Ambulance optimal routing path detection

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***Abstract*: The optimal routing problem has always been the main event of city emergency rescue. Its research object has developed from searching for" the shortest route" to searching" the optimal route". The related algorithms and techniques differ in different situations. In addition to distance problem, the influence of various parameters factors should also be analyzed under the complicated conditions. The improved method is based on a distributed architecture to compute and find the optimal path for a set of emergency vehicles. Based on the defect of the ambulance route planning, this paper puts forward a new distributed model to find the best way that minimizes the time while taking into consideration the cases of problems that can appear each time such as traffics, speed limit, number of available ambulances, the position of the hospitals.**

***Keywords:* Ambulance, Shortest path, ML, Route, Traffic**

1. INTRODUCTION

Medical technology can now treat many ailments and traumas. Accidents necessitate prompt medical attention. In such cases, a fast-response ambulance impacts the economy and society. News has reported ambulance rescues killing patients. Unexpected ambulance departures, unknown routes, and traffic delays are the main causes. For cardiac arrest patients, every minute of delay reduces survival by 24%. Because it directly impacts human lives, finding an effective ambulance route, especially in heavy traffic, is one of the most challenging research subjects. As cities grow, emergency rescue systems protect lives and social security. EMS ambulances treat patients at emergency sites or transport them to hospitals for intensive care. EMS ambulances have basic life support equipment for emergencies. EMS delivers emergency care and ambulances to patients according to protocols. EMS also offers low-cost non-emergency standby services at festivals, sports, motor racing, national and international conferences, aeroplane emergency landings or crashes, and patient transfers between hospitals. Ambulance availability and arrival time must be regulated to ensure patient arrival within goal time. Thus, better ambulance management is needed to improve EMS. Traffic congestion often slow automobiles and network users. In daily life, an emergency vehicle or fire engine may get stuck, worsening the precarious situation of those on board for treatment or early action at incidents where lives and property may be saved.

2.LITERATURE REVIEW

[1] Taha Darwassh Hanawy Hussein, Mondher Frikha, Sulayman Ahmed, Javad Rahebi, "Ambulance Vehicle Routing in Smart Cities Using Artificial Neural Network", 6th International Conference on Advanced Technologies for Signal and Image Processing (ATSIP), 2022

Taha Darwassh Hanawy Hussein proposed an AI-based neural network that helps in routing ambulances. Eight values are given as an input for the neural network. These values include the time of the accident, accident location, ambulance location, hospital location, number of streets, number of people injured, accident type, and ages of the people involved in the accident. Analysing these values, the ambulance can decide on the shortest route to the nearest hospital. Also, this paper evaluates the critical factors during an accident such as forming temporary emergency teams, the number of available ambulances, as well as the resources and responsiveness of the city.

[2] Taha Darwassh Hanawy Hussein; Mondher Frikha; Sulayman Ahmed; Javad Rahebi, "Ambulance Vehicle Routing using BAT Algorithm", International Conference on Electrical, Communication, and Computer Engineering (ICECCE), 2021

Taha Darwassh Hanawy Hussein proposed to find an efficient route for ambulances using the BAT algorithm. The node method is used to create the map of the city. At first, the control station reports the accident location to the ambulance and the hospital. Then the driver feeds the data—node position of the accident and ambulance vehicle—into the BAT algorithm which detects the shortest path to reach the accident scene.

[3] Elgarej Mouhcine, Yassine Karouani, Khalifa Mansouri, Youssfi Mohamed, "Toward a distributed strategy for emergency ambulance routing problem", 4th International Conference on Optimization and Applications (ICOA), 2018

Elgarej Mouhcine proposed to develop a distributed approach to the problem of finding the optimal emergency route for the ambulance. The primary factor of rescue operations in cities has always been detecting the optimal route. A distributed approach is suggested based on the model of the ant colony system algorithm. Considering the various issues like speed limit, traffic, available ambulances, and location of the hospital, this paper introduces a distributed model to find the optimal path that reduces the time significantly.

[4] Tressa Michael, Deepthy Xavier, "Intelligent Ambulance Management System with A Algorithm", 3rd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT), 2020

A lot of hours are wasted due to traffic in contemporary society. It becomes a huge problem for ambulances and other emergency vehicles. Every minute wasted comes at the cost of precious lives. To tackle this dreadful situation, Tressa Michael has proposed

using the A* algorithm to can find the shortest path for the ambulance. This algorithm takes traffic congestion into account and it produces a dynamic route map as per the intensity of the traffic. Once an accident occurs, the location of the accident is sent to the ambulance and the shortest path is shown on the ambulance dashboard. This helps to reach the location faster.

[5] Mohamed N. Ashmawy, Ahmad M. Khairy, Mohamed W. Hamdy, Anas El-Shazly, Karim El-Rashidy, Mohamed Salah, Ziad Mansour, Ahmed Khattab, "SmartAmb: An Integrated Platform for Ambulance Routing and Patient Monitoring", 31st International Conference on Microelectronics (ICM), 2020
Mohamed N. Ashmawy proposed a single platform that integrates ambulance routing and patient monitoring. The platform aims at dual benefits: increasing the chance of survival of the patient by soon arriving at the hospital and allowing a doctor to check the patient's biomedical data while in transit. The latter helps to do the necessary preparation before the patient arrives at the hospital. Additionally, the platform uses machine learning methods on the data gathered to assist the doctor in identifying potential medical risks.

[6] AbdelGhani Karkar, "Smart Ambulance System for Highlighting Emergency-Routes", Third World Conference on Smart Trends in Systems Security and Sustainability (WorldS4), 2019
During a critical situation, paramedics must act quickly and carry patients swiftly even through heavy traffic. But the traffic and congestion affect the speed of the ambulance significantly. The problem is that drivers react only when the ambulance is near to them but they fail to give way to the ambulance when it is farther away. So in this paper, AbdelGhani Karkar has proposed a smarter ambulance system that differs from the prevailing systems by its method of alerting drivers about the emergency routes taken by the ambulance. The system has two applications: user emergency application and paramedical application. The former shows the location of the patient and the location of the ambulance(s). And the latter locates the patient and finds the nearest hospital.
[7] Subash Humagain, Roopak Sinha, "Routing Autonomous Emergency Vehicles in Smart Cities Using Real Time Systems Analogy: A Conceptual Model", IEEE 17th International Conference on Industrial Informatics (INDIN), 2020
A short response time is crucial for emergency vehicles (EVs) like ambulances, fire, police, etc. The over congestion, numerous intersections with signals, and long queues of vehicles are major hindrances to emergency vehicles. The prior solutions to route EVs failed as they do not accustom to dynamic traffic parameters. Real-time data on hindrances is crucial to reduce the time and impact of EV movement on other traffic. So Subash Humagain has proposed using autonomous emergency vehicles (AEVs) that can drive faster and safer through complex road networks by taking real-time decisions based on live data. This is made possible by taking real-time systems (RTS) where the mixed-criticality real-time system (MCRTS) is used to schedule AEVs tasks for achieving critical response time.

[8] Mohammad A. R. Abdeen, Mohamed Hossam Ahmed, Hafez Seliem[, Tarek Rahil Sheltami, Turki M. Alghamdi, Mustafa El-Nainay, "A Novel Smart Ambulance System—Algorithm Design, Modeling, and Performance Analysis", IEEE Access (Volume: 10), 2022
Mohammad A. R. Abdeen proposed a novel system that uses modern communication, processing, and sensing technologies to transform emergency and ambulance services. The smart system uses the road traffic conditions and hospital loading information to make the best course of action. The performance of the algorithm is analysed both analytically and by simulation for verification. The results produced excellent consistency between simulation and analytical analysis—confirming the accuracy of the analysis. When compared with prior algorithms reported in the literature, the smart algorithm stood superior under considered operating conditions and scenarios.
[9] Myint Myint Sein, K-zin Phyo, Mau Luen Tham, Yasunori Owada, Nordin Bin Ramli, Suvit Poomrittigul, "Effective Evacuation Route Strategy for Emergency Vehicles", IEEE 10th Global Conference on Consumer Electronics (GCCE), 2021
Rescue teams must arrive at the incident site as soon as possible to minimise risk and damage. The Dijkstra algorithm is used to develop an effective evacuation route predicting algorithm for a complex unstructured road network. The proposed system will calculate the best evacuation route for emergency vehicles and services such as fire trucks, ambulances, and police cars. It is also provided to search the nearby relief area and guide to the safe location using the best evacuation route assessment. The closest emergency service is calculated using the surround services system. The haversine distance is used to calculate the distance between two points. After estimating the nearest emergency services, the optimal route from the service centre to the incident location is computed.
[10] Nikki Rathore, Pramod Kumar Jain, Manoranjan Parida, "A Routing Model for Emergency Vehicles Using the Real Time Traffic Data", IEEE International Conference on Service Operations and Logistics, and Informatics (SOLI), 2018
One of the several semi-government emergency medical services (EMS) that operate in India's many states is 108. The prompt response to demand and incorporation of real-time travel and traffic data into the vehicle timing and routing model are key components of EMS efficiency. This study uses the Google Maps Distance Matrix API to create an optimization technique based on real-time live traffic data that is used to calculate the routes for emergency vehicles. The vehicle routing problem is formulated using an integer programming model in the heuristic technique, and it is then optimised using Google API. The model's primary elements include dispatch optimization, shortest route finding, accident location, and vehicle tracking.

3. EXISTING SYSTEM

The existing algorithms such as and Floyd-Warshall Algorithm and Bellman-Ford Algorithm were not efficient in finding optimal route. The existing systems are not very robust in prediction. They have not evolved according to technological advancements and time. The results are also unsatisfactory and may lead to erroneous prediction of optimal path for ambulance leading to unwanted delays in the arrival of patients to the hospital.

4. PROPOSED SYSTEM

The A* algorithm is applied to determine the shortest path from KKSA to specified incident site. The shortest path obtained is based on incident site and the nearest ambulance location. It works by maintaining a pair of lists, one containing locations on the tile map which N is the path and another one contains the locations. Then, A* algorithm will continues the loop if there is still next steps that could be consider to be available next step and considers its neighbors. Difficult parts in solving A* algorithm is to create a good heuristic function to determine h(n). Castor stated that heuristic function is used to find an estimate of how long it will take to reach the destination node from start node. The proposed system will concentrate only on the non-main roads so it can able to identify the shortest path easily. Also the proposed system will use deep learning for predicting the path that has less traffic on peak traffic hours time. Also the proposed system is highly efficient and useful for complex use cases

5. PROPOSED ALGORITHM

MODULE 1 – DATA COLLECTION

All data location and information related to the routing of ambulances are collected from the libraries online and these libraries are imported . Based on the data collected, a road network is developed, where all major routes used to send patient to designated hospital are constructed in the developed road network. Road network developed involved all major roads which connected to the designated hospital. The road network consists of nodes and edges, which will be the directional links that connects the two nodes between them. The visuals are set for the map

The information related to the latitudes and longitudes of all the major hospitals in a given area is collected. An initial map is created using Folium. The hospital coordinates are loaded on the map using JSON. The data is then sent to the map client.

MODULE 2 – IMPLEMENTATION OF A* ALGORITHM

Geographic information ofroads and junctions are needed for creating road network. Followed by which, the coordinates of the hexagons in the A* algorithm is located. The parking spaces in the form of latitude and longitudes of all the parking spaces is collected using np files. Using Numpy, all the coordinates of the parking space is loaded, followed by which, a travel time API request is generated. The A* algorithm works by maintaining a pair of lists, one containing locations on the tile map which N is the path and another one contains the locations. Then, A* algorithm will continues the loop if there is still next steps that could be consider to be available next step and considers its neighbors.

MODULE 3 – CREATING A MODEL

The next step is creating hexagons for implementation of A* algorithm. Once the incident site is identified, we developed a detailed road network that shows complete distances. Here, the A* algorithm will be applied to determine the shortest path of ambulance distance from given location to other locations.

Referring to model, the idea of this algorithm is to avoid expanding paths that is already far or expensive. This algorithm choose the next node n whose g(n) + h(n) is minimal. This process repeats until the goal node reached. The algorithm choose their node based on the cost from the start node plus an estimated of the goal node. The shortest paths are based on incident site and current ambulance station. The A* algorithm is applied to the whole data and the results in the form of shortest optimal path is stored in html files.

6.CONCLUSION

With this system the ambulance can be maneuvered from the accident spot to the hospital without time lag. We have implemented the algorithm with the parallel strategies and results shows that the new algorithm with dynamic traffic data and strategy gives faster response time and faster total cycle time, which are the basic objectives of the optimal solution for Ambulance Routing. In Future, we can further improve the timing by creating more awareness in the public about the importance of saving a life and their role in that and also to have more planned road networks which are Ambulance friendly, which can solve the major problem faced by Ambulances. If the total cycle time can be reduced to 35 to 45 Minutes with immediate Medical care than we have obtained and optimal solution to the Ambulance routing in Indian Scenario.

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[1] Taha Darwassh Hanawy Hussein, Mondher Frikha, Sulayman Ahmed, Javad Rahebi, “Ambulance Vehicle Routing in Smart Cities Using Artificial Neural Network”, 6th International Conference on Advanced Technologies for Signal and Image Processing (ATSIP), 2022

[2] Taha Darwassh Hanawy Hussein; Mondher Frikha; Sulayman Ahmed; Javad Rahebi, “Ambulance Vehicle Routing using BAT Algorithm”, International Conference on Electrical, Communication, and Computer Engineering (ICECCE), 2021

[3] Elgarej Mouhcine, Yassine Karouani, Khalifa Mansouri, Youssfi Mohamed, “Toward a distributed strategy for emergency ambulance routing problem”, 4th International Conference on Optimization and Applications (ICOA), 2018

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[10] Nikki Rathore, Pramod Kumar Jain, Manoranjan Parida, "A Routing Model for Emergency Vehicles Using the Real Time Traffic Data", IEEE International Conference on Service Operations and Logistics, and Informatics (SOLI), 2018