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Developing An Intelligent Geographic System Based On Smartphones To Improve The Utilization Of University Services

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ABSTRACT
services multiplication and development are accelerating in our current time, in addition to difference in the status of those targeted from those services.The main goal of this study is to build an intelligent geographic system based on smartphones to improve university services. The proposed system is used to help campus goers to see a summary of those services with the possibility of directing to reach them geographically through using their smartphone which makes the spread of these services among the targeted people on a wide scale. The proposed system is achieving satisfactory results.

Keywords: Geographic Information System (GIS) – Spatial Data – Intelligent Systems (IS) - Intelligent Geographic information system (IGIS) – Smartphones.

I. INTRODUCTION

The development in the information and communications systems has permitted the programmers and specialists to impose a new pattern in the style of university services and methods of production of basic information and assistance [1].This is what makes mapping and collect information about countless sources possible in little time, after it had been limited, complex and characterized by monopoly and a dearth of information [2].The correlation between the services offered on campus and those targeted to them, in its traditional form barely benefit the user , where urbanization advancement measured by available services to its members, but it is not only the quantity, but also the quality of these services and their conformity with international standards and specifications [3-4].The geographical information systems (GIS) is one of the most modern techniques that have possibilities make them able to deal with the huge amount of data and many computerized operations, as well as its ability to link spatial phenomenon, and output the data [4].A GIS (geographic information system) enables to envision the geographic aspects of a body of data. It queries or analyze a database and receive the results in the form of some kind of map. Since many kinds of data have important geographic aspects, a GIS can have many uses: weather forecasting, sales analysis, population forecasting, and land use planning [5].

Intelligent Geographic Information Systems (IGIS) applications increase the reliability, volume and efficiency of the development of information systems with different classification [6]. In reference to the importance of the use of information, some studies indicate that one of the main factors affecting the benefit of students on campus services such as health services is accessibility [7]. Artificial intelligence and intelligent systems in general, and especially intelligent GIS, are one of the basic solutions to the challenges faced by university at various levels [8]. Educational authorities in Egypt looking forward to a different kind of services that meet the needs of the era which we live in and cope with the vast amount of information flowing from all over the world this type of service is reflected in many systems developed by Mansoura University to facilitate the educational process and management and save time and effort [9]. Mansoura University relies on electronic systems and e-learning management systems and there are many electronic systems used for improving the educational institution output quality. Because of the expansion of the campus and the multiplicity of institutions, exploit modern technologies in building an intelligent system improves access to educational and administrative services on campus is a foregone conclusion [10].

II. THE PROPOSED SYSTEM

The proposed system aims to determine the neighborhood services around campus goers and facilitates access to university campus services through GIS techniques. The system components and a full description of the proposed system is introduced as follow.

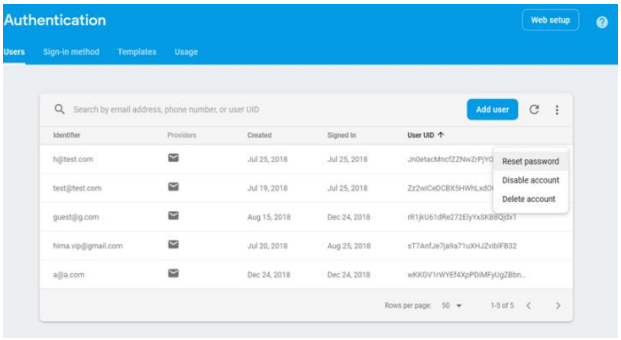
2.1 Data Collection

This stage contains database system used to store user registration data (user profile) and navigational behavior data (server log file). This database based on firebase service introduced by Google, which provides the ability to store data and analyze performance indicators within the application through this classification:

- **Authentication**: keeps track of user data acquired from registration process such as (identifier, encrypted password, email address, etc.), with the possibility of adding users, reset password, freeze account and delete account permanently as shown in figure 1

  Figure1: Authentication Administration Panel

- **Database**: contains all behavior data collected



after usage for each user in application as shown in figure 2 such as:

- Checked in points with coordinates (user-defined during the application workflow).
- Favorite places.
- Data provided about locations.

With the possibility of importing data in different formats such as JSON, file type, which able to deal statistically.

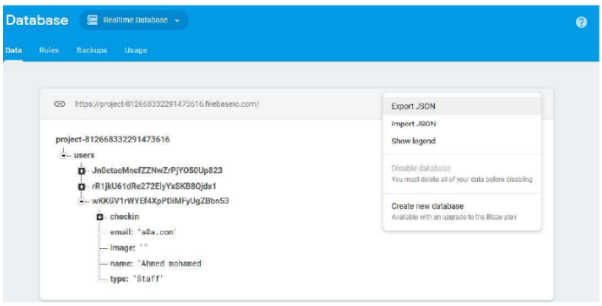


Figure 2: Database view

2.2 Data Preprocessing

Location detection: give an initial value to the coordinates of the starting point and then update it by access to the locator service on the device used, building neighborhood services list: by comparing to the updated coordinates of the user, the list of nearest and nearest services established according to distance calculating equation

$$AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

A: User location

x, y: Longitude, latitude coordinates

B: Service point location.

2.3 Building neighborhood services list

During operation, the proposed system updates the list of neighboring services according to the coordinates which the user located. Figure 3 shows neighborhood services list building Algorithm.

```
Input: SL: Services Coordinates list
Input: UC: User Coordinates
Output: NL: neighborhood services list ordered with distance
   S1 // counter for every service coordinates in the list
   SD  // variable to store the distance calculated

   Begin
   Read UC //user_ coordinates array
   Let NL= zeros(r, r)
   For each coordinates in Services Coordinates list S1= 1 to SL.size
   SD =0
   Calculate distance
   SD = result
   NL.add (SL [s1], SD)
   Next S1
   End for
   NL.Order
   Return NL
```

Figure 3: neighborhood services list Algorithm.

The update process is carried out by retrieving user coordinates through the GPS service which integrated into user's smartphone, consequently the distance between user and neighboring services is updated. Figure 4 shows Flow chart of session's array algorithm.

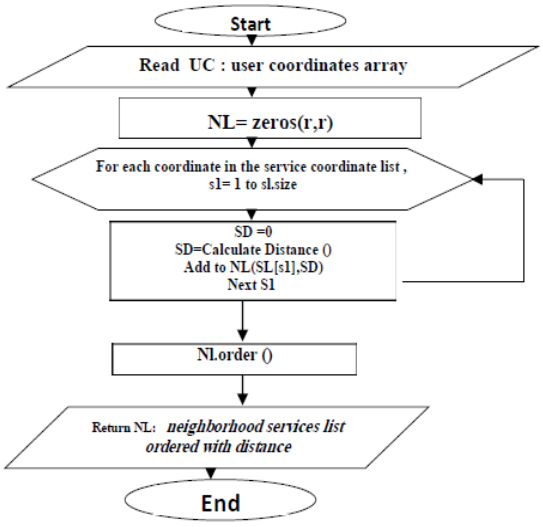


Figure 4: Flow chart of session's array algorithm.

2.4 The mobile application structures

The mobile application for the proposed system present a complete map of Mansoura university with a new vision of the most important services it's introduce to various people like students , staff and public visitors , also its present the pages of the mobile-based recommender system and the navigation paths that user can use through the mobile application . The interface of the mobile application in the proposed system explained as below:

When the user opens the application, its show splash loading screen while application data preprocessed and given permission applied successfully as shown in figure 5

Figure 5: Splash Loading Screen

When check that no permissions exist, the application asks the user to allow access to them as shown in the figure 6.

Figure 6: Check Privileges

It then automatically goes to the login screen and asks the user for one of the three options shown below in the figure 7.

- Log in if there is a previous account.
- Start a new registration process to create an account.
- Direct entry as a guest and bypass the registration process in this case the session is audited to the database under a certain code to ensure the retention of data usage.

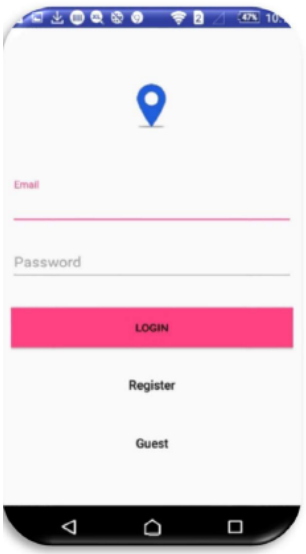


Figure 7: Login Screen

When the user completes the registration process, the application moves to the main layout, which is a specific map showing the user's actual point of reference according to the values of the device used, this map is accompanied by a list of a number of options.

During the move, the user's location is updated every period within the algorithm, which is determined by 3 seconds. The indicated mark on the map moves according to the new location that has been updated as shown in figure 8.

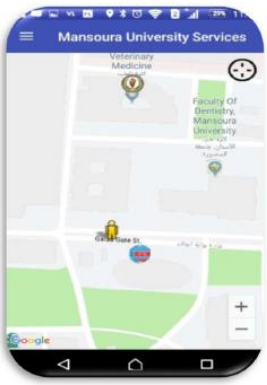


Figure 8: user map moving.

The points of interest services that we would like to define to the user displayed with graphics specially prepared for application. When the user is next to one of the points of interest by a specified distance, the program alerts the user that there is an important service around him that may be interest in. alert as shown in figure 9.

Figure 9: check in nearby service

When user checks in the place in alert, the information is stored in the database associated with the application.

Below are some simple details about the place and how to communicate with it as shown in figure 10 in addition to navigation, adding to favorite and get more details about the place and services provided.

Figure10: Details Overlap Screen within a service

The application has a side menu as shown in figure 11 that includes a number of options that allow the user the possibility of:

Access to neighboring and registered services.

- Access to the list of favorite places recorded.

- Send feedback on its use of the application.

- Choose the language of application (Arabic or English).

- Sign out (if he has a registered account).

- Brief information about the application.

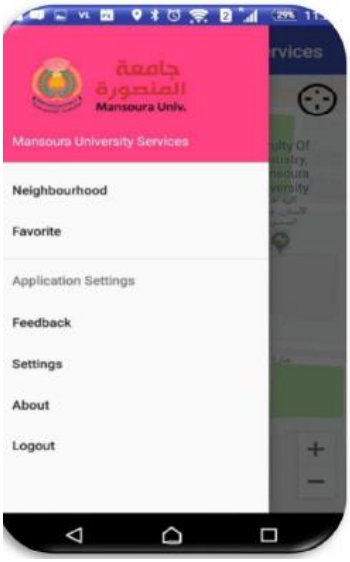


Figure 11 Side Menu for More Options

The mobile application for the proposed system is based on the open source Android system provided by Google through its platform Android Studio built on object-oriented programming with Java.

With the Google Maps Android API, we add maps based on Google Maps data to our application. The API automatically handles access to Google Maps servers, data downloading, map display, and response to map gestures. It has allowed us to add graphics to the map like icons for university services points (Educational, medical, food and technical services, etc.), It also gave us the ability to add:

- Sets of line segments (Polylines).
- Enclosed segments (Polygons).
- Bitmap graphics anchored to specific positions on the map (Ground Overlays).
- Sets of images, which displayed on top of the base map tiles (Tile Overlays).

III. APPLICATION AND EXPERIMENTAL RESULT

This software relies on server that support GIS query, Google has been chosen to support GIS services and to provide maps which is the most common and used among smart devices users.
The software presents a complete map of Mansoura university with a new vision of the most important services it's introduces to various people like students, staff and public visitors, also its present the pages of the mobile-based recommender system and the navigation paths that user can use through the mobile application. Form the main page any one can create a new account with his own e-mail otherwise use it as a guest without providing any information.

3.1 Result of First Experiment

The first system experiment was through using application as a guest and the starting point started through the university western entrance (Aljalaa Gate) The following table shows summarized results of the different interest point notifications.

Interest Point	Arrival Time H:M:S	Alert Time H:M:S	Time Accuracy (Seconds)	Location Accuracy (meter)
Faculty of Education	09:12:53	09:12:43	-10s	15m
Student Services Complex	09:14:48	09:14:42	-6s	7m
Communications and Information Technology Center	09:16:22	09:16:18	-4s	10m
Central Library	09:19:41	09:19:38	-3s	5m
Faculty of Pharmacy	09:20:01	09:19:58	-3s	15m
Faculty of Dentistry	09:21:53	09:21:45	-8s	7m
Scientific Computing Center	09:23:02	09:22:58	-4s	15m

Figure 12: summarized interest point notifications results

As seen in the figure 12 the most accurate alert time was 3 seconds before arrival and the average of timing accuracy for seven interest points was 5.43 seconds earlier as shown in figure 13 that explain differences between arrival and alert timing

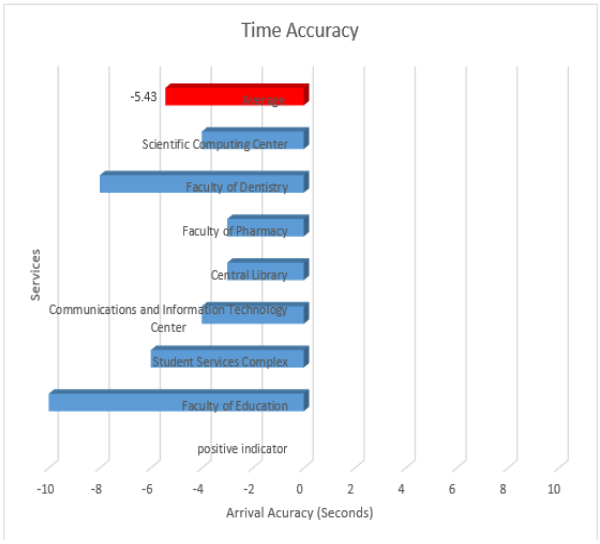


Figure 13: arrival, alert timing accuracy and average

On the other hand, there were some differences in the distances between the user and the point of interest when notification and alert occurred as shown in figure 14 that explain this matter.

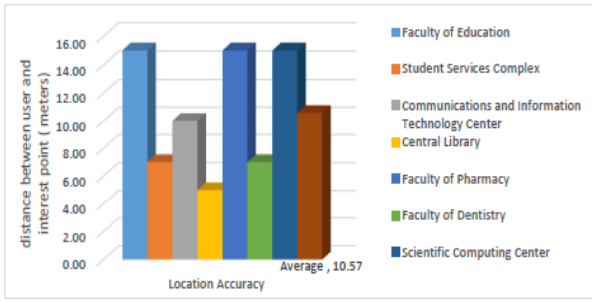


Figure 14: user arrival location accuracy

3.2 Result of second Experiment

3.2.1 Arbitrators and Experts Assessment

One of the important tools that demonstrated the system effectivity was the role of experts in judging system performance and assessing its goals, the result of the arbitration showed good agreement that proposed system achieved its objectives as shown in figure 15

Arbitrator	%	Arbitrator	%	Arbitrator	%
Arbitrator 1	92%	Arbitrator 3	100%	Arbitrator 5	96%
Arbitrator 2	99%	Arbitrator 4	98%	Average	97%

Figure 15: Arbitrator Agreement Percentage

3.2.2 Data analyzing

This application relies on the Firebase technology that enable analyzing data usage such as user's activity with their different classifications (age, type, operating system used, device model and version ... etc.).
Compared to calendar year active users for the date range, including fluctuation by percentage from the previous date range. An active user has engaged with an app in the device foreground, and has logged a user engagement event as shown in figure 16.

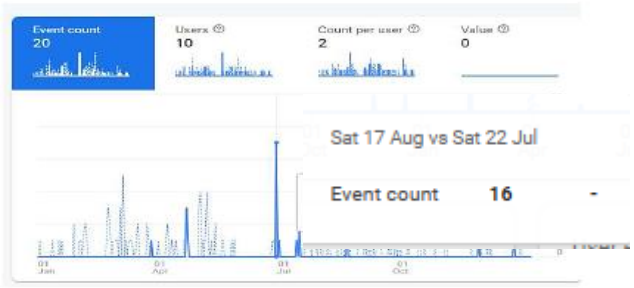


Figure 16: daily event counter results

A. User engagement

User engagement measures whether users find value in a product or service. Engagement can be measured by a variety or combination of activities such as downloads clicks, shares, and more.it is highly correlated with overall profitability. User attention is a finite resource and if users choose to spend their time on a particular app or site, they are signaling that they find value in it. It is possible to note the users' engagement with each part of the application through the following figure 17.

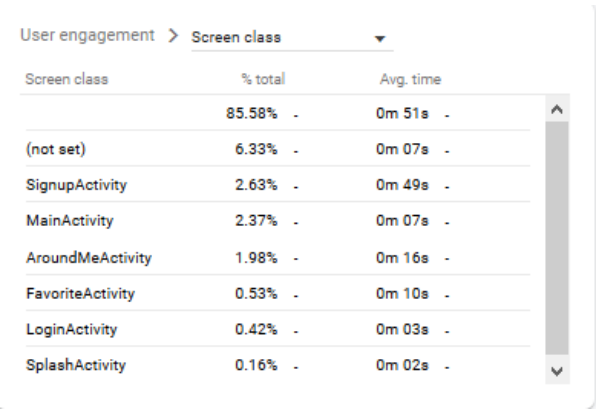


Figure 17: user application engagement

B. Event Location

One of the limitations of this study is that applied on the Mansoura University campus, which is also evident by reviewing the locations of users around the world through the following figure 18.

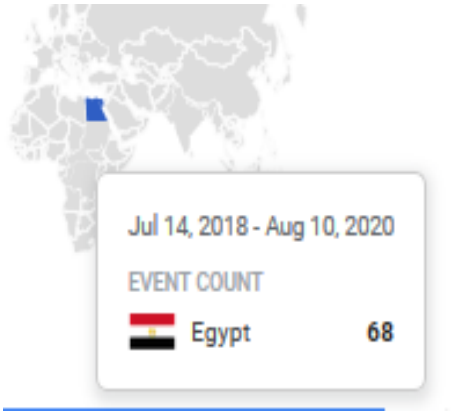


Figure 18: user's event location

C. How stable is system

Percentage of users that have not experienced crash. Uses data from firebase crashlytics as following figure 19.

Figure 19: crash-free users.

D. Devices Audience

The application has the ability to run on different versions of operating systems based on Android and this data analyzed and observed through the firebase control panel as the following figure 20.

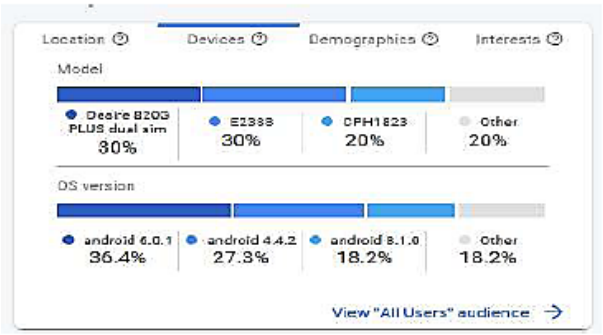


Figure 20: Data Audience

3.2.3 Neighborhood Distance Calculating

Through which user location, there is a good result of points distance around he should pass to reach as shown figure 21. Each element of the neighborhood points interactive by clicking on it to enable user with many options as follow:

- Contact information.
- The ability to direct maps to reach the site.
- See more details about the site and the services it provides.

Figure 21: Neighborhood

3.2.4 Guidance and Navigation

Depending on Google services, the application provides a good result in guidance services to users through navigational guidance with maps or voice guidance with steps to reach selected location based on google services as shown in figure 22.

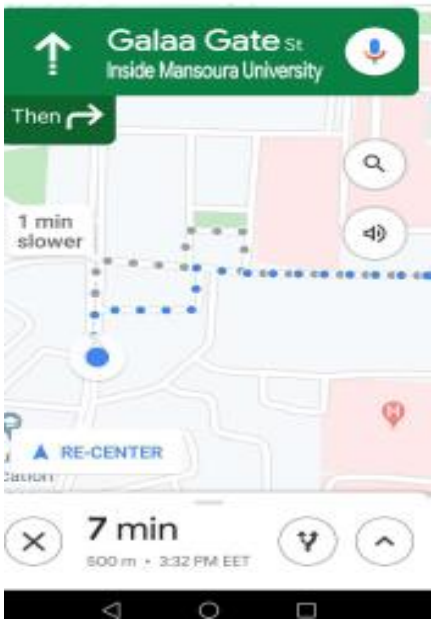


Figure 22: Interest Point Navigation

IV. CONCLUSION

The proposed system uses smartphones technologies and it's open source environment (Android) for building a geographical database of various interest points within Mansoura university that allow pre-registered users or visitors from campus pioneers to closely view the details of each service while touring campus and close proximity service geographically, or by surfing neighboring services by distance with the possibility to get direction to reach.

Proposed system allows service providers to update their information or add new services added lately to be launched among user's phones. The system knowledge base is designed to contain data generated through system operating like user database, user's favorites, users checked points, interest points available and user's information collected from their devices like (device model, OS version and others) for performance purposes subjected to user's privacy.

V. FUTURE WORK

The researcher suggests the following open lines for near further works

- Results can be improved in future work by expanding the system knowledge base to include more interest point inside Mansoura university as possible which introduce variable services and make the most utilization of those services.
- Applying the proposed system for the new communities like the new administrative capital which contains many new digitalized services.
- Developing the proposed system to include more university facilities that could be improved using the analyzed data generated from system usage.

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