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Advanced A* Algorithm with Dispersion Index for Dynamic Ambulance Routing Problem using Parallel Strategies

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ABSTRACT: Ambulance Routing has been a major area of study in research as it is the most essential service and providing an optimal path for the Ambulance in the traffic congested cities has been the major objective. The ultimate objective of any Emergency Medical service (EMS) is to save the Human Life. The major problem with the Ambulance Routing faced in India is the Traffic Congestion in most of the cities. The major challenge in the study of Ambulance Routing in India is to find the path for the Ambulance to move in the traffic congested routes, majorly at the junctions with 7 to 8 routes crossing at the circles. Another challenge in Ambulance routing is to achieve the "Golden hour" timing which is one hour two minutes in transferring the victim from the accident spot to Hospital. The main objective of the Dynamic Ambulance Routing problem is to achieve the minimum response time and fastest route to be taken to shift the patient to the Hospital. Many algorithms and strategies are devised to achieve the objective of this essential Emergency service. Many of the Algorithms provide solutions with static information in the form of Shortest path, which involves the traffic congested routes. Unfortunately, the shortest path are not the ideal optimal paths, where the ambulances are stuck in Major traffic congested routes. We need an Optimal solution with dynamic traffic scenarios which gives the fastest path for the Ambulances at Peak or non-peak hours. Here the researchers aim at developing a dynamic algorithm which is the Advanced A* Algorithm for Dynamic Ambulance Routing with dispersion index which gives the optimal fastest route and implementing time saving parallel strategies with quick response time and minimising the overall total cycle time of Ambulance service, which is the time taken from the time of the request call made for the ambulance and picking up the patient or victim from the incident spot till admitting the patient in the hospital.

Keywords: Dispersion Index, Dynamic Ambulance Routing, EMS, Heuristics, Parallel Strategies, Response time, Total Cycle Time.

I. INTRODUCTION

The Ambulance routing problem has been a major research topic over the years. While the main objective is to save the human life, the solution in real time needs dynamic strategies to achieve this. We need a dynamic real time solution to the problem with better response time and minimum travel time taken to transfer the patient to the hospital. The major concerns are - How fast the relative of a victim can get an access to the Ambulance to transfer the patient to hospital? How fast the Ambulance can reach the victim and transfer the patient to hospital by finding the fastest optimal path in traffic congested routes? The main objective is to transfer the patient/victim from the accident spot to the nearest hospital within one hour two minutes or less time. The major obstruction in achieving this is the traffic congested routes due to poor Traffic management strategies and the non-usage of alternative routes. The solution to the problem should be in real time and dynamic. The current existing system as explained in Section II uses a call method for the victim relative to book for an Ambulance, which consumes lot of time in allotting the available Ambulance by the call centre and then the Ambulance to reach the spot and transfer the patient through traffic congested routes. Although several hardware and software solutions to the problem exist as discussed in Section III in Related work, the major drawback in the previous studies is that the solutions are based on static information, which does not help in finding the optimal solution. Most of the previous studies tries to find the shortest path for the Ambulance, but the optimal solution to the problem lies in finding the dynamic fastest path with traffic constraints using parallel strategies. Here we propose a Dynamic A* algorithm with Dispersion index in Section IV to find the dynamic fastest path using parallel strategies with 3 phases of time reduction and faster response time to the victim.

While there are several algorithms which gives solution to find the shortest path with various constraints and efficiencies, the Emergency Care Ambulance need the fastest path as the solution in the real-time scenario with traffic constraints. In India, Traffic is the biggest blockage for the Ambulance movement and causes major delays in taking the patient or victim to the destination Hospital in Time and saving the Life. While the main objective of any Lifesaving System is to save the life, the traffic management has been poor and the major portion goes in waiting to cross the junctions.

We have taken the case study of 108 Ambulance Services in Bangalore, which is one of the most popular Emergency Management system existing in India. The GVK EMRI (Emergency Management and Research Institute) is a pioneer in Emergency Management Services in India. GVK EMRI is the non-profit professional organization which provides Emergency services in India. The Emergency response system is provided through a toll-free number 108/112.

Upon calling this number for emergency requests the response is generated in the form of prompt dispatch of Ambulances to the victim's location and transferring the patient to the Hospital with Emergency Medical Assistance provided before the patient is admitted to Hospital.

Today, the toll-free number 108 is synonymous as the best-in-class emergency service. The centralized Emergency Management System takes the calls, problem and condition of the patient is recorded, then the response is communicated and the Emergency Care is provided.

GVK EMRI is currently operating in 17 States and Union Territories i.e. Andhra Pradesh, Telangana, Gujarat, Goa, Tamil Nadu, Karnataka, Assam, Meghalaya, West Bengal, Himachal Pradesh, Chhattisgarh, Uttar Pradesh, Rajasthan, Kerala, Delhi and Union Territories - Dadra & Nagar Haveli and Daman & Diu.

The backbone of the emergency services transportation is the ambulance which should be appropriately maintained and manned. The GVK EMRI is the largest single ambulance operator in the world with 13,625 vehicles deployed in 108 EMS Service.

Apart from the acceptability, the Endeavour to reach the people in distress, providing pre-hospital care and admitting within the Golden Hour Rush (one hour two minutes) is well focused on a healthy transport system. It covers patients of all types such as Medical Emergencies, Police Emergencies and Fire Emergencies.

There are totally 711 Ambulances in Karnataka. Totally 72 ambulances and 19 bike ambulances are deployed in Bengaluru city limits. The ambulances may be stationed near the Police stations under the control of police officials so that they can reach the spot more easily. There are two types of ambulances in 108 ALS (Advanced Life Support) with ventilator and fibrillator and BLS (Basic Life Support).

Live tracking of ambulance through app is proposed in 25 Dec 2019 but not yet implemented in Karnataka.

This paper is arranged in the following manner in further sections. Next section II gives further information about the Existing System and how it operates. The Next Section III tells about the related work in Ambulance routing and their drawbacks. The Section IV explains the proposed Framework, three step in time saving, the Dynamic Advanced A* Algorithm with Dispersion Index which gives the fastest route for Dynamic Ambulance Routing, Illustrative Example and Comparative study of the results. The next section V is the Conclusion and Future scope of the solution to the problem. Section VI is the Acknowledgement.

II. EXISTING SYSTEM

The GVK EMRI Bangalore's centre receives about 300 calls in a day, out of which 25-30are during peak hours. Many of the calls are due to accidents in the areas like Nelamanagala, Hosur Road and K R Puram.

We have taken the KR Puram area Fig. 1 as the case study area in Bangalore.

When there is need of Ambulance the user or the relative of the victim can call the 108-toll free number, on which a call id is generated and given. The call time is recorded and the ambulance is assigned based on the type of case (Critical or Non-Critical). The following details are recorded at the BPO Centre in Excel sheet:

Call Id, CALL TIME, Base Location, Vehicle Number, Vehicle Contact, Incident DISTRICT, Incident TALUK, City, assigned time, Scene Arrival time, scene departure time, destination arrival time, Admitted time, Back To Base, Case Closed Time, Emergency Type, Hospital admitted, EROA Agent, DOC Agent, CALLER NAME, CALLER NUMBER, Victim Name, Victim Age, Victim Gender, Standard Closing Remarks.

We have taken the KR Puram area Fig. 1 as the case study area in Bangalore which is one of the most accidental areas and the traffic congested area also. With the permission from the Deputy Director, Arogya Kavacha-108, Directorate of Health and Family Welfare services, Government of Karnataka, we have collected the call list for three months from GVK EMRI Management for the study.

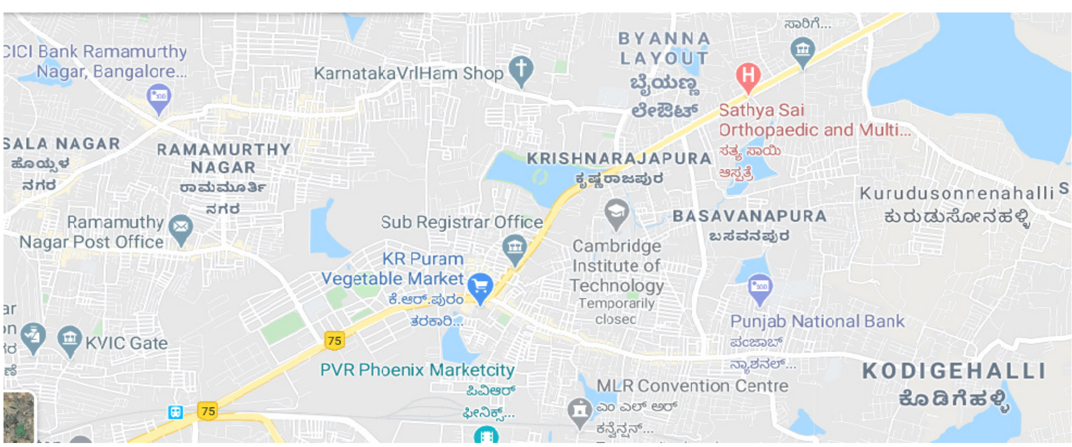

Fig. 1. K.R. Puram (Krishnarajapuram) Road Map, Bangalore.

Upon the study of the call list, every month a total of 4 lakhs to 4 lakhs 58 thousand calls are received from 30 districts of Karnataka, out of which about 2 lakh to 2 lakh 30 thousand are disconnected or calls with no proper information. The remaining are genuine. In Bangalore alone every month about 22 thousand calls are recorded. Cumulating the data for the area of study K R Puram, we collated about 528 calls in three months which are genuine. The Data Analysis have been performed by Using the Weka Data Mining Tool.

About 380 call list clearly shows that the Total cycle time, was much beyond the expected Golden Hour Rush time. The response time in many cases will take 20 to 26 minutes (After calling to 108 service, the ambulance should be assigned and time taken to arrive at the scene or spot). In more than 71.96% of the cases the objective of 108 Ambulance services to provide the service with "Golden Rush Hour" which is to transfer the patient to the Hospital within One hour and 02 minutes could not be completed.

The objective of admitting the patient to the Hospital could not happen in the Golden Hour i.e,, one hour two minutes because of the traffic congestion in that area as it is the NH75 National Highway also. In many cases, it has taken more than two hours to 3 hours 30 minutes.

As per the reports Bangalore has the worst traffic in the world. There have been more than 17 to 18 worst traffic congestions in the city which causes a delay of about 40 to 50 minutes.

There has been a total of 13 Ambulances operational in KR Puram Area. In most of the Traffic signals in that area takes more than 140 secs (waiting time) and only 30 sec Clearing time. Due to this the Ambulance, cannot achieve the target of one hour two minutes. Although many junctions have alternative routes the drivers follow the same shortest path shown by the Application.

Unfortunately, the shortest path is not the fastest path and is not suitable in Dynamic scenarios.

All these delays call for a parallel strategy to be used in the solution, where the time can be saved at different levels of operation and to introduce the algorithm which can show the fastest path to the driver in Dynamic Scenario and help him to take the victim to the Destination (Hospital).

III. RELATED WORK

The Dynamic Vehicle Routing Problem is with multiple constraints and Objectives. The solution to the Problem has multiple facets based on the scenario and the environment. Several factors affects the Solution to the Dynamic Ambulance Routing problem – the pattern of road network of the country, the rules and policies followed in each country for ambulance movement, the care and facilities provided by the medical staff inside the ambulance and also the call management and the allotment of Ambulance and the service provided as soon as the call received, the deployment of Ambulance, Ambulance locations etc..,

Several Algorithms and strategies are worked out by various researchers to find out the best optimal solution for the environment applicable. Most of the algorithms are static in nature that is they give solutions to the problem defined already, but are not the best optimal solution when the dynamic scenario of Traffic comes into Picture. Unless the solution does not work with dynamic real time environment it will not be helpful and cannot be considered as optimal solution. The most popular algorithm with optimal solution is the A* algorithm which works for static data with Heuristics. A* is generalization of branch and bound technique as introduced by [1]. Other routing Algorithms such as AO* algorithm which uses AND -OR graph search that takes more time which makes it inappropriate solution for Ambulance routing problem.

Genetic Algorithm presented by [2-4] have proposed the application of A* Algorithm to find the shortest path for Ambulance Routing in Malaysia Road Networks with 10 minutes' response time. In 2006, [5] proved that A*algorithm is faster and better than Dijkstra's algorithm because A*algorithm is an efficient algorithm to solve the shortest path. According to [6] stated that A*algorithm essentially the same as Dijkstra's algorithm, distinctive by a heuristic that utilized in A*algorithm.

The usage of Swarm based approach to solve Ambulance routing problem using PSO method (Particle Swarm Optimization) was proposed by [7] and it is used for a case study in France. It uses Cluster first route Second algorithm. Cluster first algorithm- clusters the kind of injuries through petal algorithm and then the route is computed using the Particle swarm optimization algorithm. A petal is a set of radial consecutive set of nodes. They have used VRP with pickup and delivery (VRPPD). This model is not feasible for Indian Scenarios as the Ambulance depots are unevenly distributed.

The usage of wireless communication as a solution to DVRP was proposed by [8] using Automatic Accident Identification method.The GIS/GPS is used to locate the ambulance. Another solution is provided for DVRP by [9] using GIS as Decision support system in finding dynamic shortest path in Tehran, Iran.

Solution based on choice of hospital and route was proposed by [10] which provides the solution to DVRP for the transportation of patients with acute coronary syndrome in Saint Petersburg. Usage of AHP (Analytical Hierarchical Processing) was proposed by [11] by selecting the routes based on the conditions of the roads with criteria's like road length, travel time, road type etc. The advanced Dijkstra's Algorithm is used on optimally selected routes based on AHP to find the path in Greater Cairo Region.

TheIoT Based solutions were proposed by [12, 13] have suggested the Zigbee module for the Ambulance Clearance. The Zigbee Module uses **IEEE 802.15.4** standard which requires full validation of physical layer. If the physical layer is not certified its malfunction will affect the lifespan of the battery and other devices in the ZigBee network. This creates circuit complexity and also the requires the access of traffic controlling system.

Intelligent Traffic Controlling system using IoT was proposed by [14-15] in which the traffic signals automatically change the signal to green until the ambulance passes the signal. Keeping the signal green for a certain amount of time creates congestion in the next forward junction or route Another IoT based solution was proposed by [16]. They have proposed use of hardware systems to access the patient's condition in the Ambulance and controlling the traffic signal system

using IoT hardware. They have suggested remodelling the Ambulances with new components.
The Green Path for Ambulance was proposed by [17] as a solution to DVRP. This is used for special cases with the permission to clear the route which cannot be used for all the cases. The success of this approach requires awareness created in general public to follow a disciplined humanitarian approach about giving space for the ambulance to move.
Distributed Ant Colony Optimization Method was used by [18] in the city of Morocco with several computations and all the route calculations.
Determination of Heuristics for Minimum cost paths was proposed by [19]. The Minimum cost paths are not the fastest optimal paths. Highlighting the Emergency routes was proposed by [20]. The main drawback is other timing saving strategies are required to achieve the optimal solution. Advanced Ambulance Emergency service using GPS was proposed by [21] which concentrates on tracking the ambulances under one roof, but doesn't provide the optimal solution.

IV. PROPOSED FRAMEWORK

Here we have considered the K.R. Puram Traffic Junction as the case study which is one of the most congested junction out of the 18 Worst traffic junctions in Bangalore. We have implemented the solution in the form of the Proposed Framework as in Fig. 2 and alert using IoT- RFID Reflectors as in Fig. 3 for the Dynamic Ambulance Routing problem in the above-mentioned junction.
The proposed Framework comprises of solution using parallel strategies with three stages of Time reduction in Ambulance Service from the time when the user calls or requests for an ambulance service and until the victim/patient is admitted to the Hospital.

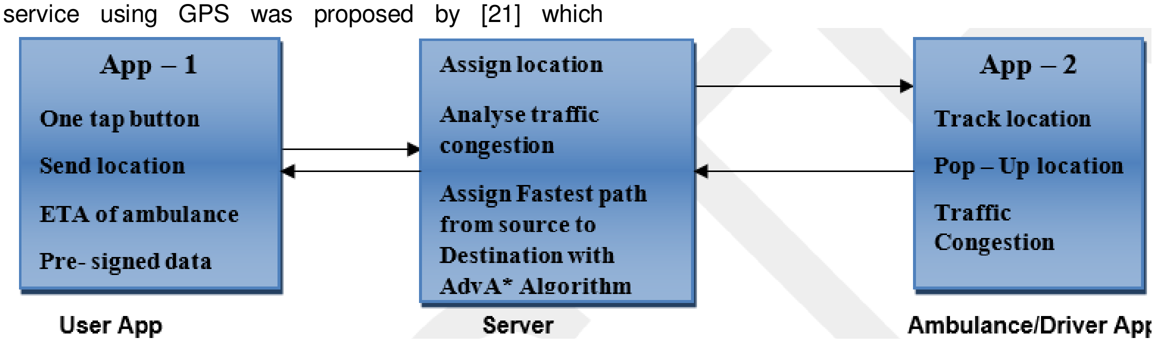

Fig. 2. The Proposed Framework.

Fig. 3. Alert using RFID Reflectors.

In Alert using IoT, we trigger the RFID reflectors which are placed on the road to indicate the public that the Ambulance is arriving at that location.
The following strategy is used for time saving at different stages aiming for faster response time and less total cycle time:
1) To use the Android Application for booking the Ambulance instead of Calling the Call Centre. The Ambulance which is free automatically is assigned and rushes to the incident spot or to the patient. This helps in achieving quick response time. This is explained in Section A.
2) The Advanced A* Algorithm with Dispersion Index gives the fastest optimal path in dynamic scenario where the alternative routes are computed in minimal time which shows non-congested routes. This avoids Ambulance entering into major traffic junctions and there by reduces the time of waiting majorly and helps in faster movement to destination. This is explained in Section B.
3) In case of the routes which are single routes and traffic signals the third strategy is implemented with LED lights which glow until the ambulance reaches the traffic signal to inform the people that the Ambulance is coming in that route and they should make way for it. This saves much more time for the Ambulance. This is explained in Section C.

A. Android Application

The Proposed framework comprises of Android Application with two apps – One is the User Application where in any user who requires the Ambulance can register in the App and book for an Ambulance. As soon as the user has successfully registered and is requesting for the Ambulance the Available Ambulance Driver gets the request and immediately is assigned. Immediately the location of the Victim is also identified by the Ambulance App and the driver rushes to the Victim or to the spot. Here the User can send details of the victim or patient and his/her Condition through a form and also can place a request for BLS (Basic Life Support Ambulance) or ALS (Advanced Life Support Ambulance with Ventilator and ICU kind of facilities) type of Ambulance by selecting Critical or Non- Critical Button. This Saves lot of time and reduces the response time i.e.., Time duration taken from the time the user booked for ambulance and it arrives at the scene of accident or at the place where the patient is there, Unlike the existing system where the user has to call the BPO service for booking the Ambulance and then the attendant has to check the availability of the Ambulance and the Area and depute the type of Ambulance after again informing to the caller. In the existing system in urban areas the average response time taken to reach a patient is around 14 minutes 30 seconds, while in rural areas it is around 26 minutes. But with the proposed Android Application saves more than 5 minutes to 7 Minutes in the assignment of the Ambulance and it is automatically done. The Ambulance status is mentioned as assigned that has rushed for the service is noted in the Server. This Saves more than 5 minutes to 7 Minutes in the assignment of the Ambulance to the Caller and improves the Response time. This is the First stage of time Reduction or Time Saving by the Proposed solution.

The Caller will also receive the ETA (Estimated Time of Arrival) of the Ambulance in his Application and the Ambulance Driver Mobile Number is also shared.

B. Advanced A Algorithm with Dispersion Index with Dynamic Traffic Data*

After the Ambulance, has arrived at the Scene of Accident and picks up the patient and departs from the scene spot towards the Hospital after giving the first aid to the Victim the Ambulance looks for the fastest path to reach the Hospital. Here the Hospital considered is LTH Hospital, KR Puram.

After Studying the various cases in the area of Study with three month's data out of 528 cases 380 cases shows that the Ambulance has taken more than one hour and two minutes, i..e.., in more than **71.96%** of the cases the objective of 108 Ambulance services to provide the service with "Golden Rush Hour" which is to transfer the patient to the Hospital within One hour and 02 minutes could not be completed. The total cycle time includes the time the ambulance is called for, the patient is picked from the accident site, paramedic examining the patient, taking the patient to the hospital and admitting him to the hospital. A thorough study shows that in many cases it has taken more than 2 hours 30 minutes to 3 hours 30 minutes' time during peak hours and 2 hours during non-peak time.

This has been due to the traffic congestion at the major junctions and the detailed study has shown that there is 50 minutes of delay caused during peak hours in the area of study. Most of the traffic signals have 140 sec delay in the area of study. To avoid this and reduce the Time further and to provide the Ambulance the fastest path with Dynamic Traffic data we propose the Advanced A* Algorithm with Dispersion Index, which helps in reducing the time by further 10 minutes to 40 minutes by avoiding the traffic congested routes and gives the alternative route without or less congestion. This is the second stage of Time saving or time reduction. The A* Algorithm was introduced by [19] in 1968 when they were aiming to build a mobile robot which can plan its own actions. They designed the algorithm which is used for searching the path using the Heuristics. Since then the algorithm is applied to several path finding problems.

Here we propose the Advanced Version of A* Algorithm with Dispersion Index by taking the Dynamic Traffic Data into consideration for Ambulance Routing. The map of Area of study is built using Open Street Map.

The proposed Advanced A* Algorithm with Dispersion index is described in the following steps:

1) Initially the area of study is formulated in the form of a graph G and is taken as an input.

2) The objective is to reach the Destination node(D) or Goal node from source node S.

3) For all the nodes from the Source to Destination, we check whether the forward node of travel is congested or not. For this the vehicle GPS location is taken in to consideration. If the GPS signal shows waiting time of 40 secs or more than that route is in traffic and needs to be avoided. We check for the condition if waiting time >=40 secs and is not a single route than the alternative route should be computed.

4) The forward node with traffic is not selected in computing the path. The remaining adjacent nodes are considered for calculating the alternative route with Min Dispersion index.

5) The formula to find the forward node and path is

$$\text{Min } f(n) = g(n) + h(n) + i(n) \quad (1)$$

g(n) represents the distance from the start node to current node and h(n) represents the distance from the current node to goal node as in A* Algorithm. To this we introduce the i(n) the Dispersion function with i as the Dispersion index. Dispersion function i(n) helps in forward node selection based on the crowd or traffic in the junction and the dispersion factor. The Dispersion function is calculated as in Equation 2.

6) The Dispersion index i(n) is defined as a set of values i(n) = [0.0-1.0]. The dispersion index Diminishes with distance from a node of highest number of Connections in a network to the node with least number of Connections. The Dispersion index is calculated using the formula

$$i(n) = \text{Min} \sum_{i=1}^{n} \left(\frac{\text{Length(node)}}{\sum_{i=1}^{n} \text{Length (All Adjacent nodes)}} \right) \quad (2)$$

Apply this value in Equation 1 as in step 5.

7) If the forward node is the single node then we take that path and calculate the dispersion index.

8) Continue the node selection to find the fastest path from the source to destination node by checking and avoiding the crowded path and computing the alternate path for all the nodes in the graph. The algorithm is formulated as in Fig 4.

Two Lists are maintained in the algorithm: OPEN and CLOSE:

OPEN consists of nodes that have been visited but not expanded which is the list of pending tasks. Whose successors are not explored yet.

CLOSE consists of nodes that have been visited and expanded whose successors are explored already and included in the open list if this was the case.

Advanced A* Algorithm with Dispersion index for Dynamic Ambulance Routing

Input: Graph(G) with Source, Destination (Goal Node) and Intermediate nodes

Output: The Dynamic fastest route from Source to Destination (Goal Node).

1. Initialize the OPEN list with S as the start node in the Search Graph G.
2. Create a list called CLOSED that is initially empty.
3. LOOP: if OPEN is empty, exit with failure.
4. Select the first node called as n from the OPEN List and put it in to CLOSED List.
5. If n is a goal node, then exit successfully with the solution obtained by tracing a path along the pointers from n to s in G.
6. Generate the set M which is the successors set of node n in G.
7. If at any intermediate node from Start to Destination node, the Vehicle stops (waiting time >=40secs) and forward node is not a single node than select alternative node from the remaining nodes with Min Dispersion index calculated as in Equation 2
   else if Vehicle stops (waiting time >=40secs) and forward node is a single node to destination then continue with same node forward by putting in CLOSED list by calculating the Dispersion index as in Equation 2.
8. Create a pointer to n from those members of M that were not already in OPEN or CLOSED in G. Add these members of M to OPEN.
9. For each member of M that was already on OPEN or CLOSED, decide whether or not to redirect its pointer to n.
10. For each member of M already on CLOSED, decide for each of its descendants in G whether or not to redirect its pointer.
11. Reorder the list OPEN, according to the heuristic function as in Equation 1, with min f(n).
    Min f(n) =g(n)+h(n)+i(n)
    Where i(n) is the Dispersion function calculated using formula as in Equation 2.
12. Goto LOOP.

Fig. 4. Advanced A* Algorithm with Dispersion Index for Dynamic Ambulance Routing.

Illustrative Example: Consider the following Search Graph G

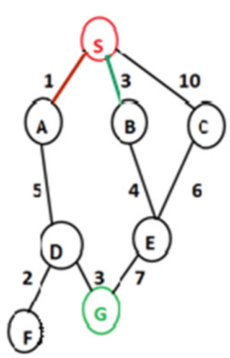

Fig. 5.

Step 1: OL: S (Null set, 0)
CL: (Null set)

In Figure 5 , we start with start node S

Step 2: OL: A (S,1.07), B(S,3.21), C(S,10.71)
CL: S

Step 3: OL: B(S, 3.21), C(S,10.71), D(A,7.07) CL: S, A

We calculate the dispersion index S→A, S → B and S→ C

A= 1/(1+3+10), B= 3/ (1+3+10) and for c = 10/(1+3+10)
A=0.07, B= 0.23 and C =0.77

If the forward node A is Congested(Path Marked in red) than the vehicle stops for 40 secs and the node A is removed from the Selection list. Other Alternative nodes i.e.., B and C are considered.

So, we select the node with min Dispersion index i.e.., B

S→B

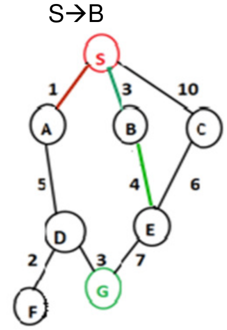

Fig. 6.

In Figure 6,

Step 4: OL:C(S,10.71), D(A,7.07), E(B,8.21)

CL: S, A, B

Step 5: OL: D(A,7.07), E(B,8.21)
CL: S, A, B, C

From B we move to node E, as this is the single node
Dispersion index for E is 4/4=1
So, the node selected is S→B→E
C →E is not considered as distance is not Min.

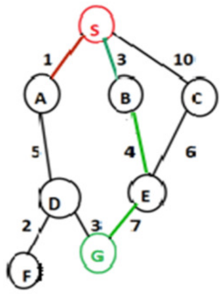

Fig. 7.

In Figure 7,
Step 6: OL: E(B,8.21), F(D,10.07)
CL: S, A, B, C, D
Step 7: OL: F(D,10.07), G(E,16.21)
CL: S, A, B, C, D, E
Step 8:OL: G(E,16.21)
CL: S, A, B, C, D, E, F
Step 9: OL: --
CL: S, A, B, C, D, E, F, G
Calculate the dispersion index for G from E = 7/7=1
S→B→E→G

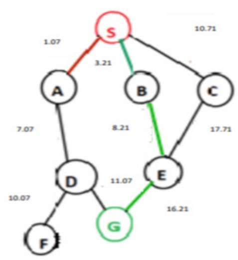

Fig. 8. Graph with Dispersion Index added.

Table 1: f value with Dispersion index and Path.

Node	F with Dispersion index	Path to Goal Node G
A	11.07	S→A→D→G
B	16.21	S→B→E→G
C	25.71	Is not considered as C→E is not Min
D	11.07	S→A→D→G
E	16.21	S→B→E→G
F	10.07	No path as the goal node G cannot be reached from F

So, the Dynamic Route taken is S→B→E→G.
Here it is important to note in Table 1 that although S→A→D→G (11.07) is the shortest route but as there is congestion at node A, we have avoided taking that path and instead diverted to B from S.
As observed in the real time example the congestion at different junctions can cause from 10 min to more than 20 min delay in crossing. So, avoiding those junctions and taking alternative route will be the best and is the requirement for the Ambulance to reach its destination as fast as possible, as it is important to save the human life.
Experimental Results: Algorithm is run with 23 different locations real time datain and around K R Puram. In all the 23 cases the total cycle time is almost one hour which shows the time saving of almost 20 to 35 minutes compared to standard algorithms. In all the 23 cases, the number of node junctions taken were around 6 to 8 with 10 to 14 edges (roads connecting edges). The proposed Advanced A* Algorithm with Dispersion index shows faster response time of 20 minutes, reduction in total travel time and total cycle time compared to other well-known algorithms like A*, AO*, Dijkstra's and PSO algorithm. The Algorithm results are displayed in Table 2.

Table 2: Algorithm Results.

Algorithms	Type	Response Time (Average)	Total Travel Time	Total Cycle Time (Average)	Computation Time	Performance of Advanced A* in terms of time saving wrt to Total Travel Time
A*	Static	30 Minutes	1 hour 10 Minutes	1 hour 28 Minutes	0.48 sec	20 Minutes
AO*	Static	42minutes	1 hour 20 Minutes	1 hour 45 Minutes	0.55 sec	30 Minutes
Dijkstra's Shortest Path	Static	35minutes	1 hour 12 Minutes	1 hour 25 Minutes	0.43 sec	22 Minutes
Swarm Based Approach with particle swarm-PSO Algorithm	Static	45 Minutes	1 hour 25 minutes	1 hour 55 Minutes	7.21 sec	35 Minutes
Advanced A* With Dispersion Index	Dynamic	20 Minutes	50 Minutes	1 hour 02 minutes	0.46 sec	-----

The best route for the Ambulance in Dynamic Scenario is not that of the shortest path but of the fastest path.

C. Usage of LED Lights at Single Routes and Traffic Signals

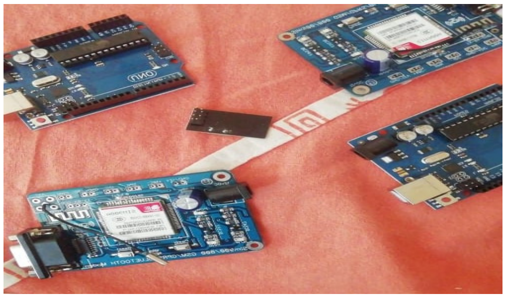

Fig. 9. RFID Reflectors, Arduino Board & GSM Module.

In the Final stage of time reduction, we are using the RFID Reflectors with Arduino Board and GSM Module CRF in the traffic congested route where there are no alternative routes. In most of the cases when the Ambulance passes through highway there are no alternative paths. The area of study also comprises of such a junction which is the only route that can be taken. In such intermediate path to reach the destination we can use the RFID reflectors to indicate to the general public that the Ambulance is arriving in that route so that they can give way to the ambulance instead of crowding. This further reduces and saves time of about 5 to 6 minutes in the traffic congested single routes. This is third level of Time reduction or Time Saving.

V. CONCLUSION AND FUTURE SCOPE

The Authors 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.

Conflict of Interest. There is no conflict of Interest in this work.

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