JoGuide: A Mobile Augmented Reality Application for Locating and Describing Surrounding Sites

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***Abstract*—Augmented Reality is a variation of virtual reality that allows users to view the real world augmented with virtual objects. Therefore, it can be used to produce systems that provide users with rich information about the scanned area. In this paper, we present an application that locates and provides the users with information about the local surrounding sites. The application, which we call *JoGuide*, is designed to help users in urban areas or tourism destinations to locate places of interest near them by moving the camera of the device in all possible directions to overlay information of places around them. Places captured by the camera are located by adding bins displaying the place name as defined by Foursquare.com database. *JoGuide* is developed with Android and is set to run on smartphones and tablets with different screen sizes, computational and memory capabilities.**

Keywords-Augmented reality; Mobile Computing; Mobile devices; Text in scene images; Android.

I. INTRODUCTION

Augmented Reality (AR) creates an environment in which real world and virtual world objects are presented together within a single display [1]. The core idea behind AR is overlaying computer generated graphics on top of the real world scenes to create a seamless spatially-registered environment [2]. The main goal of AR is providing applications and programs to the users that brings virtual information to their immediate surroundings and also to any indirect view of the real-world environment (e.g., live-video stream) [3].

Since the first appearance of AR concepts in the 1950's in the cinema industry, AR has immensely grown. Currently, AR applications can be found in many domains including medical visualization, entertainment, advertising, maintenance and repair, annotation, robot path planning, geographical information systems, and education [4] [3] [5].

The use of AR applications on mobile devices (e.g., tablets, smartphones, digital cameras) is gaining more attention due to the increasing power and decreasing prices of mobile devices. Moreover, mobile devices come with various input means (sensors, cameras, location) that facilitate the development of a wide range AR mobile applications. Mobile Augmented Reality (MAR) expands the set of services that AR offers to include a wide range of scenarios in the rich diversity of the mobile environments [6] [7]. AR can be used in many types of applications including entertainment and gaming, tourism, and navigation. A key feature of a MAR application is that it provides the user with context-related information in real time. This information can support various context-dependent applications. For example, information about surrounding places, products, events, or moving objects (e.g., transportation means) [8].

In this paper, we present a MAR application, called *JoGuide* (stands for Jordan Guide), for locating and providing information about surrounding sites, building, offices, or any buildings of interest. The application aims to facilitate the process of searching for sites surrounding the user. The application can be very useful especially for the user who goes to places never visited before (e.g., tourists). The application provides information about surrounding sites including landmarks, or small objects (e.g., shops, offices, restaurants, etc.) by moving the camera in the direction of the desired site. The information is displayed on the screen without blocking the view.

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JoGuide is designed and implemented keeping in mind the importance of achieving the following attributes: reliability, usability, extensibility, and robustness. *JoGuide* is deployed to run on Android platform version 4.1 or later and is developed to work on devices with different screen sizes and computational capabilities. *JoGuide* uses Global Positioning System (GPS) sensor, phone network and Internet connection to determine current location. The application uses a global maps website called *Foursquare* [9] to get information about the sites of interest. The application uses the phone camera to catch the scene, sends it to the site and locates sites of interest. *JoGuide* allows users to learn more information about venues and places surrounded them.

The rest of the paper is organized as follows. Section II presents related work. Section III describes the design and implementation of the presented application. Section IV presents a demonstration of the application and discusses usage issues. Finally, conclusions and future work are discussed in Section V.

II. Related Work

In this section, we provide a summary of work in mobile augmented reality that aims at developing tourism and navigation applications. Please refer to [10], [11] for a complete survey on mobile augmented reality.

Dahne et al. [12] presented a software that runs on Laptops called *Archeoguide* to provide tourists with interactive personalized information about historical sites. The application was tested on the site of ancient Olympia in Greece. Using *Archeoguide*, users can view a virtual reconstructions of the ancient site. Images and videos are all loaded with the application (i.e., no real time communication is required).

Fockler et al. [13] developed an enhanced museum guidance application, called *PhoneGuide*, to introduce exhibitions. *PhoneGuide* runs on mobile phones and displays information on the phone when visitors targeted their mobile phone cameras at exhibits. *PhoneGuide* runs a perception neuronal network to recognize exhibits in images taken by the phone camera.

Elmqvist et al. [14] presented a mixed Reality platform for navigation assistance in indoor environments. The platform, which is called *3DVN*, provides a multi-modal user interface for navigating in existing physical buildings. *3DVN* supports both path finding and highlighting of local features.

Another museum guide was presented by Bruns et al. [15]. The guide uses widespread camera-equipped mobile phones for on-device object recognition in combination with pervasive tracking. It also provides location- and object-aware multimedia content to museum visitors.

Tokusho and Feiner [16] developed an application called *AR street view* which provided an intuitive way to obtain surrounding geographic information for navigation. When users walk on a street, street name, virtual paths and current location were overlaid on real world to give users a quick overview of environment around them.

Marimon et al. [17] developed an Android service platform called *MobiAR* for tourist information based on AR. *MobiAR* allows users to browse information and multimedia content about a city through their mobile phones. The platform handles location-based information, user preferences and determines the tourist resource the user is interested in.

Bihler et al. [18] developed a prototypical context-aware museum guide that uses ultrasonic signals, sent by a cheap, stand-alone emitter. The smartphone is able to recognize the exhibits by receiving a modulated ultrasonic signal, but in any museum an adaptation of the used frequencies is necessary.

Armanno et al. [19] developed an application called *SkyLineDroid* for virtual Heritage where Augmented Reality is used on mobile phones to support visitors of outdoor cultural heritage sites. Virtual and real world are overlaid on the device screen, according to device position and orientation, in order to immerse users in the 3D historical reconstruction of ancient buildings.

Rubino et al. [20] presented a general framework for the development of multimedia interactive guides for mobile devices called *MusA*. The framework has a vision-based indoor positioning system that allows the provision of several LBS, from way-finding to the contextualized communication of cultural contents, aimed at providing a meaningful exploration of exhibits according to visitors' personal interest and curiosity.

Chianese et al. [21] developed a location-based application that aims at exploiting several location-based services and technologies in order to realize a smart multimedia guide system. The system is able to detect the closest artworks to the user, make these artworks able to tweet and talk during users visit and capable of automatically telling their stories using multimedia facilities. The system was tested at a sculptures art exhibition within the Maschio Angioino castle, in Naples, Italy.

Murino et al. [22] presented an Android touristic application called *i-Street* whose aim is to detect, identify and read the street plates in a video flow and then to estimate relative pose in order to accurately augment them with virtual overlays. The application was tested in the historical centre of Grenoble, France, proving to be robust to outdoor illumination conditions and to device pose variance. The average identification rate in realistic laboratory tests was about 82%.

Jain et al. [23] adopted a top-down approach cutting across smartphone sensing, computer vision, cloud offloading, and linear optimization in order to develop location-free geometric representation of the environment and using this geometry to prune down the visual search space. They developed a system called *OverLay*, which is currently deployed in the engineering building and open for use to

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regular public.

III. Application design and Implementation

We followed the Incremental Methodology in developing our application. We choose this approach because it has features that are suitable to our application. Mainly, it generates a working software early during the software life cycle, easier to test and debug during a smaller iteration, and easier to manage risks [24]. At a glance, incremental development slices the system functionality into increments where in each increment, a slice of functionality is delivered through cross-discipline work, from the requirements to the deployment. The unified process groups increments/iterations into the phases of: inception, elaboration, construction,and transition [24].

We show the package diagram of the proposed application in Figure 1. As the figure shows, the application consists of three main components, these are:

1) Graphical User Interface (GUI). The component contains the classes necessary for creating the GUIs. The classes contained in the package are shown in Figure 2. The component displays the following screens: (1) Splash Layout, which includes the start and the welcome screens. (2)ArActivity Layout: the main application screen, it combines two layouts, Camera Preview layout, which is a simple wrapper around a camera and a surface view that renders a centered preview of the camera to the surface to resize preview aspect ratio suitable for the screen of the device, and AR Overlay layout, which shows pins and venues names as text. (3) the output layout which show the view after calculating angle between user location and nearby venues.
   Venue information is updated every 50 ms by a request sent to Foursquare (using the communication package).
2) Location. Contains classes for managing location information. The contents of the component are shown in Figure 3.The location component is used by the GUI to get and update the user location. Location is detected every 30 seconds. That is, every 30 second the application sends a request to the GPS or network provider to get current user location.
3) Communication. Provides services to the other two components including: communicating with Foursquare, communicating with the GPS or the network provider to get location information, and checking Internet availability. Classes participating in the communication package are shown in Figure 4.

We choose to refresh the location every 30 seconds as a default value experimentally. The users can decrease this value when they are moving fast (e.g., driving on a highway) or increase it when they use the application while walking. Updating the scenes with information is performed every 50 ms to give the users a real-time experience and avoid losing important sites information.

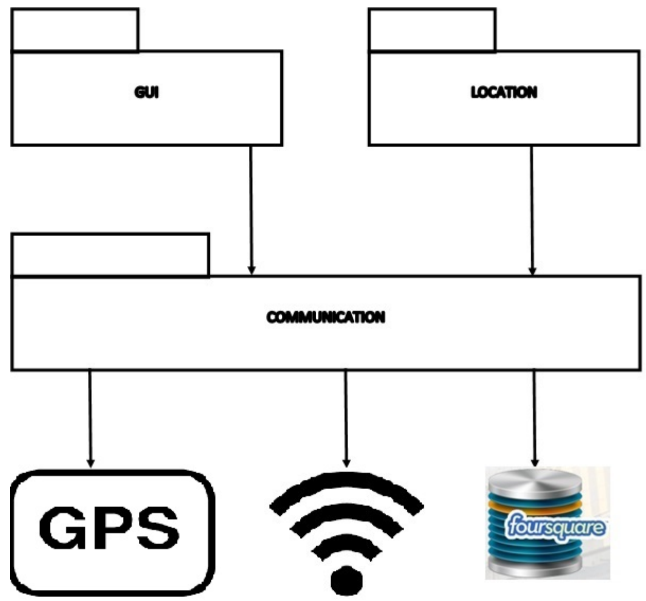

Figure 1. Package Diagram of *JoGuide*

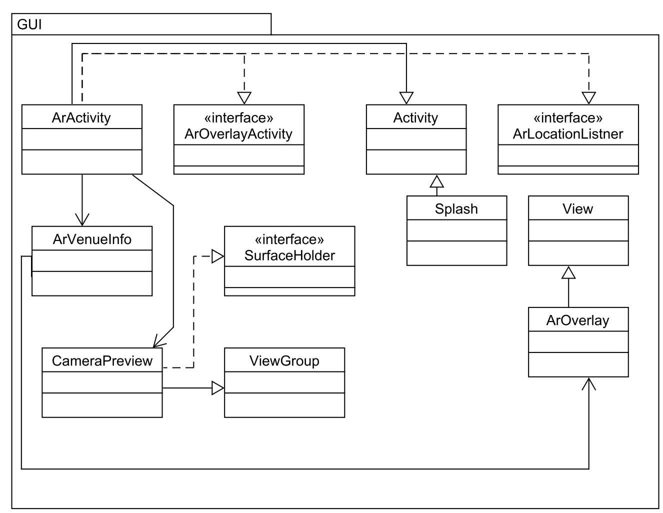

Figure 2. GUI Package

The location information from the GPS is sent to FourSquare to get information about the nearby venues. This information is used by the application to compute the angles between the user current location and the nearby venues. In addition, the application computes the rotation and orientation of the camera, using the smartphone sensor.

Using the internal measurement unit of the smartphone and the angles between current location and venues, we map the venues locations to their locations that appear on the

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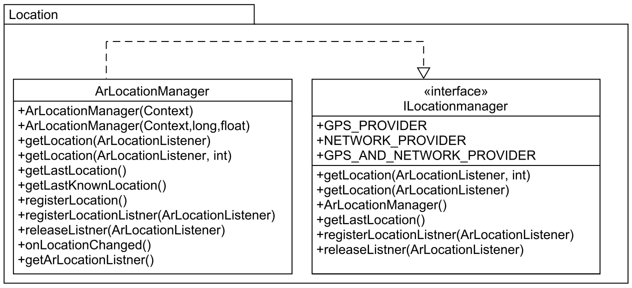

Figure 3. Location Package

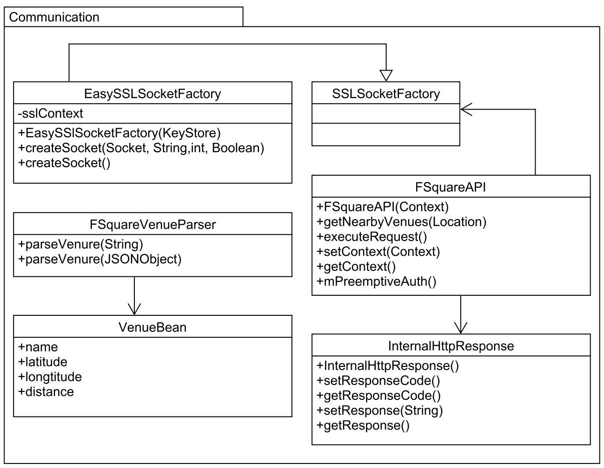

Figure 4. Communication Package

screen by drawing an icon on each venue found.

The prototype version of the application is implemented with Android. The following tools and software are used to implement *JoGuide*:

- Eclipse Indigo [25] with android plug-in.
- Microsoft Visio 2013 [26], for preparing the design documents. We used UML [27] to describe the system architecture.
- Adobe Photoshop CS5 [28], for designing icons and images.

IV. Demonstration

In this section, we demonstrate how *JoGuide* can be used to obtain information about surrounding sites and places. Figure 5 shows the first screen displayed when a user starts the application. When the application is loaded, it checks if the GPS is activated, and if an Internet connection is available. A message is displayed to the user to indicate whether any of these resources are not available. Otherwise, the start button becomes active and the user can start spotting.

Figure 6 shows the screen displayed as the user presses the start application button and *JoGuide* working by initializing

Figure 5. Start Screen of *JoGuide*

camera and loading places. The application accordingly sends a request to Foursquare and the GPS. This might take some time depending on the Internet speed.

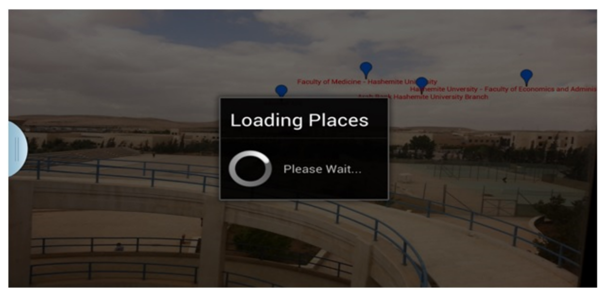

Figure 6. loading *JoGuide*

We tested the application in different urban sites, including the downtown of the city of Amman, Jordan, the city of Zarqa, Jordan, and the historical site of Petra, Jordan. In all our experiments, *JoGuide* shows to be an easy to use application, reliable, and provided the needed information about the sites and shops surrounding the user. In Figure 7, we show a camera shot with site information. We choose to display the sites pins in dark blue and the sites names in red in order to: (1) eliminate potential overlapping with objects that appear on the screen, and (2) allow the information to appear when the application is used in the dark. This is shown in Figure 8 which shows a screenshot of the application while used in the night. The icons are visible for the user and the red color can alert the user attention for the required site while the blue color is bright and easy to find on a dark background.

It is though important to emphasize that the accuracy of the displayed information depend on the information provided by FourSquare maps (which in turn depend on the information the municipality or the local government can

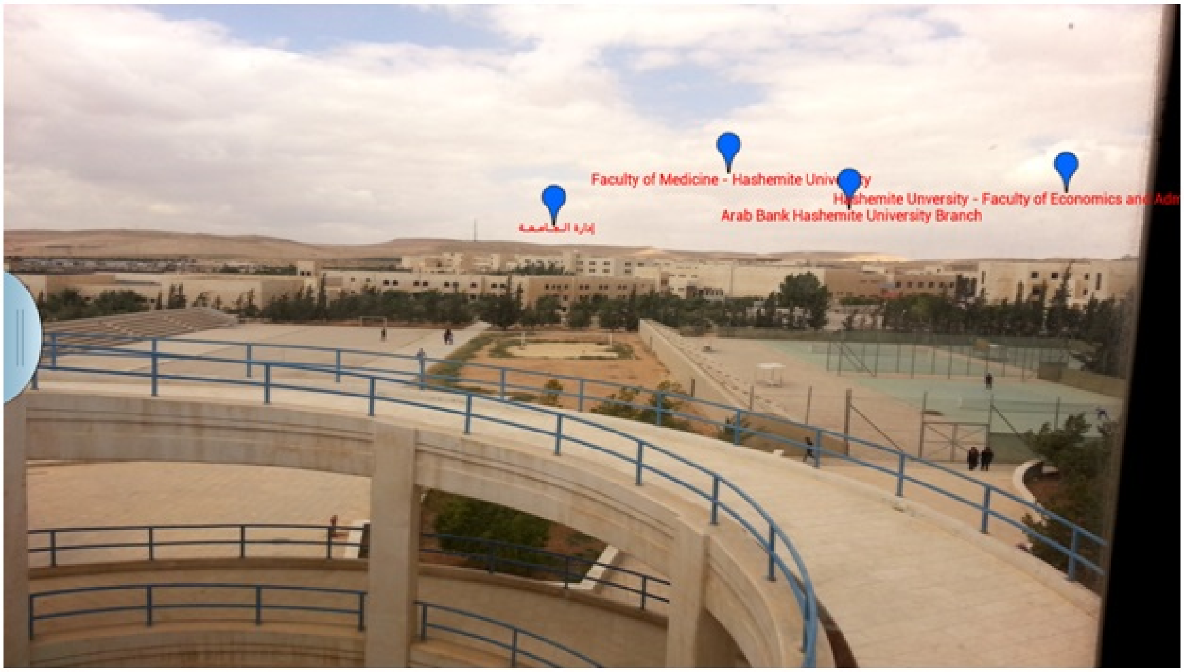

Figure 7. Camera shot augmented with sites information (taken at Hashemite University Campus)

Figure 8. A night screenshot of *JoGuide* (taken at the downtown of Amman, Jordan)

provide for public use).

In order to keep the application light, we only store the information retrieved from FourSquare obtained the current session (i.e., the currently spotted sites while the application is turned on). Users have the option of saving the augmented images in a special folder on the device or share them via email or Google Drive.

V. Conclusions and Future Work

In this paper, we presented an augmented reality based mobile application named *JoGuide*. The prototype version of the application is developed with Android, and requests data

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about available sites from maps service site. The application aims at easing the exploration of surrounding sites and helping people like tourists to identify nearby places of interest. In developing *JoGuide*, our target was to provide a lightweight application with few memory and computational requirements. We achieved our goal by minimizing the amount of data stored in memory, and by retrofiring the information via web services, and therefore, performing part of the computations on the server side. We tested the application in two major cities in Jordan and in one historical site. The application has shown to be easy to use, lightweight, and robust.

The presented work can be further extended in many directions including:

- Enabling the retrieval of more information about venues in order to give detailed and more accurate results about the venues and locations.
- Providing the option of saving the visited sites (i.e., trip tracker). This option will require saving information in a light local database.
- Providing a vocal guidance option for users with disabilities.
- Developing versions of the application that work on different platforms (e.g., iOS for iPhones, Windows phones).

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