Department of Computer Engineering

Bilkent University

Senior Design Project

Project name: InfoCam

High-Level Design Report

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1 Introduction

InfoCam is a tourist targeted, augmented reality based information gatherer application for Android platform. Application's objective is to use augmented reality to inform users about the building in front of them in an entertaining way. It detects the buildings using the camera, GPS and compass of the device and then shows information about that building like it is attached to the building. Doing this, users will be able to fetch information about any building they face without searching them on the Internet. The application will have a social face too. Users will be able to share the photos taken by the application's interface on the gallery (can be private or public) and comment on them. Using this environment, tourists will be able to get some previous experiences from other people about the places they are visiting.

1.1 Purpose of the system

The application is said to be entertaining and informative. Considering these properties, purposes listed below are coming into existence:

- To make getting information more fast and entertaining way so that people will not have to spend their time by searching information on the Internet while they are travelling,
- To provide a social environment so that people can share their thoughts and experiences without the need for another application,
- To provide an entertaining user interface so that it accomplishes the first two purposes.

1.2 Design goals

It is very important to identify the design goals of our system before composing the system. Design goals of our system are described below;

Reliability

As for any mobile application, reliability is one of the most important specifications. InfoCam aims to be entertaining so it cannot have bugs or should not fail because

these make people angrier then entertained. Therefore, the system will be as bug free as possible and there will be some error handling algorithms implemented to prevent failures.

Usability

The program will be easy and fun to use also understandable for the user. User interface will be convenient and entertaining. At first run help pop-up will guide user and a help page will be available anytime. All capabilities of the app will be explained well so that people can use them easily.

Availability

The system will be available 24 hours & 7 days and each day of the year so that users will be able to benefit from this application anytime they want.

Maintainability and Extendibility

The application will be implemented in such a way that, when required changes or extensions will be applied easily. The reason for that is, to keep up with everyday changing technology. Also, if there exist some more specifications to make application improve user experience, they should be done easily.

Portability

As there are many types of android devices, the application should be portable for any device that runs Android (as long as required hardware is available).

Security

The system will keep personal information of a user confidential. It should not share personal information by third parties without taking permission of user.
The system won't be open to security attacks. It will avoid or defuse malicious attacks.

1.3 Definitions, acronyms, and abbreviations

SQL: Structured Query Language

UI: User Interface

Server: A web server that provides software services to clients.

Client: Software end that accesses a remote server on server.

HTTP: Hypertext Transfer Protocol.

AR: Augmented Reality.

Android: Mobile operating system owned by Google®.

2 Current software architecture

There are several applications with similar functionality; however, their results lack in accuracy and they serve more as a social media platform than showing useful information related to place. We aim to provide this service to android users since there is an open need in Google play store. Our aim is to merge technology and user friendly environment for the customer.

Here are the some similar products;

Firstly, *Nearest Wiki* application that is using augmented reality gives information about the places. This application runs in iPhone however it does not generally give accurate position with related information. To prevent this, we are planning to use not only GPS but also image processing to determine the building and match the information with the building. In addition to this, this application has one information screen for one building but it shows different information in one screen. So, it distracts a user's attention to learn only one information related to one building.

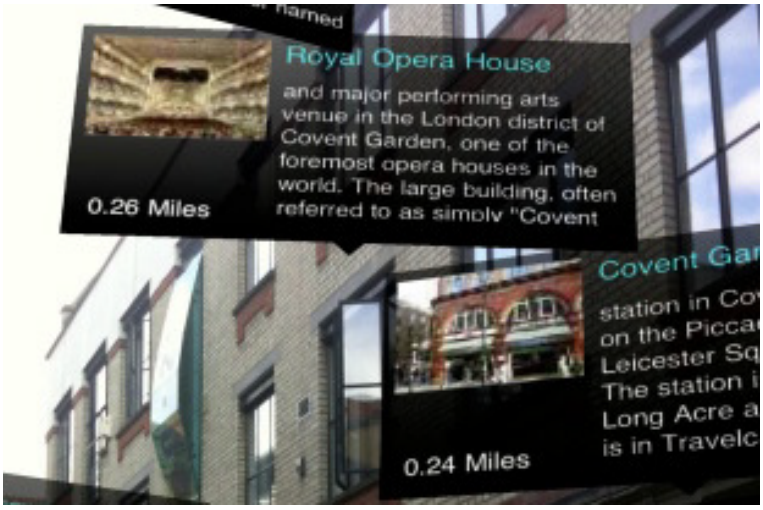

Figure 1. Nearest Wiki

Second application is *Across Air* that also runs with iOS. This application is like 3D Navigator that helps reaching location easily. In this application, you can hold your smartphone upright and look around with your camera to view restaurants, hotels,

landmarks, cinemas and other geotagged entries. So, this application gathers lots unrelated information in one step and serves them that are unnecessary information for customer at this time.

Figure 2. Across Air

Both of those applications run in iOS platform and not available in android platforms. Also, these shows lots information into one screen at the same time and it causes blocking user's attention to focus on one place and related information and waste user's time.

3 Proposed software architecture

3.1 Overview

The software architecture of the InfoCam project will be proposed during the following sections. First, in the subsystem decomposition part we will visualize the packages within our system. Also the relations between them will be shown in that part. Next, Infocam's hardware software mapping, data management and access policy are going to be explained in sections 3.3, 3.4 and 3.5 in order. Finally, the global software control and boundary conditions of the system will be described in the section 3.6 and 3.7 respectively.

3.2 Subsystem decomposition

Since client/server architectural styles are proper for systems, which manage large amount of data and we need to deal with large amount of data, we choose client/server pattern. InfoCam is designed using three tier client-server system including presentation tier, logic tier and data tier. The Figure 1 represents the general overview of our subsystem.

- Client component includes the Presentation Tier, which provides User Interfaces services to the system.
- Server component is composed of two tiers which are Logic Tier and Data Tier. Logic Tier provides GPS, Augmented Reality, Image Processing and User Management services to the system. Data Tier contains Data Management Subsystem, which stores required information for the system.
- HTTP protocol and cloud server will be used in order to create a communication between client and server subsystem and also between the tiers within the subsystem.

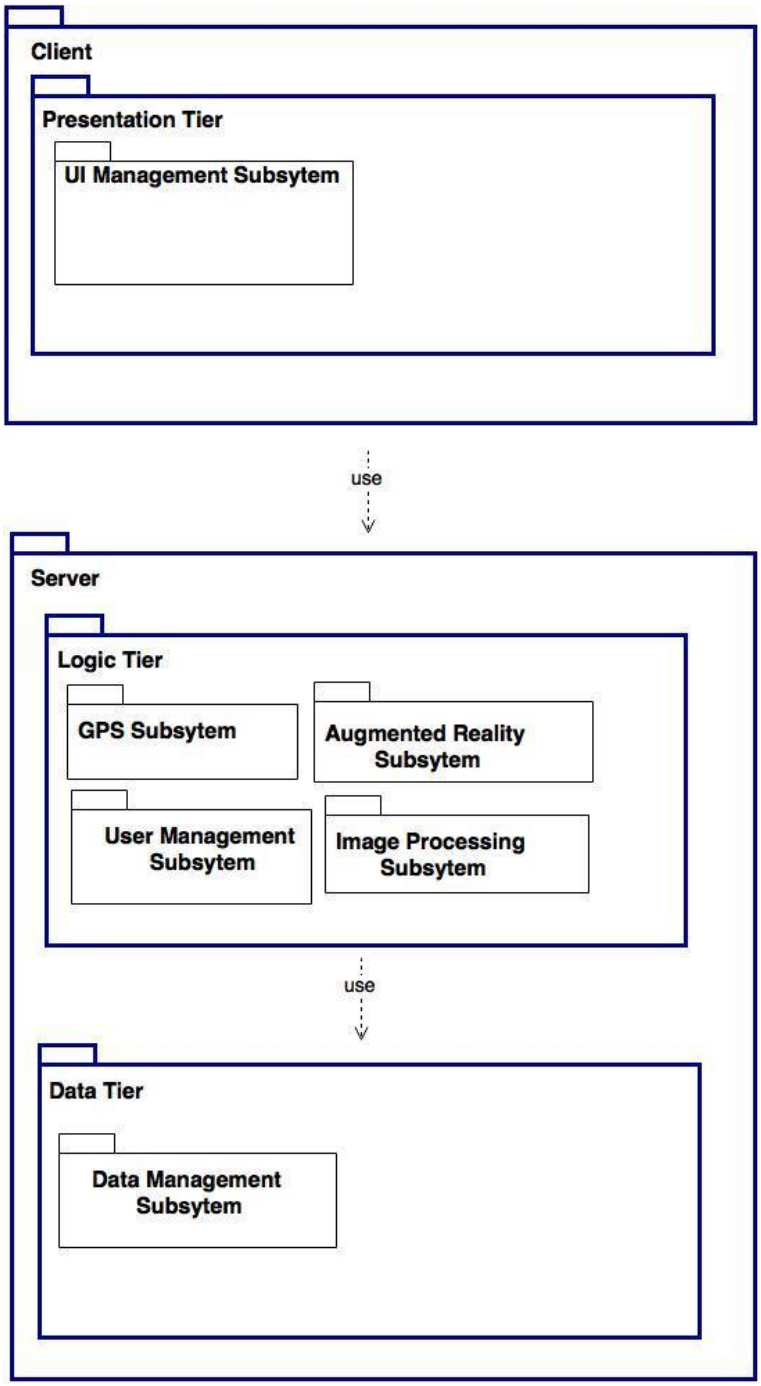

Figure 2. Subsystem Decomposition

3.3 Hardware/software mapping

Our Infocam program will be used only on Android devices. Our design goal is to make it executable on devices with Android platforms that can connect to the Internet. The program will be uploaded to the Google Play. Users who want to use

this program need to download it from Google Play Store. For the systems with Android platforms, users need to download Infocam.apk from the Google Play store. The data related to Infocam will be stored in a dedicated server in order to make the program working all the time. This server will keep the data of the locations and their images.

3.4 Persistent data management

Infocam enables building detection, related information to building including name, distance, photos and rating. That's why we need to take into account high performance, high storage capacity and time-efficiency in our database structure. As new buildings are added to the system, it will update itself accordingly. So that, users will have a large scale of building database that will increase the usability of our system. Moreover, users that are registered to the system will be recorded and they will be able to add friends, see the friends' gallery, list the buildings or friends that are in the predetermined range and etc. In order to enable users' high responses, our system needs to work in high performance in terms of time. Furthermore, the locations of the people will not be stored in the server side whereas the related quick review information about the buildings will be stored in the server side. The GPS locations of the people and buildings will be stored in the android's database in order to enable faster responses. We will acquire more information related the buildings by directing the users to the websites like Wikipedia, and other informative sources.

3.5 Access control and security

InfoCam users should register the system before starting to use. Internet access is required to register or login the system. Users can register by their Facebook or Google+ accounts or they can create accounts using email-password combination. For creating an account, users should provide a valid username, password and email. Because all the usernames, passwords and emails are stored in the system's database, entered username and email are checked to be unique. If the user does not enter a valid username and email, system returns to the login page and asks for another username and/or email. If the username and email are unique, user is leaded to the homepage of the system. Also, if a registered user enters an incorrect username or password, system remains in the login page and warns the user to enter a valid username or password.

Because InfoCam users enter the system with their emails and are able to share photos, no information of users will be shared with anybody. If the user wants to share his or her photos, after getting permission from the user, photos can be shared in their common gallery that everyone can see. Otherwise, users can store their photos in their own gallery. Also, users can arrange their visibility statues. If the user wants to be visible to their friends to see his/her location, he/she can turn on his visibility statues.

3.6 Global software control

Control flow of the InfoCam starts with logging up with Facebook, Google+ accounts or using the created account inside InfoCam. After logging up the system, users can add friends, see detailed information about a chosen building, take, share or save photos in their own gallery or common gallery, add information to their personal pages or find their friends near to their locations. Presentation tier helps users focus the camera on the building that they want to get more information; the system will recognize buildings using the GPS data and image processing technologies. The photo of the chosen building is uploaded to logic tier and the real time image will be compared to the images in the datasets with the help of data tier. The resulting information that includes the name, distance and rating of the building will be displayed using augmented reality technology. If the user wants to return to the homepage, user management subsystem takes control from the user. If the user wants to take a picture for getting more information, GPS and image processing subsystems are used. The resulting information will be displayed by the help of augmented reality subsystem. All actions between data tier and presentation tier are invoked when the user calls the data access layer.

3.7 Boundary conditions

Initialization

At the start of the application, InfoCam presents to its users register and login options. Internet access is required to register or login the system. The system also needs GPS of the mobile phone to perform location-based actions.

- If the user has already an account, he or she can sign in the system by their username and password. If the entered username and password exist in the

system's database, users can continue to use the system. If not, system remains in the login page and warns the user to enter a valid username and/or password.

- If the user does not have any account, he or she should register the system with Facebook, Google+ accounts or they can create an account inside InfoCam. InfoCam does not accept guest users.

Termination

- Users can log off from the application anytime if they clicked on the log off button.
- If the user does not quit the system by clicking the logout button, he or she will remain logged in the system.

Failure

- InfoCam requires Internet connection for all the functionality that it serves. If the Internet connection is lost, InfoCam will warn the user about the problem.
- GPS technology is used for detecting the place of the chosen building. If the mobile device's GPS facility is not turned on, InfoCam will offer the user to turn on the GPS data.
- A hardware problem can cause the system to fail.
- Database transactions will be based on ACID principles. InfoCam will save the previous state if the system fails.

4 Subsystem services

The organization of the system that is composed of more than one subsystem will be described in details. This part is also substantial because subsystems have major effects on system's features such as extendibility, modifiability, and maintainability. With the help of the subsystem decomposition, we will able to design an efficient software system by obeying the "Separation of Concern" principle that enables us to have high cohesion and low coupling. As a result of this, we will have a chance to make changes on the software easily when it is required. As we mention we use Client/Server architecture. Our project consists of 6 services: User Interface System, GPS Service, Image Processing Service, Augmented Reality Service, User Management Service and Database Management Service. GPS, Image Processing, Augmented Reality and User Management systems provide information and specify interaction with Presentation tier and Data tier.

User Interfaces Service

User interface is everything that the user can see and interact with [1]. It includes buttons, text fields, dialogs, notifications, menus and so on. Android provides many UI modules that user can easily use. User will request service from server via User Interface Service.

GPS Service

Since our application need user's location in order to provide user useful data, we are doing GPS based Android application. Most Android devices allow determining the current geolocation. This can be done via a GPS (Global Positioning System) module, via cell tower triangulation or via wifi networks [2]. The Android platform provides two sensors that let you determine the position of a device: the geomagnetic field sensor and the orientation sensor. Position sensors are useful for determining a device's physical position in the world's frame of reference. Orientation sensor enables us to determine position of a device [3]. We use these sensors in order to eliminate data in terms of user's location and orientation. Thus we are able to find which building user wants to learn. Server uses this service, specify user's location and eliminate data, then send these data to Image Processing Service.

Image Processing Service

Users wants to learn information about the building which they directs their device's camera. With help of User Interface Service and GPS Service, we have view of building and we have list of buildings around. Image Processing Service will use these data in order to specify exact building. Bilkent University Multimedia Database Group developed a mobile multi-view object image search system, using client-server architecture. Multi-view images of objects acquired by the mobile clients are processed and local features are sent to the server, which combines the query image representations with early/late fusion methods based on bag-of-visual-words and sends back the query results. [4] Image Processing Service will use this system. Augmented Reality Service will use data from Image Processing Service.

Augmented Reality Service

After building is specified with the help of the mobile multi-view object image search system, we need the serve this info to the user in a fancy way. Augmented Reality Service will work with User Interface Service and show user real time info.

Augmented Reality libraries provide to developers the tools to develop Augmented Reality applications easily. Wikitude is the one of the simplest and useful tool.

User Management Service

Database Management Service and User Interface Service will use this service. User Management Subsystem will provide the means of communication between Presentation and Data tiers. User's preferences, password, user info and also friend interaction can be changed via this service. User Management Service is responsible for everything about user.

Database Management Service

Almost all subsystems interact with Database Management Service. It provides data GPS about locations, buildings. It provides building images data to Image Processing Service. It provides building info to Augmented Reality Service. It stores user info and it provides data to User Management Service. User Interface Service also needs data from Database Management Service. It deals with data retrievals and data manipulations.

5 Glossary

Android: Linux-based and open source mobile operating system, which is being developed for mobile devices and cell phones.
Wikitude: a mobile augmented reality (AR) technology provider based in Salzburg, Austria.
Nearest Wiki: augmented reality app for iPhone

GPS: a space-based navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth

Augmented Reality: a live direct or indirect view of a physical, real-world environment whose elements are *augmented* (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data.

6 References

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