Sudan University of Science and Technology

College of Graduate Studies

Hospital Finder by Android Software

الباحث عن مستشفى باستخدام برنامج أندرويد

A Thesis Submitted in Partial Fulfillment of the Requirements of Master Degree in Computer Science

July 2016

بسم الله الرحمن الرحيم

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July 2016

الآية

قال تعالى:

﴿ وما توفيقي إلا بالله عليه توكلت وإليه أنيب ﴾

هود، الآية (88)

الحمد لله

الحمدلله رب العالمين

الذي بنعمته تتم الصالحات ،الحمدلله عدد الحركات والسكون ، عدد ماغرد طير وطار، عدد ماتعاقب الليل والنهار، ماخاب من لجا الى ربه.

الحمد لله ربّ العالمين

صاحب العظمة والكبرياء، يعلم ما في البطن والأحشاء، فرّق بين العروق والأمعاء، أجرى فيهما الطعام والماء، فسبحانك يا ربّ الأرض والسماء.

الحمد لله ربّ العالمين

يُحب من دعاه خفياً، ويُجيب من ناداه نجيّاً، ويزيدُ من كان منه حيّياً، ويكرم من كان له وفيّاً، ويهدي من كان صادق الوعد رضيّاً.

الحمد لله ربّ العالمين

الّذي سبّحت له الشمس والنجوم الشهاب، وناجاه الشّجر والوحش والدّواب، والطّير في أوكارها كلُ ُ له أواب، سبحانك يا من إليه المرجع والمآب.

فيا ربي لك الحمد حمداً كثيراً طيباً مباركاً فيه، ملء السماوات والأرض وملء ما بينهما وملء ما شئت من شيءٍ بعد، لا إله إلا أنت سبحانك إني كنت من الظالمين.

DEDICATION

*First and last Praise is due to **Allah**,*
To the soul of all my life, a symbol of love and healing balm, to
*white heart my beloved **Mother (Zainab**).*

To the great man, the men marker, the generation educator and
*the school of life, my **father (Ahmed).***

*To the source of my happiness my **brothers** and **sisters**.*

To those who were my salvation, to those who we spent the most
*beautiful moments with them my **friends***

To all of who encourage and support me.

Researcher

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*First of all, all thanks belong to **ALLAH**, the almighty for giving me the will power to make this work; truly without his grace nothing is achievable.*

*I am extremely thankful to my respective guide **Prof. Dr. Dieter Fritsch** for his valuable guidance, advice, motivation, encouragement, moral support, sincere effort.*

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*And my grateful to whom always encourage me from the beginning till the completion of the thesis my beloved **Mother** and **Father.***

Finally, I would like to thank everyone who participates in success of this thesis.

ABSTRACTION

Technological advancements which have shown a substantial growth concerned with each and every field of humanity, the rapid development that has occurred in smart phones has become a very significant factor in achieving our daily tasks.

Quite often, spatial search applications of smart phones do not effectively operate in the State of Sudan because they mainly rely on Google maps has lack of information of many health care units and therefore cannot deliver any results at all.

This thesis aims to make an android application that is looking for hospitals with a specific specialization and choosing the distance between the user and its location with respect to the type of the health care unit: hospital, clinic or health center. Moreover it delivers brief information about it, with the ability of showing the location on the map, and also drawing the route between the user and the health care unit.

By implementing and testing the application that has been able to reduce the problem, we were facing another problem. This is missing location data and information of some health care units in Google maps.

المستخلص

التطور التكنولوجي المتسارع الذي يشهده العالم اليوم في شتى مناحي الحياة كان له الأثر الواضح في كثير من المجالات، كما أن التطور التكنلوجي السريع الذي ظهر في الهواتف الذكية أصبح الاعتماد عليه كبيراً جداً في إنجاز مهامنا اليومية.

أغلب تطبيقات البحث المكاني الخاصة بالهواتف الذكية لا تعمل بصورة فعالة في دولة السودان وذلك لأنها تعتمد بصورة أساسية على خرائط قوقل والتي تفتقر لمعلومات كثير من الوحدات الصحية من مستشفيات وعيادات وغيرها.

تهدف هذه الدراسة لعمل تطبيق يقوم بالبحث عن الوحدات الصحية وفقاً لنوعها والتخصص المطلوب مع اختيار بعدها الجغرافي عن المستخدم وإظهار معلومات مختصرة عنها ويوفر التطبيق أيضاً إمكانية عرض موقع الوحدة الصحية على الخريطة وخاصية رسم طريق بين المستخدم والوحدة الصحية.

بعد تنفيذ التطبيق واختباره وفر لنا إمكانية حل المشكلة التي كانت موجودة في التطبيقات الأخرى القائمة على قواعد البيانات الخاصة بخرائط قوقل.

LIST OF TERMS:

IT	Information Technology
GIS	Geographic Information System
GPS	Global Positioning System
PC	Personal Computer
MySQL	My Structured Query Language
WGPHSSs	Web GIS-based Public Health Surveillance Systems
OS	Operating System
WAMP	Windows Apache MySQL PHP
PHP	Hypertext Preprocessor
Android App	Android Application
CPU	Central Processing Unit
HTTP	Hyper Text Transfer Protocol
API	Application Programming Interface
Windows XP	Windows eXPerience
SP3	Service Pack3
GTK+	GIMP (GNU Image Manipulation Program) Toolkit
STL	Standard Template Library
IDEA	Integrated Development Environment for Android
ADT	Android Development Tools
UML	Unified Modeling Language
TV	Television

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CHAPTER 1

INTRODUCTION

1.1. Introduction

In the beginning it must be pointed out the fact that human history has proven, that human beings were, are and will be creative in inventing and making their needs for living tools. Therefore, they have been able to diversify, develop and improve those tools over time, to meet all objectives more efficiently throughout the past centuries.

The second half of the twentieth century witnessed an explosion in scientific knowledge, IT development and manufacture in addition to distribution across the globe, which exceeded the whole of what happened in the past, both quantitatively and qualitatively and widespread.

With the increasing of the mobile phones availability; the desire of people to access mobile internet getting information and services from anywhere and everywhere is increased as well. Smart phone apps emerged and are offered in electronic stores such as Apple store, Google play, 1mobile Market, Mobo Market, ... etc, with different and varying features in all areas and specializations. Some app examples are given here: Al-Quran, my health, WhatsApp, …etc. However, some of these apps should be available to work in a specific environment or in a specific region. So, it is necessary for all countries to put their mark and develop their specific environments.

In this study we will look at an android application which is searching for near hospitals and shows brief information about it. Moreover, it shows the hospital locations on the map.

1.2. Problem of the Study

Are those smart phone apps, which are performing a spatial search, and are totally dependent on Google Maps to provide the desired information, working in Sudan?

Is the global digital map reliable enough to see the distribution or search for hospitals in Sudan without missing any information?

1.3. Suggested Solution

Android applications with database servers in the background allow for a search of near hospitals, which are stored in a database and should also deliver brief information about them - the hospital's location is displayed on a digital map.

1.4. Importance of the Study

Obviously, only a few actors and institutions in the Republic of Sudan are recorded in Google Maps. In particular, amongst information services such as hospitals, water systems, gas stations, and others we will find only a few of them, and sometimes we note that some areas in those maps have no names at all.

The importance of this study is to clarify the importance of geographic information systems (GIS), taking advantage of it in creating an application with its benefit to find the nearest hospitals.

1.5. Objectives of the Study

- Create an application that is looking for the nearest hospitals or health centers and providing brief information about them.
- Motivate all of those creative people who can create such applications and systems to facilitate the needs of the people in Sudan and making a contribution to Sudan's footprint in electronic app stores.
- Show the potential of geographic information systems (GIS) technology in the application of spatial analysis methodology for hospitals in Omdurman.

1.6. Study Limits

- **Spatial border**: Khartoum state (Omdurman – Khartoum - Bahri).
- The application is not useful for iOS and Windows Phone users.

1.7. Methodology of the Study

Consist of the following steps:

- Gathering information about hospitals like specializations and health services to test the efficiency of the app.
- Determine the coordinates of the hospitals using the Global Positioning System (GPS).
- Store all the information and coordinates of hospitals in WAMP server MySQL.
- Use Android studio to create the system.

1.8. Organization of Thesis

There are 7 chapters in this thesis. It is organized as follows:

- Chapter 2- This chapter contains a literature review of using GIS (Geographic Information Systems) in analytics of geographical distributions, accessibility and utilization of services, surveillance of health services, as well as a Restaurant Delivery System by using an android application for digital table booking and food ordering system.
- Chapter 3- This chapter describes the methodology and the phases of the application creation.
- Chapter 4- This chapter talks about the spatial limits (area of study) of the application with historical background about it.
- Chapter 5- This chapter focuses on the description, components, and user function of the application. Furthermore it contains simulations and analyses, besides a detailed explanation of the performance of the developed application.
- Chapter 6- In this chapter conclusions and future research work are discussed.
- Chapter 7- This chapter declares the reference.

CHAPTER 2

BACKGROUND AND LITERATURE REVIEW

2.1. Introduction

This chapter contains a literature review of using GIS (Geographic Information Systems) in geographical distribution, accessibility and utilization of services. Also existing Web GIS-based Public Health Surveillance Systems (WGPHSSs) are reviewed and assessed, based on 20 indicators adapted from previous studies.

2.2. Background

- **Android**

    The Android Operating Systems have considerably improved in the last 15 years. Starting from black and white phones to recent smart phones or mini computers, mobile OS have made giant steps in developments, particularly for smart phones. It can be stated here, that mobile OS did greatly evolve from Palm OS in 1996 to Windows pocket PC in 2000, and then to Blackberry OS and Android.

    One of the most widely used mobile OS these days is **ANDROID.** Android is an operating system for mobile devices and is based on a modified version of Linux. It was originally developed by a startup of the same name, Android, Inc. Google acquired Android in 2005, as part of its strategy to go into the world of mobiles, and took over also the Android development work with its development team [1].

    Android runs on all kinds of devices from phones to tablets and even televisions. These huge different devices could be targeted with just one platform. Google supports developers with all of the material needed to get started building Android apps for free. Anyone can build Android apps on various operating systems (Macs, Windows, or UNIX) and circulate the apps using Google's Play store without waiting for agreement from anyone [2].

    The main advantage of adopting Android is that it provides an adaptive app framework that allows for providing unique resources for different device configurations. In the world of smart phones, the most important part of the success chain is the applications [2].

    Android is a powerful Operating System supporting a large number of applications in Smart Phones. These applications make life more comfortable and advanced for the users.

- **Android applications**

   Today the world is toning with the development of mobile phone technology. As the number of users is increasing day by day, services are also increasing. Starting with simple regular handsets, which were used just for making phone calls, mobiles have changed our lives and have become part of it. Now they are not used just for making calls, but they have innumerable uses and can be used as a camera, music player, tablet PC, TV, Web browser and many more. As technologies are further developed, new software and operating systems are required [9].

   Android applications are software applications running on the Android platform. Because the Android platform is built for mobile devices, a typical Android app is designed for a smart phone or a tablet PC running on the Android OS [10].

2.3. Related studies:

- (Eklund, L. and Martensson, U., 2012 [3]), this study using Geographical information systems (GIS) and network analysis to generate different estimations of accessibility based on the existing road network and transport barriers. People, who live outside urban centers and in governorates without general hospital, were mainly negatively affected. They used GIS to get quantitative measurements to confirm qualitative studies, which are based on interviews and questionnaires and enhance the understanding of the results. Working with a spatial analysis tool also helps to describe clearly the weaknesses in the current infrastructure, therefore improving the efficiency of future investments to improve health care in the West Bank.

   This study aimed to estimate the current accessibility to health services in the West Bank, and to compare the present situation with a best- and a worst-case scenario so as to quantify the impact of Israeli policies on the Palestinian population. The study focused on accessibility by private cars.
   - ➢ The similarity between the earlier study and this dissertation study is that both aimed to enhance the accessibility to health care units.
   - ➢ The difference is that the earlier study used (GIS) and network analysis to make various estimations of accessibility to health care

units, but this current study uses Android to create an application to find health care units nearby.

- (Majid, A., 2013 [4]), this study identifying the scope of the effect of the topography of Mina on the distribution of government services - also to know the spatial pattern of distribution and access of the most appropriate government services in Mina using GIS technology. Therefore this study investigated an analytic descriptive approach, which relies on the study of the phenomenon on the ground and then described flour as an example. To complete all the requirements of the study,it had to collect data, to transform it to digital maps by GIS programs and to build a geographic database. Many examples were represented in a variety of digital maps.
  - ➢ The similarity between the earlier study and the current study is that both used GIS technology: GIS programs like Esri's ArcGIS in the earlier study, and GPS in the current study.
  - ➢ The difference is that the earlier study aimed to identify the scope of the effect of the topography of Mina on the distribution of government services - the current study is using Android to create an application to find health care units nearby.

- (Bellini, P., et al., 2014 [5]) this study created to find a solution that addresses the aspects of communicating among medical staff. Thus the modalities and protocols had to be formalized to provide information helping the medical personnel during emergency conditions. This could be realized with a support of a Central Station (command center) to deal with an emergency management and best practice network to generate and distribute intelligent content to mobile devices of the medical staff. As a benefit, this approach decreased the time needed to respond and to cope within emergency organizations, while facilitating connections.
  - ➢ The similarity between this earlier study and the current study is that both created an android application and both are dealing with hospitals.
  - ➢ The difference is that the earlier study offered an application that is available for iPad, iPhone, Windows Phone 7, and Android, to communicate with the medical personnel and to reduce the response

time for emergency conditions. The current study will make an application that is available for just Android to search for the nearby hospitals with various specializations.

- (Abd-Alaziz, et al., 2014 [6]) published a paper to create a system that has an Android application and a website that allows the customer - after login to the system - to select available restaurants and then choose the meals. The customer's current location is sent to the server through the android application by GPS technology.
The system offers the customers making orders immediately without any effort. It also reduces the customer's waiting minutes to receive the orders, and increases the restaurant's revenue.
    - ➢ The similarity between the earlier study and the current study is that both created an android application using GPS technology.
    - ➢ The difference is the earlier study created a system has an Android application with website (client\server), which search for meals by the restaurant name and deliver the orders of the customers. Current study searches for hospitals nearby by calculating the distance between the user's location (GPS position) and the stored hospital's locations.

- (Dhore, et al., 2014 [7]), and others published an article aiming at to create a remote food ordering system, through which one can order food before visiting a restaurant. Furthermore it allows for booking a table, and also makes payments. As an example, two or more customers can place orders for the same table from remote locations. This application contains three applications within itself. The first one is for the customer who can book tables and place orders. The second one is for the kitchen part in a restaurant that enables the staff to view current orders. Thirdly it is for the manager of the restaurant to keep track of all the operations. The system suggests menus to the customer while placing an order; it is also using a compression algorithm that compresses the size of images used throughout the application at various stages.
   This system increases quality and speed of service; it also increases the popularity of restaurants among potential customers. Implementing this

system gives a cost-efficient chance to grant customers a personalized service experience where they are in control of choosing what they want, when they want.

- ➢ The similarity between the earlier study and the current study is that both create an android application.
- ➢ The difference is that the earlier study made a system that has an Android application, which is divided into three parts: one for the customers, the second one for the kitchen and the last one for the restaurant manager. The current study is offering a one part system for the user, who wants to search for nearby hospitals, by calculating the distance between the user location and the stored hospital locations.

CHAPTER 3

METHEDOLOGY, TOOLS AND TECHNIQUES

3.1. Introduction

This chapter describes the idea and methodology, phases of application creation with definition for tools and techniques, which are used in creating the app.

3.2. Idea and methodology

The idea of creating this application is based on searching for the nearest hospital, health center or clinic by choosing the type of health unit (hospital, health center or clinic) and then choosing specialties and distances between the user and health units.

3.3. Phases of creating the application

3.3.1. Information and coordinates of hospitals:

The coordinates: Some of it are gathered by going to hospital locations and get it with a GPS receiver embedded in a smart phone. Sometimes they are collected by using Google maps.

The information: Information about the hospitals like specializations and health services can be enquired either: the management of hospitals or gathered randomly to test the efficiency of the app.

3.3.2. The database: It is installed in WAMP server software and stores the data in MySQL on a WAMP server. The connection to the database is realized with PHP files and uses Notepad++ in writing the PHP file. These files are connected later with java class file in the Android Studio.

3.3.3. The coding of building the app:

- For this we have installed the Android Studio Program Version 1.5.1 for creating the android app.
- Creating database in MSQL and storing data of hospitals in it.
- Creating PHP files to manipulate with the database and the conditions of selection, which are delivered by the JAVA files in Android studio, according to the user demands.

3.4. Tools and techniques

3.4.1. Windows:

Windows is the most widely used operating system for desktop and laptop computers. Developed by Microsoft, Windows primarily runs on x86-based computers (the ubiquitous PC), although some versions run on Intel's Itanium CPUs. Windows provides a graphical user interface and desktop environment, in which applications are displayed in resizable, movable windows on screen.

Microsoft announced the last version Windows 10 in September 2014 [19].

3.4.2. WAMP Server:

WAMP stands for (Windows, Apache, MySQL, and PHP); WAMP server is a web development environment on Windows, which lets web developers create dynamic Web applications with Apache, PHP, and MySQL. WAMP server automatically installs everything to be needed to develop Web applications. The Web developer will be able to tune his server with no need to change its file settings.

The most important part of the WAMP package is Apache (or "Apache HTTP Server") that is used to run the web server within a Windows machine, which allows the Web developer to test web pages in a web browser without putting them live on the Internet [14].

WAMP also contains MySQL and PHP; those two are the most common technologies used for creating dynamic websites. MySQL is a high-speed database, while PHP is a scripting language that can be used to access data from the database. Installing these two components locally, a developer can build and test a dynamic website before publishing it to a public web server.

Best of all, WAMP server is available for free in both 32 and 64 bit versions. WAMP server is not compatible with Windows XP, SP3, or Windows Server 2003 [15].

3.4.3. Notepad++:

Notepad++ is a free source code editor which supports a lot of languages and it replaced the old Notepad module.

Based on the powerful editing component Scintilla (free source code editing component for Win32, GTK+, and Mac OS), Notepad++ is written in C++ and uses pure Win32 API and STL, which ensures a higher execution speed and smaller program size [16].

3.4.4. JAVA:

Java is a high-level programming language developed by Sun Microsystems. The Green Team, which was a small team of engineers, initiated the language in 1991. At that time, Java was originally called OAK, and was designed for handheld devices and set-top boxes. OAK was unsuccessful, so in 1995 Sun changed the name to Java and modified the language to take advantage of the burgeoning World Wide Web [17].

Later, in 2009, Oracle Corporation acquired Sun Microsystems and took ownership of two key Sun software assets: Java and Solaris, Java explicitly designed for use in the variable environments of the Internet. It was designed to have the "look and feel" of the C++ language, but it is simpler to use than C++ and enforces an object-oriented programming model [18].

3.4.5. Android Studio:

Android Studio is an IntelliJ IDEA based IDE and declared by Google as the official IDE for the Android application development. On top of IntelliJ's powerful code editor and developer tools, Android Studio provides even more features that can improve productivity when building Android apps, such as:

➢ A flexible Gradle-based build system.
➢ Build variants and generates numerous APK files.
➢ Offers code templates helpful in building common app features.
➢ A powerful layout editor, which supports drag and drop theme editing.

> ➢ Lint tools to catch performance, usability, version compatibility, and other troubles.
> ➢ Code shrinking with ProGuard and resource shrinking with Gradle.
> ➢ Built-in support for Google Cloud Platform, making it easy to integrate Google Cloud Messaging and App Engine.

Android Studio is designed specifically for Android development, and it is available to work on Windows, Mac OS X and Linux, and replaced the deprecated editor which was called Eclipse Android Development Tools (ADT) as Google's main IDE for original Android application development [11].

3.4.6. Enterprise Architect:

Enterprise Architect is an outstanding tool with high end capabilities and a rich set of features to help manage information and innovations in today's complex and demanding environment. It is a tool for the design and comprehensive analysis of Unified Modeling Language (UML).

For 15 years it has been incessantly developed, enhanced and refined to meet the rising needs of programmers, business analysts, enterprise architects, testers, project managers, designers and others. Based on open standards and proven best-practice, Enterprise Architect can comfortably scale from small single user models to large team based repositories and even to globally distributed Cloud based solutions [20].

3.4.7. Android OS (Operating System):

Android is the customizable, easy to use operating system that powers more than a billion devices across the globe — from phones and tablets to watches, TV, cars and more to come. So, it is powering screens of all sizes [22].

3.4.8. GPS:

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, the government made the system

available for civilian use. GPS permits land, sea, and airborne users to determine their position, velocity and the time, 24 hours a day, in all weather, anywhere in the world. The GPS signals are available to an unlimited number of users simultaneously. There are no subscription fees or setup charges to use GPS [12] [13].

3.4.9. UML(Unified Modeling Language):

UML is an industry standard modeling language with a rich graphical notation, and comprehensive set of diagrams and elements. A comprehensive UML modeling tool like Enterprise Architect is the ideal way to take control of your software or business project now.

The use of UML as a tool for defining the structure of a system is a very useful way to manage large, complex systems. Having a clearly visible structure makes it easy to introduce new people to an existing project [21].

CHAPTER 4

THE TEST BED
(KHARTOUM STATE)

4.1. Introduction

This chapter talks about the hospitals and the spatial limits of the application – also some historical background information is given.

4.2. Hospitals

Hospitals are a health care institutions providing patient treatment with specialized staff and equipment. The best-known type of hospital is the general hospital, which has an emergency department - the district hospital typically is the major health care facility in its region, with large numbers of beds for intensive care and long-term care.

Specialized hospitals include trauma centers, rehabilitation hospitals, children's hospitals, seniors' (geriatric) hospitals, and hospitals for dealing with specific medical needs such as psychiatric problems (see psychiatric hospital) and certain disease categories. Specialized hospitals can help reduce health care costs compared to general hospitals.

4.3. Khartoum state:

Khartoum, the capital of Sudan is divided into three towns (Omdurman – Khartoum – Bahri, see fig. 4.1) by the confluence of the Blue Nile and White Nile [23].

Geography: Khartoum State is in Central Sudan and is surrounded by:
- ❖ Al-Jazira State.
- ❖ White Nile State.
- ❖ Kassala State.
- ❖ Gedaref StateNorth Kordofan State.
- ❖ Northern State.
- ❖ River Nile State.

There are a number of state hospitals and health centers, while distributed in the state center and various neighborhoods, such as the Educational Omdurman Hospital and the Ibn – sena Hospital [24].

Figure (4.1): Map of Khartoum State

❖ **Why Khartoum State is the test area?**

At first, Omdurman town as test area for the application has been selected, and here particularly its governmental hospitals. It turned out later, that the application could not efficiently be tested, because of missing data. Therefore, it was decided to select Khartoum state to be the testbed.

In total about 60 health units (as a minimum number of it) from Khartoum state could be selected to test the app. These are distributed at the three towns of Khartoum state; Omdurman - Khartoum - Khartoum North (Bahri).

4.3.1. Omdurman city:

Omdurman is one of the three towns (with Khartoum and Khartoum North), located at east-central Sudan. Situated on the bank of the main Nile River and just below the confluence of the Blue and White Niles, Omdurman was an insignificant riverine village until the victory of

Muhammad Ahmad, known as al-Mahdi, over the British in 1885. Al-Mahdi and his successor, the caliph Abd Allah, made it their capital, and it grew rapidly as an unplanned town of mud houses. Omdurman was captured by Anglo-Egyptian forces led by Major General Sir Herbert (later Lord) Kitchener in 1898 but continued to develop into the cultural, religious, and commercial centre of Sudan. Whereas Khartoum is the executive capital of Sudan, Omdurman is the country's legislative capital. Abd Allah's house is now a museum, and the tomb of al-Mahdi has been restored [25] [26].

4.3.2. Khartoum city:

Khartoum town lies along the left bank of the Blue Nile, and forms a huge triangle. Its vertex is at the confluence of the two Niles, the White Nile on its west side and the Blue Nile on its east and the base bordering Gezira State some 30km southward. It is situated on latitude 15.36 N, and longitude 31.32 E, and it is 1352 ft. above sea level. Its population has grown to over 5 million people. Khartoum, together with the two cities, Omdurman and Khartoum North (Bahri), are jointly called the tri-capital, constitute the National Capital of the republic of Sudan [27].

4.3.3. Khartoum North:

Al-Khartoum Bahri city, east-central Sudan, lies on the North bank of the Blue Nile and on the East bank of the Nile proper, with bridge connections to its sister cities of Khartoum and Omdurman. Hosting the main industrial centre of the region and the country, the city contains dockyards, marine and rail workshops, and sawmills. Khartoum North trades in cotton, grains, fruit, and livestock; industries include tanning, brewing, brick making, textile weaving, and food processing. Arabic is spoken by most of the inhabitants [28].

CHAPTER 5

DESCRIPTION, COMPONENT, ANALYSIS, IMPLEMENTATION AND RESULTS

5.1. Introduction

This chapter deals with descriptions, components, and user functions of the application. Moreover it demonstrates implementation and analyses. Furthermore it also introduces an explanation of the application working and the scenarios tested by a detailed presentation of the application interfaces, finally it shows the results.

5.2. Application description

The mechanism of the application is based on getting the location of the user by GPS measurements and combining the information of the health units from the database. Here, a special type of health unit and its specialty can be chosen by the user. The selection is carried out by calculating the distance between the user and a resulting hospital – these have been in a specified distance range.

5.2.1. User of application: He/she just looks for hospitals without any authorization for his/her identity.

5.2.2. User functions:
- Choosing the type of health units (hospital, health center or clinic) and choosing a specialty from an expandable list of entries, shown by the application. Select the distance between the user and the health units.
- Showing the hospital on the map.
- Demanding for a drawing route between the user's location and the hospital location.

5.2.3. Application functions:
- Retrieving results according to the selected data by the user.
- Showing the hospital location on a map in order to satisfy the user demand.
- Drawing a route between the hospital location and user location on a map.

5.3. Application components:

The application consists of two components: hardware and software.

5.3.1. Hardware components:
- The computer works as a server and stores data of hospitals.
- The smart phone with the Android operating system and having internet access.

5.3.2. Software components:
- **User part:** It is an Android application letting the user search for hospitals.
- **Server part:** Consists of MYSQL database which contains the hospital's data and uses PHP language accessing the database.

5.4. Analysis of application:

5.4.1. Use Case Diagram:

A use case diagram is a scheme used to identify the different types of actors and represents their functions and interactions with the system.

Figure (5.1) illustrates the use case diagram of the application and the processes to be carried out.
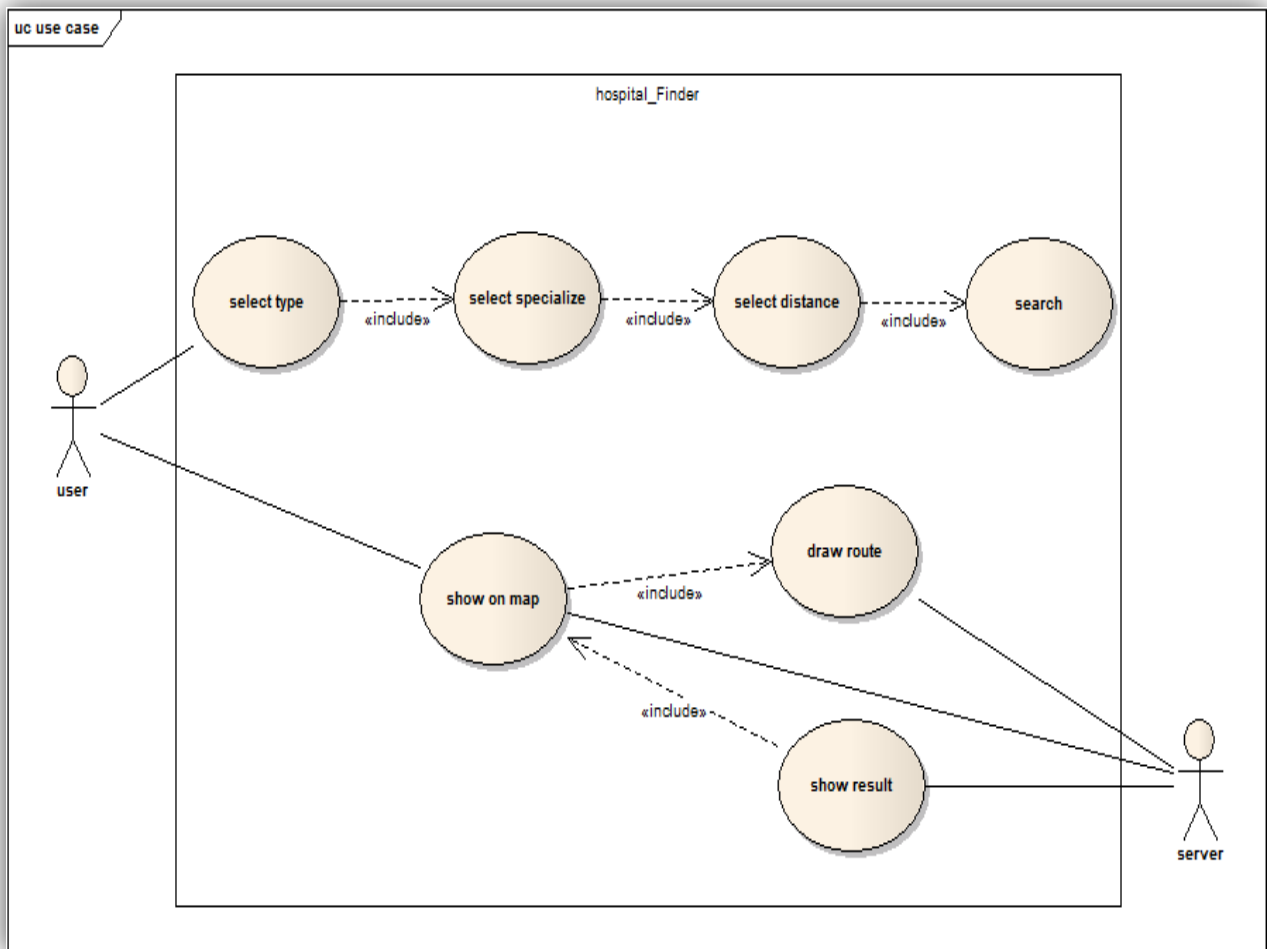
Figure (5.1): Use Case Diagram

5.4.2. Sequence Diagram:

A sequence diagram is a scheme to show how the processes collaborate with each other, and in what order they appear, to show the flow of data and messages between the various components of the system.

- Horizontal components in diagram show the objects in the system.
- Vertical components show the order of messages exchanged.

In total three sequence diagrams for this application are used - each of them illustrate functions provided by the system, whether to the system administrator or the user.

5.4.2.1. Select choices and search for hospitals:

Use Case Name	Select choices and search hospitals
Actors	User
Preconditions	No
Main Flow Of Events	1. The application asks the user to select the type of health care units, its specialization and the distance range. 2. The user selects the type of health care units, specialization and the distance range.
Post Conditions	1. The application searches the database for hospitals according to the selection of the user. 2. The system responds to the user with a list of hospitals - if nothing is found it shows a message.

Table (5.1): Sequence Diagram for Selecting Choices
& Searching for Hospitals
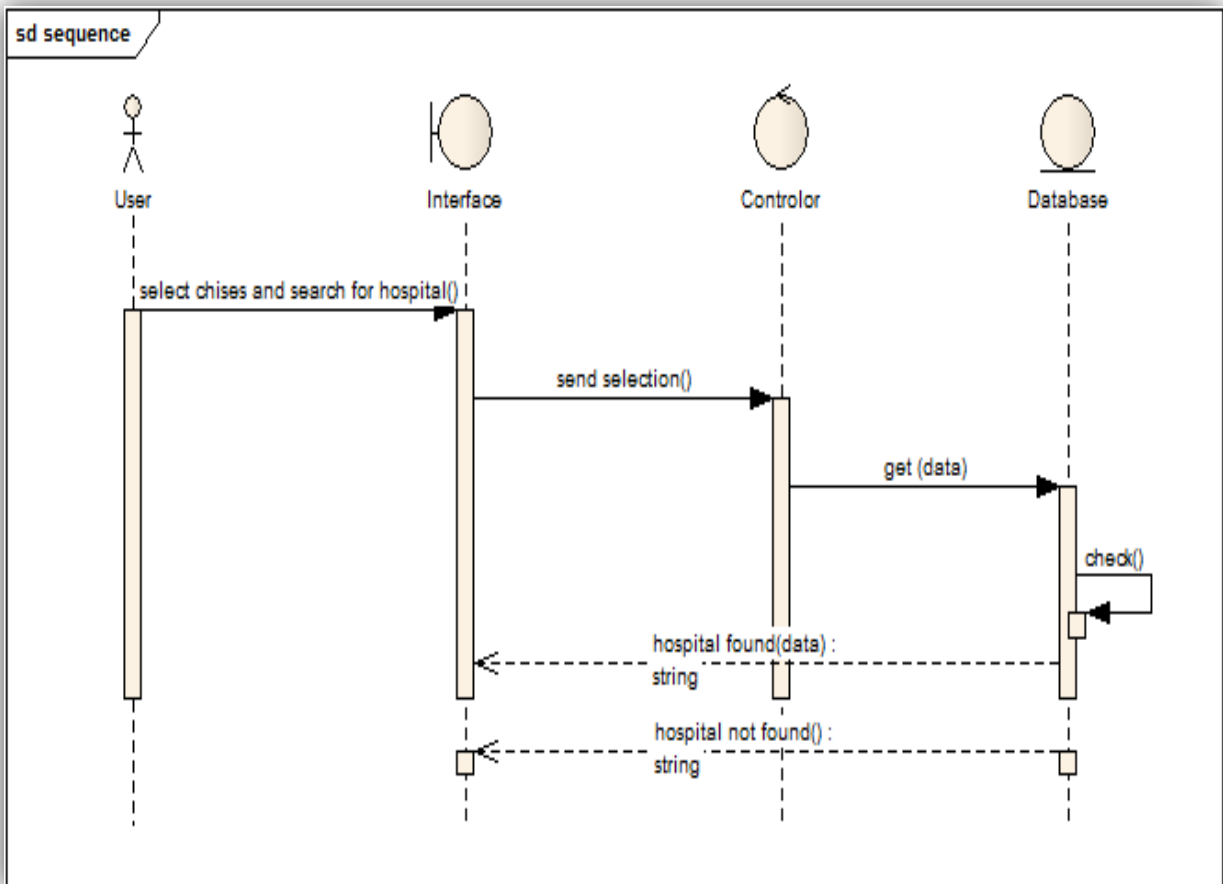
Figure (5.2): Sequence Diagram for Selecting and Searching

5.4.2.2.   Show hospital on map:

Use Case Name	Select choices and search hospitals
Actors	User
Preconditions	No
Main Flow Of Events	1. The user asks the application to show the hospital on a map.
Post Conditions	1. The application shows the hospital on map.

Table (5.2): Sequence Diagram for Map Displays
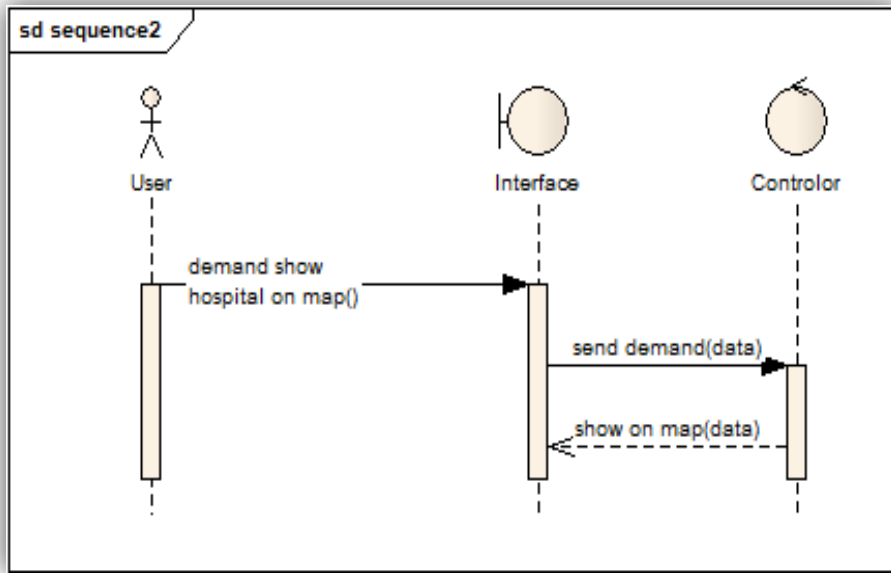
Figure (5.3): Sequence Diagram for Map Displays

5.4.2.3. Draw route between hospital and user locations:

Use Case Name	Select choices and search hospitals
Actors	User
Preconditions	No
Main Flow Of Events	2. The user asks the application to draw a route between the hospital and the user locations.
Post Conditions	2. The application responds with a route between the hospital and user locations.

Table (5.3): Sequence Diagram for Drawing Routes
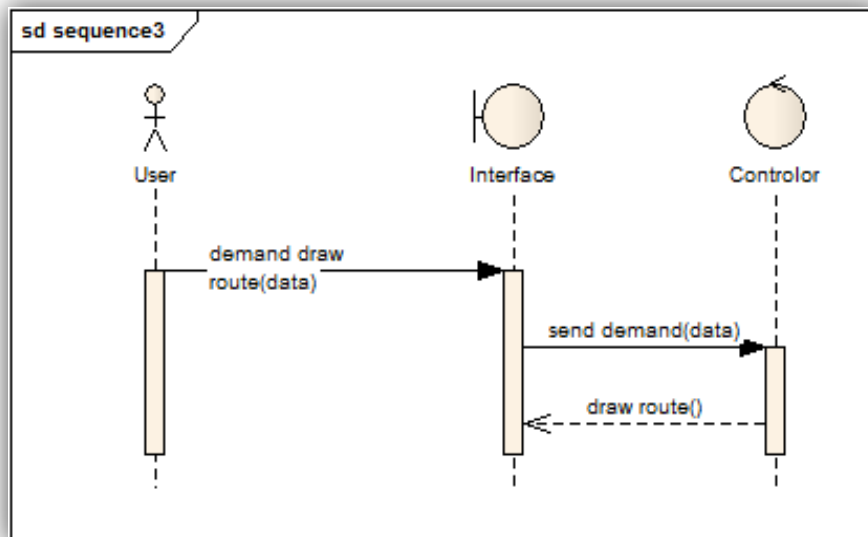
Figure (5.4): Sequence Diagram for Drawing Routes

5.4.3. Activity Diagram:

An activity diagram is intended to model both, the computational and organizational processes. Activity diagrams show the overall flow of control.

For this application only one activity diagram is used, as demonstrated in **Figure (5.4)**.
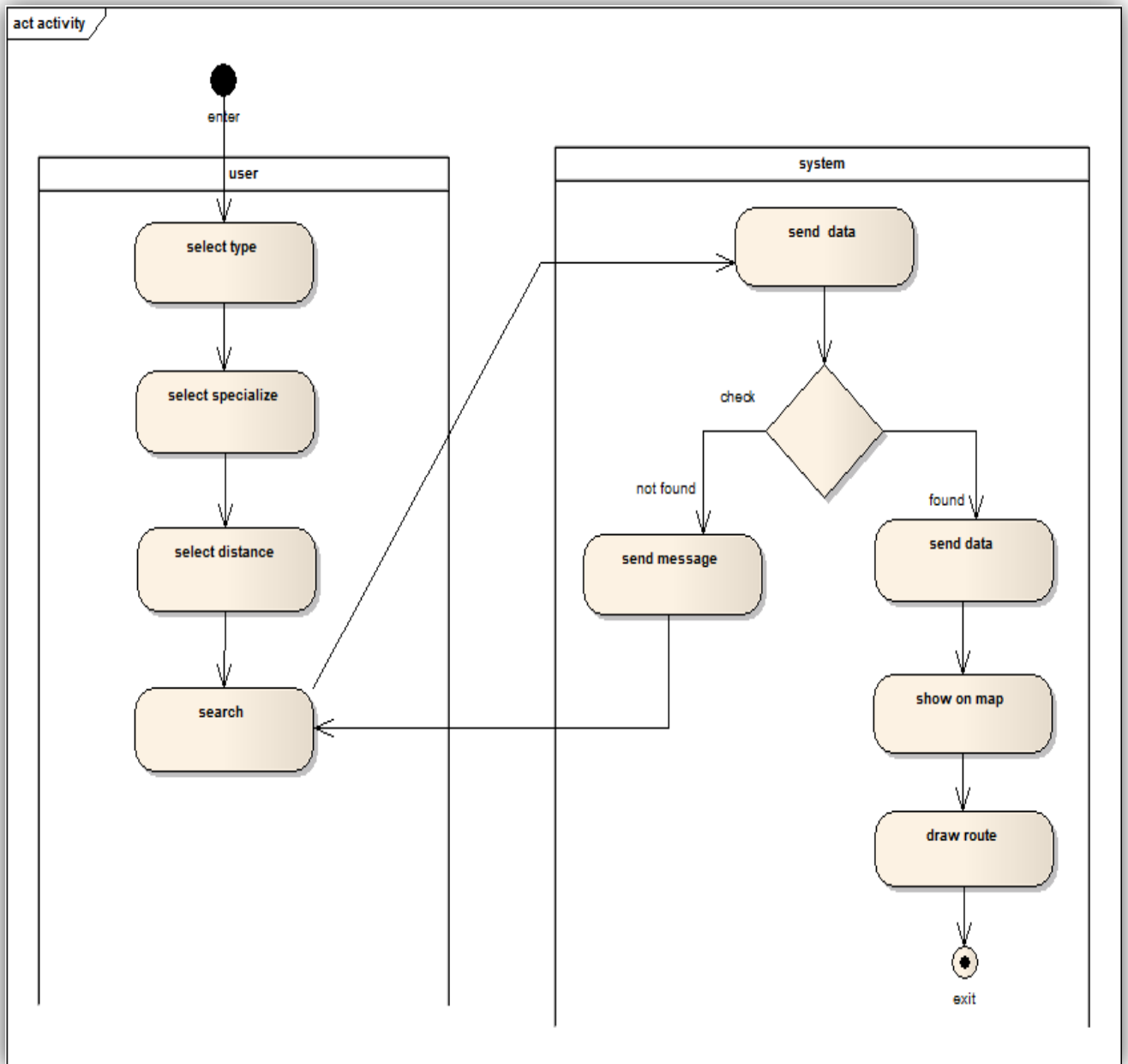
Figure (5.5): Activity Diagram

5.4.4. Deployment Diagram:

The deployment diagram illustrates hardware and software used in the application and how these components interact with each other.
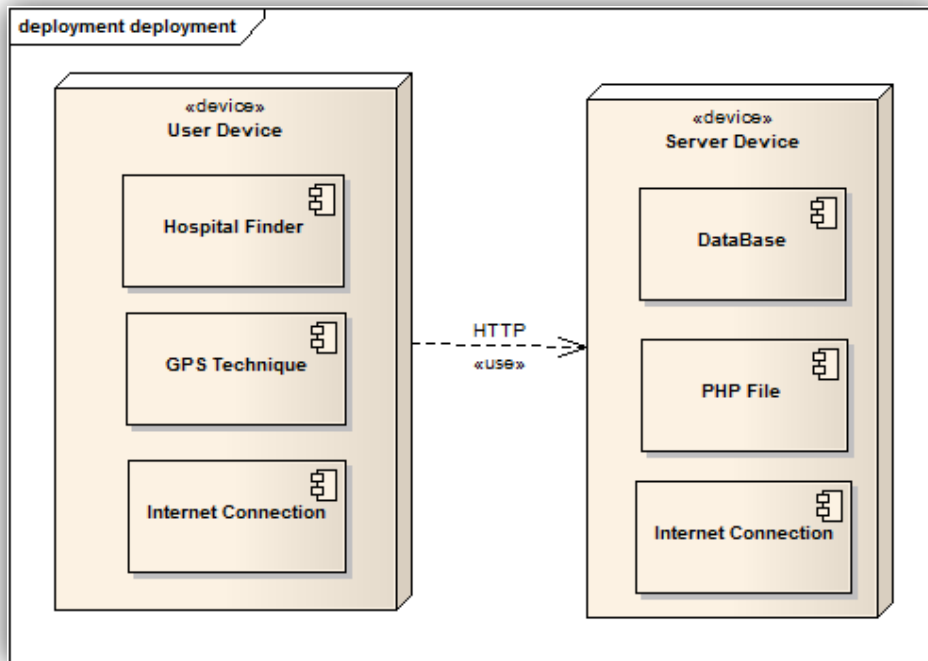
Figure (5.6): Deployment Diagram

5.4.5.   Class Diagram

A class diagram illustrates the parts of application with their methods and attributes.
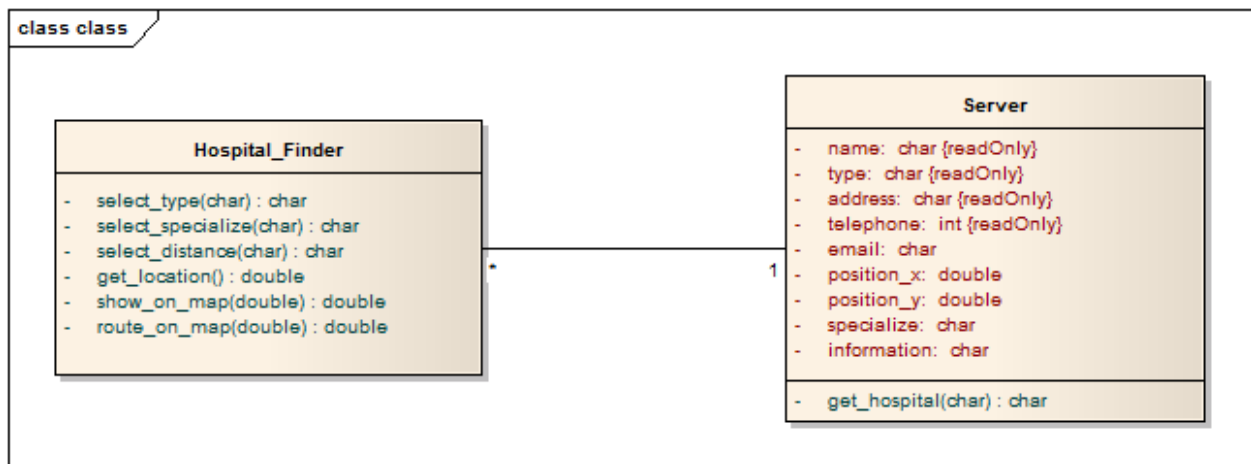
Figure (5.7): Class Diagram

5.1. Implementation and Application interfaces
5.1.1. The main interface:
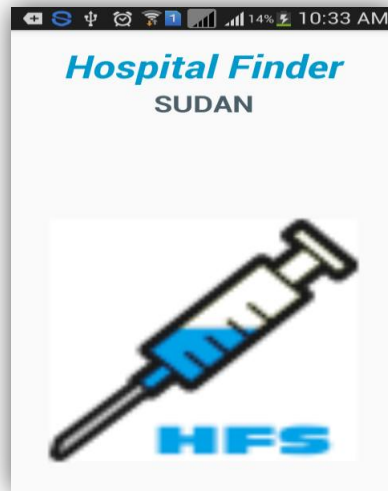
Figure (5.8): Main Interface

The above figure shows the launcher page of the application – when swiped or clicked it moves directly to the next interface, which contains expandable list for selections.

5.1.2. The selection interface:
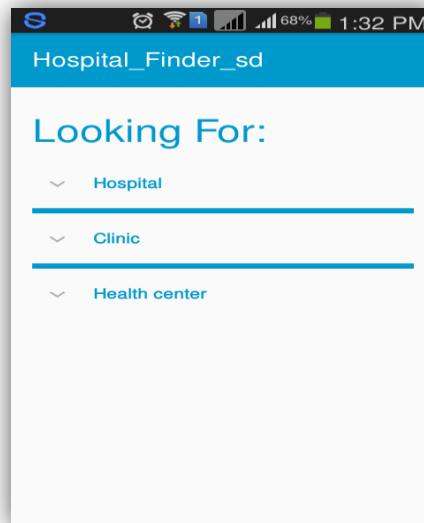
Figure (5.9.1): Selection Interface-1
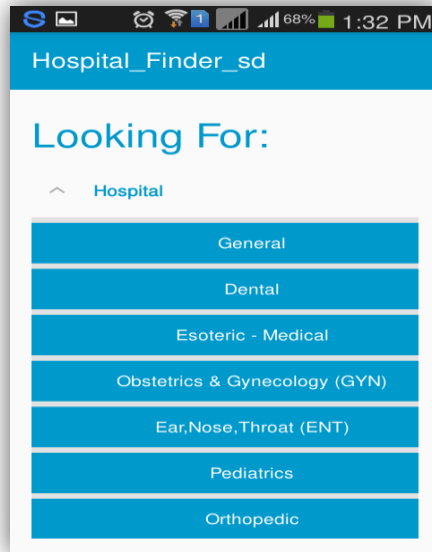
Figure (5.9.2): Selection Interface-2

The two figures above show the home page or the selection interface of the application, which contains a list of the types of the health units (hospital, health center and clinic), see **Figure (5.9.1).** When pressed a submenu pops up with the kinds of specialties available see **Figure (5.9.2)**, and when pressed again on the demanded specialization, it moves to the search interface for more choices.

5.1.3. The search interface:
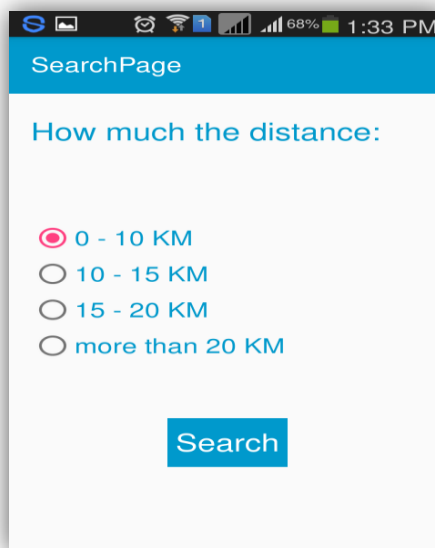
Figure (5.10): Search Interface

The above figure shows the search page of the application, which contains a list of buttons representing the choices of distances (ranges) between the user and hospitals. The user can choose from these radio buttons the range, for which hospitals are within. Finally the page contains a button (Search) to be pressed and which moves to the result information interface.
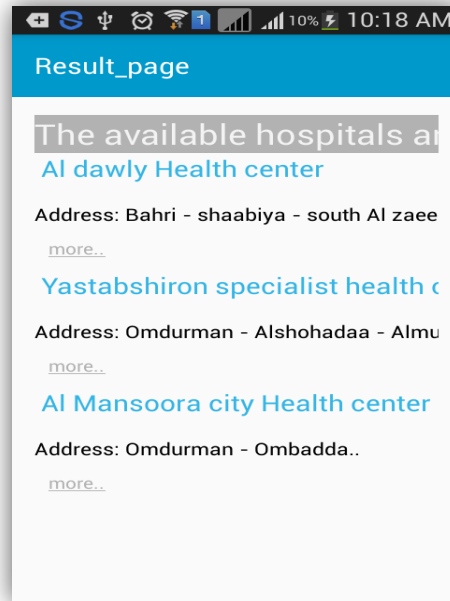
5.1.4. The resulted information interface:

Figure (5.11.1): Result Interface-1

Figure (5.11.1) shows the result page of the application, which contains a list of resulting hospitals with their addresses from the database regarding to the previous type of health unit and the specific specialization. When clicking on the word (more..) then more information about the hospital appears, as seen in **Figure (5.11.2)**. Replacing the word (more..) with the word (less..) the app will hide the information.
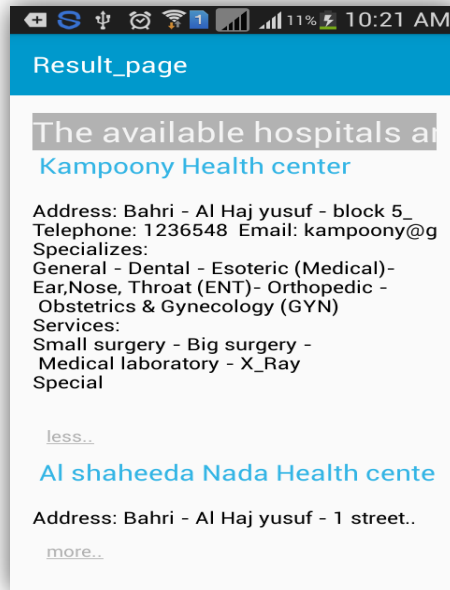
Figure (5.11.2): Result Interface-2

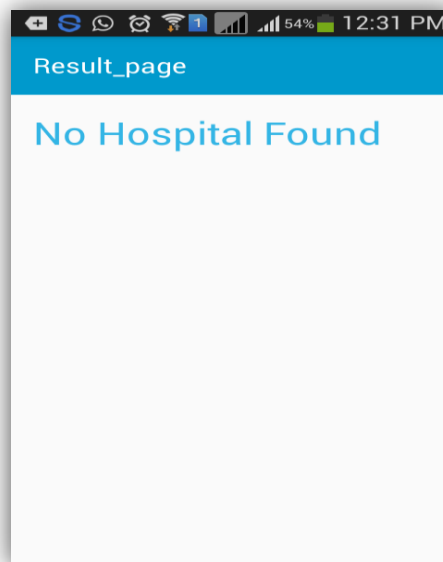When pressing on the hospital's name, it moves to the last interface that represents the map interface.

Figure (5.11.3): Result Interface-3

Figure (5.11.3) appears, when the result is null that means there is no hospital within the demanded range.
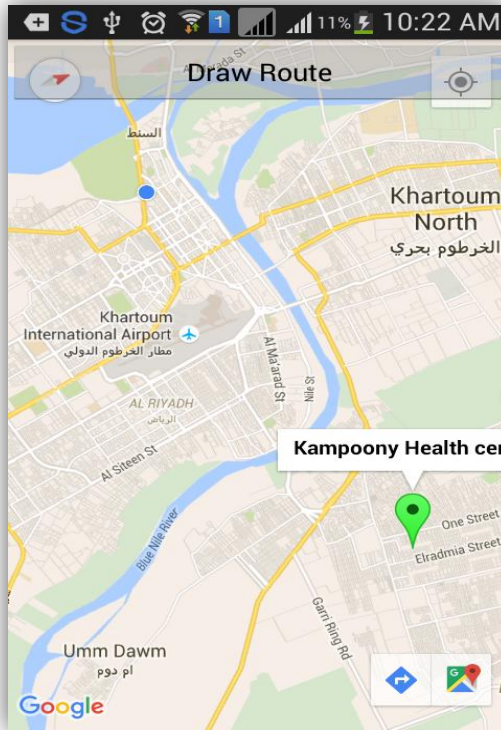
5.1.5. The map interface:
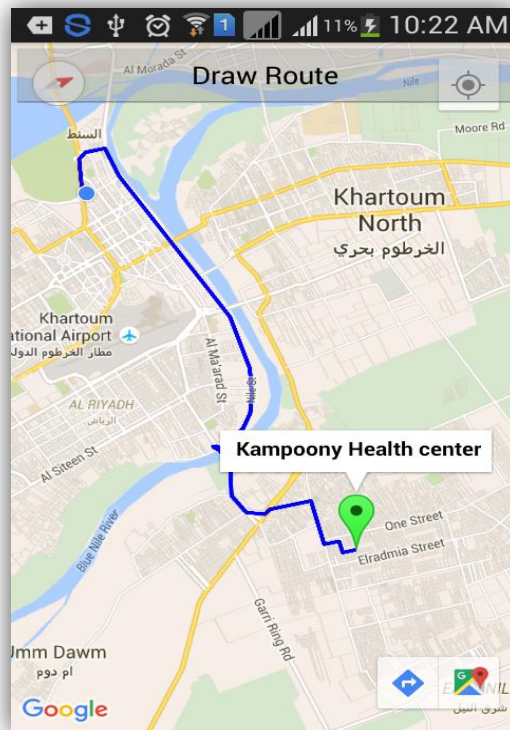

Figure (5.12.1): Map Interface-1

Figure (5.12.2): Map Interface-2

The above **Figures (5.12.1)** and **(5.12.2)** represent the last page of the application, which contains Google Maps to show the hospital that was selected from the previous interface. It also shows a button on the top of Google Maps, which emerges the route between the user and the hospital locations, as given in **Figure (5.12.2)**.

5.2. Scenarios

5.2.1. Scenario No 1:

In this scenario **User1**we are looking for a hospital has a **pediatrics** service with minimum distance between the user and the hospital. Thus, we press on **hospital,** then chose **pediatrics** and indicate the minimum distance "from 0 km to 10 km".

When the user clicks the search button, he will receive the result on a list like **Figure (5.13.1).** If he is moving to the map interface with pressing on the hospital's name, the result is shown on the Google Maps see **Figure (5.13.2).** After clicking on the button to draw a route, this will be carried out and displayed **Figure (5.13.3)**.
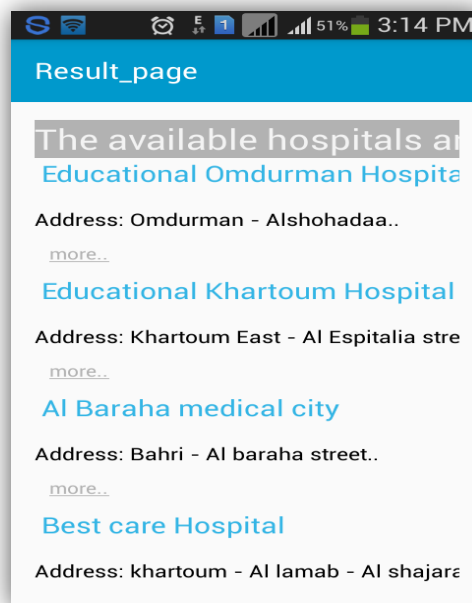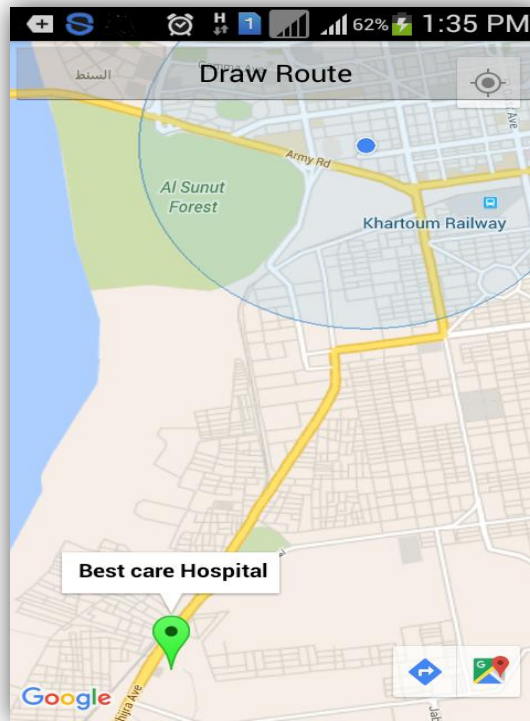

Figure (5.13.1): Scenario-1-1

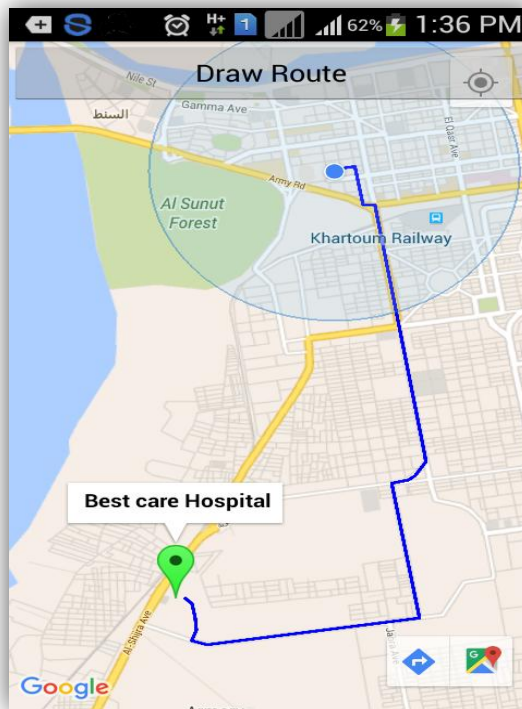**Figure (5.13.2): Scenario-1-2**

Figure (5.13.3): Scenario-1-3

5.2.2. Scenarios No 2 :

In this scenario a **User2** is looking for **cardiology** health care and has no problem with the distance value.

So, he is pressing on **health care,** then on **cardiology** and indicating the minimum distance "from 0 km to 10 km".

When the user clicks the search button, he receives one result and clicks on the word (<u>more..</u>) to show more information about it, see **Figure (5.14.1).**Then he is moving to the map interface with pressing on the health care name – this is shown on Google Maps, as seen in **Figure (5.14.2).** After that he clicks on the button to draw a route between him and the hospital, and the route is displayed, see **Figure (5.14.3)**.
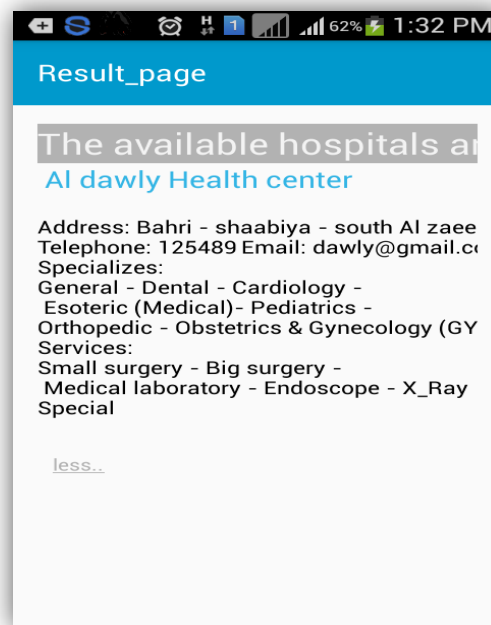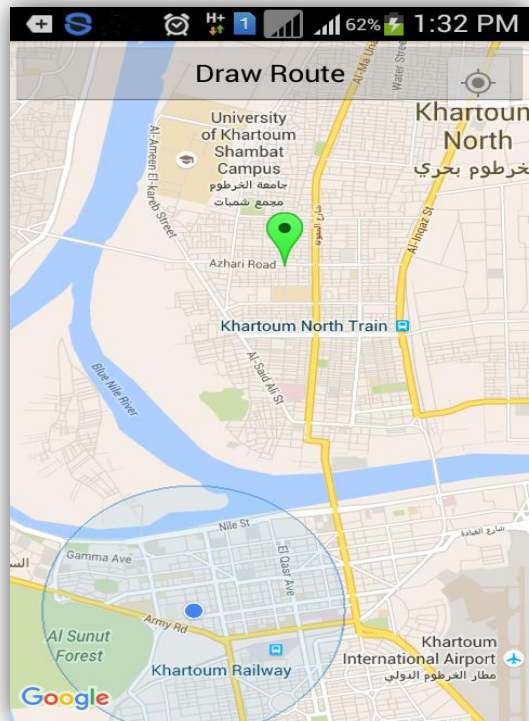

Figure (5.14.1): Scenario-2-1

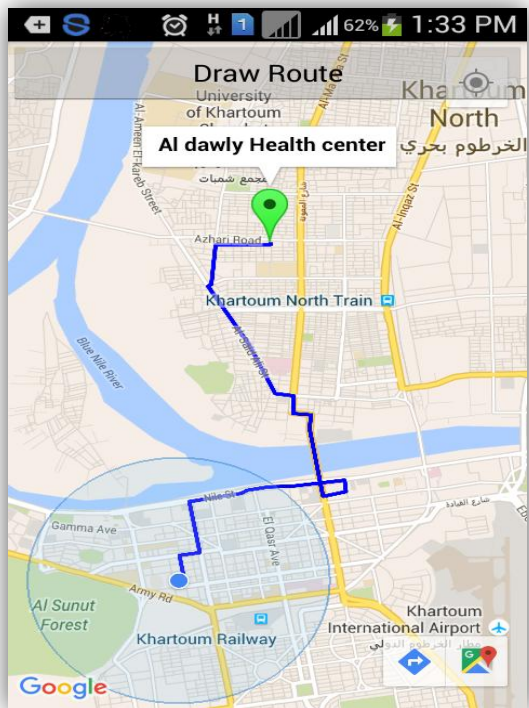**Figure (5.14.2): Scenario-2-2**

Figure (5.14.3): Scenario-2-3

5.3. Results:

After executing the application and carrying out several tests the following results appear:

- The application allows the user to look for the nearby hospitals with multiple choices.
- The application eases the searching for hospitals and minimizes the time of asking for hospital information.
- The application shows some healthcare units that do not appear automatically on Google Maps.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1. Conclusions

This thesis shows the powerful use of the Android Operating System with its numerous utilities to solve most of our daily-life problems. Smart phones and their operating systems offer a great opportunity for software developers to use their power providing people with useful applications.

After testing the application and showing the results, the performance was as expected and planned for. In the near future this application will help everyone seeking for hospitals or clinics, and to reach them fast.

6.2. Recommendations

After the completion of this project and the many tests carried out, we recommend the following to improve the system:

- Adding the feature of searching for a hospital by name.
- Adding the feature of insertion a hospital in the database to make the app more efficient.
- Making the app working properly on more than one operating system for smart phones (e.g. iOS, Windows Phone) to keep up with the technological evolution.
- Using independent wearable GPS trackers instead of smart phone embedded GPS.

CHAPTER 7

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