

GEO Locate Project Design Report Summary

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GEO Locate is a mobile application that supports underground navigation and mapping during exploration. The system is designed to improve safety by allowing users to record their path in real time, retrace their movements, and share map data with other users. Because underground environments do not support reliable GPS or internet connectivity, the application is built to function in offline conditions using device sensors such as accelerometers and gyroscopes. The system also includes an SOS feature that assists in emergency situations by recording and transmitting the user's last known location and path data.

The primary users of GEO Locate are underground explorers, including both recreational and professional users. These users operate in environments with limited visibility, harsh terrain, and restricted communication, so the system must remain simple, reliable, and easy to use. Administrators act as secondary users and are responsible for managing user accounts and maintaining the shared map repository. Additional stakeholders include developers, testers, and emergency responders who rely on the system's data during rescue operations.

The system is defined through a set of core use cases that describe how users interact with the application. Users are able to create accounts and log in to access system features. A user can start a map session before entering an underground environment, which activates the device sensors and begins recording movement data. As the user moves, the system continuously tracks direction and distance to construct a path of navigation. During an active session, users can mark checkpoints to record important locations such as hazards, intersections, or points of interest. Once the session ends, the system saves the recorded data locally on the device. Users can later view the map, retrace the recorded path for navigation, upload maps to a shared repository, or download existing maps for future use. In the event of an emergency, the user can trigger the SOS feature, which records the current location and session data and prepares it for transmission when connectivity is available.

The system requirements emphasize performance, reliability, and usability. GEO Locate must respond to user inputs within two seconds and update location data at regular intervals to ensure accurate path tracking. The system must maintain functionality in offline conditions, allowing users to record and retrace paths without internet access. Data must be stored locally to prevent loss during interruptions and synchronized with a cloud database when connectivity is restored. The application must also meet reliability requirements, ensuring that failures do not

result in loss of recorded data. Security requirements include user authentication, role-based access control, and protection of user data from unauthorized access. The system must also log key activities such as login attempts, map uploads, and SOS triggers.

The design of GEO Locate is structured around multiple subsystems that work together to support system functionality. The User Management subsystem handles account creation, authentication, and role management. The Mapping and Session subsystem manages the recording of movement data, creation of map sessions, and construction of maps. The Navigation subsystem provides functionality for viewing maps and retracing recorded paths. The Storage and Synchronization subsystem manages local data storage and cloud-based map sharing. The SOS subsystem handles emergency alerts and data transmission. The Administration subsystem allows administrators to manage users and maintain the shared map repository.

The system uses a set of core data entities to represent information and relationships within the application. A User can create multiple Map Sessions, each of which produces a Map. A Map consists of Nodes and Edges, where Nodes represent recorded positions and Edges represent connections between those positions. Checkpoints are associated with nodes to mark important locations. The SOS Alert entity represents emergency events and references a location within the map. These data relationships form the foundation for the system's functionality and support both navigation and emergency response.

The user interface is designed to be simple and effective in underground environments. The system uses a high-contrast design with large, readable elements to ensure usability in low-light conditions. The interface provides clear access to key actions such as starting a session, marking checkpoints, retracing paths, and triggering SOS alerts. The design minimizes unnecessary elements to reduce distraction and allow users to interact with the system quickly and safely.

Overall, GEO Locate provides a complete solution for underground navigation by combining real-time mapping, offline functionality, and emergency support. The system addresses the limitations of existing navigation tools by removing dependence on GPS and providing a reliable method for recording and retracing paths. Through its design, GEO Locate aims to improve safety, efficiency, and accessibility for underground exploration.