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Movement of Emergency Vehicles - Using Shortest Path Simulation Method

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Abstract: Emergency vehicles if delayed for a couple of seconds can cause a major loss for some. In this paper, a simulation technique is proposed for movement of emergency vehicles in least time using shortest path .The objective is to direct Fire Brigades and Ambulances from source to destination point in most efficient and effective time. Movement of these vehicles should be safe and vehicles should follow shortest path with least congestion route.
The suggested prototype algorithms successfully control the traffic signals. The emergency vehicle movement path from main service station to accident point and from accident point to hospital is considered in a case study.

Keywords: Global Positioning System, intelligent transportation system, Geographical Information System, Dijkstra's shortest path Method, Automatic movement of emergency vehicle System

I. INTRODUCTION

In this paper proposed technique AMEVS (Automatic movement of emergency vehicle System) help in selecting emergency vehicles from m-Number of Fire Brigades and n- number of Ambulances available in a city. Dijkstra's algorithm is used for directing the shortest safest and least crowded path for the vehicles so that it can reach the accident point in most efficient time. Movement of these vehicles should be in time and safe. This requires routing the emergency vehicle and making traffic control signal as per these Vehicle movements **as mentioned by Aminu A. and Ibrahim in [1].**

This developed technique is called as AMEVS that is Automatic Movement of Emergency Vehicle System. In this paper we explain a case study using AMEVS Technique, and solve a case of Raipur City. Let place of accident is near Agarsen Chowk, Raipur. Main Service Centre is in Santoshi Nagar.

In this case, an emergency vehicle available in main service centre is selected and move to Agarsen Chowk, Raipur. The main server stores database for number of emergency vehicles available in a city or town along With the data of Police Stations and the Hospitals. A large database is created for storing information of Traffic Control Signal (node) available in a Raipur city .Each Traffic Control Signal stated as node consists of a micro- controller GSM Server and a GSM Modem. The position of emergency vehicle is also available to the main server operator (desk person) through GPS.
After receiving information from an informer this system identifies the accident-point, here it is the Agarsen Chowk, Raipur. Collect information of available emergency vehicle and directed it to the destination point using Google Map (GIS).

An Intelligent Transport System (ITS) deploys communication systems in the form of location sensor used in GPS, mobile telephony or wireless network that is GSM. The intelligent transport System offers efficient service which helps in getting instant services for accident spots.
The idea behind this technique is to implement an intelligent transportation system (ITS) in a town or city or state. It would control the traffic light in the path of the emergency vehicles and provide a smooth flow for the fire brigade and ambulance to reach the accident spot in time using shortest path method.

There are two ways for selecting the Emergency Vehicle. One is considering all vehicles available in Main Service Centre. We are using terminology off route Method. Another is selecting Emergency Vehicle available at any place within city. Locating present Emergency Vehicle (On route Method)

II. SHORTEST PATH

Shortest path is a fundamental problem in graph theory. Shortest path problem is a problem of finding a path between two vertices (source and destination). For example to find the shortest way from capital city to another city, then cities are represented as vertices in the map.

The server will find the nearest destination and calculates the shortest path connecting the emergency vehicles current location and the accident spot. The shortest path will contain nodes in the path. The server takes the GPS coordinates of all the emergency vehicles and accident spot. Using the nodes database and finding nearest node from the selected nodes. Emergency vehicles can be directed to move.

Let(X1, Y1) be the initial position of the emergency vehicle and (Xn, Yn) be the final position.

The last coordinate (Xn, Yn) will indicate the accident location that is the destination location. The node next to the emergency vehicles spot and the node in the path to destination must be traced. So that emergency vehicles node(X1, Y1) is taken as source and the accident node (Xn, Yn) is taken as destination and the Dijkstra's algorithm is applied for shortest path finding.

III. DIJKSTRA'S SHORTEST PATH METHOD

Dijkstra's algorithm is an algorithm for finding the shortest path between nodes in a road netwok.It was conceived by computer scientist Edsger W.Dijkstra's in 1956. The algorithm fixes a single node as the "Source "node and finds shortest paths from the source to all other nodes in the graph, producing a shortest path tree.

For a given source node in the graph, the algorithm finds the shortest path between that node and every other node. It can also be used for finding the shortest paths from a single node to a single destination node by stopping the algorithm once the shortest path to the destination node has been determined.

For example, if the node of the graph represents cities and edge path costs represent driving distances between pairs of cities connected by a direct road, Dijkstra's algorithm can be used to find the shortest route between one node and all other nodes or one Traffic Control Signal (TCS) to another Traffic Control Signal (TCS).

Movement from one place to another place within a city can be possible in more than one way. As shown below

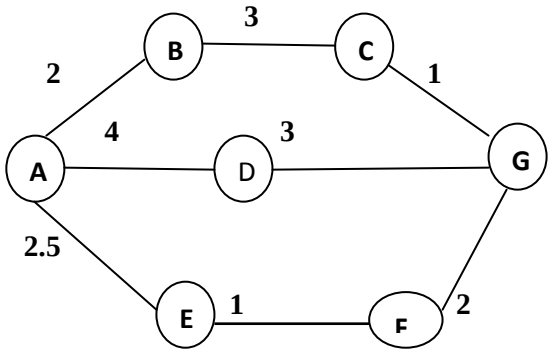

Fig: 1 To Find Shortest Path

Moving Form A ⟶ G node is possible by three paths. That is-

A ⟶ B ⟶ C ⟶ G

A ⟶ D ⟶ G

A ⟶ E ⟶ F ⟶ G

If A, B, C, D, E, F, G are nodes or Traffic Control Signal (TCS). An Edge denotes connecting nodes than as suggested above these are 3 ways to reach from A to G.

Dijkstra's Shortest Path Method algorithm helps to find the shortest path among too there.

IV. CASE STUDY: MOVING EMERGENCY VEHICLE FROM PLACE OF ACCIDENT TO NEAREST HOSPITAL

Let us take the example of Raipur city. An accident occurred near Agarsen Chowk Raipur. One person (informer) informs it to Azad Chowk Police Station. Information from police station is transferred to server and Desk person. This information has been received by main service centre operator. Information of the Place of accident is Agarsen Chowk, nature of accident, injured and burned (that is the Fire brigade or Ambulance both are required) and 4 number of people injured and 4 number of' people burn in collected. The place of accident has to be ascertained from the informant.

Now the operator will have to decide the requirement of emergency vehicle to be sent. For this purpose He will access the availability of required vehicle in Main Service Centre near that is santoshi nagar.

Using GPS will locate the nearest Hospital identified as AIMS Hospital (Fig.1).Using list of available Ambulance and Fire Brigade from server, operator find that ambulance AB [I] and Fire Brigade FB [J] is available in Main Service Centre near santoshi nagar. They are nearest to Agarsen Chowk. He informs available Ambulance AB [I]and Fire Brigade FB [J] the details of accident, place of accident and number of people injured.

Target is set by both the drivers, of Ambulance and Fire Brigade. They will use GPS System to get perfect route with least congestion path using Dijkstra's shortest path method. Now the next important task is to give direction that is shortest path with least congestion route from main service centre to accident point for AB [I] and FB [J].

It means that he will ascertain that there is no congestion on the path; the traffic signal on the path will be controlled automatically using ITS and Google Traffic API. The flow chart and the developed algorithm, program takes care of the situation.

Similar procedure will follow to move the vehicle to the nearest hospital from the place of accident.

As there emergency vehicles reach the accident point i.e. Agarsen Chowk, they pick the injured people. Now the source is accident point (i.e. A.C.) and destination in nearest hospital (i.e. AIMS), Raipur.

Again using Dijkstra's shortest path method driver is directed to follow the best path from accident point to AIMS hospital. Along with is, there are three traffic signal available in path, they are set "green" for emergency vehicle.

There are more than one path between Accident Point and AIMS hospital. Say path one is only 1km and path two is 1.5 km long. Using AMEVS technique and Dijkstra's shortest path method it is found that path two is least congestion. Therefore second path is informed to both drivers and making all signals green of second path.

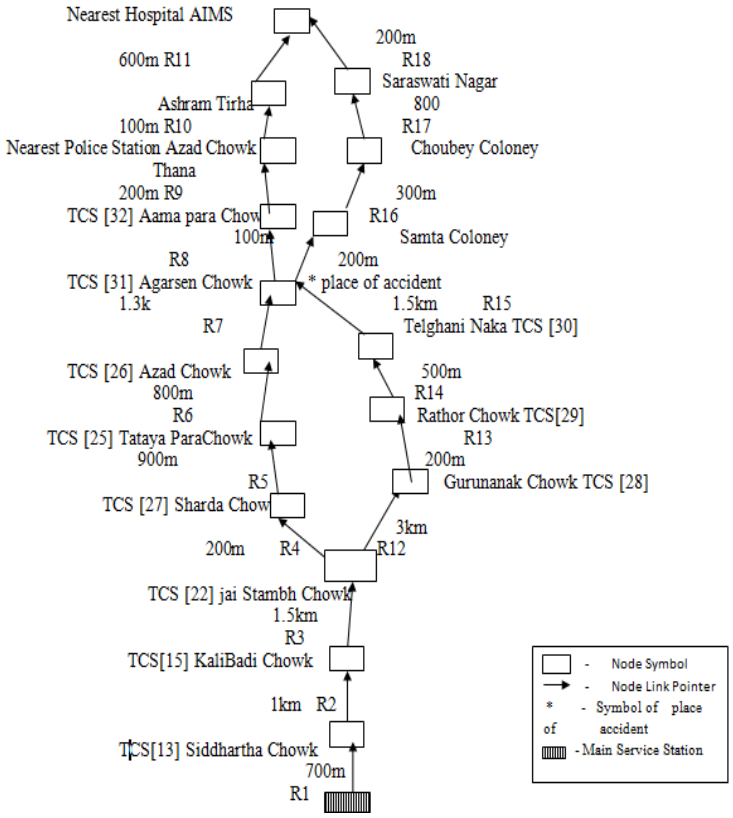

Fig: 1 Moving Emergency Vehicle place of accident to Destination Point

In this case, let shortest path for AmbulanceAB[I] and Fire Brigade FB[J] will be

Main Service Centre → Siddhartha Chowk → KaliBadi Chowk → Jai Stambh Chowk → Sharda Chowk Tataya Para → Azad Chowk → AmaparaTirha → Agarsen Chowk (place of accident)

As well As find shortest path for Ambulance AB[I] and Fire Brigade FB[J] will be

Agrasen Chowk → Aama Para Chowk → Azad Chowk → Ashram Tirha → Nearest Hospital AIMS

And another path can be

Main Service Centre → Siddhartha Chowk → KaliBadi Chowk → Jai Stambh Chowk → Gurunanak Chowk → Rathor Chowk → Telghani Naka Agarsen Chowk (place of accident)

A. DIJKSTRA'S ALGORITHM FOR MOVING EMERGENCY VEHICLE

In this section cerate algorithm find shortest path with least congestion route for Emergency Vehicle Ambulance and Fire Brigade.

Array AB [I]; -------List of Ambulance where I varies from 1-N
Array FB [J]; ------List of Fire Brigade where J varies from 1-M
Array TCS [K]; -------List of Traffic Signal where Main Service Centre represented as... SC
Accident point represented as... AP

Hospital Represented as... H

//Finding shortest path with least congestion route for Emergency Vehicle (Ambulance and Fire Brigade) main station to place of accident//

If AB [I] and FB [J] in SC is 'YES' Then

Direct AB [I] and FB [J] to AP (accident point)

ELSE

Search the free position of AB [I] and FB [J]

//check free AB [I] and FB[J] emergency vehicle //

If AB[I] and FB[J] is "found" Then

Find shortest path for AB[I] and FB[J] to AP(accident point)

If Congestion Path = = 'YES' Then

//Find least congestion path AB [I] and FB [J]//

Move emergency vehicle AB [I] and FB [J] to AP (accident point)

//Make Traffic Signal green for AB[I] and FB[J]//

ELSE

If Road = Crowded Then

// find proposed alternative shortest path for AB [I] and FB [J]//

Move AB[I] and FB[J] to AP

Redirect AB[I] and FB[J] to H

//Make Traffic Signal green for AB [I] and FB[J]//

B. MOVEMENT AS PER DIJKSTRA'S ALGORITHM

Let the node at which we are starting be called the initial node is Main Service Centre that is Santoshi Nagar.Let the distance of destination node is TCS [31] (Agarsen Chowk).The 6.5km distance from the initial node Main service centre to Destination node TCS [31].Dijkstra's algorithm will assign some actual distance value and will try to improve them step by step.

1. In this Fig:1 assign to every node a actual distance value such as Main Service Centre to TCS[13] 700m,TSC[13] to TCS[15] 1km,TSC[15] to TCS[22] 1.5km,TCS[22] to TCS[27] 200m,TCS[27] to TCS[25] 900m,TCS[25] to TCS[26] 800m,TCS[26]to TCS[32] 100m,TCS[32] to TCS[31]1.2km. And set it to zero for our initial node Main Service Centre and infinity value for all other nodes.
2. Set the initial node Main service Centre as current mark. And mark all other unvisited nodes as TCS[13], TCS[15], TCS[22], TCS[27],TCS[25],TCS[26],TCS[32], TCS[31].Create a set of all the unvisited nodes called the unvisited set.
3. For the current place main service centre santoshi nagar , consider all of Its unvisited neighbourTCS[13]toTCS[15]=1km,TSC[15]toTCS[22]=1.5km,TSC[22]toTCS[27]=200m,TCS[27] to TCS[25] 900m,TCS[25] to TCS[26] 800m,TCS[26] to TCS[32]100m,TCS[32]to TCS[31]1.2km. And calculate their actual distance. And compare the newly calculate tentative distance main service center to TCS [13] 700m and TCS[13]to TCS[15]1km and TCS[15] to TSC[22] 1.5 km and TCS[22] to TCS[27] 200 m and TCS[22] to TCS[28] 3km distance the current assigned value and assign the smaller one.
4. When we are done considering all of the neighbors of the current place Main Service Centre, mark the current place Main Service Centre as visited and remove it from unvisited set(TCS[15]------- TCS[31].then move on current place Main service Centre to another unvisited node these process is followed to reach the destination node TCS[31].A visited node will never be checked again.
5. The destination node TCS[31] has been marked visited(when planning a route between two specific nodes initial node Main Service Centre to destination node is Agarsen ChowkTCS[31])or the smallest tentative distance **among the nodes in the unvisited set is---TCS[13] → TSC[15] → TCS[22] TCS[27] → TCS[25]**→TCS[26]→ TCS[32]→TCS[31]

   Infinity value when planning a complete traversal; occurs when there is no connection between the initial node Main Service Centre and remaining unvisited nodes—TCS[13], TCS[15],TCS[22],TCS[27],TCS[25],TCS[26],TCS[32],TCS[31], then stop process.
6. Otherwise,selecttheunvisited node markedTCS[15],TCS[22],TCS[27],TCS[25],TCS[26],TCS[32],TCS[31],that is marked with smallest tentative distance, set it as the new current node such as TCS[15],and go back to step 3

V. CONCLUSION

In this paper a solution is proposed for controlling the Traffic Control Signals in favour of Emergency Vehicles movement at the time of emergency call. With this system the emergency vehicle can be reached to the accident spot without time lag.

Shortest path or alternative shortest paths are proposed using Dijkstra's algorithm. The Traffic Control Signal are identified using proposed path, and marked green as the emergency vehicles reached there.

In the proposed method a green path is made for emergency vehicles movement. In this paper only Off Route method is considered. That means Emergency Vehicles are available at main service centre. So the movement will

be faster from main service centre near that is santoshi nagar to Agarsen Chowk. And Agarsen Chowk to AIMS hospital

AMEVS if implemented in Chhattisgarh State can produce better results.

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