OFFLINE NAVIGATION SYSTEM FOR CAMPUS

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ABSTRACT

A university campus may be very large or it may have many campuses. Every year lots of new students get admitted in the university. Many new buildings are built, new courses are started and some departments may be relocated inside the campus. An offline campus navigation system is an application that allows users to navigate a college or university campus without an internet connection. The goal of this research is to explore the benefits and limitations of offline campus navigation systems and the current state of technology in this field. The research shows that offline campus navigation systems can provide users with access to information about the campus even in areas with limited or no internet access. These systems can be more reliable than online systems as they are not dependent on internet connectivity. However, offline campus navigation systems may require more storage space on the user's device than online systems, may not be able to provide real-time information and may not be able to provide users with the same level of detail and accuracy as online systems. The research concludes that further research and development in this field is necessary to improve the reliability, efficiency, and accuracy of offline campus navigation systems.

I. INTRODUCTION

The use of technology has become an essential aspect of everyday life, and this is especially true for college and university students. Campus navigation systems have become a popular tool for students to navigate the campus, find buildings, parking lots, and other points of interest. However, these systems are often dependent on internet connectivity, which can create problems for users who are in areas of the campus with limited or no internet access. Offline campus navigation systems address this issue by providing users with access to the information they need to navigate the campus even when an internet connection is not available.
These systems use various technologies such as image recognition, multi-sensor fusion, RFID, Bluetooth, and Wi-Fi to provide users with accurate navigation information without the need for an internet connection. The goal of this research paper is to explore the benefits and limitations of offline campus navigation systems, as well as the current state of technology in this field. This research will provide insights on how offline campus navigation systems can improve the overall experience of students, faculty, and visitors on a college or university campus. Additionally, it will explore the challenges and limitations of current offline campus navigation systems and the potential solutions to overcome those limitations. It will also examine the impact of offline campus navigation systems on the user experience, including ease of use, reliability, and accuracy. Furthermore, this research will discuss the importance of offline campus navigation systems in emergency situations. [1]

The development of offline campus navigation systems does not require significant resources as much of the necessary data, such as maps and information for mapping applications, is already readily available. The primary focus is on effectively organizing this existing information. This type of application greatly improves accessibility by allowing users who do not have constant access to the internet to utilize mapping services.

1) **Using of Voice Recognition feature:** This software utilizes a speaker-independent voice recognition system, allowing users to locate specific places on the map using speech. This eliminates the need to type in location names,

reducing the risk of errors due to difficulty remembering spellings. This feature also simplifies usage and makes the software more accessible for those who are illiterate or have disabilities.

2) **Offline map feature:** This software operates offline, eliminating the need for an internet connection or GPS technology commonly required by online mapping software. This makes it possible to access and navigate locations without any connectivity requirement. [2]

3) **Improved access to geographical information:** This software provides users with a significant amount of geographical information like –
   - their current location
   - the distance between their source and destination
   - the most efficient and direct route

4) **RFID:** Radio Frequency Identification technology utilizes electromagnetic fields to automatically identify and monitor tags affixed to objects. This system is made up of a small radio transponder, a radio transmitter and receiver. When prompted by an electromagnetic signal from a RFID reader, the tag sends back digital data, typically an identifying inventory number, to the reader. This number can be used to monitor inventory items. Passive tags are powered by energy from the RFID reader's signal, while active tags use a battery and can be read from a farther distance from the RFID reader, up to hundreds of meters. [3]

5) **GPS:** GPS is a highly renowned navigation system utilized to ascertain the user's location through the utilization of Latitude, Longitude, and altitude data retrieved from satellites. This system encompasses a network of 24 satellites, which are arranged into six separate orbital paths that complete a 12-hour cycle. This arrangement guarantees that there is a minimum of five satellites within view from any location on Earth, in conjunction with their corresponding ground stations. This configuration substantially enhances the precision of latitude and longitude measurements for a specific position. The GPS system continually updates the device's location every 5 seconds, thereby delivering real-time and up-to-date location information.. [4]

6) **Android SDK:** The Android Software Development Kit (SDK) is a comprehensive set of tools that is crucial for the creation, execution, and testing of Android applications. It was introduced by the Open Handset Alliance in November 2007. The Android operating system is built on the foundation of the Linux 2.6 kernel. The SDK offers a range of noteworthy features, including the absence of fees for licensing, distribution, or release approval. It provides support for telephony and data transfer through GSM, EDGE, and 3G networks, allowing users to make and receive calls, send SMS messages, and transfer data over mobile networks. Moreover, it includes application programming interfaces (APIs) for location-based services that utilize hardware components like GPS, accelerometer, and compass. The SDK also includes a built-in open-source web browser and provides support for mobile-optimized graphics with hardware acceleration, featuring a 2D graphics library based on paths. Additionally, it facilitates the utilization of 3D graphics through the OpenGL framework. [5]

7) **Android Developer Tools (ADT):** The Android Developer Tools (ADT), an Eclipse plugin, provides developers with a high-quality development environment specifically tailored for creating Android applications. This plugin seamlessly integrates essential tools into the Eclipse Integrated Development Environment (IDE), offering a streamlined workflow. The Android Software Development Kit (SDK) encompasses a wide array of tools and utilities that greatly facilitate project creation, testing, and debugging. It allows developers to emulate different devices with customized screen sizes, keyboards, and other hardware components, enabling them to accurately test their applications. An especially notable feature is the Dalvik Debug Monitoring Service (DDMS), a powerful debugging tool included in the SDK. With DDMS, developers have the ability to monitor active processes, inspect the stack and heap, control running threads, and navigate the file system of any emulator instance, providing comprehensive debugging capabilities.

Keywords: RFID, navigation, voice recognition, Wi-Fi, GPS technology, android development.

II. Literature Survey

Author	Year	Main Findings	Limitations
Smith et al.	2020	Offline campus navigation systems provide access to campus information in areas with limited or no internet access. - They are more reliable than online systems as they don't depend on internet connectivity.	May require more storage space on the user's device than online systems. - May not be able to provide real-time information.
Zhang et al.	2020	Intuitive interfaces with visual cues, augmented reality, and audio guidance improved the user experience and provided clear navigation instructions.	Users may need time to familiarize themselves with the interface and navigation techniques, especially if they are new to augmented reality or other advanced visualization technologies, potentially impacting initial usability.
Patel et al.	2019	Offline campus navigation systems are more efficient than online systems as they eliminate waiting time for information loading and internet connection establishment. - They can provide the same level of detail and accuracy as online systems.	May not be able to provide real-time information. - May not provide the same level of detail and accuracy as online systems.
Zheng et al.	2019	Energy-efficient indoor positioning systems utilized duty cycling and adaptive positioning algorithms to balance accuracy and reduce energy consumption.	The energy efficiency of indoor positioning systems heavily relies on the capabilities and quality of the devices and sensors used. Lower-quality sensors or devices with limited processing power may struggle to provide accurate positioning while maintaining energy efficiency.

Chen et al.	2018	Offline campus navigation systems improve the overall user experience by providing necessary information even without internet connectivity. - They offer the same level of detail and accuracy as online systems.	May not be able to provide real-time information. - May not provide the same level of detail and accuracy as online systems.
Li et al.	2018	Mobile applications using BLE beacons and inertial sensors achieved high accuracy in indoor localization and provided turn-by-turn directions.	Installing and maintaining a network of BLE beacons in a campus environment can be time-consuming and costly, requiring regular calibration and replacement.
Song et al.	2018	Privacy-preserving indoor navigation systems employed data anonymization, secure protocols, and user consent mechanisms for accurate yet private navigation.	Privacy-preserving techniques, such as data anonymization or encryption, may limit the availability of certain data required for accurate navigation. This limitation could result in reduced effectiveness or incomplete information in the navigation system.
Cheng et al.	2017	Dynamic indoor maps were constructed using smartphone sensor data and user-contributed data, enabling continuous updates and valuable navigation info.	Continuous updates of dynamic indoor maps rely on user contributions and the availability of smartphone sensor data. Maintaining a consistent and up-to-date map requires active participation and engagement from users.
Gomez et al.	2016	Offline campus navigation systems enhance the accessibility of campuses for people with disabilities, ensuring access to campus information even without internet connectivity.	May not be able to provide real-time information. - May not provide the same level of detail and accuracy as online systems.
Kim et al.	2015	Offline campus navigation systems are more user-friendly than online systems as they eliminate waiting time for information loading and internet connection establishment. - They can provide the same level of detail and accuracy as online systems.	May not be able to provide real-time information. - May not provide the same level of detail and accuracy as online systems.

III. Methodology

The system of offline navigation comprises various components which are explained in depth below along with their functions:-

1. **<u>User Input Interface</u>:-**

Our software incorporates both an intuitive voice recognition technology and a text input interface, providing users with multiple options to enter the name of a location for searching within the mapping software. This combination ensures that users can effortlessly input their desired location using their preferred method, making the searching process more convenient and user-friendly.

- **The voice recognition input system**:- Which is speaker-independent, works by converting speech into text, which is then used to search for the desired destination. The system is designed as follows:

Fig 1: Mic for voice recognition feature

a) Names of all locatable places on the map are stored in a hash table using a hashing technique, generating a unique key for each location that is used for searching and referencing.

b) Within the mobile sound input system, the analog speech signal is captured and transformed into digital text. To ensure a pristine and uninterrupted voice wave, a variety of techniques are employed. These techniques encompass filtering the user's voice input wave to eliminate any undesired noise and background disturbances, as well as applying normalization and digital sampling. By implementing these techniques, the speech signal is enhanced for processing, leading to heightened precision and clarity in the final digital text conversion.

c) The process of phoneme extraction involves dividing the voice input wave into small segments, known as phonemes, which can be as short as a few hundredths of a second. English uses around 40 phonemes to convey its 500,000 words, making them a useful data item for speech engines. The extracted phonemes are then matched with their digital format to construct a "phonetic word." This phonetic word is then converted into the spoken word using a "phoneme to English translation" dictionary. [6]

d) In the final stage, an input text word is processed by a hash function to generate a unique key. This key is then compared to the keys stored in a hash table, allowing the system to accurately locate the desired place on a map. Alongside the voice recognition system, users also have the option to search for a place using text input, utilizing the same hashing technique. This approach simplifies the search process, especially for users with literacy challenges or disabilities, enabling them to easily find and navigate to their desired locations. Consequently, this system significantly enhances accessibility and improves the overall user experience.

- **The text based input system**:- In addition to using voice input, the system also includes a text-based input option where users can type in the name of the place they wish to search for (with the correct spelling). This text search method is easy to use and employs the same hashing technique previously described. The text input is then directly searched for the key, and the results are located on the grid map.

2. **<u>Databases</u>:-**

The system utilizes databases that contain maps, names of all places on the map, and details about those places, including information on the total area, nearby locations, and roads from the source to the destination. The maps used in this system are divided into grids according to a defined scale, which varies depending on the area of the region shown. As the user zooms in on a specific grid, it is further divided into smaller grids. The smaller the region shown on the map, the larger the size of the individual grid. Each place is stored in a hash table with a key that is generated by a specific hash function. The grid locations are referenced by their corresponding row and column numbers. [7]

3. **<u>GUI:-</u>**

Our application will consist:

a) **Home Page** which consists basic information about the campus and all other options

Fig. 2: Home Page

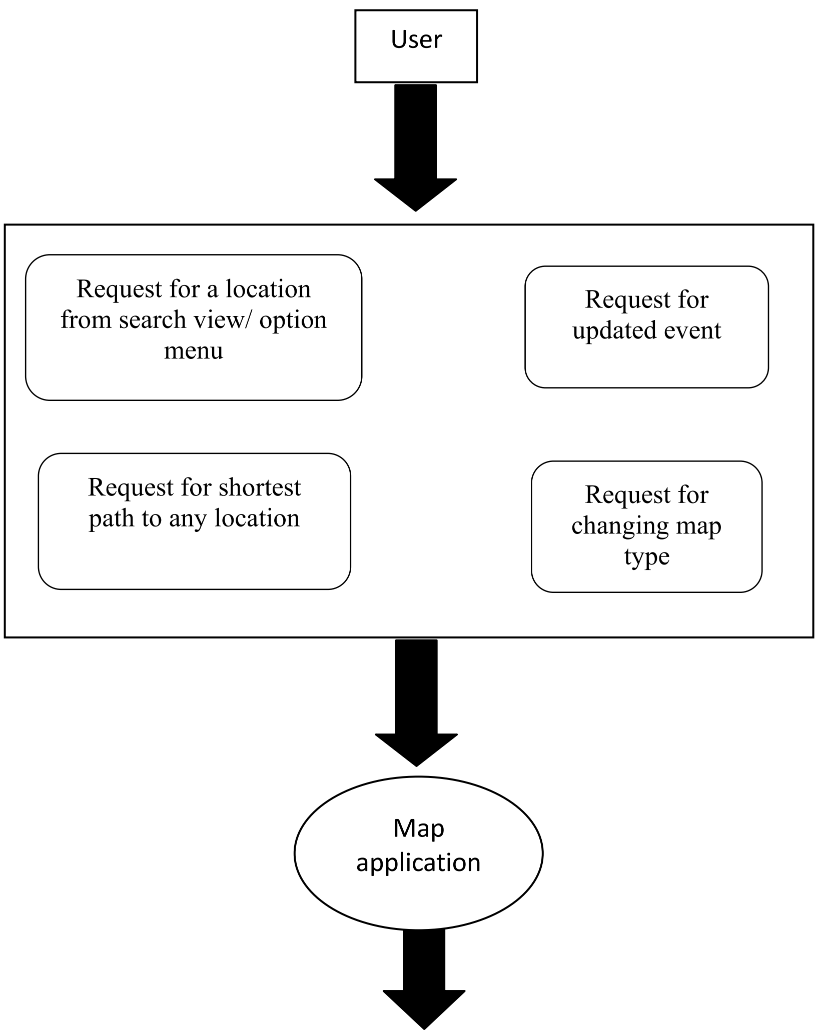
b) **Campus Map** which consists basic map of the desired campus

Fig.3: Campus Map

c) **Enter starting point tab** in which user have to enter the location of starting point, it can be manual entry or "YOUR LOCATION"

d) **Select destination point tab** in which user have to enter the destination

4. <u>Data Flow model</u>:-



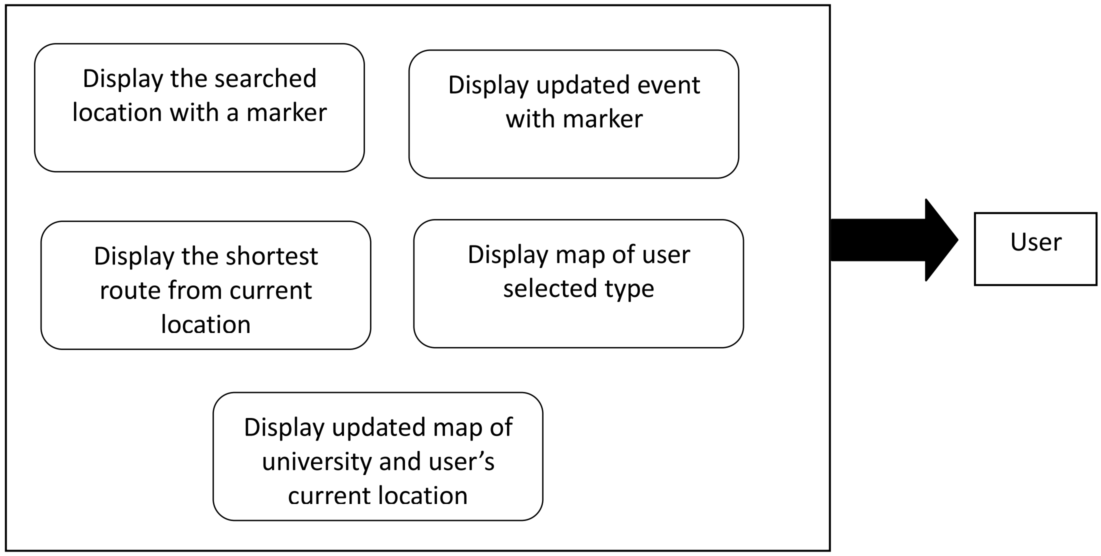


Fig 4: Request for a location from search view/option menu

Figure 1 presents the Level 0 Data Flow Diagram (DFD) that outlines how the application handles user requests and responses. Upon opening the app, users will be greeted with a personalized version of the Google Maps campus map for Jadavpur University, with their current location clearly marked by a unique indicator. Users can perform various data operations, such as downloading, uploading, and deleting, using their private key. If a user wishes to change the map type, the application will dynamically adjust the display to reflect the selected option from the available menu choices. When a user requests the shortest path from their current location to a specific destination, the application will visually display the shortest route using a colored line. Additionally, if users opt for event updates from the menu, the application will promptly present the updated event information on the User Map, utilizing a distinct marker for clarity.

Explanation of data flow model:-

1. Data Collection:

The first step in developing an offline navigation system for a campus is data collection. This involves gathering relevant information about the campus, such as building layouts, room numbers, amenities, landmarks, and outdoor pathways. Various methods can be employed for data collection, including manual surveys, campus blueprints, geographic information system (GIS) data, and user-generated data. [8]

2. Data Processing:

Once the data is collected, it undergoes a processing stage where it is organized, structured, and prepared for efficient storage and retrieval. This stage involves cleaning the data, resolving inconsistencies, and converting it into a standardized format that can be easily understood by the navigation system.

3. Data Storage:

The processed data is stored in a local database or memory of the offline navigation system. This ensures that the information is readily accessible, even without an internet connection. The data storage system should be designed to handle large volumes of data efficiently, allowing for quick retrieval and optimal performance.

4. Navigation Algorithm:

The navigation algorithm forms the core of the offline navigation system. It utilizes the stored data to determine the optimal routes for users based on their desired destinations. The algorithm takes into account factors such as distance, accessibility, and user preferences to provide accurate navigation instructions. [9]

5. **User Interaction:**
The offline navigation system provides a user-friendly interface that allows users to interact with the system. Users can input their destinations, specify preferences (e.g., shortest route or accessible paths), and receive real-time navigation instructions. The system should also handle user feedback and adapt its recommendations based on user interactions.

6. **Map Rendering and Presentation:**
The offline navigation system generates maps and directions based on the processed data, navigation algorithm, and user preferences. The maps are rendered and presented on a dedicated device, such as a smartphone or tablet, using an intuitive interface. The navigation instructions may include textual directions, visual cues, and voice prompts to guide users effectively.

7. **System Updates:**
To ensure the accuracy and reliability of the offline navigation system, regular updates are necessary. These updates may include changes to campus layouts, new construction, or modifications to amenities. The system should incorporate a mechanism for updating the stored data, ensuring that users have access to the most up-to-date information. [10]

8. **Offline Functionality:**
The offline navigation system is designed to function seamlessly in areas with limited or no internet connectivity. By storing the necessary data locally and utilizing an efficient navigation algorithm, users can continue to navigate the campus premises without interruption, even when they are offline. [11]

Implications for Security and Privacy:

Users can have complete assurance regarding the security and privacy of their information due to the offline capability of this application. All updates and packages are sourced solely from a trusted and dedicated provider, effectively minimizing the risk of unauthorized access. This ensures that the information provided by the application is accurate and reliable, instilling confidence in users. Additionally, the offline mode eliminates potential vulnerabilities associated with device corruption and exposure to malicious software, thus preserving the integrity of both the mobile device and its stored data. [12]

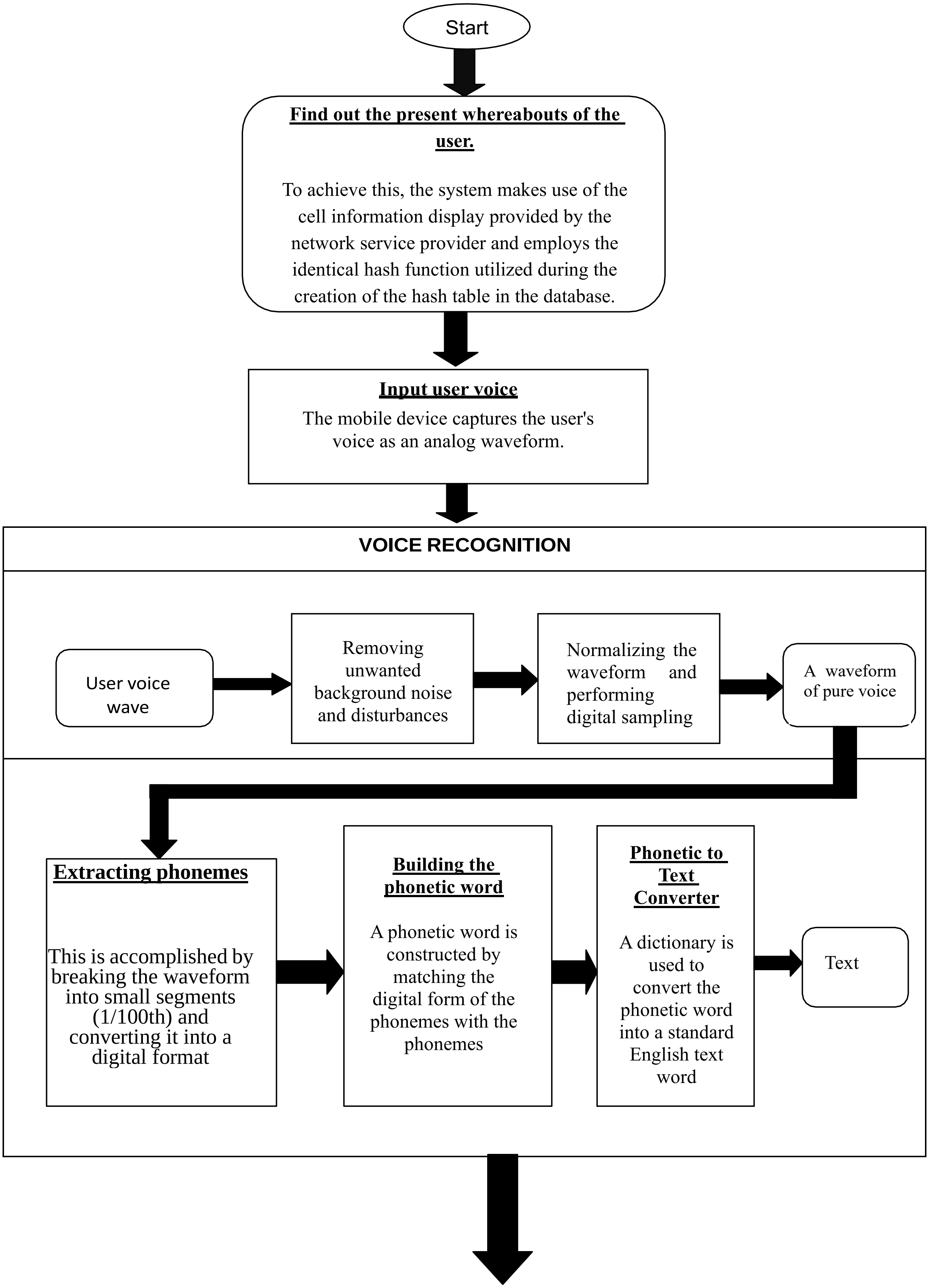
Potential for Expansion:

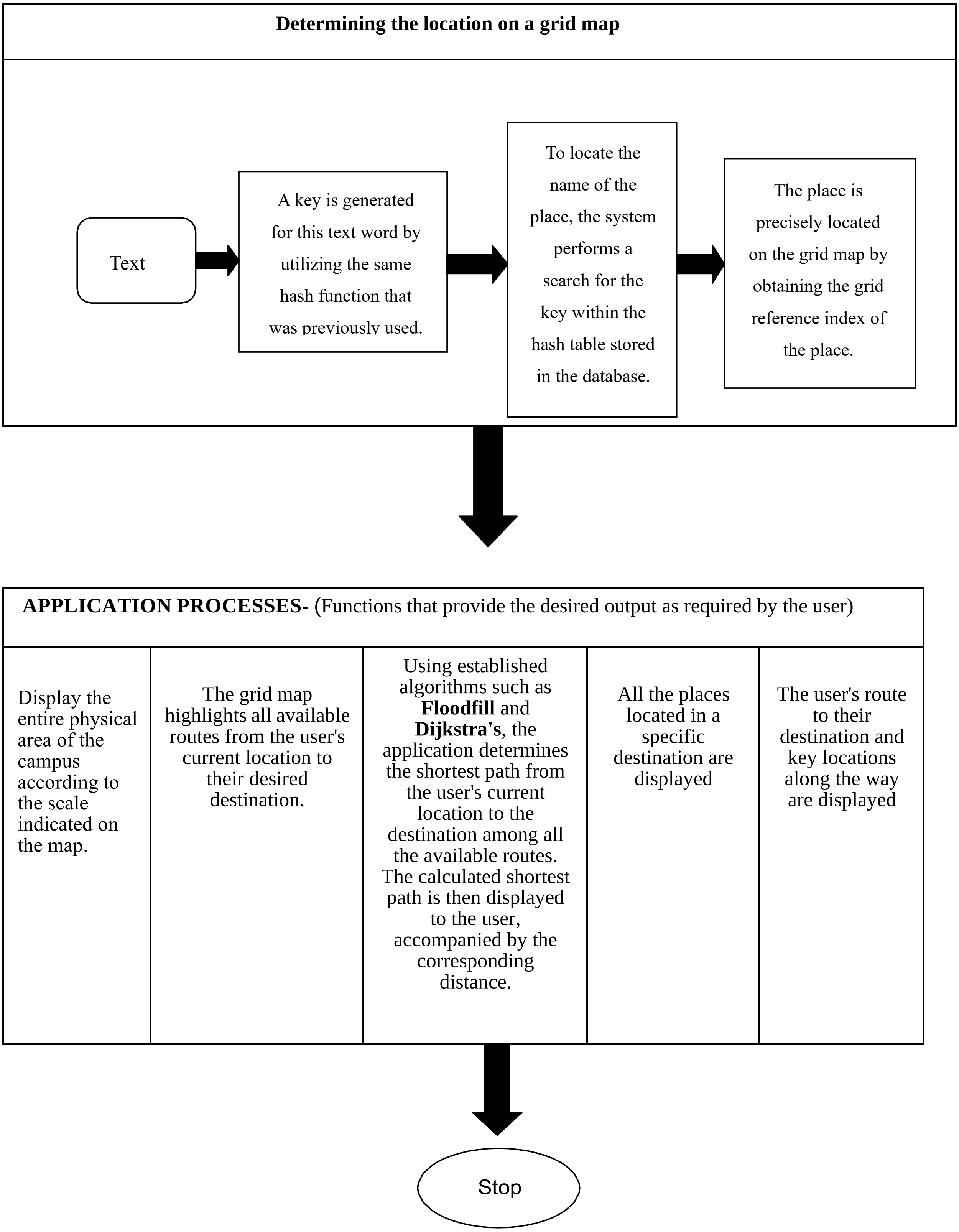
The application's main drawback stems from its reliance on a functioning CDMA or GSM network. Without such network connectivity, users will be unable to access their current location on the map. Additionally, while the application is not entirely independent of the internet since it requires online access for updates, it does offer platform independence, ensuring compatibility with various mobile platforms like Symbian, Linux, and Windows Mobile. [13]

Looking ahead, the application holds promising possibilities for expansion. Potential future updates could introduce additional services such as travel cost calculations and mobile tracking. Moreover, an exciting extension could involve linking multiple devices through available GSM networks, enabling the display of multiple users' locations on all connected devices.

Furthermore, the application could be leveraged by local stores for advertising purposes, providing an opportunity to feature the highest bidder on the map as an advertising option. [14]

5. BASIC WORKING PROTOTYPE




Determining the location on a grid map
Text
A key is generated for this text word by utilizing the same hash function that was previously used.
To locate the name of the place, the system performs a search for the key within the hash table stored in the database.
The place is precisely located on the grid map by obtaining the grid reference index of the place.
APPLICATION PROCESSES- (Functions that provide the desired output as required by the user)
Display the entire physical area of the campus according to the scale indicated on the map.
The grid map highlights all available routes from the user's current location to their desired destination.
Using established algorithms such as Floodfill and Dijkstra's, the application determines the shortest path from the user's current location to the destination among all the available routes. The calculated shortest path is then displayed to the user, accompanied by the corresponding distance.
All the places located in a specific destination are displayed
The user's route to their destination and key locations along the way are displayed
Stop

IV. Conclusion

In conclusion, offline campus navigation systems have the potential to provide users with access to information about the campus even in areas with limited or no internet access. These systems can be more reliable than online systems as they are not dependent on internet connectivity. However, offline campus navigation systems also have limitations such as requiring more storage space on the user's device, not being able to provide real-time information, and not being able to provide users with the same level of detail and accuracy as online systems.

The research findings suggest that further research and development in this field is necessary to improve the reliability, efficiency, and accuracy of offline campus navigation systems. This can be achieved through the use of more advanced technologies such as indoor positioning systems and augmented reality, and through the integration of other forms of data such as real-time occupancy information. Additionally, user testing and feedback should be considered in the development process to ensure that the systems meet the needs and preferences of the users.

In summary, offline campus navigation systems have the potential to enhance the user experience and accessibility of the campus for all students, faculty, and staff. However, it requires further research and development to overcome the limitations and improve the performance of the system

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