typing, saving time in a crunch. [3]

Review and Comparison: it is more iOS than Android. Still using outdated iOS User interface elements. Quickly find buildings and Telephone number, can handle adding contacts, and will add Email sent to the wrong contact on the user's phone. Link for online services, this application will be extraordinary. [3]

2.1.2 Problems

Currently the most popular navigation systems used in the market are smartphone applications or stand-alone systems that use distance-based writing and home-satellite navigation. The navigation method is displayed and the user's current configuration. Typical navigation systems show navigation information in a restricted from that usually shows arrows pointing in the direction or by providing a "bird's eye view" of the map and the intended route. [4]

2.2 Requirements for an AR system

The requirements for AR technology are described by Ihsan Rabbi and Sehat Ullah in seven categories as follows.

- Performance. Performance refers to the computation of the information required for AR in real time. These calculations are very costly and can greatly affect the performance of an AR system. [5, S. 29 - 46]
- Alignment. Alignment refers to the placement of the objects themselves. The placement must be as exact as possible at a suitable position. Therefore, the calculations must be performant and error-free. [5, S. 29 - 46]
- Mobility. An AR application should be usable in any environment. This means that the AR application must work in any place in the real world. Therefore, it is necessary that the hardware used is small and mobile. [5, S. 29 - 46]
- Visualizations. The way the virtual objects are displayed in the real world is also a challenge. For example, the virtual objects should be presented as

realistically and user-friendly as possible. [5, S. 29 - 46]

- Interaction. Interaction is about usability with the virtual ob- jects. How he can interact with them and how well this is implemented. [5, S. 29 - 46]
- Application-specific challenges. [6]
- Tracking. Tracking, i.e. The localization of real objects in the real world plays an important role for most requirements. Such as in performance or alignment.

There are two types of tracking:
Tracking with sensors, in which technical aids such as sound, magnets or cameras are used. Visual tracking without these technical aids. This in turn is divided into two sections. [5]

– Marker-based tracking, which makes use of specific markers placed in the real world. Tracks on a road-way can serve as an example. These are easy to identify and their position can also be easily calculated. [5, S. 29 - 46]
– Tracking without markers. Here, no specific markers are placed, but the contours of real objects serve as a basis for distinguishing them from others. [5, S. 29 - 46] Tracking without markers is a method of track-ing that uses the contours of real objects as a basis for distinguishing them from others. [5, S. 29 - 46]

2.3 Use cases of augmented reality

There are a lot of use cases of AR nowadays. We would just show a few of this use cases in this section.

- **Medical field**
  In this field we have a lot of use cases, from MRI (Magnetic resonance imaging) to complex surgeries. AR show Defibrilla- tors in the nearby and this can save life. Doctors can use AR with collaborative surgeries, and even have effective meetings on any medical issue with AR video conferencing. AR can also patients to describes their symptoms better, example of Eye Decide, an app that use the camera display and help the doctor to better detect the symptoms of Eye diseases. This use cases are just a few from a lot of use cases in medical field. [1]
- **Gaming**

  A lot of games are using AR e.g. Pokémon Go, Ingress, Brickscape, Zombies Run., etc. [8]
- **In Retail**
  People have the possibility to try glasses, clothing, shoes and other article like furniture from Ikea with an AR App before their orders this articles. This is also available for makeup, the customers can first try this on their photo with a virtual app, and this is the case for Sephora. [9]
- **Transportation**
  It is the case of **Navion** developed by Way Ray. Navion is a navigation system for cars which uses holographic augmented reality technology to project navigation instructions on wind-shield. [10]

3 Augmented Reality systems

3.1 Problems with Navigation Systems

Navigation is the system that allows us to reach the destination in the shortest and fastest way. This, even if we have never been to an address before, we can reach an address without any problem. The navigation system gives the direction both in the form of a map on the screen and with voice commands. If the direction is missing, recalculation will show the most current route according to your location. In summary, we can describe navigation as an application that finds the most convenient way to get from one point to another.

Typical navigation systems display navigation information in a limited form, usually shown as arrows pointing in the direction of travel, or by providing a "bird's eye view" of the map and intended route. The driver's attention is distracted by alternately looking at the navigation system display and the road. Such distraction poses a major problem by compromising the safety of the driver.
By using augmented reality in navigation procedures, such a distraction can be prevented. Here, the driver is convinced to concentrate on the road.

Figure 1: Statistics Allianz [16]

This diverts the driver's attention from the road; this reaction affects the driver's safety. For a long time, alcohol was considered one of the most dangerous causes of impaired driving ability in Germany, but now the distractions caused by smartphones, navigation systems and other technical applications are proving to be a greater risk. Around 74 percent of all drivers admit to dealing with these distractions while driving. A new study by the Allianz Centre for Technology (AZT) shows that the risk of accidents increases significantly when drivers' attention is focused more on the technical equipment available to them and less on the traffic. The research emphasizes that there is a statistical correlation between the use of information, communication and entertainment functions in the car and higher accident rates [13]. This type of distraction can be prevented through the use of augmented reality in navigation systems, so that the driver can concentrate solely on the road.

3.2. Design Considerations

The main focus of augmented reality navigation is the combination of reality and virtual reality to a common view, which is enhanced by a virtual route representation. The perspective adjustment of the virtual image scene as well as the route calculation requires a navigation concept. The concept is built on the basis of a combination of screen map and augmented reality. The instruction consists of a virtual route representation, which is presented concurrently in front of the image of reality on the screen. The structure of the reality view is composed of the two parts user and system, which are connected via an interface. The system-side processing forms the output and presentation of the instruction on the screen. The user perceives the presentation visually and processes it. The result is an action that is implemented in the form of a movement and leads to a new run through the process chain. [13]
There are basically two display technologies that allow us to combine virtual objects with reality:

- **Video Display**

- The real environment is recorded with the help of one (monoscopic) or two (stereoscopic) video cameras and displayed on a computer screen. Here, both worlds are rendered by a computer and visualized on the screen.
- An example of this type of display is a head mounted display with cameras
- Head Mounted: - most dominant visualization principle in AR.

- **Optical Display**

Allow the user to look directly at the real world and the virtual objects or the additional information is superimposed into the field of view by means of a transparent and reflective screen - a so-called combiner.

- **Projection Display**

Projects the desired virtual information directly onto the physical objects in the user's real environment. This method uses a projector that is either attached to the user's body or fixed at a specific location in the room. The user can interact with the virtual objects by, for example, clicking on a virtual button or picking up a virtual ball.

3.3. Different Kinds of AR Navigation

Finally, we will take a look at the application areas of AR and classify AR systems into indoor- and outdoor-systems.

3.3.1 Car Navigation

The main objective of the practical use of the augmented reality navigation system is to keep the driver on the road and to solve problems associated with traditional navigation. AR Navigation is offered for car navigation, which allows the user to free up additional AR resources.
This is achieved by integrating the operating equipment into the user environment, i.e. the vehicle. This needs to be tracked in order to respond to the above: A car windshield on the screen, tracking locations using GPS and other sensors. [4]

Fig 2: AR Navigation for Vehicles [4]

3.3.2 Indoor Navigation

Indoor navigation is a new form of orientation inside buildings by visualizing the exact route in the field of view. It is well known that GPS reception is usually not available inside buildings, so other positioning technologies are used. Users of an indoor navigation system select a destination on an overview map [13]

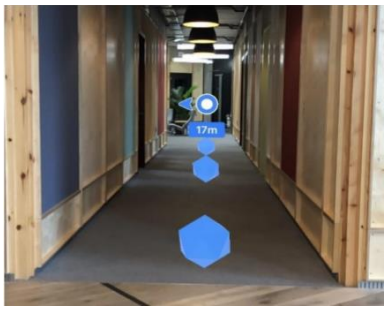

Fig 3: Indoor Navigation [4]

3.3.3 Outdoor Navigation

A program like the one in section 3.3.1 sent to the smartphone because smartphones are ubiquitous today. The software uses orientation sensors to display ARs as effectively as a smartphone can be accessed in any way. Location information is collected via sensors, If GPS is temporarily unavailable, and the location can be detected by looking at the dead reckoning using the orientation and the accelerometer sensor of the smartphone. A view of the real world is available on an existing one on a smartphone. After that, the navigation details/information created are integrated with real world camera streaming and displayed on a smartphone screen. Extended functions such as rendering graphics, routes, etc and transferred to another server.
Nowadays, these functions can be deployed on separate cloud computers while the smartphone acts as a small client.

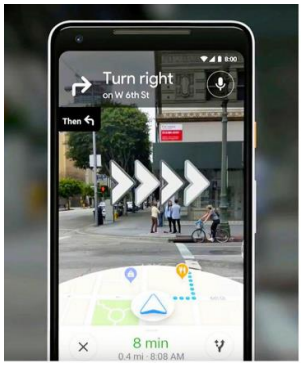

Fig 4: Outdoor Navigation [4]

3.4 Opportunities and Challenges

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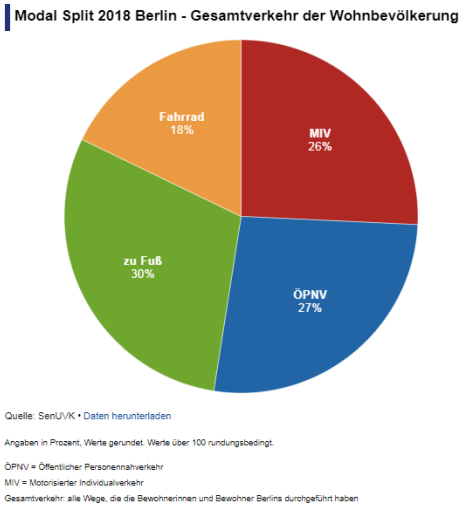

Fig 5: Statistics Berlin Senate Department 2018 [16]

4. Ecological Aspects

In Germany, we are in the midst of a mobility revolution. Due to the ever increasing CO2 emissions and particulate matter in the cities, we as a society have to rethink. The distribution of road use will also be important in the near future. That's why in Berlin in 2018 there was the so-called mobility law, which should help to treat both bicycles and public transport (Ö PNV) in transport planning in priority to the car. [5]
Recent developments show that more and more people in Berlin are cycling and fewer and fewer are taking the car.
Statistics from the Berlin Senate Department for Environment, Transport and Climate Protection show that between 2013 and 2018, the share of cycling in Berlin increased by 5% to 18%. During this time, motorized private transport decreased by 4% to 26%. [18]

Fig 5: Statistics Berlin Senate Department 2018 [19]

5. Discussion

This paper provides a thorough literature review on AR navigation technology, including design considerations and different navigation types. It brings various opportunities and challenges for using AR in navigation.
Augmented reality is a very powerful way to enhance user Experience in Navigation Applications. In addition to user Experience, it goes far beyond driving safety. Investigation
The research literature shows a significant increase in the AR Driver Attention. Although the current technical distance.
From the perspective of mature AR experience, research is advancing rapidly
Many institutions and companies such as BMW, Pioneer and Toyota are working on the development of navigation.
It should be noted that the use of AR in navigation is
Strongly depends on advances in augmented reality. In addition, the adoption of AR navigation depends on
Better user experience. See how interesting this will be
The technology will continue to evolve in the future.

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