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Dynamic path optimization of traffic signal system for ambulance dispatch in emergency medical response using analytical hierarchy process

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ABSTRACT

With the increase in vehicles on a day-to-day basis, the congestion on roads has exaggerated linearly. This congestion results in what is known as traffic. With traffic comes accidents, resulting in emergency situations. It is abundantly a necessity for clearance of vehicles. Each second matters once it involves saving a human's life. With more traffic and not giving way to emergency vehicles, the life is at stake. Being citizen-oriented act of assistance, Medical Emergency Response explores many issues acting right way within the essential amount of your time. Foremost reason behind this disadvantage supported the segregated data foundations as well as conjointly diverse characteristics of info concerned for making proper decisions. Therefore, to provision fast as well as correct deciding technique to see the simplest machine and hospitals among them on the market alternatives is important. In the planned system, both the ambulance and the traffic signal station are connected using cloud network. Each and every signal at the junctions collect and analyze the traffic details using AHP consumes information sourced from the sources, and a dynamically use the shortest path formula to enable quick as well as an accurate decision for effective action in the medical crisis.

Keywords: *Analytical hierarchy process, Medical emergency response, Dynamic shortest path optimization, Ambulance unit, Traffic signal control system.*

1. INTRODUCTION

In a sensible town, fast as well as a correct response during emergency medical could be an obligatory act of assistance for all of its citizens. But, now in India, maximum of circumstances that represent acceptably as well as dealing response for the emergency medical process isn't appropriate, however, greatest cause for it is because no regulation exists from the state or the central government bodies which perform as steerage for understanding possible medical response during crisis or emergency for Indian metropolises. Once the analysis is completed, state and central government with top-down operation model have hurled centralized emergency response service during a medical crisis, and then there are several fundamental difficulties that might hamper towns and city after furnishing tolerable medicinal emergency provision for its citizens. Some of the issues together with an accountable figure to succeed wide emergency response system during a medical crisis, the accessible arrangement as well as possessions, and even disposition of participants to affix the root cause.

With respect to the information storage as well as classic process and model in health services as well as hospitals, e- information accessible for much core practice, however, it still is present in silos. The most reason behind the disadvantage because of there is no long concerning information integration at the interval preparation. In order to boost the predominant complaint, only two choices out there. Primary is to create a brand new process or a system that consists information amalgamation as well as a

compacted process inside awareness, therefore the next is to create clever usage of this current system as well as arrangement, thus associate degree upgrade within the use of obtainable information.
The thought that redisposition provision with assimilated mindset would require more duration as well as determination while the needs of the citizens for swift as well as precise health services as well as medical occur on daily basis, the need for a swift yet practical method is more crucial. With a close information demand as well as several information possessions, the structure of information amalgamation, which uses obtainable data from varied data foundations can also, planned.

In the time of medical response during an emergency, need is form fast and correct selections supported by the market knowledge, which regularly sustains numerous processes. A number of crucial activities to be employed as well as an assignment the faster, nearer, as well as acceptable emergency response unit within permissible the serious amount of period for the patient. To understand the idea, an outline that modifies information amalgamation as well as universal approach process which shelters every concerned thought is very important. The new framework would have altered the choice maker that is posted agent to think about foremost appropriate auto elements be sent, thus limitation of the duration required form associate correct call in a very short amount.

A. Smart City and System:

The smart town is represented as a town that is adapting instrumented, connected, and intellectual solutions to change as well as fittingly respond to quickly ever-modifying surroundings, endure impulsive intrusion, and enhance activities for higher management of town subsystems [1]. From such description, we will derive the description of a wise process as below:

The present stage of recent towns is represented as a system of systems, during which a town is represented as an oversized system consisted of smaller systems, that successively is coexisted of smaller subsystems, to make sensible town is to make its clever subsystems primary. When the sensible town is comprised many varied features, health service of town is debatably the one amongst foremost important facility that is crucial for its citizens because of its directly associated with the comfort of the citizens. As an area of a city's health services, medical response during an emergency could be an important service that wants consideration as well as energy to accomplish well.

2. PROBLEM STATEMENT

Due to the rise in the traffic rate, the Ambulance service does not seem to reach the destination on time. So, Dynamic Path Optimization of Traffic Signal System for Ambulance Dispatch in Emergency Medical Response Using Analytical Hierarchy Process can be used to suggest an optimized Dynamic path using specified algorithms along with it a collaborated system to control traffic signals and allow the ambulance to reach the destination easier and faster.

3. EXISTING SYSTEM

Currently, there are only automatic signals, which has a specific time cycle with which it works can handle only the flow of the traffic. These are not reliable and not in a condition to clear the traffic and make way for the Emergency vehicles.

However, the existing process is very well planned and executed the traffic and signals in the path taken by the ambulance between the blocks or stages followed in the Flow diagram. The traffic in the signal is cleared after the ambulance is heard and that clearance time is very variable. In a few situations, there are cases where people have lost their precious lives due to the congestion in traffic signals. The existing system follows the below process.

A. Medical Emergency Response

The medical emergency response is an integral part of health and medical system of a city, which aims to provide medical support and services for its citizens. MER is a critical service, which often integrated with other emergency responses including fire, police, and disaster relief effort. In order to provide an integrated medical emergency response system, which could support those other emergency responses, MER needs to be able to perform well in its own terms first.

If we apply the definition of a "smart system" into the Medical emergency response system, then it translates into how we can improve the quality of services in the medical emergency response system through the implementation of a "smart" framework which can support optimal, responsive, and robust decision making even when multiple actors and multiple components are involved in achieving the goals of the system.

B. Typical Medical Emergency Response Process

The typical flow is started from the moment the dispatch receives an emergency call. Afterward, the dispatch assigns the severity of the incident and then determining the best ambulance unit to be dispatched. The dispatched ambulance travel to the scene with the paramedics by using the fastest route to reach the location of the patient, and providing in-situ treatment as soon as the patient is reached. Afterward, the paramedics would decide whether the patient still require further hospital treatment. If she does, then the dispatch officer would determine the optimal hospital assignment, and the ambulance unit will then take the patient to the

appointed hospital. After the patient has been safely taken to the hospital, the ambulance returns to base or dispatched for another call.

With time efficiency as one of the critical measurement of a success MERS aside than cost efficiency and patient survivability [3], the speed and accuracy in taking initial actions, especially determining the optimal ambulance unit, is deemed critical. In dealing with real emergency cases, dispatch officer is expected to be able to make accurate decisions in a short window period, with the most of the available response time which is around 25-30 minutes in some of the cases [3] [2] is reserved for the travel time of the ambulance unit and for the paramedics to reach the location of the patient.

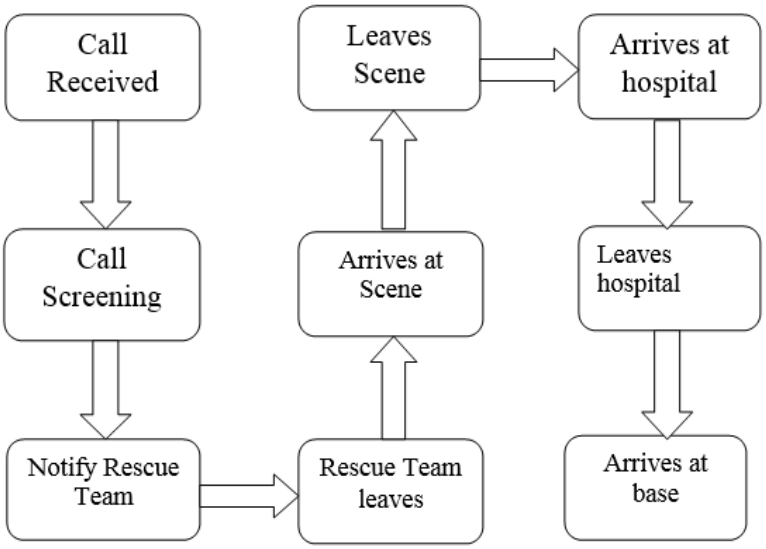

Fig. 1 Flow Diagram of Existing system

4. PROPOSED SYSTEM

A Dynamic path for the Ambulance will be created for its easier and fast reach of the destination by using the Analytic Hierarchy Process (AHP) and cloud, which allows the system to switch the signals for the better movement of the Ambulance, without affecting the normal traffic in the city.

As previously stated, to make an improvement by implementing an ideally preconceived system from the start would require an enormous capital and effort. Therefore, a framework to upgrade the current condition by leveraging the existing systems and data flow is required. An emergency incident, however, still require direct and immediate attention regardless of the status and readiness of the medical emergency response.

When an emergency crisis or an incident happens, the possible worst scenario would be as follows:

1. The patient would make an emergency call to an emergency service center or hospital, where the hospital is located far and would require quite time to reach the destination;
2. No available ambulance unit stationed in the emergency service center or hospital;
3. An ambulance unit has been dispatched, the route taken is not the most direct and/or trapped in a traffic jam;
4. In case patient requires further medical attention, the suitable hospital's availability is unknown, and the routing problem exists.

Along with the AHP, a route optimization algorithm is applied to enhance the efficiency of AHP. By only implementing AHP we will only be able to achieve some amount of time and accuracy. Along with the AHP and optimization algorithm to the signals to reduce the traffic congestion in signals in the optimized route calculated by the AHP process by this both time and accuracy of the Emergency dispatch system can be enhanced.

A. Algorithm for AHP:

- Allocate each node a tentative distance worth, zero to the position of the ambulance and infinity for all other nodes.
- In case the primary node does not belong to any previously described nodes, add a new node on the location of the ambulance unit, and allocate the relative value towards other nodes accordingly.
- For edges with high ambiguity, allocate new values that can best represent the current condition.
- Allot primary node as the present, and all the other nodes as unvisited, integrate all unvisited nodes in a set.
- The present node, anticipate all neighbors and calculate tentative distances. Compare fresh calculated uncertain distance to the present allotted worth and assign the slighter one.
- When considering all neighbors of this node, mark this node as visited and take away from the unvisited set.
- We get the optimum path using the above 6 steps

- Then we configure the signals along the path traced
- Just as the ambulance approach is the signal junction, the path is traced and those two signals in along the path of the ambulance are made open.
- As soon as the ambulance passes, the signal is reset.
- As soon as the ambulance passes that junction, the signals are reset to their normal state.
- In addition, the same thing happens along the other junctions along the ambulance path derived from the pickup of the patient and until the Ambulance reaches the hospital.

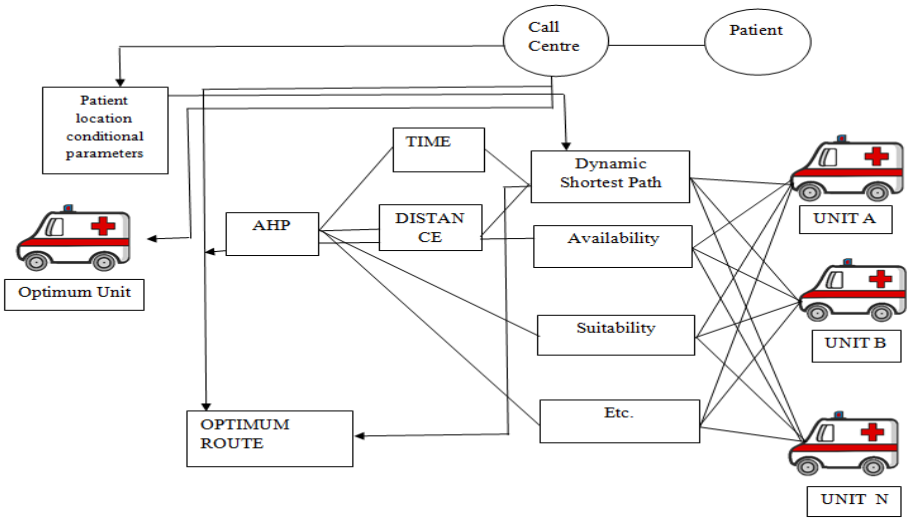

Fig. 2 Flow Diagram of Analytic Hierarchy Process (AHP)

B. Algorithm for Path Optimization:

- Emergency call by the patient.
- Nearest present Ambulance picks up the patient location and locks on to that location.
- The dynamic fastest path is assigned proving all the signals on the route to be free to reach the patient location as soon as possible.
- After reaching the patient, the nearest and fastest reachable hospital is searched and the location is locked on to the ambulance.
- With the patient, the dynamic fastest path is assigned proving all the signals on the route to be free to reach the hospital in time to save the patient

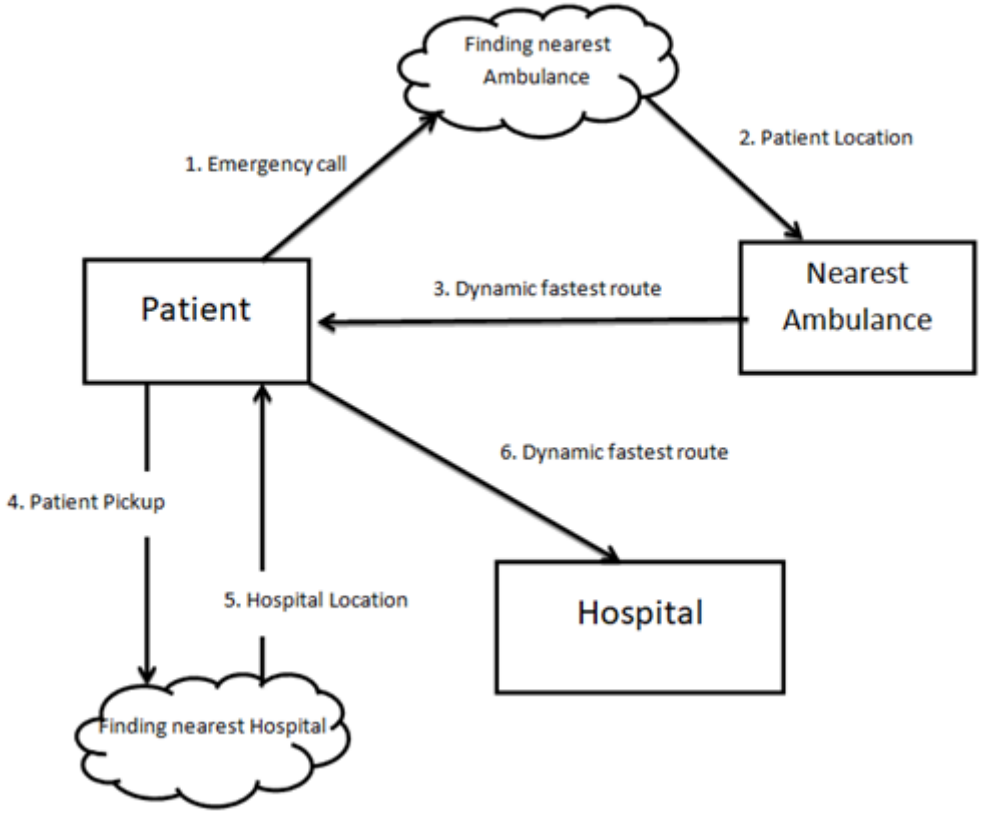

Fig. 3 The process of Path Optimization

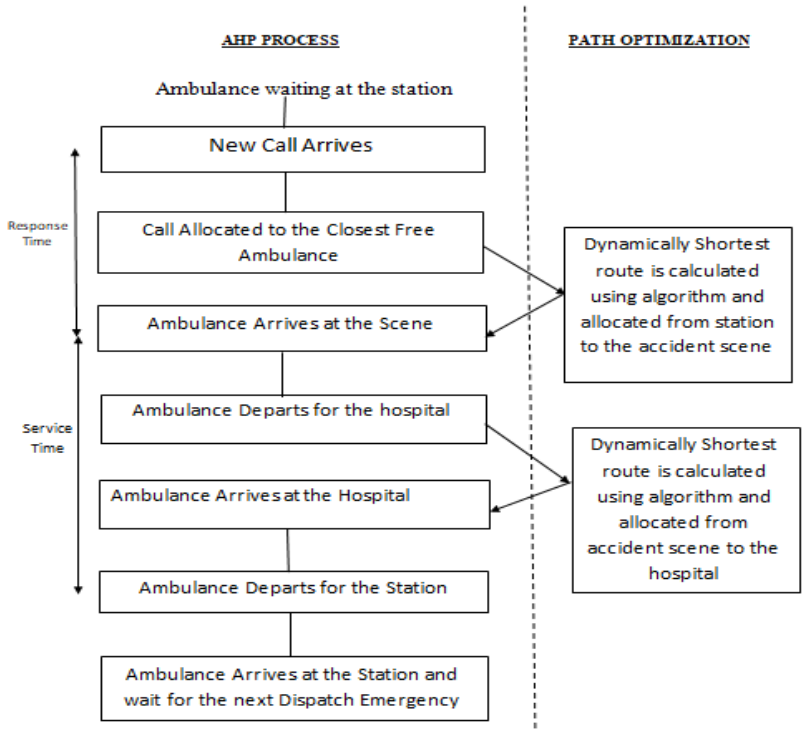

Fig. 4 Complete Process Flow Diagram

5. CONCLUSION

This will be complete from the outcome of the analysis that projected Analytical Hierarchy Process and dynamic algorithm for the shortest path for the aim of development in present medical services and health will put to use to support analytics for Medical Emergency Response System. Development of pace and precision of decisive the most effective action to require has ascertained.

In our future analysis, we would wish to enhance computerization of value or cost allocation for Analytical Hierarchy Process computation, so bettering the indifference of study as well as developing the duration required to proceed with any further steps.

Along with in implementation of very efficient Analytical Hierarchy Process the path optimization algorithm would complement it very well, as well as the proposed optimization algorithm that would enhance and also reduce the waiting time at signal junctions and reach the pickup location or any hospital or health service centers in the minimal amount of time possible. And in future works, we can use Deep Learning for better and optimized results.

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