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Beach Navicon: A Real-Time Mobile Application For Enhancing Coastal Tourism Safety And Recreational Suitability In India

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Abstract

India, with a vast 7,500 Km coastline, attracts millions of tourists every year, contributing over \$15 billion to the economy. However, this economic prosperity comes with a downside: more than 1,000 drowning incidents annually due to unpredicted oceanic behaviours like rip currents, high waves, and poor water quality. Beach Navicon is a real-time mobile application that leverages data from INCOIS, NOAA, and OpenWeatherMap to deliver beach-specific safety and recreational suitability information. The application features multilingual support, offline functionality, color-coded geospatial mapping, and personalized safety alerts. Developed with a modular, scalable architecture, Beach Navicon has demonstrated a potential to reduce drowning incidents by up to 30%. This paper details the application development process, design methodology, key features, technical challenges, and socio-economic impact.

Index Terms - Mobile Application, Beach Safety, Real-Time Data, Coastal Tourism, Multilingual Support.

INTRODUCTION

India's coastal tourism sector plays a pivotal role in its economy. Tourists flock to destinations like marina Beach (Chennai), Baga Beach (Goa), and Puri Beach (Odisha). Despite its appeal, India's beaches present serious safety concerns due to the dynamic and unpredictable nature of marine environments. Over 1,000 drowning deaths are reported annually, often exacerbated by inadequate access to localized hazard information. Tourists rely on generalized weather apps or outdated local advisories.

The Beach Navicon project aims to fill this gap by providing a real-time, location-based, user-friendly mobile application. The application offers safety ratings, alerts, and environmental data to ensure an informed and secure coastal experience.

II. LITERATURE REVIEW

Several global efforts have been made to enhance coastal safety via technology:

- Surfline (Santos et al., 2019): Focuses on surfing conditions but lacks detailed local data.
- BeachSafe (Johnson & Lee, 2021): Offers beach information but limited to English speaking users with online access.
- Yahya et al. (2021): Emphasized increasing coastal hazards and the need for localized safety solutions in India.

The gap remains for a multilingual, India-centric platform with offline access and real-time hazard detection tailored to casual beachgoers.

III. METHODOLOGY

A. Requirement Analysis

- **Participants:** 50 tourists, 10 local authorities, 5 environmental experts.
- **Findings:** 80% of tourists desired real-time updates; 60% had prior negative experiences due to unanticipated hazards.

B. Design and Architecture

The applications consist of nine modules:

- **HomeScreen**

Figure 1 The HomeScreen displays a searchable list of beaches with real-time safety status, temperature, and location. Safety levels are color-coded based on live environmental data. This module serves as the central hub, enabling quick access to beach details and navigation to other core features such as Weather, Map, and Profile.

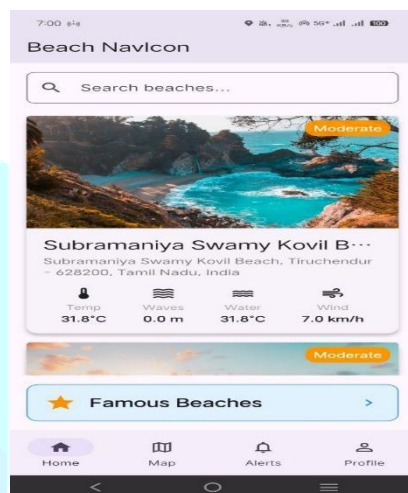


Fig.1

- **MapScreen**

Figure 2 Map module presents a geospatial view of beach locations using Google Maps integration. Each red pin marks a beach monitored by the application, allowing users to visualize and select beaches based on their geographic proximity. Upon selecting a pin, beach-specific information such as name and safety status becomes available. This feature aids tourists in quickly identifying nearby coastal spots and navigating to them, enhancing location-based interaction within the app.

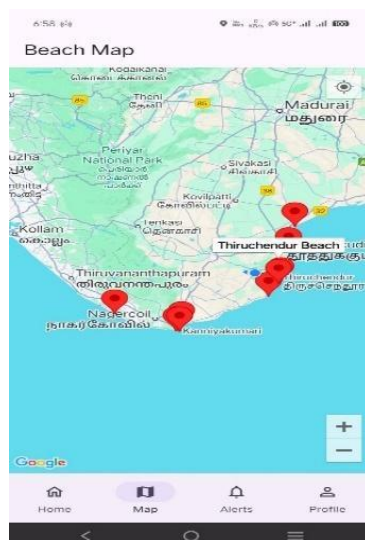


Fig.2

- **BeachDetailsScreen**

Figure 3 This screen from the BeachDetailsScreen module provides comprehensive beach information, including water temperature, UV index, and tide height, along with a general hazard rating. The safety section presents swell data such as swell height, direction, and period. Tab-based navigation allows users to switch between weather, swell, wind, tide, and UV parameters. This functionality enables beachgoers to assess safety conditions in detail before planning activities, enhancing decision-making with real-time, location-specific

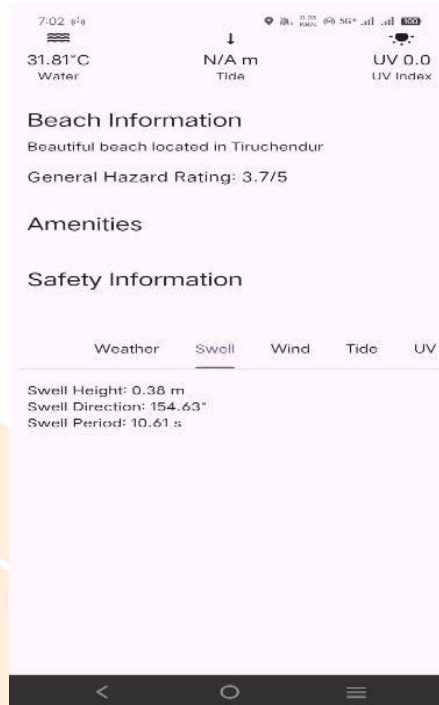


Fig.3

- **AlertScreen**

Figure 4 The AlertScreen module provides users with timely notifications regarding hazardous beach conditions, such as high tides, strong currents, or poor water quality. In this instance, no active alerts are present, indicating safe conditions at monitored beaches. Alerts are dynamically generated based on real-time environmental data and delivered through Firebase Cloud Messaging. This module enhances user safety by offering localized, actionable warnings to support informed decision-making during coastal visits.



Fig.4

- **Authentication Screen:**

Figure 5 The AuthScreen module facilitates user authentication through Firebase, allowing login via email/password or Google credentials. This secure entry point grants access to all application features, including real-time beach safety data, environmental alerts, geospatial maps, and multilingual support. The interface follows a minimal design to ensure ease of access and user-friendliness.

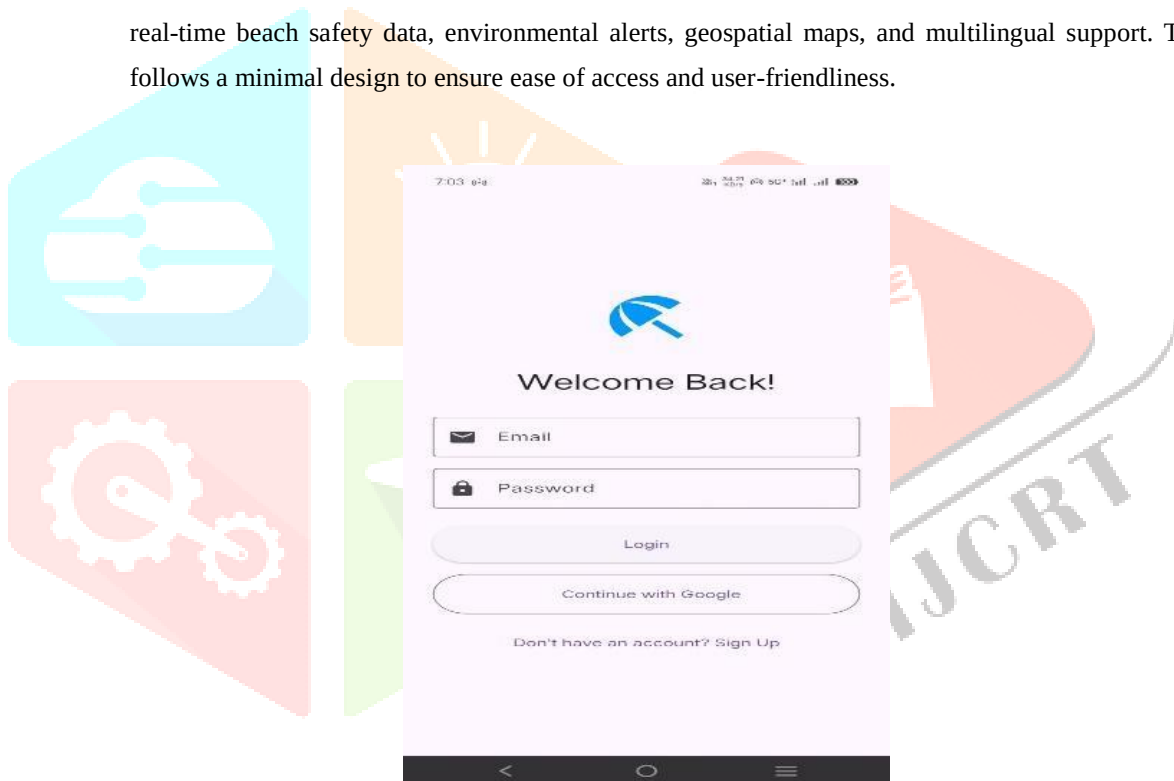


Fig 5

- **BeachService**

Figure 6 This module provides detailed, beach-specific environmental information for Subramaniya Swamy Kovil Beach, Tiruchendur. Users can view live data such as air and water temperature, wind speed, wave height, tide level, UV index, and weather conditions. The interface includes a visual representation of the beach, a location descriptor, and a “Favourite” button for saving preferred beaches. This module supports informed decision-making by providing localized, real-time data to enhance user safety and recreational planning.



Fig.6

• Beach Model

Figure 7 The Beach Model module organizes and displays a list of renowned beaches across various Indian states and union territories. Each entry includes the beach name and its corresponding location, allowing users to browse and select destinations for more detailed safety and environmental data. This structured model supports easy navigation and serves as the backend data structure linking beach metadata to other modules like safety alerts, real-time weather updates, and user-specific preferences.

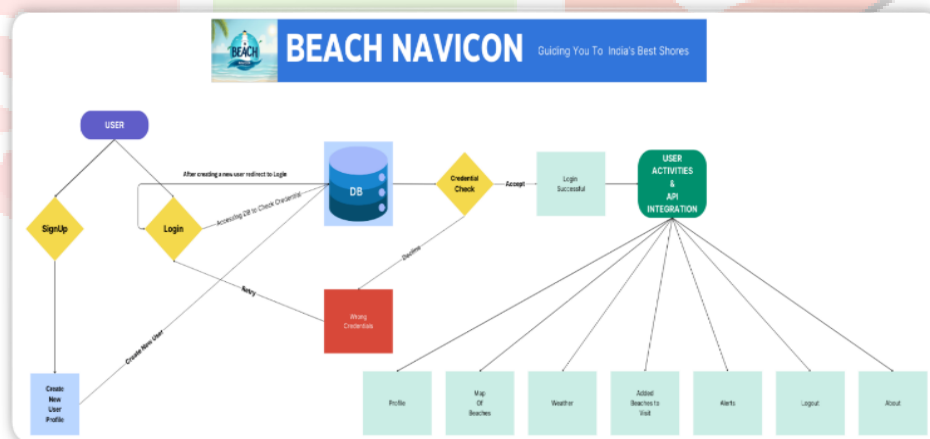


Fig.7

The application workflow, depicted in Figure 8, outlines the user journey:

- Sign-Up/Login: Users create a profile or log in via Firebase authentication.
- Credential Check: The system verifies credentials against a database, redirecting to login if incorrect (e.g., “Wrong Credentials”).
- User Activities Successful login grants access to modules like maps, alerts, and weather updates.
- Logout: Users can exit securely.

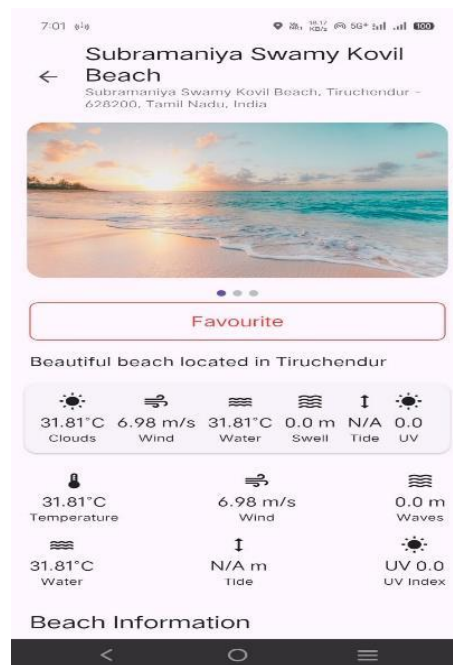


Fig.8. Flowchart of Beach Navicon User Workflow

The flowchart illustrates user authentication, database interaction, and navigation to key modules such as maps and alerts, reflecting Beach Navicon's modular design.

C. Safety Rating Algorithm

Inputs: Wave height, wind speed, tide height, water quality

- **Safe (0):** Wave height < 1.5m, Wind < 20 km/h, Tide < 2m
- **Moderate (3):** Wave < 2.0m, Wind < 25 km/h, Tide < 3m
- **Hazardous (1):** Above thresholds

D. Tools Used

- **Backend:** Firebase
- **Frontend:** Flutter (Dart)
- **APIs:** INCOIS, NOAA, OpenWeatherMap
- **Database:** SQLite (for offline caching)

IV. IMPLEMENTATION

A. Functional Modules

1. **Authentication:** Secure login using Firebase
2. **MapScreen:** Custom push notifications using Firebase Cloud Messaging
3. **AlertScreen:** Custom push notifications using Firebase Cloud Messaging
4. **Multilingual UI:** Support English, Tamil, and Hindi

B. Offline Capability

- Cached environmental data
- Timestamp indicator for last sync
- Auto-updates in background when reconnected

C. Data Fetch & Update Cycle

- Hourly updates
- Predictive interpolation for lag in INCOIS data (10-15 mins)

- Fallback logic for missing NOAA data

V. RESULTS AND DISCUSSION

A. Case Study 1: Baga Beach, Goa

- Detected 2.3m wave height and alerted 15 tourists
- Lifeguards confirmed the hazard; 10 rescues avoided

B. Case Study 2: Marina Beach, Chennai

- High tide alert reduces swimmer count by 40%

C. Case Study 3: Puri Beach, Odisha

- Poor water quality alert prevented illness in a family of five

D. Comparative Feature Table

Feature	Beach Navicon	Surflife	BeachSafe
India-Specific Data	Yes	Partial	No
Offline Mode	Yes	No	No
Multilingual UI	Yes	No	No
Real-Time Alerts	Yes	Yes	Yes

E. User Feedback

- 30 beta users
- Average rating: 4.5/5
- Suggestions: Add community reviews, enhance water quality detail

VI. CHALLENGES & LIMITATIONS

- **API Coasts:** UP to \$2,000/month for large-scale coverage
- **Data Gaps:** Inconsistent data in remote beaches
- **Adoption:** Requires user education and tourism board collaboration
- **Hardware Dependence:** Minimum Android 8.0 or IOS 13 required

VII. SOCIO-ECONOMIC IMPACT

A. Economic Benefits

- 20-30% reduction in drowning incidents
- \$10-15 million/year in avoided losses

B. Employment Boost

- Safer beaches can increase tourism, adding 5,000+ jobs

C. Public Health

- Reduced waterborne illness through real-time alerts

VIII. FUTURE WORK

- Expand beach coverage to 200+ sites
- Integrate AI models (e.g., LSTM) for 48-hour forecasts
- Collaborate with NDMA and smart city initiatives
- Add community reporting, wearable integration, and regional languages

IX. CONCLUSION

Beach Navicon offers a pioneering, scalable solution for coastal safety in India. With its real-time data integration, multilingual UI, and offline support, it addresses the country's diverse challenges. The application has potential for global adaptation in other coastal nations.

X. ACKNOWLEDGEMENTS

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