A New Approach of Web App Based Road Traffic Analysis

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Abstract: This research paper focuses on the development and analysis of a web-based system which is designed to study road traffic conditions and their routing behaviour in a dynamic environment. Nowadays Traffic congestion has become a major issue in urban areas due to the increasing number of vehicles and frequent changes in road conditions such as congestion, accidents, and peak-hour delays. Efficient route planning during those conditions requires routing approaches that can calculate traffic variations in real time. In this thesis, the road network is modelled as a weighted graph, where intersections are represented as nodes and road segments are represented as edges with weights corresponding to traffic conditions. The proposed web application allows users to interact with the road network by selecting source and destination points. They can also modify traffic conditions, and routing techniques and observe how routes change dynamically. Both static shortest path computation and dynamic routing approaches are implemented to study their behaviour and performance under varying traffic scenarios. The study provides visual representation of road networks and routing paths and also their performance metrics such as computation time and route cost. Thus it helps understand the clear comparison between static and dynamic routing methods and the impact of traffic changes depending on routing decisions. The developed web application serves as an analytical and educational tool for studying road traffic analysis and routing algorithms. The study shows the usefulness of web-based platforms in visualizing traffic behaviour and evaluating routing performance. But the current approach is limited to simulated data. This leaves room for future work that could improve the system by integrating real-world traffic data and explore more advanced routing strategies.

Keywords: *Network Modelling , Dynamic and Time-Dependent Routing Algorithm, Web-Based Traffic Analysis, Classical Shortest Path Algorithms.*

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I. INTRODUCTION

Traffic congestion has become a huge problem in many modern cities now days due to increase of vehicles [1][9]. Traffic congestion results in longer travel times, higher fuel consumption, increased air pollution, and significant economic losses [2][9]. Efficient traffic management and route optimization have therefore become critical components of intelligent transportation systems (ITS) [3][8].

With advancements in computing and web technologies, there is a growing demand for systems that can analyse road traffic conditions and provide optimized routing solutions in real time [5][7]. Road networks can be effectively modelled using graph theory, where intersections are represented as nodes and road segments are represented as edges with weights, which is corresponding to travel time, distance or congestion level [4][6]. Here comes shortest path algorithms who play a vital role in identifying optimal routes within these networks [6][10].

Traditional routing algorithms like Dijkstra's algorithm are well suited for static environments but they perform inefficiently when traffic conditions change frequently time-to-time [6][10]. Real world traffic scenarios are dynamic in nature. Because they need to consider some factors such as accidents, peak hour congestion, weather conditions, and road closures, necessitating adaptive routing approaches [8][9].

Recent research has focused on dynamic shortest path algorithms and traffic-aware routing techniques that can efficiently update routes in response to changing conditions [3][5][10]. Alongside these algorithmic developments, web-based applications have gained importance due to their

accessibility, interactivity, and ability to visualize complex data [7][8]. Interactive web platforms allow users to observe traffic behaviour, modify network parameters, and analyse routing performance in real time, making them valuable tools for both research and practical applications [7].

This project, titled "A Study of Road Traffic Analysis Web App," aims to study and develop a web-based system for analysing road traffic conditions and computing optimized routes using graph-based routing algorithms. It aims to integrate dynamic shortest path computation with interactive visualization and performance analysis. Here we compare routing behaviours under varying traffic conditions which gives us insights of traffic analysis and also demonstrate the effectiveness of web-based tools in intelligent transportation systems [8][10].

II. LITERATURE REVIEW

One of the biggest challenge in today's modern environment is Road traffic congestion which increased due to rapid urbanization, population growth, and increased vehicle ownership [1][9]. This mess leads to longer travel times, increased fuel consumption, environmental pollution, and economic losses [2][9]. To address these challenges, intelligent transportation systems ITS, started to rely heavily on computational models and algorithms that helps analysing road networks and predicting congestion and by also identifying optimal travel routes [3][8].

In recent years, road networks have increasingly been modelled as weighted graphs, where intersections are represented as nodes and road segments as edges with weights corresponding to travel time, distance, or congestion level [4][6]. In these systems shortest path algorithms play a crucial role by enabling route optimization and traffic-aware navigation [6][10]. But real-world traffic conditions are not exactly static, they tend to be highly dynamic due to considering the factors such as accidents, peak-hour congestion, weather conditions, and road closures [5][9]. As a result, static routing algorithms are often insufficient for real-time applications [10].

Recent research emphasizes dynamic shortest path algorithms, traffic-aware routing, and real-time analysis platforms that can adapt to continuously changing road conditions [3][5][10]. Alongside algorithmic advancements, web-based applications and visualization tools have gained importance as they allow users, researchers, and traffic planners to interactively analyse traffic scenarios and routing behaviour [7][8]. This literature study reviews key research contributions in road traffic analysis, shortest path routing, dynamic transportation networks, and web-based traffic analysis systems, and identifies research gaps that motivate the proposed project.

III. ANALYSIS OF EXISTING METHODOLOGIES

A. Graph-Based Road Network Modelling:
Most traffic analysis and routing systems represent road networks using graph theory. Nodes represent intersections or junctions, while edges represent road segments connecting them [4][6]. Edge weights might be related to travel time, distance, congestion level, or composite cost metrics [6]. Several studies noticed the effectiveness of graph based modelling because it captures road connectivity and enables its algorithmic route computation [4][10]. However, realistic modelling remains challenging due to dynamic traffic conditions and varying intersection delays [5][9]. Research points out the importance of flexible graph structures that support frequent edge weight updates without requiring complete recomputation of routes [5][10].

Graph abstraction offers a solid theoretical foundation but for a real time application scalability, data freshness, and update efficiency remains an active research concern.

B. Classical Shortest Path Algorithms:
Classical shortest path algorithms such as Dijkstra's algorithm and Bellman-Ford algorithm are widely studied and form the backbone of many routing systems [6][10]. Dijkstra's algorithm is efficient for static graphs with non-negative edge weights. But in contrast to that, Bellman-Ford algorithm supports negative weights at the cost of much higher computational complexity [6].

Literature study shows that these algorithms perform really well in static environment or small-scale networks but as for facing large and dynamic road networks, they have their own limitations [10]. Frequent traffic updates require repeated recomputation of routes, leading to increased latency and computational overhead. Despite these limitations, classical algorithms are used as baseline methods for evaluating more advanced dynamic routing approaches [6][10].

C. Dynamic and Time-Dependent Routing Algorithms:
Many studies came out with a solution known as dynamic and time-independent shortest path algorithms to overcome the limitations of static routing [5][10]. These approaches consider edge weights that change with real-time traffic conditions. It can update routes efficiently without needing to recompute everything from the start [3][5].

Researching on dynamic transportation networks introduces to incremental and decremental update strategies, where only affected portions of the shortest path tree are updated when traffic conditions change. Algorithms like Lifelong Planning A* and its optimized variants can reuse their previous computation results [3]. It helps them improve their response time in dynamic environment. Time-dependent routing models focuses on how traffic conditions change over time, differences between peak and off-peak hours and expected congestion in those times [8][10]. Although these methods can noticeably improve routing performance, they usually rely on complex data structures and are mostly tested in controlled or simulation-based settings [5][10].

D. Traffic Simulation and Routing Evaluation:

Several studies rely on traffic simulation frameworks to evaluate routing algorithms under dynamic conditions [7][8]. Simulation-based approaches shows how vehicles move and how delays occur at intersections and also shows how congestion spreads across road networks [8]. These studies show that using real-time routing information on a vehicle can reduce travel time compared to static routing [5].

But most simulation tools are built considering specific traffic models and they offer limited flexibility. So, they often focus on testing algorithms rather than supporting user interaction with it, which makes them less suitable for learning and exploration [7].

E. Web-Based Traffic Analysis and Visualization:

Recent trends shows that the web-based platforms for traffic analysis and visualization are growing [7][8]. Interactive web applications allow users to visualize road networks, modify traffic conditions, and observe route changes in real time [8]. Visualization tools help bridge the gap between algorithmic theory and practical understanding by making routing behaviour more interpretable [7].

Studies indicate that web technologies combined with graph visualization libraries enable scalable and user-friendly traffic analysis systems. However, many existing web-based solutions focus on navigation services rather than comparative algorithmic analysis. There is limited research on platforms that allow systematic comparison of static and dynamic routing algorithms within an interactive environment [8][9].

F. Performance Metrics and Evaluation Criteria:

The studies assesses routing algorithms using metrics. Those are computation time, path length, travel time, number of node expansions, and scalability with network size [6][10]. Dynamic routing studies emphasize update time and responsiveness as key performance indicators [5][10].

Comparatively these evaluations points out that dynamic algorithms significantly outperform the static recomputation methods, especially in environments with frequent or dynamic traffic updates [10]. Nevertheless, standardized benchmarking and visual analytics for performance comparison remain limited in existing research [9].
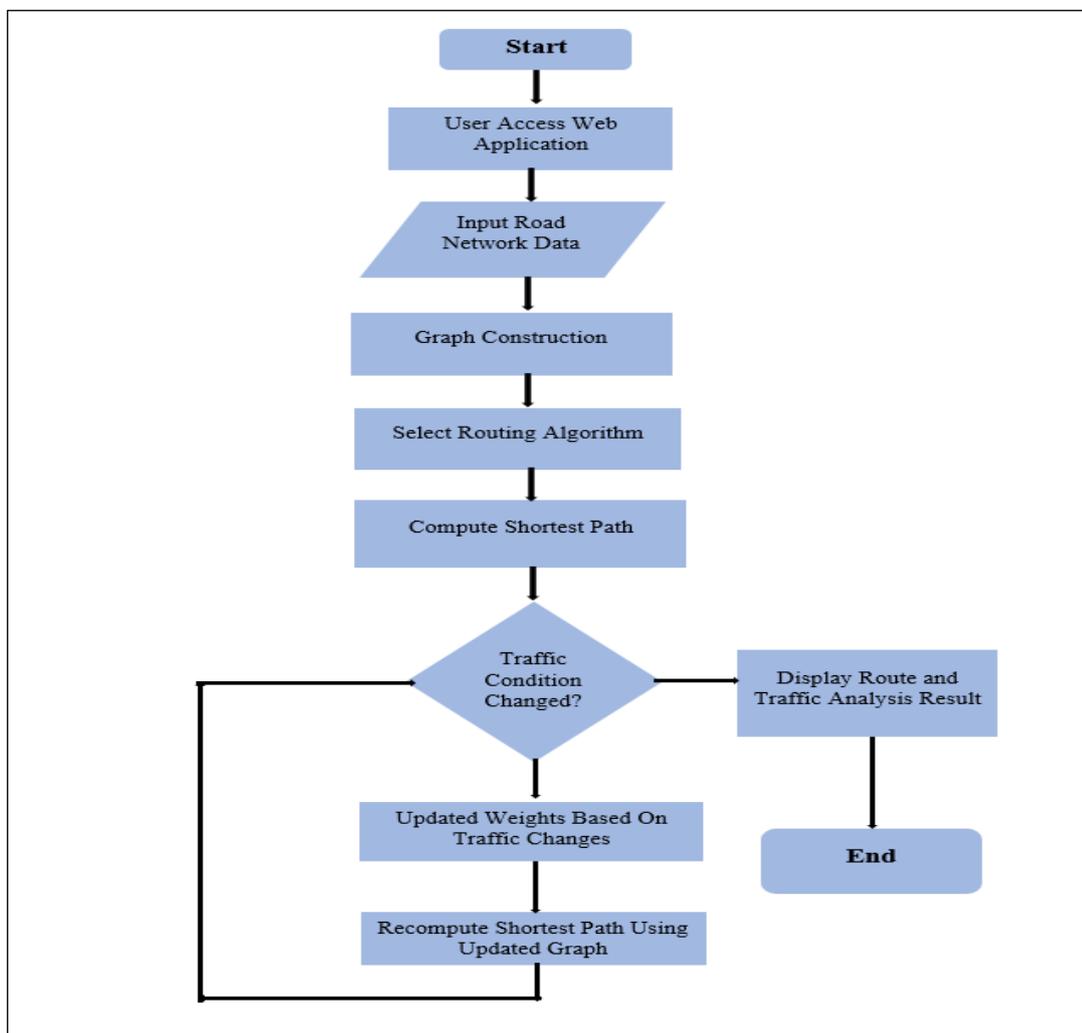
IV. PROPOSED METHOD

Fig 1: Flowchart of Proposed Method

This flowchart represents the working of the proposed road traffic analysis web application from the user's entry into the system to the final route display.

➤ *Start*

The system is initialized.

➤ *User Access Web Application*

User now accesses the road traffic analysis web application through a browser and interacts with the system interface.

➤ *Input Road Network Data*

Here, the required road network data is provided to the system for route computation. It may include: Road segments, Intersections, Distance or travel time, Traffic conditions.

➤ *Graph Construction*

The road network is converted into a graph model which represents the algorithmic processing: Intersections are represented as nodes**,** Road segments are represented as edges**,** and Edge weights represent distance, time, or congestion level.

➤ *Select Routing Algorithm*

This step supports algorithm comparison and analysis which allows the selection of a routing algorithm. Ex-Dijkstra's algorithm, Dynamic shortest path approach.

➤ *Compute Shortest Path*

Using the selected algorithm, the system computes the shortest or optimal path between the source and destination based on current edge weights.

➤ *Traffic Condition Changed?*

This is a decision-making step. If traffic conditions have not changed, the system proceeds to display the result. Or, if traffic conditions have changed, the system updates the graph to reflect the new traffic situation.

➤ *Update Weights Based on Traffic Changes*

When traffic changes occur, the edge weights of the graph are updated accordingly to reflect the new conditions.

➤ *Recompute Shortest Path Using Updated Graph*

The shortest path is recomputed using the updated graph without restarting the entire process.

➤ *Display Route and Traffic Analysis Result*

The final optimized route along with traffic analysis results is displayed to the user through the web interface.

➤ *End*

The process ends after the results are displayed to the user.

V. CONCLUTION

This project presents a study on the design and analysis of a road traffic analysis web application by using graph-based routing algorithms. In many literature study it was observed that while significant research has been conducted on shortest path algorithms, dynamic routing, and traffic prediction, limited emphasis has been placed on interactive and web-based platforms that integrate real-time visualization, algorithm comparison, and performance analysis. Traditional static routing algorithms are often used for static environments because they are quite insufficient for real-world traffic scenarios where road conditions change dynamically.

The proposed system addresses this gap by focusing on an interactive web application that models road networks as weighted graphs and computes optimal routes based on changing traffic conditions. The project shows how web technologies can be effectively combined with routing algorithms for traffic analysis by enabling dynamic updates, visualizing of routing behaviour, and analysing of performance metrics. The study offers a practical foundation for understanding the dynamic routing behaviour and how it can support future improvements in real-time data integration, traffic prediction, and scalability improvements. Overall, the project helps understand intelligent transportation concepts into practice in a way that is easy to understand and useful for academic study.

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