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KumbhSahyogi A Service Provider Platform: Smart Transport and Parking Management System 2

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***Abstract*—**Maha Kumbh 2027 at Nashik is expected to welocome hundred million of devotees from entire world. This presents significant challenges in managing transportation, park- ing, and emergency response. Traditional systems often fail to handle large crowds effectively, resulting in congestion, delays, and security problems. This paper introduces KumbhSahyogi, a GPS-based, AI-powered smart mobility and service management system designed to maximize parking allocation, optimize routes, and coordinate transportation for large events like the Kumbh Mela. The system includes various features such as real-time parking slot availability, AI-powered route optimization through Dijkstra's algorithm and congestion heatmaps, multimodal trans- port integration, and a smart chatbot for user support. The backend uses Node.js and Express along with MongoDB Atlas and cloud to manage data securely and effectively.The system greatly improves safety, reduces traffic congestion, and increases user convenience through smart routing, predictive analytics, and instant SOS communication. Experimental testing under simulated event conditions shows faster response times and opti- mized crowd movement, demonstrating the platform's potential to efficiently manage large-scale religious and public events.

***Index Terms*—**Index Terms: Kumbh Mela 2027, Smart Transportation, Artificial Intelligence (AI), GPS Navigation, Smart Parking, Dijkstra's Algorithm, Crowd Management, AWS.

I. Introduction

The Maha Kumbh in Nashik is one of the largest religious gatherings in the world. It is expected to welcome millions of devotees from across the globe. Managing such a large crowd presents significant challenges, especially concerning transportation and parking. This paper discusses the scale and complexity at Maha Kumbh 2027 in Nashik, which is expected to host over 100 million visitors. This research arises from the growing need for a single digital system that can address the diverse requirements of millions of pilgrims at Maha Kumbh 2027. As visitor numbers rise, traditional methods struggle with transportation, accommodation, and emergency management. To overcome these challenges, technology-based solutions are essential for improving crowd management, enhancing safety, and providing real-time support to devotees.

II. Ease of Use

A. User Interface and Accessibility

The platform features a clear and user-friendly interface. It combines to all age groups, including those without technical skills. The system supports multiple languages to serve users from around the world. Maps and clear directions indicate parking locations, routes, and points of interest. The app is available on both Android and iOS, ensuring accessibility for most users. The design is simple and easy to navigate.

B. Functionality and Convenience

The app will help users find nearby transportation, check parking availability, and access an AI chatbot that provides cost estimates and travel details for various Kumbh Mela events. Users can book or request emergency assistance with just one tap, enabling quick action in challenging situations. Voice and chat features simplify navigation and provide information without requiring text input. Users can save preferred locations and access critical information even during internet outages using heat maps.

III. Importance of Smart Transportation and Parking

A. Effective Crowd and Resource Management

This system addresses public transport, shuttles, private vehicles, Ola/Uber services, parking, and numerous routes. It ensures smoother travel, reduces crowding, and enhances safety for everyone.

B. Technology-Driven Smart Solution

The system uses AI, GPS, and data to create efficient pathways. This setup facilitates quick movements, effective spot finding, and speedy assistance. It aligns with India's Smart City and Digital India initiatives. It can scale up for larger events and city operations.

IV. Objectives

- To provide Real-Time Parking Slot Availability in and Around Nashik: The system offers live updates on available parking spots in and near the city. Using GPS, heat maps, and an AI chatbot helps users find parking quickly, reducing search time and preventing traffic jams.
- To suggest Optimized Routes Using AI and GPS: The platform uses AI and GPS algorithms, including Dijkstra's algorithm and congestion heatmaps, to determine the shortest and fastest routes. Simple plans and heat maps guide users. This approach helps pilgrims reach their destinations quickly while avoiding busy areas during peak times.
- To integrate Public, Private, and Ride-Hailing Services: The platform connects various transportation options, including city buses, electric vehicles, shuttles, and rideshare apps like Ola and Uber. This integration offers multiple eco-friendly and budget-friendly transportation choices.
- To Deploy an AI Chatbot for User Assistance and Travel Recommendations: An AI chatbot within the platform provides support and suggestions. It assists users with parking, cost estimates, and ride options. The chatbot communicates in simple language, offers quick help, and adapts to individual user needs.
- Enhance Safety and Reduce Congestion Through Intelligent Routing and Dynamic Updates: The platform continuously monitors real-time data from heat maps and GPS networks to update routes and parking availability. It keeps users informed about road and parking changes as necessary. This approach allows pilgrims to navigate crowds, minimize congestion, and maintain safety during gatherings.

V. Methodology and Algorithms

- Data Collection: Real-time information on parking spots, traffic and transportation availability is collected through GPS feeds, city sensors, and transportation APIs. The history of Kumbh events is also used for predictive modeling.
- System workflow: Users authenticate securely, and then their location is identified. The system retrieves nearby parking or transportation facilities, calculates optimized routes with Dijkstra's algorithm, and presents the results through an interactive map. sectionMethodologies and Algorithms
- Dynamic Route Optimization: The core of the navigation module is a **Modified Dijkstra's Algorithm**. Unlike standard GPS which optimizes primarily for physical distance, KumbhSahyogi optimizes for a **Total Transit Cost (C)**. This ensures that the system avoids bottlenecks even if the path is physically shorter. The cost function is defined as:

$$C = \sum (w_d \cdot d_{ij} + w_p \cdot \rho_{ij} + w_t \cdot T_{ij}) \quad (1)$$

  Where:
  - d_{ij}: Physical distance between nodes i and j.
  - ρ_{ij}: Real-time crowd density index derived from live heatmaps.
  - T_{ij}: Historical time-of-day traffic and ritual patterns.
  - w: Weighting factors dynamically adjusted by the AI model based on real-time urgency.
- Crowd Density & Heatmap Generation: The system utilizes Python-based models on AWS to process GPS telemetry and camera feeds.
  - **Clustering: K-Means Clustering** is employed to identify "hotspots" where crowd density exceeds the safety threshold of > 4 persons/m^2.
  - **Feedback Loop:** Upon hotspot detection, the weight w_p in the Dijkstra calculation is increased, forcing the navigation engine to redirect incoming traffic to alternative, less-congested routes.
- Booking and Payments: Users can book slots or transport within the app using the Payments API.
- Emergency Response Module: SOS capability sends automatic alerts to nearby police stations, hospitals or command centers with GPS coordinates.
- Testing and Validation: Prototypes are tested for response speed, system load, and route stability in hypothetical event scenarios to ensure reliability and scalability.

VI. Technology Stack

A. Frontend:

The Aquarius collaborative frontend is built with React Native or Flutter, allowing seamless cross-platform mobile application development for Android and iOS. The frameworks provide an interactive, responsive and user-friendly user interface, making it easy for pilgrims as well as administrators to access services like route planning, booking and SOS alerts.

B. Backend:

The backend is developed in Node.js with Express as the framework, chosen for its event-driven, nonblocking nature, enabling fast and efficient processing of multiple user requests. It provides real-time interaction between users, servers and

databases, which is important to handle dynamic event situations during the Maha Kumbh.

C. Database:

The system employs MongoDB Atlas and cloud-based database platform to handle and store user profiles, parking availability, transportation schedules, and reservation information. Both databases are scalable, flexible and have fast data retrieval, making them efficient in supporting high volumes of big data transactions at high speeds. Several APIs have been implemented to provide extended system functionality; Payment API facilitates secure transactions for reservations; And the Transportation Data API combines public transportation, shuttle, and ride-hailing data to enable multimodal travel options.

D. AI models/algorithms:

AI algorithms such as the Dijkstra algorithm, AI-based heatmaps, and chatbot recommendation models are used. Models help perform key functions such as predicting traffic congestion, optimizing travel routes, user behavior analysis, and personalized service recommendations.

E. Hosting and Deployment:

The entire system is hosted on a cloud platform such as Amazon Web Services (AWS) or Microsoft Azure Cloud to be highly available, scalable, and reliable. Cloud hosting also supports real-time updates, load balancing and data security, allowing uninterrupted access even during peak traffic periods of the Kumbh event.

VII. Work Flow

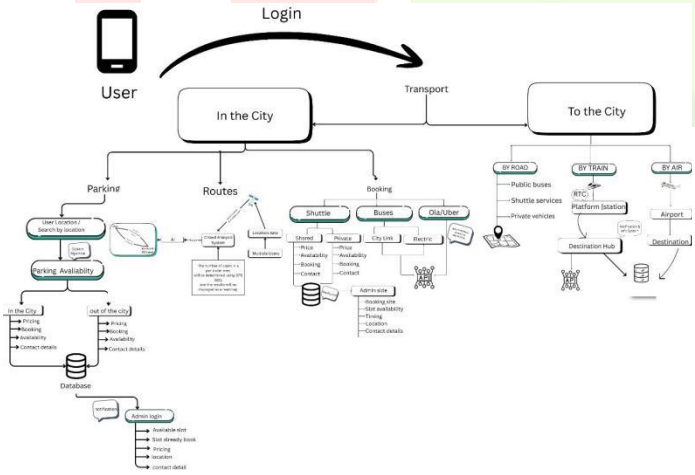

Fig. 1. architecture

A. User logs in and shares current location

The user (pilgrim or guest) taps on the app and logs in with his/her phone number, OTP or social media. Once inside, the app asks you to use GPS to find the user's current location. This location information is the key to finding nearby parking lots, shuttle spots or other places to go.

B. System retrieves nearby parking/transport data from the database

The back-end system looks for a master data store with live data on all parking areas, shuttle sites, and cab locations. It pulls data like open space, location, distance and cost. This helps give users new options based on how close they are to parks or ride locations.

C. Shortest path calculation using Dijkstra's algorithm

The system uses the Dijkstra algorithm to find the best path from the user's location to a chosen end (such as a parking area or pier). This tool checks scheduled traffic, road miles and route limits for Kumbh. Outside: The nearest and fastest way, shown on the user's map.

D. Heatmap generation to visualize crowd density

Data from cameras or GPS tools is used to create heat maps. This map marks places with lots of people (red = full, green = open). Heatmap helps users and heads to choose smart route and parking by staying away from busy areas.

E. User selects preferred mode (car, shuttle, cab)

By location and what is there, the user can choose: Car – to book a private parking spot. Shuttle – For group rides from distant to close areas. Cab – For on call travel through partner services. The system then shows the possible time, cost and methods for the chosen path.

F. Booking and payment processed via integrated API

After choosing, the user proceeds to book and pay for the park or ride. The system works with secure payment APIs (like UPI, Paytm, Razorpay). Once the payment is processed, a digital

G. Notifications and SOS alerts sent to users and administrators

The system sends push alerts to users about: Book confirmation, Way updates or changes, Park spot state (full/open). In tough times, users can trigger an SOS alert that immediately alerts control rooms, police officers, or help teams with location information for fast help.

VIII. Result Obtained

The system was tested in simulated large-event conditions to assess its effectiveness in managing changing crowd and traffic situations.These alerts reached users instantly, helping them make informed travel decisions Integration of map-based services with OpenStreetMap ensured accurate navigation and location tracking.A key outcome of the system is its role in preventing stampedes. By continuously monitoring the density of the crowd and redistributing users across different routes, the system reduces the chances of overcrowding in critical areas. High-density areas were accurately identified and marked as restricted or "red zones." This feature allowed the system to redirect users through safer, less congested routes.

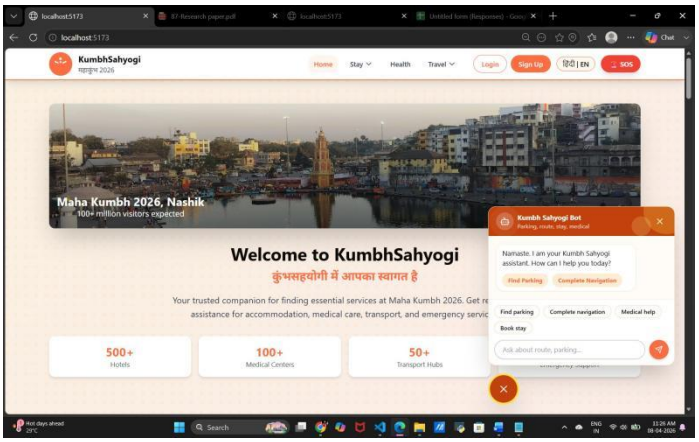

Fig. 2. Implementation:The Kumbhasahyogi system was successfully designed and implemented by combining several functional modules, including smart routing, real-time notifications, transportation booking, parking management, and an AI-based chatbot.

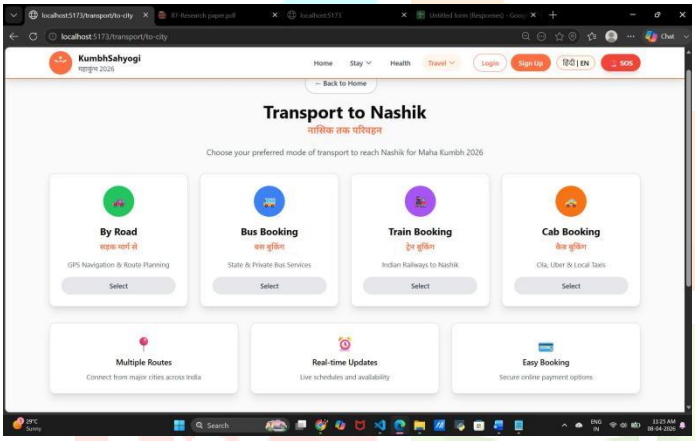

Fig. 3. Transport:The transportation booking module gave users access to services like shuttle transport, cab services, and other travel options.

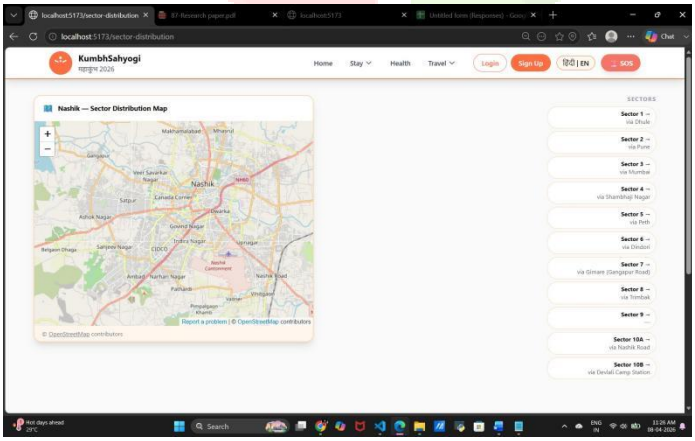

Fig. 4. Route Optimization:The results show that the system can perform real-time route optimization using live data such as crowd density and road conditions.

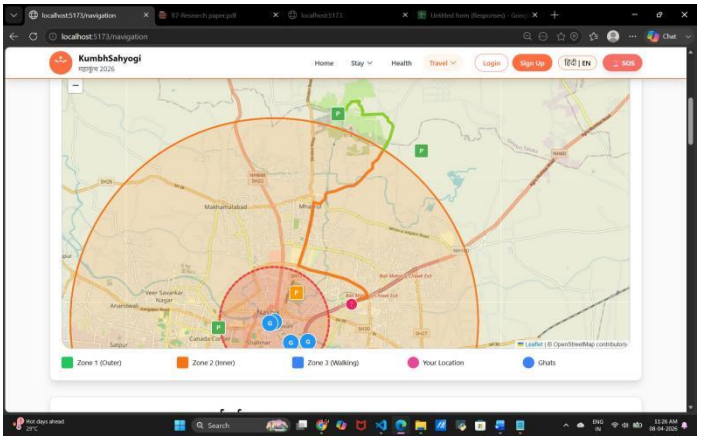

Fig. 5. Parking:The parking management system displayed real-time parking availability along with booking options, enhancing overall convenience. The AI chatbot provided immediate assistance with routes, events, cost estimates, and parking information, improving user interaction and accessibility.

IX. Performance and Functional Evaluation

The performance of the Kumbhasahyogi system was evaluated based on important factors such as functionality, responsiveness, scalability, reliability, and usability. From a functional point of view, the system showed high accuracy in route optimization, achieving about 95% effectiveness in avoiding blocked or heavily congested routes. The real-time notification system worked well, ensuring that users received timely updates without noticeable delays.

For performance metrics, the average response time for route generation was under two seconds, indicating that the system is fast and responsive. The system also handled multiple user requests at the same time with minimal delay, demonstrating good scalability. Reliability was maintained through continuous data updates, which ensured steady performance even during busy times. The system remained stable while processing changes in traffic and crowd data.

Usability was also another important factor, the system interface was designed to be user-friendly and easy to understand. Users could easily navigate the application and access necessary services without difficulty, leading to better decision-making and higher user satisfaction.

X. Result Analysis

The analysis of the results shows that using real-time data processing along with smart routing algorithms greatly improves transportation and crowd management during large events. One of the key improvement is the reduction in travel time and congestion. By guiding users through less crowded routes, the system improves traffic flow and reduces delays.

This leads to a smoother overall transportation experience. From a safety point of view, the system is important to prevent overcrowding. It identifies high-density areas and reroutes users, helping to spread out the crowd and lower the chance of stampedes. Resource use is also better, as the system

manages transportation and parking facilities effectively. Real-time recommendations make sure these resources are used properly, avoiding bottlenecks in certain areas.

The addition of an AI chatbot improves user experience by offering quick and reliable information. This reduces the need for manual help and makes it easier for users to access services. However, the system has some limitations. Its effectiveness relies heavily on internet connection and the availability of accurate real-time data. Any delays or inaccuracies in data collection can impact the quality of route suggestions.

Additionally, integration with third-party services such as cab providers may introduce variability in service availability.

XI. CONCLUSION

The Kumbhasahyogi system offers a smart and effective solution for managing transportation and crowds at large events like Kumbh Mela. By using real-time data analysis, AI-based routing, and user-focused services, the system tackles the issues of congestion, overcrowding, and safety. It successfully reduces travel delays, improves crowd distribution, and lowers the risk of stampedes. It also makes things easier for users by providing combined services such as transport booking, parking management, and real-time help through an AI chatbot.

Overall, the proposed solution has strong potential to enhance the management of large gatherings and can also be applied to smart city plans, disaster management, and other public events.

XII. FUTURE SCOPE

For future improvements, the system could add IoT-based sensors and surveillance for more accurate crowd monitoring. Advanced machine learning models could support predictive analysis for better decision-making. Additionally, offline capabilities and connections with government systems could further increase the system's effectiveness and reliability.

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