Shortest-Path: Dynamic and Extensible Indicator for Geographical Search on Road Networks

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Abstract: The reason for choosing this project is to reduce the cost involved as well as reduction in overall time and distance and thereby enhancing the shortest pathway possible to be produced in terms of using proposed Fuzzy logic guided genetic algorithm (FLGA) method to calculate the optimal value, so that we can produce better results in finding a logical and better coherent shortest pathway generation and having proper and efficient scalable index on road networks in solving real-world problems. These days everybody is using location based services to find the possible paths and by using Google maps, we will show the best optimal path amongst the other possible paths. This project deals specifically with the vehicle routing optimization. Since the overall traveled time is not restricted or confined always with regards to a time window constraint, the intention in making this project consists not only the cost involved due to the overall traveled distance, but also the cost involved due to the overall travelling time.

Index Terms: Fuzzy Logic, Genetic algorithm, vehicle routing, optimization, optimal value.

I. INTRODUCTION

The criteria of calculating an optimal path between two locations is a familiar problem in transportation system. Optimal path algorithms are prone to extensive research, in resulting a multiple approach for different conditions and restrictions [5, 3, 2]. The optimal path problem; In transportation system finding the route between source and destination with minimum distance, time, or cost is one of the main key problem. In a more complex problem setting, it arises in a wide range of engineering and scientific problem settings, both as stand- alone models and sub problems [4]. In this paper, Fuzzy Logic guided Genetic Algorithm can be used to find the optimal path problem. Usually, a transportation network is represented by a graph or two locations in a map with more possible connections and in assuming that the path distances are common at all times to as such a transportation network is replaced with a graph each node that is representing a location and each edge represents a path between two locations. Usually, drivers select the shortest path way to reach their destination since they assume that it should take less time to travel the optimal route in a real-world scenario. However, if some kind of events, such as accidents, traffic congestions happens in the optimal route; the overall travel time spent on this route can be much greater than that of time spending on the longest route, so finally users cannot find out which is the best shortest path amongst the other possible paths.

II. EXISTING SOLUTIONS

Many existing networks support queries include three types, mainly shortest path query, KNN search query, keyword-based KNN query on road networks and also, these three queries will not work together at a time in the existing network. [1]. By using this system, it could not consider road and traffic condition based on control centre details and also works based on Dijkstra algorithm, we do not get the path details clearly. Dijkstra's algorithm used to find out the optimal path between two locations on a road network. In 1959 Dijkstra's algorithm introduced by Dutch computer scientist, Edsger Wybe Dijkstra [3] is a graph search algorithm. Dijkstra's algorithm completely works based upon latitude and longitude for time calculation between two places. As stated in the encyclopedia of Management science and Operations Research, it is described as a 'node labeling greedy algorithm' and a greedy algorithm is to explain as a heuristic algorithm that in every step chooses the best choice available in the step without any regard to the further consequence [6].

III. DIJKSTRA'S ALGORITHM

The Dijkstra's algorithm is used to calculate and estimate the optimal path between two interceding points on a network using a connected graph that is made up of nodes and edges. It assigns a cost value to each and every node and set it at zero for the source and infinity for all other remaining nodes. The nodes can further be divided into two different sets based on this algorithm; likely permanent and tentative. As it selects nodes and makes them tentative by examining them and if indeed they pass the criteria, it makes them permanent. The above-mentioned algorithm works in the following steps as mentioned below [8].

1) Begins with the starting node: means it will start from the tree's root.
2) To make it a first permanent node, allocating a cost to source node with '0' is necessary.
3) By inspecting each and every neighbor node of the node to make sure this will be the last permanent node.
4) Allocating a collective cost to each and every node to make it a tentative node.
5) Tentative nodes amongst the list.
    i. Detect the node with the minimum collective cost and mark it as permanent. It will not be checked again, its cost also final.
    ii. In more than one directions If a node could be reached, the direction which is the shortest collective cost can be selected.
6) Steps 3 to 5 will repeat until all the nodes become a permanent one.

To find the optimal path between the source (starting node) and the destination (ending node) if the algorithm is applied to the network in fig.1, starting node is 'a' (1) and the ending node is 'b' (5), the optimal path would be 1-3-6-5 with a cost of 20.

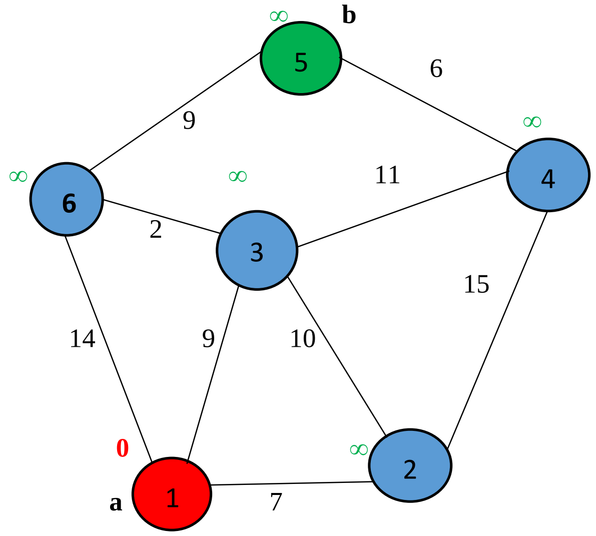

Fig 1. Network topology

IV. OUR CONTRIBUTION

In order to make further enhancement and make a valued contribution to my proposed model, a proposed fuzzy logic guided genetic algorithm can be used to find the optimal path between two locations and by using this technique, we can get the exact distance and shortest path can be produced through internet and by means of Google map and also based upon road and traffic condition including control centre feedback and also of significance in my proposed system is that we can easily get the pathway details including road condition and land marks, also thereby reducing error in distance measurement compared with global land mark embedding, A number of bench mark problems are used to examine its search performance to demonstrate the effectiveness of FLGA. Simulation results show that by comparing it with all other search methods FLGA performs well in all the three different scenarios. The core idea behind this project was by using a method called graph search technique, also called as FLGA (fuzzy logic-guided-genetic algorithm) and using the best computational results carried out in this project. Graph compression and graph online search are the two optimization techniques that will be used and also proposed with the goal of improving query accuracy and reducing index size furtherly. My proposed model will be so effective, so that it can be applied in the real-world scenario and solving the shortest pathways in keeping view of optimal value and the total travel time travelled as well as the cost involved and other factors involved in making this project more successful and viable.

V. ARCHITECTURE

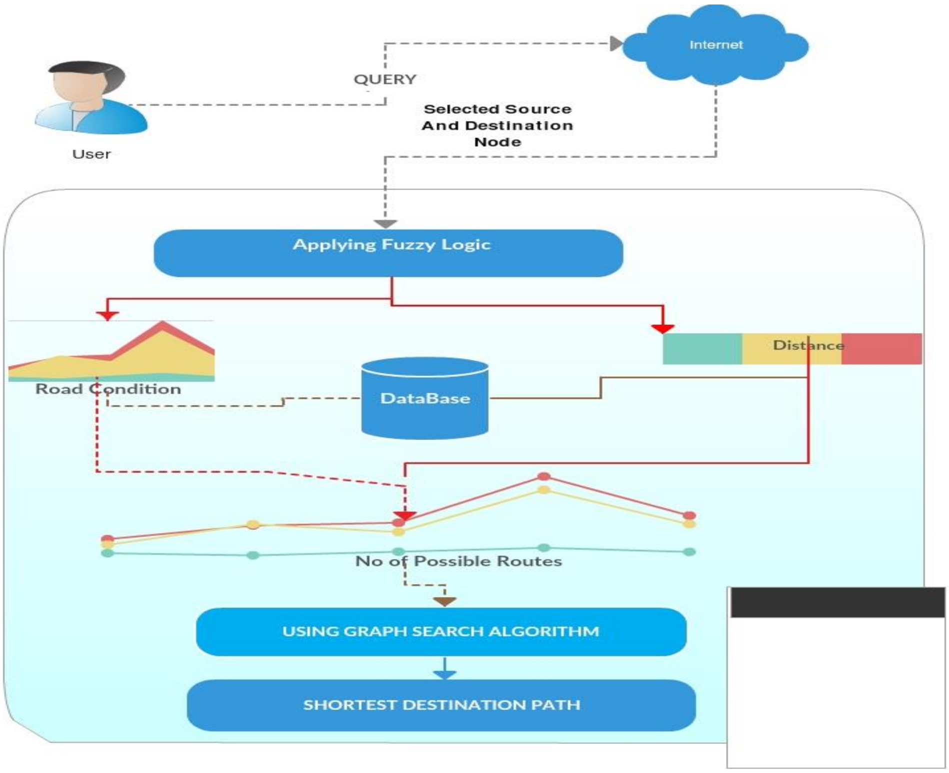

Fig 2. Architecture of Finding optimal route

VI. IMPLEMENTATION

6.1 Fuzzy Logic

To define the Fuzzy logic, it is a mathematical approach for traffic designing and planning of transportation problems to be specific in describing the Fuzzy Logic, it is characterized by four different issues, such as uncertainty, subjectivity, ambiguity, and imprecision. Fuzzy logic systems are introduced to solve various kinds of traffic and transportation planning problems [10]. Transportation planning is a very big challenging problem to be solved in the recent days and while most of the traveling decisions takes place under uncertainty, partial truth, and imprecision. Many models of hard computing could not deal effectively about the transport decision-makers uncertainties and ambiguities. In the past many years, many stochastic and deterministic models have been introduced to solve transportation planning and more complex traffic problems. However, when it comes to solving the real world transportation problems, the information which is linguistic is often used that is frequently hard to find the mathematical and classical techniques. To define, linguistic information means subjective knowledge. The main objective of this logic is to finding the solution of the transportation and traffic planning problem and furtherly to show the direction through research in the field.

6.2 Fuzzy Logic Systems for Transportation

The basic results that are linked to the fuzzy logic development dates back to Zadeh (1973) [9] and Assilian and Mamdani (1975) [11]. "Approximate reasoning" was introduced as a concept method by the above-mentioned authors. Zadeh has effectively showed that the statements that are vague in logical enables the formation of those algorithms that can be used to extract more data from the vague inferences. Zadeh stated that his method of approach would be more beneficial above all that were there up until at that time in the study of many composite humanistic systems.

To further enhance the statement that is mentioned above and to correlate why fuzzy logic systems were developed and utilized for transportation planning problems can be explained in a very logical and coherent manner. Many of the problems that are currently being faced in the field of traffic and transportation planning which are often interlinked are often not defined in a logical and materialistic manner. As already defined and evidenced, many traffic and transportation problems, their phenomena, and their parameters are characterized by subjectivity. It is very hard to ignore the basic fact that instinctive judgement is a factual factor present in problems dealing with the choice of routes, the way of elaborating the method of transportation and carrier, a driver's awareness and reactions and establishing the level of services that are required so that it can be gleaned and used for determining safety standards, in turn, which determines the criteria for effective alternate transportation projects and plan, etc.

6.3 Route choice

The route choice problem has been problematic for many past years in the past in conjunction with the traffic administration problem that has been conceived to be a worldwide problem by a large number of people, who are working to solve the route choice, especially as evidenced by authors that have been mentioned below.

Teodorovic and Kikuchi (1990) [7] were the first ones to solve the complex route choice problem by using fuzzy logic method. They used the so called "fuzzy inference techniques" to study the route choice problem by studying about the binary route problem. Akiyama et al. (1993) [13] also introduced a standalone model for the route choice behaviour based on the reasoning of the fuzzy reasoning approach. Lotan and Koutsopoulos (1993a, b) [15, 16] had also developed models for the same route choice behaviour in the presence of information- concepts by using the distinction from the approximate reasoning and fuzzy control. The research of Lotan and Koutsopoulos (1993a, b) [15, 16] is particularly most important and logical based on within the context of ongoing research, which are to be used in determining and defining the "Intelligent Vehicle Highway Systems" (IVHS). "Teodorovic and Kalic" (1995) [14] has developed an algorithm based upon approximate reasoning to solve the problems in route choice that in turns will help to solve the problems in air transportation, etc. Akiyama and Tsuboi (1996) [12] studied behaviour of route choice by multi-stage fuzzy reasoning.

For example, to say, in a case where a user chooses one possible route amongst the other possible routes between source and destination in navigation system. Distance, road, and traffic conditions are based on control centre feedback, which are the parameters to find the optimal value for all the possible paths. Fuzzy values could be assigned for parameters, then the optimal value could be calculated for all the possible paths between the source and destination through fuzzy logic.

In fuzzy logic model, based on the results of a particular area survey and by taking the help of expert's in this survey the input parameters are determined. In the fuzzy logic, rule-based mechanism is used to get the output parameters and the rule-based mechanism consists of many rules mentions as in the below (table 1)

Distance	**value**	**Road condition**	**value**	**Traffic condition**	**value**
<100 meters =100 meters >100 meters	1 0.5 0	Smooth Normal Bad	1 0.5 0	Less Normal More	1 0.5 0

Table – 1. fuzzy values of the parameters

All the fuzzy values as shown above to be added to get the optimal value for each area based upon the area parameters and after finding all the areas of optimal values, it is need to be added together to get the final optimal value of possible routes between the source and the destination. The possible route has more optimal value than the route as the final optimal route because if one possible route has more optimal value, it means that the route has more smooth road and more traffic less road and distance also will be reduced based upon the road and traffic conditions and it also means that the travel time will be reduced. As said above, my proposed fuzzy logic guided genetic algorithm will select the exact optimal route amongst the other possible routes.

VII. GENETIC ALGORITHM

Genetic algorithms are search algorithms that are introduced in United States by Johan Holland in the 1970's [17]. As shown below, it can be used to find out many problems, which are not easy to solve by other techniques. Primarily, genetic algorithm consists of the three basic operations; selection, crossover, and mutation operations [18].

A global search process is accomplished on a specific population of chromosomes thereby gradually upgrading the population. The search process is constrained by two objectives; one is utilizing the best available solutions and considering that the second objective is the search space. The process of generating the first population is called the 'Initialization.' We use a genetic algorithm to find a problem of unusual possible solutions that will be generated. Each and every one of random solutions will be tested until we find a best solution and then it will be good enough for a specific problem. Fig 3 represents an example of a simple network where various kinds of vehicles were present. In nodes, specifically to say 3 or 7, the transfer does not happen, but the remaining other nodes allows the user to travel from one node to other node.

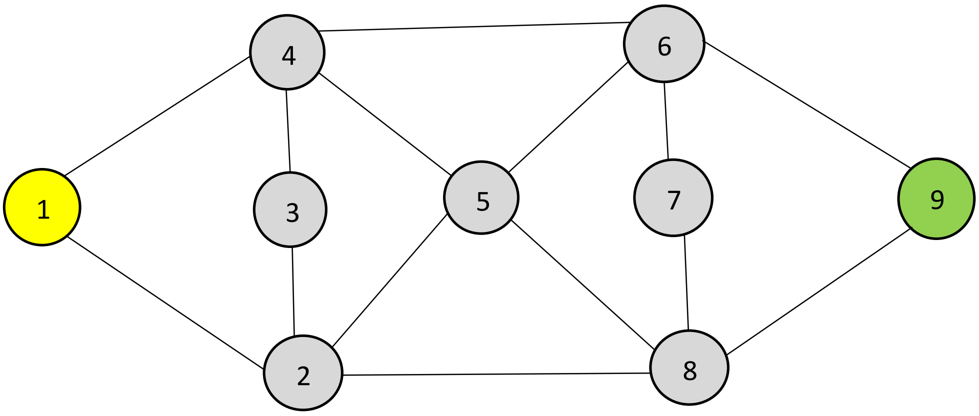

Fig 3. Network topology of genetic algorithm

Representation: A chromosome can be represented from source to destination through linking the nodes. If the starting node is 1 and the ending node is 9, a chromosome can be represented by an array of nodes that include node 1, which is placed in the starting position and node 9, which is placed in the ending position.

Initialization: The initialization means based up on the present population size the initial population of chromosomes are generated. All nodes are initiated randomly for each and every chromosome, as mentioned in the following order.

C1 = (1, 4, 6, 9)

C2 = (1, 2, 5, 8, 9)

C3 = (1, 4, 5, 8, 7, 6, 9)

Evaluation: This definition means that it plays important part in the environment role and specific solutions rating in terms of their fitness and their fitness function evaluation. For example, evaluation function eval for node vectors can be defined by the below-mentioned example, i.e., if C can be as set of total travel time taken from the starting node to ending node, the eval can be stated as,

$$eval(c) = gene\_travel\_time(x) \quad [19]$$

Selection: To upgrade the present population selection process is required that is an existing process. Some of the chromosomes are produced again in the next generation to protect effectiveness of chromosomes instead of participating in the mutation and crossover operations. In this way, those efficient chromosomes can be protected from being deleted in the process. Selection process also includes the process, which is selected from the parent chromosomes for mutation or crossover operations, which is defined in the following section.

Genetic operators (Crossover and Mutation): By the means of crossover and mutation some of the members in the initial population undergo alteration. Crossover means to produce new chromosomes it combines the features of parent chromosomes that is called as "child chromosomes" by choosing a randomly crossover point. For example, if the parent chromosomes are C2 and C3, then a common node (e.g. Node 5) could be selected, after this node for generating new children chromosomes the section of chromosomes are crossed.

C2 = (1, 2, **5**, 8, 9) → C2 ' = (1, 2, **5**, 8, 7, 6, 9)

C3 = (1, 4, **5**, 8, 7, 6, 9) → C3 ' = (1, 4, **5**, 8, 9)

Mutation operation mutates one or more genes value randomly according to the smallest probability of mutation and the mutation used to make some changes on the children chromosomes to make the solution very close to the reality.

If a specific gene is selected as a selective target of mutation, then it can be a thought of a temporary origin and likewise, a chromosome section is created that it reaches the ending point and assuming that the C2 has been identified and selected and third gene, namely Node 5, is selected as a mutation operator, then Node 5 becomes the temporary origin producing a chromosome from this node to Node 9, a new C2 can be created after the mutation in the following order.

C2 = (1, 2, **5**, 4, 6, 7, 8, 9) → C2 '= (1, 2, **5**, 4, 6, 7, 8, 9)

Example of Road map

Fig 4. (a) A piece of the road map (b) Starting and Ending point of the optimal path [18]

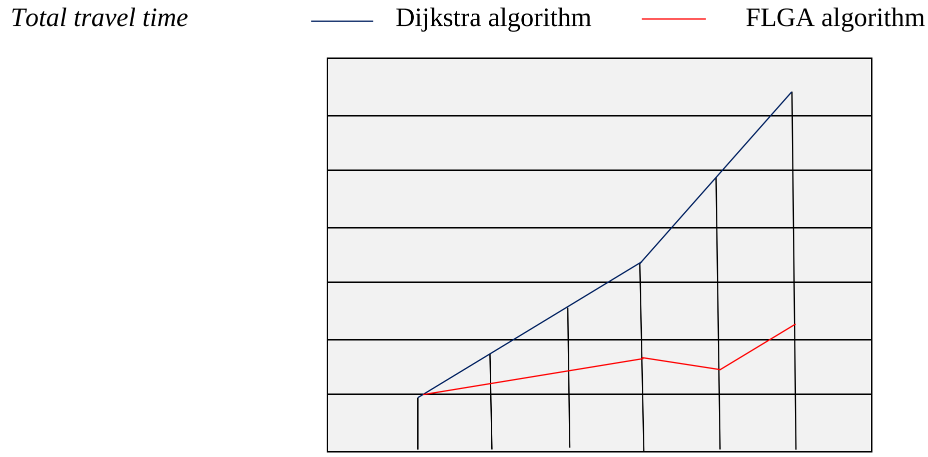

Fig. 5 Travel time comparison

VIII. CONCLUSION

In this paper, as proposed and evident by the above mentioned model, an efficient, scalable, and reliable index on road networks can be derived that is based on the proposed FLGA algorithm method to solve the optimal path recovery issue, which also includes methods and algorithms used for generating shortest pathway possible.

REFERENCES

[1] Ruicheng Zhong, Guoliang Li, Kian-Lee Tan, Lizhu, and Zhiguo Gong, "G-Tree: An Efficient and Scalable Index for Spatial Search on Road Networks", *IEEE Transactions on knowledge and engineering*, 2015.
[2] R. W. Floyd R. W., Algorithm 97: shortest paths, *Communications of the ACM*, Vol. 5, 1962, 345.
[3] E.W. Dijkstra, "A note on two papers in connection with graphs", *Numeriske Mathematics* Vol. 1, pp. 269-271, 1959.
[4] S. Abeysundara, B. Giritharan, S. Kodithuwakku, "A Genetic approach to solve the shortest path problem for Road maps", *Proceedings of the International Conference on information and Automation*, pp. 272-275, 2005.
[5] C. Davies, P. Lingras, "Genetic algorithms for rerouting shortest paths in dynamic and stochastic networks", *European Journal of Operational Research* Vol. 144, pp. 27-38, 2003
[6] M. Sniedovich, "Dijkstra algorithm revisited: the dynamic programming connection", *Journal of control and Cybernetics* 35 (3): 599-620, 2006.
[7] Teodorovic A, D., Kikuchi, S., "Transportation route choice model using fuzzy inference technique", In: Ayyub, B.M. (Ed.), proceedings of ISUMA '90, *The First International Symposium On Uncertainty Modelling and Analysis. IEEE computer press*, College Park, Maryland, pp.140-145, 1990.
[8] B. A. Forouzan, "*Data communications and networking"*, Fourth Edition McGraw Hill, 2007.
[9] Zadeh, L., "Outline of new approach to the analysis of complex systems and decision processes", *IEEE Transactions on systems. Man and Cybernetics* SMC-3, pp.28-44, 1973.
[10] Amrita Sarkar, G.Sahoo, U.C. Sahoo, "Application of fuzzy logic in transport planning", *International Journal on Soft Computing USC*, Vol.3 No.2, May 2012.
[11] Mamdani, E., Assilian, S., "An experiment in linguistic synthesis with a fuzzy logic controller" *International Journal of Man- Machine Studies*, Vol. 7, pp. 1-13, 1975.
[12] Akiyama, T., Tsuboi, H., "Description of route choice behaviour by multi-stage fuzzy reasoning", *Paper Presented at the Highways to the Next Century Conference*, Hong Kong, 1996.
[13] Akiyama, T., Yamanishi, H., "Travel time information service device based on fuzzy sets theory", In: Ayyub, B.M. (Ed.), proceedings of ISUMA '93, *The Second International Symposium on Uncertainty Modelling and Analysis. IEEE computer press*, College Press, College Park, Maryland, pp. 238-245, 1993.
[14] Teodorovic A, D., Kalic A, M., "A fuzzy route choice model for air transportation networks", *Transportation Planning and Technology* Vol. 19, pp.109-119, 1995.
[15] Lotan, T., Koutsopoulos, H., "Route choice in the presence of information using concepts from fuzzy control and approximate reasoning", *Transportation planning and Technology*, Vol. 17, pp. 113-126, 1993a.
[16] Lotan, T., Koutsopoulos, H., "Models for route choice behaviour in the presence of information using concepts from fuzzy set theory and approximate reasoning "*Transportation*, Vol. 20, pp. 129-155, 1993b.
[17] M. Mitchell, An Introduction to Genetic Algorithms: The MIT press, 1998.
[18] SAEED BEHZADI, and ALI A. ALESHEIKH, "Developing a Genetic Algorithm for solving shortest path problem", *WSEAS International Conference on URBAN PLANNING and TRANSPORTATION (UPT'07),* Heraklion, Crete Island, Greece, July 22-24, 2008.
[19] C.jun, "GA-based path finding for public transportation network". *Dept. of Geoinformatics, University of Seoul, Korea.*