Routing in GIS

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Introduction to Geospatial Technologies

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<u>Abstract</u>

Our project endeavours to address the contemporary challenge of efficient route planning and navigation through the amalgamation of geospatial technology with web-based and desktop Geographic Information Systems (GIS) applications. With the ubiquitous nature of transportation and the increasing demand for optimized travel experiences, our project aims to offer users an intuitive platform for obtaining precise and expedient route recommendations between two locations. Leveraging APIs such as Google Maps and ArcGIS, our web-based application empowers users to input their start and end points, facilitating the visualization of optimal travel routes via various modes of transportation, including trains and buses. Additionally, through the integration of QGIS, a powerful desktop GIS software, we provide users with in-depth analysis and visualization capabilities, enabling them to explore and evaluate transportation routes with enhanced granularity. This project not only showcases the practical utility of geospatial technologies in addressing real-world navigation challenges but also underscores the potential for innovation and advancement in transportation management and accessibility. Through rigorous implementation and evaluation, we demonstrate the efficacy and viability of our approach, laying the foundation for future endeavours in the realm of geospatial route planning and navigation.

Introduction

In an era defined by rapid urbanization and increasing reliance on public transportation, the development of an innovative application that provides real-time routing information for buses, trains, and other modes of transit is not merely a technological endeavour but a societal imperative. The genesis of this project stems from a deep-seated recognition of the critical role that efficient and accessible public transportation systems play in shaping the fabric of modern cities and the lives of their inhabitants.

Why this project?

This project stems from a recognition of the growing importance of efficient route planning and navigation in contemporary society. With urbanization on the rise and an increasing reliance on public transportation systems, the need for accurate, accessible, and real-time travel information has become paramount. Traditional route planning methods often fall short in providing users with comprehensive and up-to-date data, leading to suboptimal travel experiences, wasted time, and unnecessary frustration.

By embarking on this project, we aim to bridge the gap between conventional route planning approaches and modern geospatial technologies. We recognize the transformative potential of Geographic Information Systems (GIS) and APIs in revolutionizing how we navigate our surroundings. Through the integration of these technologies, we seek to empower users with the tools they need to make informed decisions about their travel routes, whether it be for daily commutes, leisure outings, or business trips.

Furthermore, this project is driven by a desire to showcase the practical applications of GIS beyond academic or professional settings. We believe that by developing user-friendly web-based and desktop GIS applications, we can democratize access to geospatial

data and analysis tools, thereby empowering individuals from diverse backgrounds to harness the power of spatial information for their own benefit.

Ultimately, our project is motivated by a commitment to enhancing the everyday experiences of people through innovative technological solutions. By offering a seamless and intuitive platform for route planning and navigation, we hope to contribute to a more connected, efficient, and sustainable transportation ecosystem for all.

Real-Life Applications

1.Improved Commuting Experience: The application will significantly enhance the commuting experience for daily commuters by providing them with accurate and real-time routing information for public transportation options. Users can rely on the application to plan their daily journeys, avoid traffic congestion, and minimize travel delays, leading to a more efficient and stress-free commute.

2.Enhanced Accessibility: By offering comprehensive routing information across various transit modes, including buses and trains, the application will improve accessibility for individuals with limited mobility or those who rely on public transportation for their daily travel needs. Users can easily access information about accessible routes, wheelchair-friendly stations, and other amenities, empowering them to navigate the transit system with greater ease and confidence.

3.Reduced Environmental Impact: By promoting the use of public transportation and facilitating more sustainable travel choices, the application will help reduce the environmental impact of urban transportation systems. By encouraging individuals to opt for public transportation over private vehicles, the application contributes to reducing greenhouse gas

emissions, alleviating traffic congestion, and conserving natural resources.

4.Optimized Transit Operations: The application can also benefit transit authorities and transportation agencies by providing valuable insights into transit usage patterns, travel demand, and route performance. By analysing user data and feedback, transit operators can identify areas for service improvement, optimize transit routes and schedules, and allocate resources more effectively to meet the evolving needs of commuters.

5.Emergency Response and Disaster Management: During emergencies or natural disasters, the application can serve as a crucial tool for emergency response and disaster management efforts. By providing real-time updates on transit service disruptions, evacuation routes, and alternative transportation options, the application helps authorities coordinate evacuation efforts, ensure the safety of residents, and minimize disruptions to critical transportation infrastructure.

6.Tourism and Visitor Information: The application can also cater to tourists and visitors by offering them valuable information about local transit options, tourist attractions, and points of interest. Users can explore the city with confidence, knowing that they have access to reliable routing information and transportation options that suit their preferences and interests.

7.Economic Development: Finally, the application can contribute to the economic development of urban areas by improving access to employment opportunities, educational institutions, healthcare facilities, and other essential services. By facilitating efficient and affordable transportation options, the application supports workforce mobility, encourages economic activity, and fosters social inclusion and community development.

Literature Survey

For the research paper 1:

- The main author, Mäe, along with Antov, Antso, and Kalenoja, developed a methodology for determining travel-related zones in urban and suburban areas, presented at the XXVIII International Baltic Road Conference.

For the research paper 2:

- The main authors, L.A. and O.L., conducted a comprehensive study on the performance analysis of urban public transport systems using open tools, emphasizing accessibility and headway optimization for tram vehicles.

Problem statement

The problem at hand revolves around the inefficiencies and limitations inherent in traditional route planning methods, particularly in the context of urban transportation systems. These methods often rely on static maps and predefined routes, failing to account for real-time traffic conditions, varying modes of transportation, and individual preferences. As a result, users may encounter delays, congestion, and suboptimal routes, leading to frustration and wasted time.

Explanation: In today's fast-paced urban environments, efficient route planning is essential for navigating complex transportation networks. However, traditional methods, such as paper maps or static online platforms, lack the dynamic capabilities needed to adapt to changing traffic conditions and user preferences. Moreover, these methods often provide limited information about alternative

transportation modes, such as trains or buses, leading users to overlook potentially faster or more convenient routes.

By addressing this problem, our project seeks to revolutionize route planning by harnessing the power of geospatial technologies. Through the integration of APIs like Google Maps and ArcGIS, we aim to provide users with real-time, personalized route recommendations that consider factors such as traffic congestion, public transportation schedules, and user-defined preferences. By doing so, we hope to streamline the route planning process, reduce travel times, and enhance the overall transportation experience for users.

Goal Objective

Empowering Seamless Urban Navigation in Mumbai

1. Granular City Knowledge

  - Designed with meticulously layered data on Mumbai's sections, stations, and most popular bus stops, our platform provides a comprehensive understanding of the city's intricate layout.

  - This in-depth understanding fuels our routing algorithms for precise route planning, ensuring accurate and efficient navigation through the city.

2. Unifying Bus & Train Integration

  - Our innovative routing functionality seamlessly blends bus and train networks, offering users a consolidated view of the most efficient travel options, regardless of the mode of transportation.

- Say goodbye to navigating through disjointed transportation systems as you experience the power of unified mobility for a smoother and more seamless travel experience.

3. Real-Time Navigation

- Our platform incorporates real-time updates to ensure your routes are always current, taking into account potential traffic disruptions or schedule changes.

- Navigate with confidence, knowing you have the most up-to-date information at your fingertips for a stress-free journey.

4. Optimized Travel Efficiency

- Prioritizing your time, our algorithms meticulously analyse potential routes, integrating real-time data to suggest the fastest and most efficient options for travel.

- Less time spent in traffic translates to more time for what truly matters, allowing you to make the most of your day.

5. Information at Your Fingertips

- Our platform is packed with an abundance of valuable information, from travel routes to navigation maps, ensuring a well-informed user experience.

- Access everything you need to make informed travel decisions and ensure a smooth and hassle-free journey through Mumbai's urban landscape.

By focusing on user-centric design and a commitment to efficiency, our platform aims to transform urban travel within Mumbai, simplifying navigation and enhancing the overall travel experience for all users.

<u>Methodology</u>

QGIS

1. Layering the City:

   - We meticulously mapped critical data layers onto the QGIS platform, including:

    - Mumbai Sections: Precise city segmentation for enhanced location awareness.

    - Mumbai Stations: Comprehensive railway station network for multi-modal routing.

    - Mumbai Best Bus Stops: Strategic bus stop locations for convenient access to public transit.

    - Navigation Map: A clear and informative map serving as the visualization backbone.

2. Time-saving Techniques:

   - Integration of the "Travel Time " plugin enabled us to accurately calculate travel times between key points of interest, like easily determining the travel time between Dadar to Churchgate, Dadar to Ulhasnagar etc.

- Meaningful Visualization: Strategic use of legend layer plotting ensured a clear and concise representation of data for intuitive user comprehension.

3.Deployment with webGIS-We deployed our created map with the help of webGIS and NextGIS plugins.

1. Seamless Integration:

- Allowed us to flawlessly deploy the QGIS-generated map using NextGIS, ensuring convenient online access for users.

Methodology in ArcGIS

1.Enhanced Navigation:

- Incorporating ArcGIS features enabled the creation of an advanced navigation map specifically tailored for bus, train routes within Mumbai, providing users with a clear visualization of efficient bus and train routes.

2.Routing Made Easy:

- ArcGIS's routing capabilities played a vital role in displaying real-time routing information, where users can input their start and end locations. Our model dynamically generates the optimal route, considering current traffic conditions for a seamless travel experience.

3.Real-Time Navigation Integration:

- To keep users updated with the latest traffic information, we integrated ArcGIS for real-time navigational guidance, ensuring users can navigate through the city efficiently.

Google Maps API: An Invaluable Ally

- Precise Routing: By seamlessly integrating the Google Maps API within ArcGIS, we ensured accurate and reliable route generation, guaranteeing the highest level of precision in real-time routing calculations.
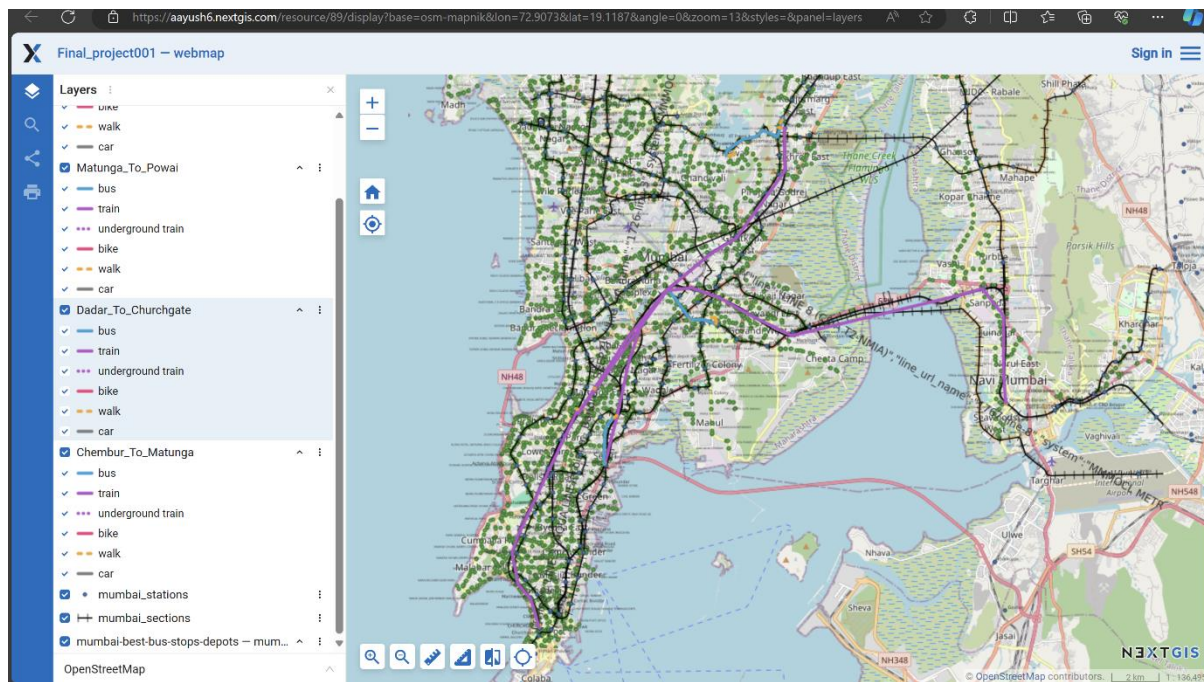
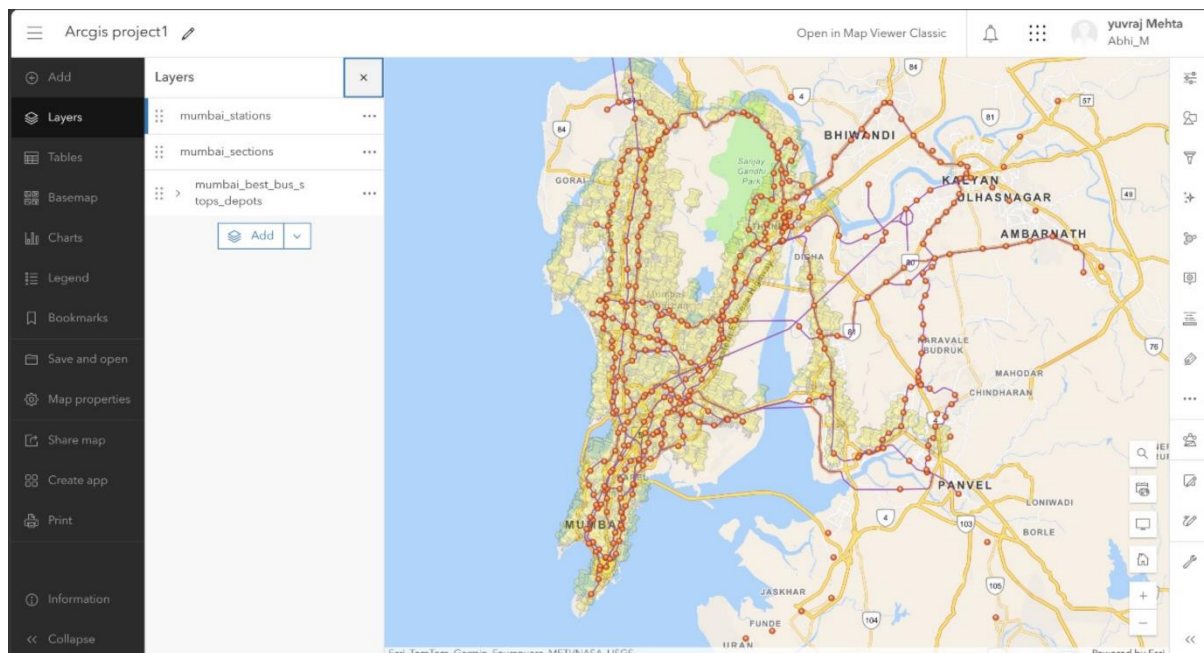# RESULT

Implementation in QGIS:
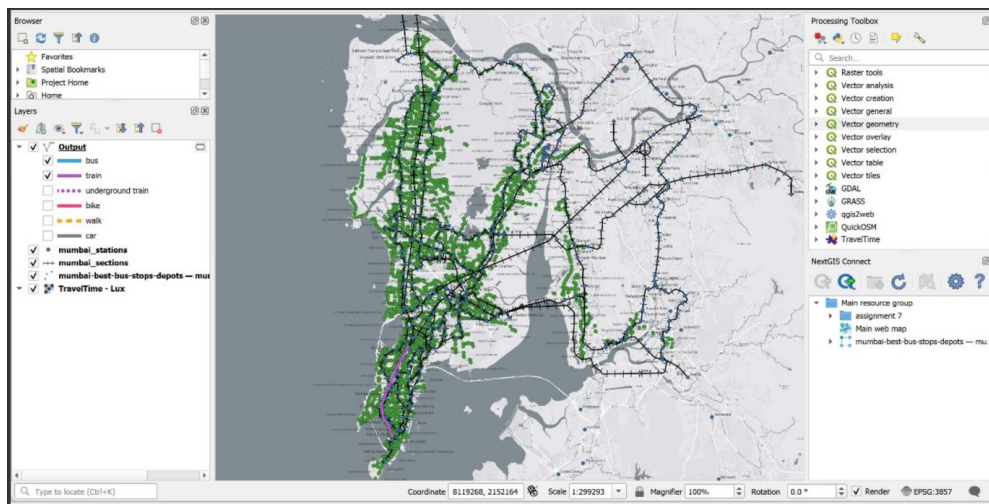
Route mapping using Travel Time:
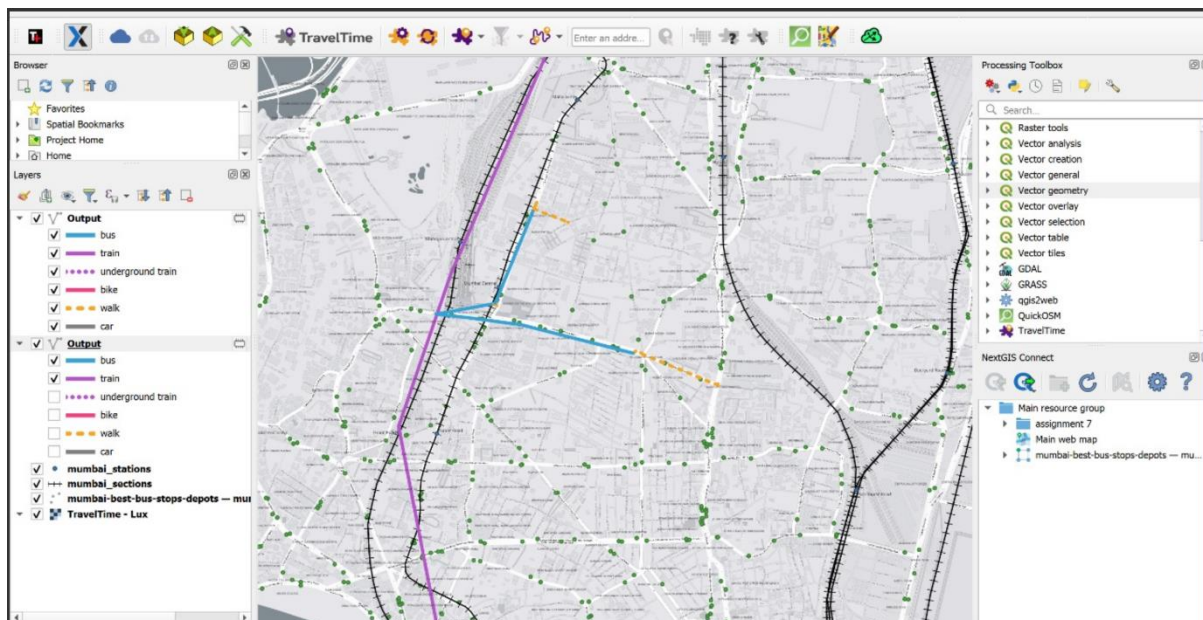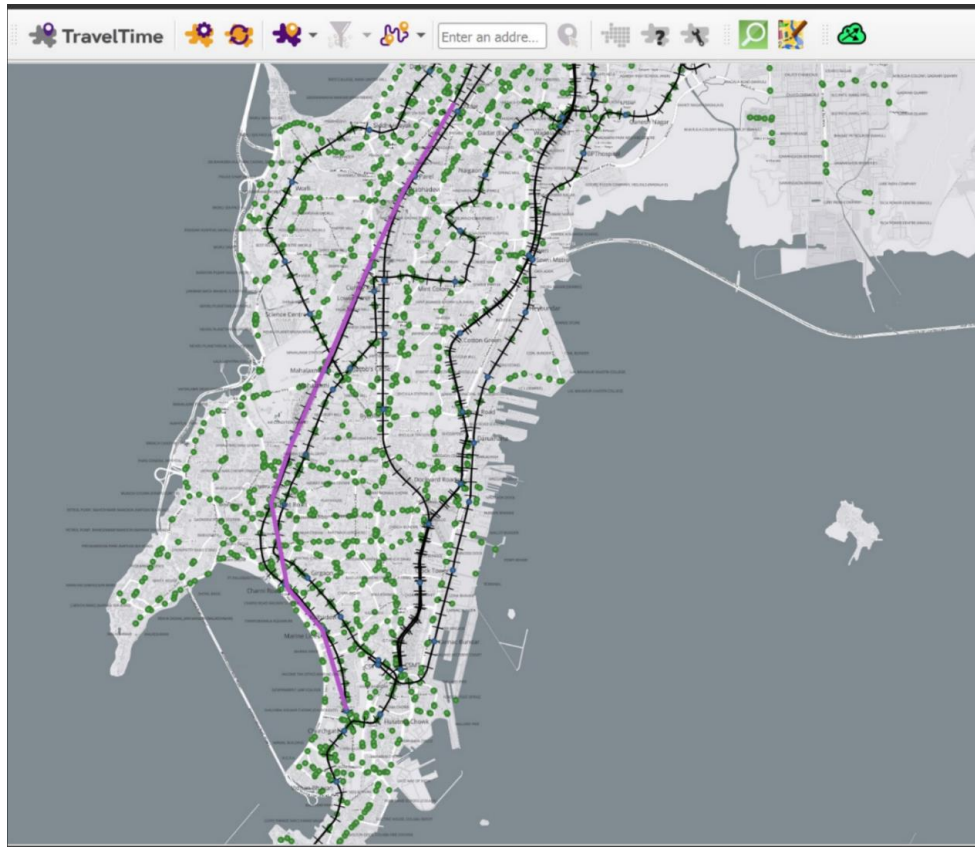
Deployment using webGIS and NextGIS:

ArcGIS work:

Project:

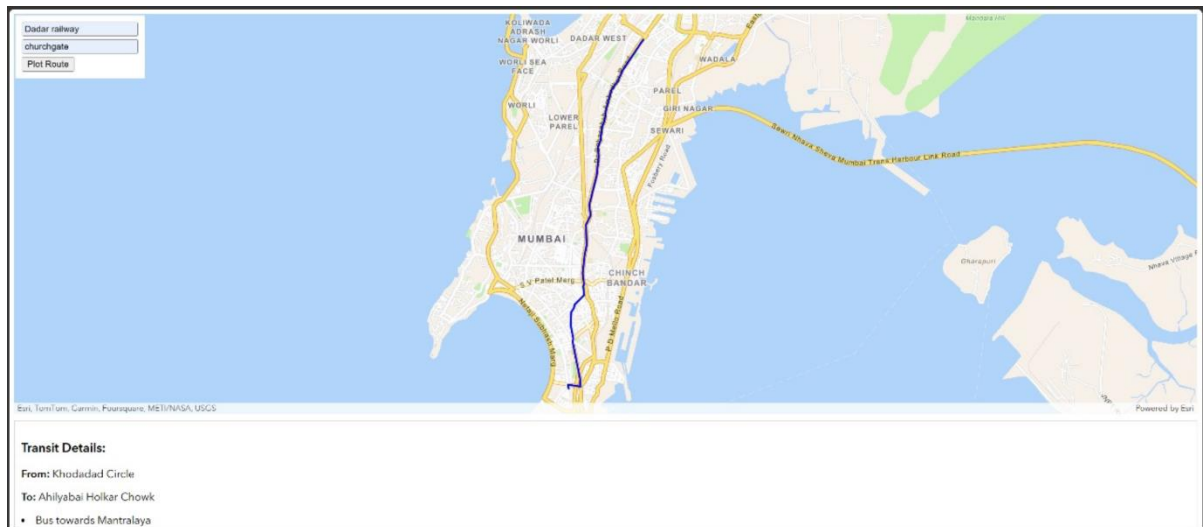## Deployment on Website:

Information of Layers:

Real time transit details:

From Dadar to Ulhasnagar:
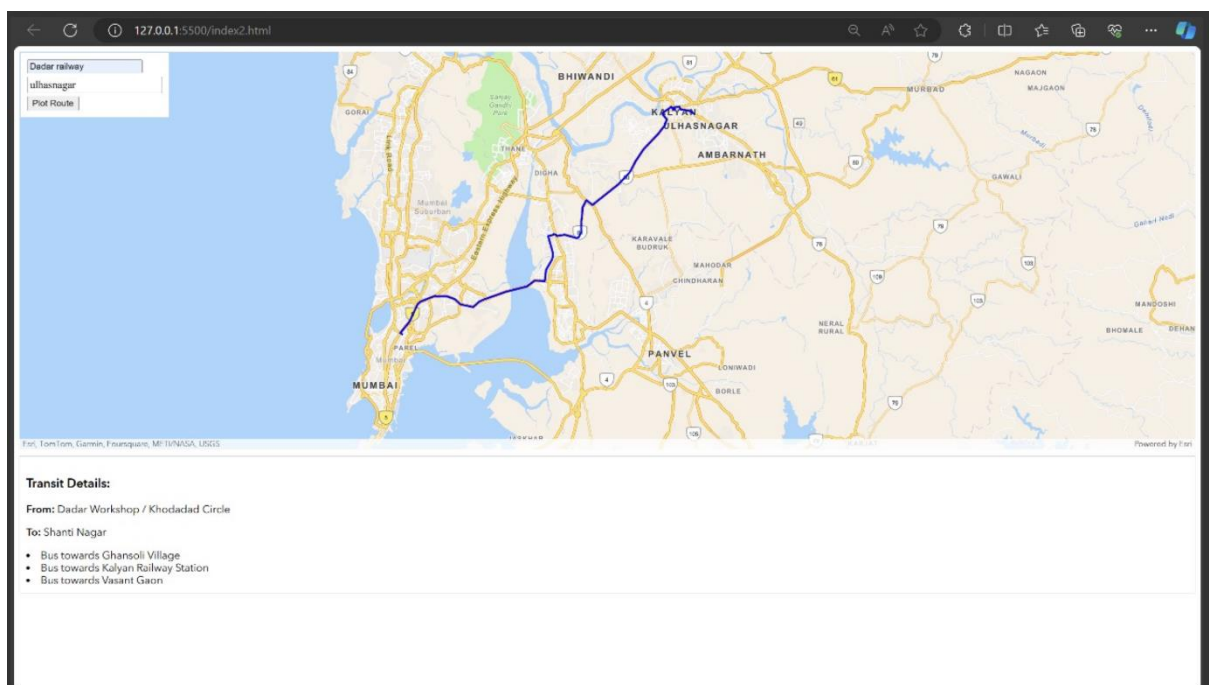
From Dadar to Churchgate:

CONCLUSION

To tell about the conclusion of our project we have did route mapping in QGIS of buses and railways using various datasets as we have mentioned the layers already which we have used, we have done real time routing as well in QGIS using Travel Time plugin for various places, we have worked on a plugin to implement real time mapping which is our future aspect for the project in QGIS and we have implemented the map using webGIS and NextGIS. For ArcGIS online we have implemented it in the same way using the dataset for showing static routes for information purposes. Foe real time routing we integrated **Google Maps API** with **ArcGIS online** to do so, we have created a web page for this, this does real time routing for the user enabling the user to travel and provide routing information. Hence, we have used both GIS based software for our project and enabled the user to get valuable information as well as do real time routing of buses and trains using GIS. This will help the user in great details regarding their travels and navigation.

FUTURE SCOPE

Conquering the QGIS Plugin Challenge

Moving Beyond the Current Limitations

- Acknowledging the current non-functionality of the QGIS plugin, we are committed to addressing this challenge by leveraging geo coding.

- Enhanced Travel Time Calculation: By incorporating geo with the Travel Time plugin, we aim to achieve more sophisticated and accurate travel time estimations, considering factors such as traffic patterns for improved navigation.

Enriching Data with Google APIs

- We plan to harness the power of Google Maps APIs to seamlessly integrate real-time bus and train information within the platform, enabling the display of live bus arrival times and train schedules directly on the map, enhancing the user experience with comprehensive real-time travel information.

Real-Time Routing: The Next Frontier

Realizing the Full Potential

- Our future focus will prioritize optimizing the real-time routing functionality for a seamless user experience, ensuring the platform delivers the most efficient routes to users.

Dynamic Traffic Integration

- To achieve a truly real-time experience, we are committed to incorporating live traffic data feeds into the routing algorithms. This will allow for route adjustments based on current traffic congestion, ensuring users always receive the fastest possible travel option.

Key Takeaways

- Transitioning to geocoding and integrating the Google Maps API will empower us to overcome the QGIS plugin hurdle and offer comprehensive real-time travel information.

- By prioritizing a fully functional real-time routing experience, we aim to elevate the user experience significantly, enabling travellers to navigate Mumbai with unparalleled ease and efficiency.

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