Integrating Mobile GIS for Efficient Location Tracking and Management

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***Abstract:** With the advancement of Mobile Geographic Information Systems (GIS) technology, there is significant potential for leveraging wireless communications and Internet-based mapping services in regional environmental management programs. This article provides an overview of the development of mobile GIS tools and wireless Internet Map Server (IMS) services aimed at enhancing monitoring and management tasks. This paper gives an overview of development of mobile GIS tools, and wireless Internet Map Server (IMS) services, focused on improving monitoring and management tasks. Users can visualize spatial data in real time and navigate through their environment. It also focused on Mobile GIS Application, GPS Integration, and setup of spatial data using PostGIS and potential issues in its implementation. Therefore it outlines the research agenda for mobile GIS, highlighting future directions for development and innovation.*

***Keywords:** Mobile GIS, GPS, Wireless Communication*

INTRODUCTION

Mobile Geographic Information Systems (GIS) and Location-based Services (LBS) are set to play a key role in the future, benefiting users such as tourists, field workers, and emergency responders (Gagliano, 2021) by providing localized information on mobile devices anytime, anywhere. These systems rely on mobile hardware that requires different interaction methods compared to desktop-based GIS. To ease the cognitive load on users, new techniques are needed, particularly sensor-based systems that capture data on position, speed, orientation, and other variables.

This paper introduces a novel approach that integrates GIS with LBS through embedded sensors, enabling automatic extraction of environmental data. Key aspects of this system include mobility and distributiveness. Traditional field mapping is time-consuming and limited by desktop computers and network constraints, while mobile GIS offers a more efficient solution. By combining GIS, GPS, and remote sensing on mobile devices, GIS users can access geospatial data in real time, making data collection, validation, and updates easier and faster.

Mobile GIS solutions are especially useful for environmental management and habitat monitoring, providing real-time access to geospatial data, navigation functions, and seamless GPS integration. These systems are increasingly adopted by private companies, government agencies, and academic researchers. Mobile GIS can assist a range of users, from environmental scientists validating sensitive species locations to consumers navigating to shopping malls or police officers reporting traffic accidents. The article defines "Mobile GIS" and explores its various applications, demonstrating the evolving role of mobile technology in field data acquisition and real-time spatial analysis.

OBJECTIVE

- To identify the numerous disciplines and technologies that can be related to mobile GIS, such as LBSs and telegeoinformatics.
- Analysis of mobile device to display geospatial data received, process and retrieve the GIS requests of mobile user.
- To apply shortest path algorithm to display Geo-spatial data and execute GIS operation efficiently on mobile devices.

METHODOLOGY

Mobile GISs will offer geospatial data that's a lot of intelligent (Elhashash, 2022) than paper maps by providing, as an example, route directions and extra data regarding associated thematic kind in surroundings to enhance a user's model of an area (Boulos, 2020). For a system to show intelligence adapt to a user's specific geospatial data needs, intelligent mobile GISs need associate insight into the user's egocentric read. This insight is gained victimisation sensors like GPS and digital compasses supported these issues we have a tendency to design associate intelligent mobile GIS, which is actually a mobile mapping system at its core. Its advantage over alternative mapping tools is to use the insight into the user's GPS to mechanically adapt the map through panning, zooming and rotation supported the user's globe movements. Additionally, to adjust the map show, machine-controlled choice provides data regarding the user's surroundings by exclusively standing and facing a feature of interest. Adaptation improves the employment of the mobile GIS and overcomes limitations of the mobile computing devices.

Implementation Steps

(A) Setting up the Mobile GIS Application

1. Select a Mobile GIS Platform:

Use an existing GIS platform (e.g., ArcGIS Field Maps, QField for QGIS, or a custom mobile app using open-source GIS libraries like Mapbox or Leaflet).

Ensure the app can interact with the device's GPS functionality.

(B) GPS Integration:

Enable location services on the mobile device.

Access the device's GPS hardware via native SDKs (Android: LocationManager, iOS: CoreLocation).

Fetch the device's current latitude, longitude, and altitude.

Code (Android):

```
Location Manager location Manager = (Location Manager) get System Service (Context. LOCATION_SERVICE);
Criteria criteria = new Criteria();
String provider = location Manager.getBest Provider(criteria, true);

location Manager.requestLocationUpdates(provider, 60000, 10, new LocationListener() {
   @Override
   public void onLocationChanged(Location location) {
       double latitude = location.getLatitude();
       double longitude = location.getLongitude();
       double altitude = location.getAltitude();
       // Send the coordinates to the server
   }
});
```

(C) Map Display:

Use libraries like Google Maps, OpenStreetMap, or Mapbox SDK to display maps and the current GPS position.

Code (API - Android):

```
GoogleMap googleMap;
googleMap.setMyLocationEnabled(true);
googleMap.addMarker(new MarkerOptions().position(new LatLng(latitude, longitude)).title("Current Location"));
googleMap.moveCamera(CameraUpdateFactory.newLatLngZoom(new LatLng(latitude, longitude), 15));
```

(D)Server-Side Implementation

1. Set up a Spatial Database (PostGIS):

```
<category
        android:name="android.intent.category.BROWSABLE"/>
<category
        android:name="android.intent.category.DEFAULT"/>
<action
android:name="android.intent.action.VIEW"/>
</intent-filter>
</activity>
<activity>
```

(E)API Development:

Create RESTful APIs to receive GPS data from mobile devices and send data back to the mobile app.

API (Node.js/Express):

```
app.post('/api/location', (req, res) => {
   const { latitude, longitude, timestamp } = req.body;
```

```
    const query = 'INSERT INTO
locations(gps_coordinates) VALUES
(ST_SetSRID(ST_MakePoint($1, $2), 4326))';
    pool.query(query, [longitude, latitude], (err,
result) => {
        if (err) {
            res.status(500).send('Error saving location
data');
        } else {
            res.status(200).send('Location saved
successfully');
        }
    });
});
```

Data Synchronization:

- The mobile app periodically sends data to the server to store the GPS points.
- When a device goes offline, the app should cache data locally and sync it once the network is available.

(F) Real-Time Tracking

1. Web Interface: Implement a web interface for administrators to track locations in real-time. The interface can use WebSocket or similar technologies to receive live location updates from mobile devices.
2. Geospatial Querying: Use SQL queries or spatial queries (PostGIS, MongoDB) to retrieve and visualize location-based data. For example, finding the closest device or assets to a given point using the ST_DWithin function in PostGIS.

Algorithm for the Shortest Path using LBS:

Input:

- G(V,E): A graph with vertices V and edges E.
- S: The start node.
- G: The goal node.
- w(u,v): The weight of the edge between nodes u and v.
- h(n): A heuristic function estimating the cost from node n to the goal.

Output:

- The shortest path P from S to G.
- Total weight of the path.

Steps:

1. Initialize:
   - Create an open set O={S}, containing only the start node.
   - Create a closed set C={}, initially empty.
   - Set g(S)=0, the cost from S1 to S2 .
   - Set f(S)=g(S)+h(S), where f(n) is the total estimated cost of the path through n.
   - Set parent(n)=null for all nodes n.
2. Iterate Until Open Set is Empty:
   - Select the node current in O with the lowest f(current).
   - If current=G, the goal has been reached. Exit the loop.
3. Process current:
   - Remove current from O and add it to C.
4. Expand Neighbors:
   - For each neighbor n of current:
     - Skip n if n∈C.
     - Compute the tentative cost: gtentative=g(current)+w(current, n)
     - If nOn not in O or gtentative<g(n)g_{tentative} < g(n)gtentative<g(n):
     - Update parent(n) = current.
     - Updateg(n)=gtentativeg(n).
     - Update f(n)=g(n)+h(n).
     - Add n to O if not already in O.
5. Reconstruct Path:
   - If G is reached, reconstruct the path by backtracking using parent(n).
   - Return the path and its total cost.
6. Return Failure if No Path Exists:If the open set becomes empty without reaching G, return failure.

CONLUSION

The real challenge for securing mobile GIS applications is to create a hierarchical security framework to define different user groups (administrators, special-access users, regular users, guests) with different permissions to access various security levels of geo data from a single GIS content server. Such a solution will require not only the progress of future mobile GIS technologies, but also participation from both administration-level users and field workers. Moreover, some field-based data, such as census tracks and parcel records, may involve potential problems of location privacy (Kim, 2021).

An integrated mobile GIS framework can provide field personnel and first responders with mobile geospatial information services that directly support and help to optimise their field-based collection, analysis and resource management tasks. Mobile GIS is a very promising technology with strong demands from both field-based workers and GIS vendors. With the progress of new mobile GIS technologies, many future applications (such as homeland security, emergency rescue, real-time environmental monitoring, virtual tour guides, wildfire management and vehicle navigation services) will benefit from, and ultimately rely on, mobile GIS technology.

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