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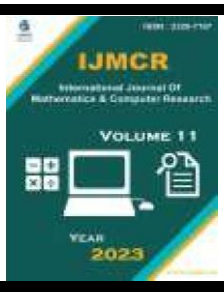

Geographical Information System: Application to the Geolocation of the Nearest Health Facilities in the Town of Kananga

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INFO ARTICLE

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ABSTRACT

New technology now makes it possible to determine the location of an object or person with a certain degree of accuracy. This technology is generally based on the GPS system or the communication interfaces of a mobile phone. Geolocation has a wide range of applications and purposes, from navigation assistance and personal contact to real-time management of human and vehicle resources for individuals or companies. This work, linked to mobile applications, shows how a well-defined entity can be located if, for example, it goes missing. Today, new technology remains an essential tool in geographic information systems. Every user is expected to have precise knowledge of how to use geolocation when necessary.

The tool chosen for this work can be a smartphone, a tablet, an Android phone or any other model the user chooses. The user enters a reference and, by pressing the search button, a new window opens showing the structure closest to his position and the steps he should take to reach his destination as quickly as possible. Once the destination has been found, the user simply selects the shortest route to get there. Then there is the issue of geolocation, something that should never be forgotten. First and foremost, geolocation raises the issue of personal data protection and privacy. The importance of the application that has been put in place is to help anyone who doesn't know a place that is sometimes remote, without having to make a lot of effort or go through a person, but he ends up getting there, or discovering someone and something else.

KEYWORDS : Localisation**,** GIS, Geolocation, Mobile environment, Mobile phone, Satellite Positioning System

I. INTRODUCTION

The greatest difficulty that humans have had to overcome is locating a moving object in real time, which raises questions such as: How do you detect an object? How can we get information about its position by communicating with it or against its will? How can we then locate it accurately and quickly on a map? How do you get an itinerary for a given area? To achieve these goals, geolocation is the solution that man has created to overcome all his difficulties. It is a process that makes it possible to locate an object (person, information, etc.) on a map using its geographical coordinates. This operation is carried out using a terminal that is able to locate itself using a GPS receiver or other techniques and to publish its geographical coordinates (latitude/longitude) in real time or at a later date. Behind the word "geolocation" lies a fairly simple concept: by providing an origin and coordinates, anyone can find an object using location technologies, hence the need to agree on absolute coordinates that are accepted by all, as demonstrated by (NEBRAL, J. J., 2001). In this thesis, three points will be developed: geolocation, the geographic information system and the presentation of results.

II. GEOLOCALISATION CONCEPTS

II.1. ORIGINS AND HISTORY OF GEOLOCATION

Geolocation technologies have a long history (Merabtene A., Agred N., 2013). In fact, for a very long time, people have needed to locate themselves in space and take reference points to find their way and send them to others. These are the vectors by which location is achieved.

With the advent of increasingly sophisticated warfare from the 19th century onwards, it became important to know the

position of moving objects, whether troops, equipment or individuals, in real time.

At the same time, the discovery of directional antennas and electromagnetic waves led to the development of techniques for locating objects using observed time differences, which are used today in GSM geolocation, for example. The first of these systems was proposed by Raytheon Corporation in response to an Air Force tender for a guidance system.

It was the company's Vice President of Engineering and Research, Dr Ivan Getting, who later proposed to investigate the use of satellites as the basis of a three-dimensional navigation system for fast-moving vehicles. When Dr Getting left Raytheon in 1960, the technology he had proposed was one of the most advanced forms of navigation in the world. It laid the foundation for the future creation of the Global Positioning System (also known as GPS).

This led to the form of geolocation most familiar to the general public: GPS, the first satellite positioning system called TRANSIT. Developed in 1958 for the US Navy and first used in 1964, it became available for civilian use in 1967.

In the 1990s, the advent of mobile phone networks led to the development of a new type of geolocation, known as GSM. A person with a mobile phone switched on could now be located in any area covered by the network.

Since 1999, with the discovery of WIFI technology, it has been possible to locate a person connected to an access point using their MAC address.

Finally, with the development of information technology in the 2000s, it has also become possible to locate a person on the Internet using their IP address.

II. GEOLOCATION TYPOLOGY

Geolocation is available in a variety of technologies that cover complementary areas of activity. The following section looks at the main types of geolocations (S. Hérault, B. Belvaux, 2014).

1. ***MOBILE PHONE GEOLOCATION***

- **Mobile phone localisation**

Geolocation by GSM (second generation mobile phones, currently used by the majority of people) is based on the IMEI (International Mobile Equipment Identify) obtained from the SIM card, which is a unique 15-digit code. The IMEI number identifies the device (the phone itself), while the SIM number identifies the SIM card, and therefore the desired phone number. All the information is contained in the SIM card, and when a user identifies himself to a mobile network, his IMEI number is transmitted to the operator's management system so that he can be authorised to use the various options available.

A GSM network is made up of a number of cells, each of which contains a Base Transceiver Station (BTS), which handles radio communications from mobile phones. Each BTS is then connected to a BSC (Base Station Controller), which controls all the BTSs and manages the handover of a mobile phone from one cell to another. This is done using the handover principle (choosing which cell will take over the mobile phone).

- **Localisation by Cell-ID cells**

This method is based on the address of the BTS to which the mobile is connected.

The BTS locates the mobile to be able to answer the call, and the SIM card is identified before the call is initiated. Each BTS cell therefore knows which mobiles are within its coverage area, and this data is automatically transmitted to the BSC, as it is the BSC that decides which BTS is assigned to each mobile.

This data is then sent to a database that knows which SIM cards are in the area of each cell. This database also knows the exact address of each antenna. The approximate location of a SIM card can therefore be determined

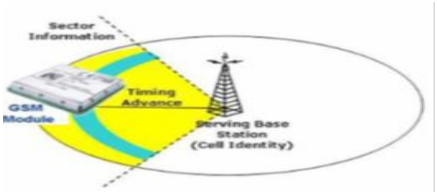

Figure 2.1: Cell-ID localisation technique.

- **Localisation par temps (E-OTD)**

The E-OTD (Enhanced Observed Time Difference) method requires a signal to be transmitted from the mobile phone. The mobile phone must therefore be switched on in order to be located.

The BTS transmits signals at regular intervals, and as soon as the mobile receives one of these signals, it transmits again. The BTS can therefore calculate the distance by measuring the round-trip time. To get a more accurate time, we use several BTS cells to locate a mobile. Ideally, there should be three cells within range of the mobile for optimal location. To get a more accurate time, we use several BTS cells to locate a mobile. Ideally, there should be three cells within range of the mobile for optimum location.

Figure 2.2: E-OTD localisation technique

However, all these different GSM geolocalisations are less accurate than GPS, especially in rural areas, and depend mainly on the density of the antenna around the mobile phone.

2. *GEOLOCATION USING IP AD*

IP (Internet Protocol) based geolocation is a way of locating a computer or mobile device that is connected to the Internet.

Let's start with the basics. An IP address is a unique identifier for any computer or phone connected to the Internet, and consists of a series of numbers separated by dots. (Example: 196.173.123.1).

IP addresses allow electronic devices to connect to each other and share data, and each computer or device connected to the Internet has its own IP address.

For IP-based geolocation, all you need is the IP address of your target and a geolocation search tool. The geolocation tool then queries public databases to determine the coordinates and registration information of the requested IP address, and this tool is online, you can track an IP address and trace back to the vicinity of a person's exact location if they are communicating with you over the Internet and you want to know where they actually are, as illustrated by (A. Vervisch-Picois, 2022).

We will see that there are several reasons why you might want to access this information. If you manage to recover its IP address, you will be able to find out the location of the device to within a few kilometres, in fact you will obtain the following information

- Country;
- Region;
- City
- Postcode;
- Latitude and longitude.

There are currently several geolocation sites that use the IP address technique. Here's an example of localisation using the Hostip.info site, a community site that generates a geolocation database.

Figure 2.3. IP address location technique

3. WI-FI GEOLOCATION

In the same way that a GSM terminal locates itself on a GSM network using the Cell ID method, a Wi-Fi terminal can use the same method based on the identifiers of the Wi-Fi terminals it detects (MAC addresses).

4. GEOLOCATION USING RFID

RFID (Radio Frequency Identification) technology allows objects to be identified, tracked and located remotely using a tag that emits radio waves and is attached to or embedded in the object.

This method uses devices based on geolocation chips, which act as transmitters, and RFID readers, which interpret the information contained in and sent back by the chips using radio signals.

Figure 2.4. RFI chip and portable RFI reader

5. SATELLITE POSITIONING SYSTEM

A satellite positioning system, also known as GNSS (for Geolocation and Navigation Satellite System), is a set of components based on a constellation of artificial satellites that provide a user with 3D position, speed and time via a small portable receiver.

This category of geolocation systems is characterised by its metric accuracy, global coverage and terminal capacity, but also by its sensitivity to obstacles between the receiving terminal and the satellites at (P. Roques, 2018).

The system is based on the measurement of the distance between the receiver and the satellite in orbit. The overall concept is: distance = time * speed, and the speed corresponds to the velocity of the transmitted waves, i.e. very close to that of light = 3*1088 m/s.

For (H. Amel, 2015), the satellite positioning system works on the principle of triangulation. Again, the position of the observed object is calculated from the signals exchanged between the receiver it is equipped with and a set of at least 3 satellites forming a constellation.

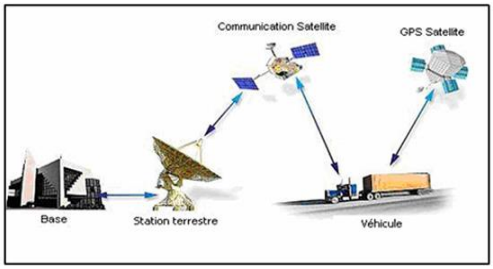

Figure 2.5. Technique de Localisation par Satellite

II.3. GEOLOCATION SERVICES

Geolocation can be useful or even essential in many sectors. The goals and objectives are different for each sector, but thanks to its adaptability, geolocation meets the diverse needs of a wide range of professions.

- Stay in touch.
- Surveillance.
- Passenger transport.
- Monitoring mobile workers.
- Security.

III. MOBILE APPLICATION

III.1. DEFINITIONS

A mobile application is primarily a software application designed to run on a mobile device, i.e., a programme designed specifically for a mobile electronic device. Electronic devices include mobile phones, smart phones, PDAs, personal digital assistants, touch screen tablets and computers (N. Samama, 2009).

It is a program that is downloaded to a mobile device, that lives on that device, making it easily accessible, and that is used for entertainment, shopping, or other service functions that the designer offers to its customers, as defined in (C. Moumeni, 2019):

- Google play (Google / Android platform)
- App Store (Apple platform)
- Windows Pone Store (Microsoft platform)

Figure3.1. Applications mobiles

III.2. MOBILE APPLICATION TYPES [9]

Technically speaking, there are three types of mobile application that any user can encounter: Native, Web and Hybrid as approved I. Ouellet-Morin, at in (I. Ouellet-Morin, M. P. Robitaille, R.-P. Juster ,2021).

✓ **Native application**

A native application is a mobile application designed specifically for a single mobile operating system. It is developed using the language and tools associated with that operating system and installed directly on the mobile device. Native applications are designed for the systems in which they will be used. Note that a native application designed for the IOS system may not work or be supported by the Android and other systems (A. Cosson, 2018).

Here's an example of the native applications that run on the Android system (camera, radio, calculator, etc.).

Figure3.2. Native applications for Android

There are also standard native applications that run on all Android platforms, including:

- WhatsApp ;
- Snapchat ;
- Gmail, etc.

The IOS system also has applications that are also native, adapted according to its specificities and adapted according to the system, for example:

- Gmail ;
- Safari;
- Instacast;
- WhatsApp;
- Snapchat, etc.

Figure 3.3. Native applications for IOS

- ***The advantages***

These applications can use all the features of the mobile phone and can be used without internet access. They can also be adapted to new business models, such as freemium applications, where installation is free, with the added benefit of access to additional features (Kheznadji K., 2022).

- ***Disadvantages***

However, there are a number of disadvantages, such as the fact that native applications take time to develop and implement and are relatively expensive (Mamta Pandey, Ratnesh Litoriya, Prateek Pandey, 2018).

✓ **Web app**

Unlike a native app, a web app is a mobile application developed using web development tools such as HTML5, CSS and JavaScript. Once developed, it is accessible and executable on all smartphones through a web browser.

Examples of mobile web applications include

- Facebook ;
- Twitter
- Instagram
- YouTube

Here is also an illustration of the interface of the Facebook application, considered as a web application.

Figure 3.4. Web applications: Facebook

- ***The benefits***

Their unified code means that they are compatible with all browsers, which means that web applications can be developed more quickly, resulting in a significant reduction in project costs (J. Smolinski, C. Calvignac, 2017).

What's more, web applications are easy to develop on these platforms because they don't require validation testing.

- ***Disadvantages***

Web apps generally do not have access to all the features available on mobile phones. For example, they cannot access the phone's address book.

✓ ***Hybrid application***

These are considered to be a cross between web apps and native apps. They are compatible with all mobile platforms. But these applications are mainly developed using HTML5 combined with CSS and JavaScript.

So, unlike a native application, a hybrid application is not dependent on a particular mobile platform. In the same way, and unlike web applications, hybrid applications can access all the features that are available on the mobile phone, and this is made possible by the links that are made between the native language and the web technology that is present in the hybrid application. As you can see, by combining the strengths of native and web applications, they are increasingly attracting the interest of mobile application developers.

Here's an example of a LinkedIn application that is considered a hybrid application, which is a social network.

Figure 3.5. Hybrid applications : LinkedIn

III.3. MOBILE OPERATING SYSTEMS

Mobile operating systems can be defined as software that enables a mobile device (smartphone or phone) to function. They allow users to make calls, browse the different areas of their phone, download applications, and configure and personalise their phone (B. K. Eddine, Bechiri, Nourdine, 2014).

In general, there are three mobile operating systems that are currently popular on the market (F. Simon, J.P. Imbert, P. Cailleton, L. Hublet, Anke Brock, 2022):

✓ **The Android System**

Android is defined as an open-source mobile operating system for smartphones and tablets. This mobile operating system is basically developed using the Java language. This programming language allows any software to be easily compatible with different operating systems such as UNIX, Windows and others, with just a few adjustments.

✓ **The IOS system**

Designed by Apple exclusively for its own mobile devices, IOS is a mobile operating system developed using Objective-C, a language that is part of C ANSI and is known for its fast messaging and dynamic loading.

✓ **The Windows Phone System**

Designed by Microsoft, Windows Phone is a mobile operating system that is not limited to professionals but can also be used by individuals. On the other hand, since the launch of Windows Phone 8, Microsoft has launched advanced offerings for businesses. Windows Phone is developed using C#, a programming language similar to Java in syntax and basic concepts.

III.4. CHALLENGES FACING MOBILE APPLICATIONS

Mobile applications were initially designed to improve productivity and make it easier to find information such as emails, electronic calendars, contacts, weather information, geolocation and so on. The development of mobile applications then met a great public need in various areas of activity, and the availability of development tools led to a rapid expansion into other areas such as:

✓ **GPS and location-based services**

In this area, mobile location-based applications such as Google Maps and Geo-Location can enable users to find information about their location from their mobile phone, as long as they do not have information about their travel route.

✓ **The medical service**

In the health sector, we can mention the case of the mobile medical application Cardio-App. This mobile application shows users their heart rate and provides preventive measures to avoid risks.

✓ **The communication service**

In this area, we are still looking at social networks, for example. We can see that with the development of technology, the world has become a small village, and the example of social networks shows this.

Nowadays, social networking applications allow us to stay in constant contact with our loved ones at a distance, enabling us to communicate and exchange information...

✓ **The sales department**

There are mobile applications that allow you to track orders, buy tickets online and carry out banking transactions, all from your mobile phone. This reduces the cost of travel and makes information available at all times from a mobile phone.

IV. GEOGRAPHICAL INFORMATION SYSTEMS

Geographic Information Systems (GIS) bring together various computer methods and techniques for the modelling, digitalisation, storage, management, retrieval, analysis and presentation of geographic objects or collections of objects, with the essential feature that the spatial characteristics of these objects are taken into account in the same way as the descriptive attributes associated with them. In fact, the term "GIS" covers a wide variety of software products, built according to different technical choices, with very different functionalities and performance levels.

Geographic information systems are unique in that they draw on a wide range of scientific and technical fields and methods, from geodesy to database management systems, including image processing, modelling and geometric interpolation, statistics, automated mapping, spatial analysis, etc. Building a geographic information system without abandoning scientific rigour is a complex task, both in terms of concept definition, functional organisation, software architecture, algorithms, ergonomics, etc. (L. Cherroun, 2014).

IV.1. DEFINITION OF A GIS

A GIS (Geographic Information System) is an information system capable of organising and displaying spatially referenced data and producing plans and maps. It is used to process and distribute geographic information (Sanae El Janyani, 2014).

Finally, a GIS can be defined as a computerised system capable of representing an area or part of an area in digital form (A. Zoghlami, 2013).

Figure 4.1. GIS model. Localised information (real world) and digital representation

IV.2. COMPONENTS OF A GIS

A GIS has four main components: software, data, hardware and people (W. Beaudemoulin, M. Chesne, 2014).

Figure 4.2. GIS components

1. THE HARDWARE

This is an essential component of the system and the fundamental element of this component is the computer.

GIS systems use computers and peripherals, which may or may not be interconnected, to provide users with all the GIS functionalities grouped around the 5A's (Abstraction, Analysis, Acquisition, Display and Archive). Client-server systems on intranets, extranets or even the Internet facilitate the distribution of results.

2. SOFTWARE

GIS software provides tools and functions for storing, analysing and displaying all types of information. They are tools for entering, manipulating and storing geographic information, databases (DBMS), querying, analysing and displaying via graphical user interfaces for ease of use. In short, software helps to make a GIS coherent.

Here is an example of some of the GIS software used in this system:

- GV-SIG : Geograpic Visualisation ;
- Abc-Maps ;
- JOSM-Location.

Here is an example of the interface that runs the GV-SIG software

Figure 4.3. Screenshot of the GV-Sig.

3. LES DONNEES

Les données représentent le contenu même d'un SIG. Elles peuvent être des cartes géographiques ou des informations relatives aux objets, C'est aussi donc les composantes les plus importantes d'un SIG. Les données géographiques peuvent être, soit importées à partir de fichiers, soit saisies par un opérateur.

4. LE PERSONNEL

Un SIG est avant tout un système et ce sont ses utilisateurs (le personnel qui entretient et gère le système) qui lui permettent de fonctionner pour livrer tout son potentiel au besoin de l'homme. Les utilisateurs et potentiels utilisateurs d'un SIG sont principalement :

- ✓ Les techniciens et ingénieurs chargés de la conception, de l'entretien et de la gestion du SIG ;
- ✓ Les techniciens et personnels qualifiés à l'utilisation quotidienne du SIG dans leur travail ;
- ✓ Les décideurs utilisant le SIG comme moyen d'aide à la prise des décisions.

5. DATA

Data is the actual content of a GIS. It can be geographical maps or information about objects and is therefore the most important component of a GIS. Geographical data can either be imported from files or entered by an operator.

6. THE PERSONNEL

A GIS is first and foremost a system, and it is its users (the people who maintain and manage the system) who enable it to function to its full potential to meet human needs. The users and potential users of a GIS are mainly

- ✓ Technicians and engineers who design, maintain and manage the GIS;
- ✓ Technicians and staff who use GIS in their daily work;
- ✓ Decision makers who use GIS as a decision support tool.

IV.3. TYPOLOGY OF GIS DATA [20]

GIS data can be divided into two main types: geographic data and attribute data (H. Mouncif, A. Boulmakoul, 2014).

1. GEOGRAPHICAL DATA

Geographic data is data that can be located either directly by its geographic coordinates or indirectly by its postal address or cadastral reference. Geographical data can be divided into three categories: geometric data, graphical data and metadata.

- ✓ **Geometric data**: This refers to the shape and location of objects or phenomena.

Any cartographic representation involves the translation of the real elements observed (health infrastructure, road, administrative boundary) into geometric objects of three types:

a. **The (x, y) point**: which represents, for example, the places of residence of geo-referenced subjects;
b. **The line (x1, y1)**: Also represents, for example, roads, rivers, lines.
c. **The polygon or surface** : Administrative boundaries, large industrial sites, groundwater bodies, etc.

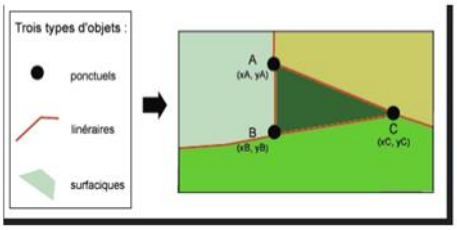

Figure 4.4. Object types.

Note: *X and Y are the geographical coordinates of the point. These are terrestrial coordinates that treat the Earth as an ellipsoid. The ellipsoid is the mathematical surface used to calculate the geographical coordinates of a location in longitude and latitude.*

- **Graphical data:** This describes the visual representation of the object.
- **Metadata:** This is information about the origin and ownership of a piece of geographic data.

2. ATTRIBUTE DATA

They represent the characteristics or properties of an object or phenomenon other than its shape or location. Examples include information about the postal address of a geographical location.

2.1. GIS DATA REPRESENTATION

There are two ways to display geographic data: vector mode and raster mode (H. Rey-Valette, P. Maurel, J.-M. Salles, C. Jabbour, 2019).

2.1.1. DISPLAY IN VECTOR MODE

In vector mode, the point with its coordinates is the bearer of geometric information. Lines and surfaces are understood as a defined sequence of characteristic points. Vector data is usually the result of manual or semi-automatic digitisation.

In general, vector data distinguishes between points, lines and surfaces (polygons), which are always represented in different layers (Jean Jack NEBRAL, 2001).

Figure 4.5. Vector data model.

2. DISPLAY IN RASTER MODE

The essential element of raster data is the pixel, which is distributed in a raster in regular rows and columns, as shown in the figure below. Lines and areas can only be represented by a sequence of individual pixels. Raster data is essentially derived from aerial photographs, satellite images or scanned plans, which are displayed as an image in the SISG.

An object can therefore only be represented approximately, so the size of the raster pixel (spatial resolution) determines the accuracy of the representation.

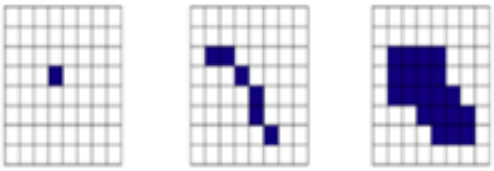

Figure 4.6. Raster data model

3. COMPARISON BETWEEN THE TWO MODES

Table 4.1. Table showing the advantages and disadvantages of each mode

	Raster Mode	Vector Mode
	• *Simple but not very good data*	• *Good representation*

Advantages	*structure.* • *Easy to overlay and combine data (spatial analysis).* • *Spatially continuous representation of variables.*	*of data structure.* • *Excellent graphical display.* • *Can be linked to a relational database.*
Disadvantages	• *Large amount of cumbersome data.* • *Resolution of data display depends on the phenomenon being studied.* • *Poor visual appearance of documents.* • *Poor spatial accuracy*	• *Complex data structure* • *Overlay operation, limited spatial analysis.* • *Low thematic resolution.*

IV.4. FUNCTIONALITIES OF A GIS [2]

Geographic information systems have functions grouped into five families, known as the 5A's, which are (M. Amel, A. Nouara, 2013):

- ✓ **Acquisition**
  This is the operation used to integrate geographic data into the system.
- ✓ **Archiving**
  The structuring and storage of geographic information in digital form.
- ✓ **Abstraction**
  This is the operation that allows a complex real-world geographic situation to be represented by a simple system that is sufficiently accurate and understandable.
- ✓ **Analysis**
  This is the operation used to perform processing or interpretation related to the geometry of objects (e.g., route calculation, cross-referencing thematic data in layers).
- ✓ **Display**
  Presentation and formatting, particularly in cartographic form, with a focus on ergonomics and usability.

  Its five basic GIS functions allow it to create a virtual platform of real-world information in the form of thematic layers that can be overlaid with geographic maps.

IV.5. FIELDS OF APPLICATION OF GIS

The use of a GIS is a priori relevant in all areas where entities, objects and information that can be located in an area can be used to support decision making processes.

GIS can be applied to a number of areas, including :

- **Forest management:** mapping for development, management of logging and silviculture;
- **Transport :** urban transport planning, route optimisation.
- **Tourism**: infrastructure management, tourist itineraries.)
- -**Marketing**: customer location, location analysis.
- **Biology**: studies on the movement of animal populations.

IV.6. ADVANTAGES OF SIG

GIS has a number of benefits, including

- Lower cost of producing maps and plans.
- They can be produced faster and cheaper.
- It is also possible to produce maps and plans that could not be produced by hand. Information can be used to produce new products that could not be produced by hand.
- It avoids the need for different departments to carry out topographical surveys of the same area and avoids the loss of information over time by accumulating information gathered in the field.
- Once the GIS is in place, installing an application requires a modest investment and the return on investment is rapid.
- Makes it easier to conduct studies for all projects with a geographical component. It allows you to increase the number of visual representations, making decision making easier and reducing the risk of error.
- -Improves service to users by providing them with the quality information they need, quickly and reliably. For example, all information provided by the urban planning department is always up to date and complete.
- Enables calculations that are useful for decision making. These range from simple calculations such as map overlays to complex spatial analysis calculations involving a large number of parameters.

III. RESULTS OF THE APPLICATION

At the end of this implementation, we present the results of our application in the form of annotated screenshots, which consisted of setting up a geolocation assistance tool in a mobile environment for the nearest health facilities in the city of Kananga.

The figure below is the one that opens when our application (GéoSaniT 1.0) is launched. It shows 3 possible events that the user can use according to his needs.

Figure 51. Home screen

Figure 5.2. Application Selection screen

On this screen, the application (GéoSaniT 1.0.) offers the user 3 options: firstly, to search for a route, then to get help or consult information about the application, and finally to consult or consult the different hospitals available in this version of the application.

The following window is the one displayed when searching for an itinerary: Here the application also offers the user 3 possible choices of directions that could take them to their destination, so they can choose either:

- ✓ The direction for the car;
- ✓ The direction for walking (pedestrian);
- ✓ And finally, the direction for motorbikes.

It should be noted that each direction has its own route and stages to follow, which are different depending on the direction chosen.

The following window is the one that opens when a route direction is chosen or selected. (Direction for car)

Figure 5.3. Reference entry screens

At this point, the user has to enter a geographical reference or, alternatively, a strategic location not far from his or her physical location. This reference also includes the geographical coordinates of the nearest health facility, in order to provide the simplest and clearest route, indicating the shortest route.

Once the user has entered a reference, he or she presses the search button and a new window opens showing the closest health facility to his or her location and the steps he or she should take to get there as quickly as possible.

The following window shows an example of a search carried out by selecting the direction of the car, using the KAMBOTE tabernacle as the geographical reference, to find the nearest health facility.

Figure 5.4. Search screens and search results

Here is an example of some of the source code for the Search button, which retrieves and displays search results from the geographical database.

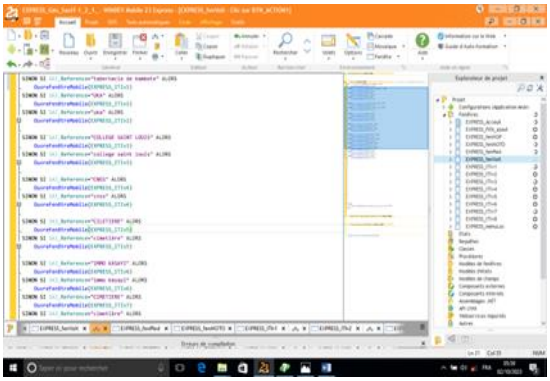

Figure 5.5. Route search codes.

Here you can also find some of the source code that is used to exchange data from the database to the mobile phone window:

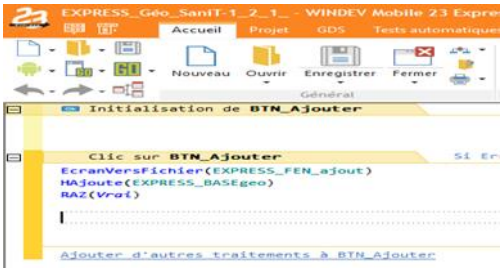

Figure 5.6. Illustration of database and window relationship codes.

Figure 5.7. Hospital List window in landscape mode

IV. CONCLUSION

The present work revolved around three main points. The first of these had two aspects, the aim of which was to explain the different concepts of approaches to geolocation, while demonstrating the mechanisms and processes put in place to achieve the location of a well-defined entity. The second aspect was to explain the concepts related to mobile applications, showing the different mobile systems or platforms on which mobile applications have to run and some of the issues related to mobile applications in certain areas of life.

The use of new technologies, such as Geographic Information Systems (GIS), was the subject of our second point. In this section we describe GIS and its applications, which have become easier to use.

Until now, GIS has been the preferred tool for designing ideas and simulating situations according to local or global strategies.

Thanks to the software and hardware architecture discussed in the last section, we have implemented our application, which allows users to easily find a health facility near their location without having to be connected to the Internet or asking a passer-by for directions.

However, this application does not solve the traffic problem. The user cannot find the nearest health facility and its route taking into account traffic jams, as this is not possible with the version of the system that has been developed.

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