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TRAFFIC ROUTE IN SIMPLEX FORM

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Abstract

This project paper is a solution to the traffic snarls all around the world which create problems for millions of commuters. The system we are developing provides the fastest route to reach a destination after considering the traffic and five other factors on every possible route to that place and also provides the knowledge of traffic density on each road of the world. We have also derived a route ranking equation known as GPSL equation to rank various routes.

Introduction

Traffic is one of the most major problems that we face today and every person who has ever stepped on the road is affected by it, yet there aren't many systems to help the daily commuters navigate the roads smoothly. The Global Positioning System is a very popular means to find the route to reach a place but sadly it does not consider traffic at all. With traffic jams a common sight everywhere and drivers not being aware of which is the fastest route, a system is needed which will provide them with the fastest possible route and also with the information about how much traffic is present on which road even before they step into their vehicles. We kept the grim scenario of jammed roads and frustrated commuters in our minds and have come up with the idea of this system which will give every person about to travel, the complete information about how much traffic is present on every road that a person wishes to know about and also will find the fastest possible route to reach a place. With this kind of information already available to a person his journey on the road would then become heavenly and traveling then would not be such a frustrating experience.

We are developing a system which takes input as source, where a person is present and a destination, where he wishes to go and provide the output as the fastest route to reach that place and thus save time. Also this system will provide information about how much traffic is present on each road so that if a person wishes he can pick the roads he wants to travel for smooth navigation. This system also provides automatic traffic management as a person already knows which roads have lesser traffic and will avoid the busy roads thus saving the already chocked heavy roads of more vehicles and hence the traffic will automatically get distributed. This system will consider 6 factors to find the fastest route unlike the conventional GPS which only considers distance. The six factors are:
(1) Distance, (2) Traffic density, (3) Previous history of route, (4) G.P.S. enabled vehicles, (5) Location and (6) Weather conditions.

Some Terminologies used throughout this Paper

Traffic density: It refers to the amount of traffic on the road. More traffic density means more the number of vehicles occupying the road. More formally – The average number of vehicles that occupy one mile or one kilometer of road space, expressed in vehicles per mile or per kilometer. -

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Dictionary of Military and Associated Terms, US Department of Defense 2005.

Route: Route refers to all the roads that would be taken to reach from one place to another.

Best route: Best route is the route where the traveler takes the least time to commute, or best route may be defined as the fastest route to reach a place.

G.P.S.: The Global Positioning System (GPS) is a global navigation satellite system (GNSS) developed by the United States Department of Defense and managed by the United States Air Force 50th Space Wing. It is the only fully functional GNSS in the world, can be used freely, and is often used by civilians for navigation purposes. It uses a constellation of between 24 and 32 Medium Earth Orbit satellites that transmit precise microwave signals, which allow GPS receivers to determine their current location, the time, and their velocity. Its official name is NAVSTAR GPS.

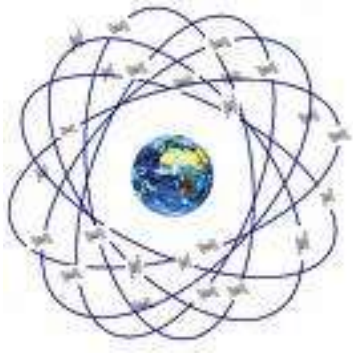

Fig. I – GPS Satellite Navigation.- wikipedia.org

Present Traffic Scenario

One of the major challenges that we face today is finding the best route to reach a destination. Generally shortest route is regarded as the best route to reach a destination which may not always be true. Traffic is one of the biggest problems all around the world today. With traffic jams a very common sight everywhere, it has become a challenge to find roads without traffic. The shortest route has the heaviest traffic most of the times; it may be possible that taking an alternate route in which the distance may be longer but possibly the time taken may be shorter due to less traffic. In an era where time is money, lesser the time wasted in traveling the better it is for anyone. Many systems exist that can tell the shortest route to a place but there aren't many systems that can help us detect traffic density on roads, some that exist are not very reliable resulting in traffic snarls everywhere and frustrated commuters.

Fig. II- Traffic Congestion

In today's scenario everyone wishes for a system that would help a person to find the best route to reach a destination without any hassles. Traveling would then be a wonderful and enjoyable experience. As Robert Frost says – I took the road less traveled by and that made all the difference! This would indeed be true (literally) if a person knows which road is being less traveled and take that road save time and make his journey a wonderful experience. It would be a great boon to regular commuters, if they knew which road to take and which road to avoid. If only they knew which road had how much traffic at a particular time, and what the best routes to reach a place are, their experience on the road would be a heavenly journey. Imagine them sailing smoothly on roads and since they won't be taking any heavy traffic roads, those roads would be free from further addition of vehicles which could've worsened the situation. There would be no need for any traffic management system, since traffic is getting automatically managed as everyone will take low traffic roads. Traffic on every road could be easily monitored and if a road shows consistent heavy traffic, plans like road widening or making flyovers could be implemented to ease the traffic in that particular place. Surely a system like that holds the power to change the world. But how can traffic be calculated on roads? And then on the basis of that how can we calculate the best route to reach a place?

Detailed Project

In this project we will be calculating the best route to reach a place which takes many factors other than distance. With the help of this project we will be able to see the traffic density on each and every road in the world. We can also extend this route calculating method to the Global Positioning System (G.P.S.), so that this project becomes available to people all over the world. The Global Positioning System (G.P.S.) is a very popular and widely used system all over the globe by people to navigate from one point of earth to another. The

conventional G.P.S. calculates the best route to reach a destination on the basis of distance only. If traffic density could also be seen by G.P.S. users it would be a blessing for them.

The best route would be calculated on the basis of the following factors:

1. **Distance:** The distance between two places from different routes is an important factor. If there are many routes to reach a place from a given location, we will have to check the distance of all routes. If the distance between the shortest route and the next shortest route is more than 7kms then there is no need to check any other factor because then taking the shortest route will take the shortest time no matter how much the traffic density is, else if the difference in distances between different routes is less then other factors will come into play.

2. **Traffic Density:** This is a very important factor and makes this project unique. After considering the distance factor, we will check the traffic density on every possible route. Then we would be using the GPSL equation to rank all the routes. If we can find a route whose traffic density is below the set level and its distance is not too much then that route is the best route. We would be calculating the traffic density on different roads by clicking pictures of roads around the world using satellites, periodically and analyzing those images to detect traffic density. Pictures of empty roads will be fed into the database and then compared with the presently clicked pictures. Software can be created which compares the two pictures and determines the change in texture of the road with traffic; more difference in texture means more traffic density.

3. **Previous history of the route:** This can also be a factor which determines the best route. We will have the data about how much traffic a particular route has been having in the past few months and we can predict on the basis of this, the amount of traffic to expect in the future.

4. **Vehicles which have subscribed to the GPS system:** Since this method of detecting traffic is already in use in a few places though not a very useful one, we can also make use of these vehicles with fitted GPS system to help us provide with the flow of the traffic. In this method vehicles are fitted with GPS devices so that their location and speed can be tracked anytime and according to that information, we will know the traffic density and speed of traffic at a particular location where the GPS vehicle is at present. The problem with using only this method is that only a few vehicles are GPS enabled, hence this method covers a very small area, another problem is, it may be possible that the GPS vehicle is currently parked somewhere and the traffic detection system may mistake it for a traffic jam at that area. Hence we will make a limited use of this method only to enhance the accuracy of our system. Our system will check if there are any GPS enabled vehicles on the route and then check their speed on the road, which will tell us how fast the traffic is flowing.

5. **Location:** The location of the route is also important, which areas the route goes through e.g. residential area or industrial area. Generally industrial areas have more traffic than residential areas.

6. **Weather:** Last factor and the least significant one would be the weather conditions, good weather conditions means more traffic.

Equation for Ranking the Various Routes:

$$BSR(G, S, P, L, W) = G + (S)^{1-((n)/d)} + (P)^{1-((n+1)/d)} + (L)^{1-((n+2)/d)} + (W)^{1-((n+3)/d)}$$

G	S	P	L	W
NOT AVAIL. = 0	NOT AVAIL. = 0	NOT AVAIL. = 0	NOT AVAIL. = 0	NOT AVAIL. = 0
<20 = 2	JAM = 2	JAM = 2	INDUSTRIAL =2	BAD =2
>20<40 = 3	MEDIUM = 3	MEDIUM = 3	RESIDENTIAL =3	MEDIUM =3
>=40 = 4	FREE/SMOOTH= 4	FREE/SMOOTH = 4	N/R (INTERMEDIATE)=4	GOOD =4

Table 1. Table for values of various factors

Where,
G= GPS ENABLED VEHICLE FACTOR
S = TRAFFIC DENSITY USING SATELLITE PICTURES

P= PREVIOUS DATA ABOUT TIME OF REQUEST
L = LOCATION OF THE DESTINATION
W = WEATHER FACTOR
D= DISTANCE (IN KM)
FOR d<=5: n=1
For d>5 and <=10: n=2
For d>10 and <=15: n=3
For d>15 and <=20: n=4
For d>20 and <=25: n=5
For d>25 and <=30: n=6
For d>30 and <=40: n=7

G is the average speed of at least 4 vehicles on a route (Speed of the GPS enabled vehicles will be checked). Therefore, from above table, if G<20 then value of G for equation would be 2.

S is the traffic density therefore put conditions for values 2, 3, 4, for example you may put that if traffic density calculated by the program is >20 then S=2. Remember S=4 is the best.

P is the previous data at the time of request. If about a particular route the database has information at the time of request that it s normally heavy traffic at this time or if DB has no info than we will check the time of request that whether its office time or else and then the system will assume or derive value of P as jam/medium/free or smooth therefore if P is jam then value of P for equation would be 2(worst).

L is the location if system can check the destination or places in between the routes are residential or industrial or intermediate then it can also affect the choice of best route. Values can be derived from the table.

W is the weather conditions. Values can be derived from the table.

Points that we consider during the formation of the equation:
1. G is of highest weightage i.e. G will have the greatest effect in choosing best route.
2. Weightage in decreasing order is G>S>P>L>W.

Fig. III - Green lines show different routes to reach a place. Orange spots show traffic congestion. Red spots show severe traffic congestion.

Equation Testing:

Assuming L and W to be 4 that is almost best in 99% cases.

$$\mathbf{BSR\ (G, S, P) = G + (S)^{1-((n)/d)} + (P)^{1-((n+1)/d)} + (L)^{1-((n+2)/d)} + (W)^{1-((n+3)/d)}}$$

(In all calculations below L=W=4)
FOR d=5 => n=1:
BSR(4,4,4) = 12.3893
BSR(3,4,4) = 11.3893
BSR(2,4,4) = 10.3893
BSR(4,3,4) =11.7695
BSR(4,2,4) = 11.1026
BSR(4,4,3) = 12.0251
BSR(4,4,2) = 11.6077
BSR(0,4,4) = 8.3893
BSR(4,0,4) = 9.3579
BSR(4,4,0) = 10.6482
BSR(0,3,4) = 7.7695
BSR(0,2,4) = 7.1026
BSR(0,4,0) = 6.092
BSR(0,4,2) = 7.6077
BSR(0,4,3) = 8.0251
BSR(0,0,0) = 3.0606
BSR(0,0,2) = 4.5763
BSR(0,0,3) = 4.9937
BSR(0,0,4) = 5.3579
BSR(0,2,0) = 4.8017
BSR(0,3,0) = 5.4686
BSR(0,4,0) = 6.092
BSR(0,2,2)=6.3174
BSR(0,2,3) = 6.7348
BSR(0,3,2) = 6.9843
BSR(0,3,3) = 7.4017
BSR(2,2,0) = 6.8017
BSR(2,3,0) = 7.4686
BSR(3,2,0) = 7.8017
BSR(3,3,0) = 8.4686
BSR(2,0,2) = 6.5763
BSR(2,0,3) = 6.9937
BSR(3,0,2) = 7.5763
BSR(3,0,3) = 7.993
For d=12 =>n=3 :
BSR(4,4,4) = 12.8339
BSR(3,4,4) = 11.8339
BSR(2,4,4) = 10.8339
BSR(4,3,4) =12.285
BSR(4,2,4) = 11.6872
BSR(4,4,3) = 12.3901
BSR(4,4,2) = 11.8934
BSR(0,4,4) = 9.8339
BSR(4,0,4) = 10.0055

BSR(4,4,0) = 10.3024
BSR(0,4,0) = 6.2024
BSR(0,0,0) = 3.374
BSR(0,0,2) = 4.965
BSR(0,0,3) = 5.4617
BSR(0,0,4) = 5.9055
BSR(0,2,0) = 5.0557
BSR(0,3,0) = 5.6535
BSR(0,2,2)=6.6467
BSR(0,2,3) = 7.1434
BSR(0,3,2) = 7.2445
BSR(0,3,3) = 7.7412
BSR(2,2,0) = 7.0557
BSR(2,3,0) = 7.6535
BSR(3,2,0) = 8.0557
BSR(3,3,0) = 8.6535
BSR(2,0,2) = 6.965
BSR(2,0,3) = 7.4617
BSR(3,0,2) = 7.965
BSR(3,0,3) = 8.4617

By studying only these two cases it can be derived that

1. Values share a common range. Therefore equation can be used for any limits i.e. we can calculate a common bsr irrespective of values of'd' and 'n'.
2. If bsr >=10.6482 then the route which the system has selected is the best possible route. And we can display the traffic density and other parameters to the users.
3. If bsr>=7.4017 then this route can be taken if the next possible route has a distance difference of less than 7kms.
4. If bsr>=6.5763 then this is the second best possible route.
5. If bsr<6.5763 then user should be prompted not to go and can be shown that there is currently no route which will suit you for travelling right now.

Conclusion

We are calculating the traffic density on every road in the world in an easy way and also finding the best or fastest route to reach a place. First all the different routes to reach a place are calculated. Then there distances are calculated, if the difference between the distances of different routes with the shortest route is more than 7kms then those routes are disregarded. Then the traffic density of each route is calculated. The traffic density is calculated by taking periodic photographs of roads using satellites and analyzing those pictures. Other factors also determine which the best route is. These other factors are previous history of route; GPS enabled vehicles plying on the road, location and weather conditions. The various routes are ranked according to the following equation and the best route is calculated:

The route with the highest points according to this equation is the best route.

Using this simple concept the traffic density on any road can be calculated as well as the best possible way to reach a destination.

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