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SURVEY OF MULTIPLE DESTINATION ROUTE DISCOVERY PROTOCOLS

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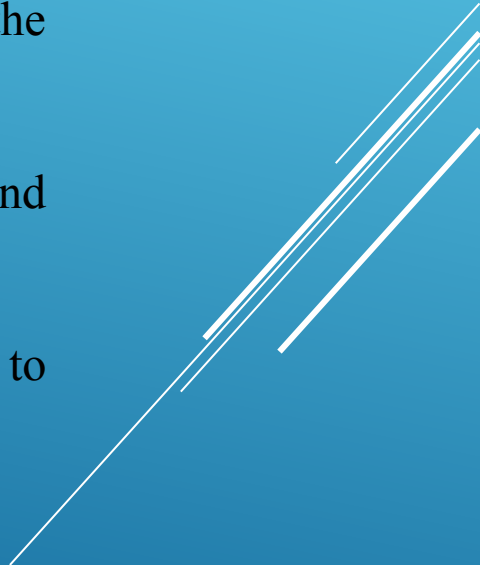- **Conclusion and Future Work**

INTRODUCTION

Smart cities need smart application for the citizen not just digital devices. The smart applications will provide a decision making to users by using artificial intelligence. Many real-world services for online shopping and delivery systems were used and attract customers.

such as: delivery service around the city for restaurants, online shopping needs multiple shipping destinations, route planning for companies and delivery agents, and generating navigation map to help the tourist to visit multiple destination

LAYERS FOR SMART CITY

To have a city with "smart" infrastructure it needs to develop three layers of "smartness" as follows:

▸ The application layer for end users that interact directly with the user and consists of the deployment of smart applications.

▸ The service-oriented middleware layer that process big data and real-time analysis that support smart city applications.

▸ Data acquisition layer base on sensors connected in networks to gather data.

Figure (1): Layers of Smartness

ROUTE DISCOVERY PROTOCOLS

Route planning can be classified mainly into:

▶ **Single destination route planning**

Single destination route planning is based on finding a single destination path from source and usually finding the shortest path is the main target.

▶ **Multiple destination route planning**

Multiple destination route planning is based on finding a many intermediate nodes in the path from source to multiple destinations.
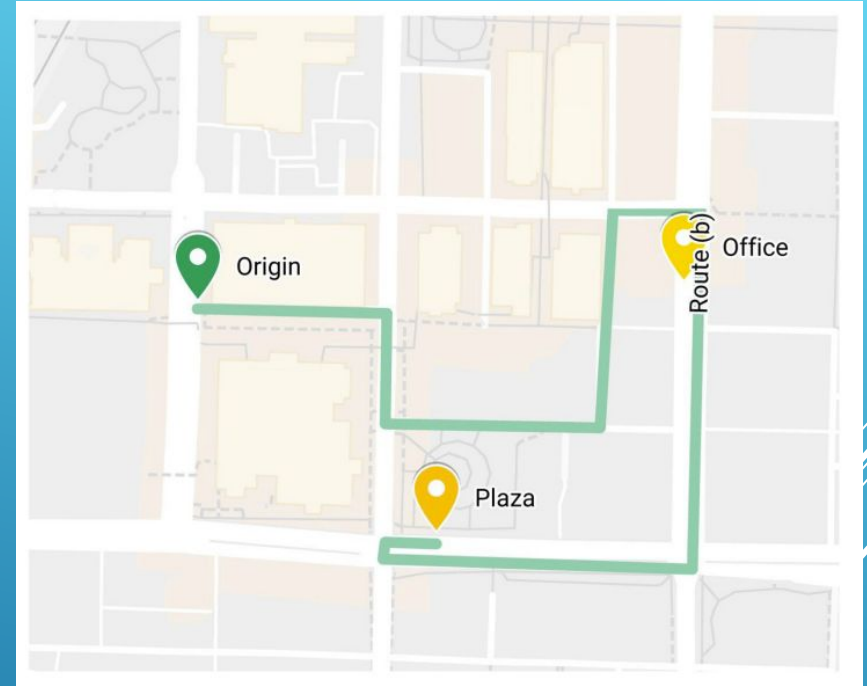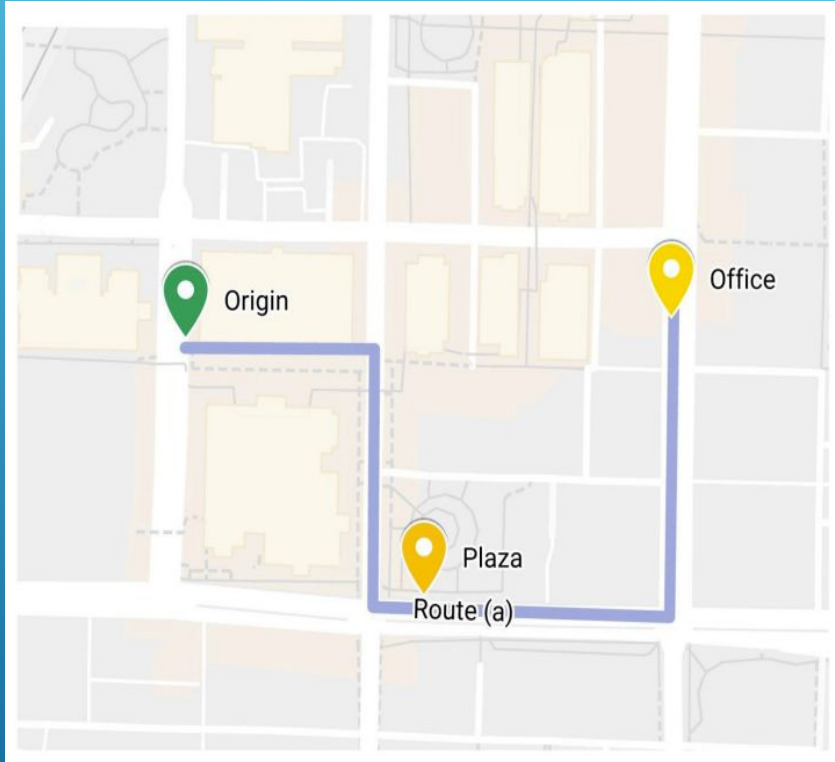
Figure (2): Erbil City - Iraq

Figure (3): Route discovery protocols for multiple destination

AIM OF THE RESEARCH

Route discovery protocols for multiple destination is one of the most interesting research topics since it is applied for real-world applications and needed in smart cities services such as: delivery services. The inclusion of artificial intelligence can improve the performance of multiple destination route discovery protocols. In this paper, we studied and analyzed multiple destination route discovery protocols based on different search strategies especially artificial intelligent methods. The survey compares between multiple destination route discovery protocols relate to its applications and implementation tools.

The main contribution of this work is as follows:

▶ Study and compare different protocols relate to multiple destination route discovery.

▶ Analyze multiple destination route discovery protocols relate to artificial intelligence strategies.

ANALYZE MULTIPLE DESTINATION ROUTE DISCOVERY PROTOCOLS

► Mapping Model

► Search Techniques

► Consider Artificial Intelligence

►Simulation and Tools

MAPPING MODEL

Mapping model represents the search space for the source and multiple destinations. The graph is used to represent the source and multiple destination. In the literature, two-dimensional graph and weight graph are the most used model to map the location of the nodes. Data structure such as tree structure is used in early research. The following section will describe the three most used mapping models.

2D and 2D Grid graph

Two-dimension (2D) graph model is represented as x and y coordinate for each node to have the location of source and multiple destination. The 2D grid graph is used to represent the location of the nodes according to their distance between each pair of nodes.
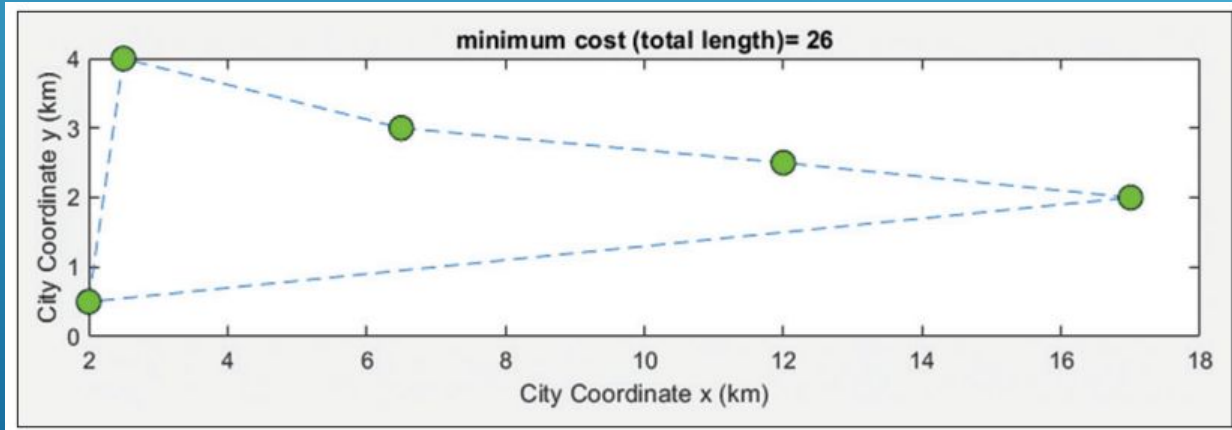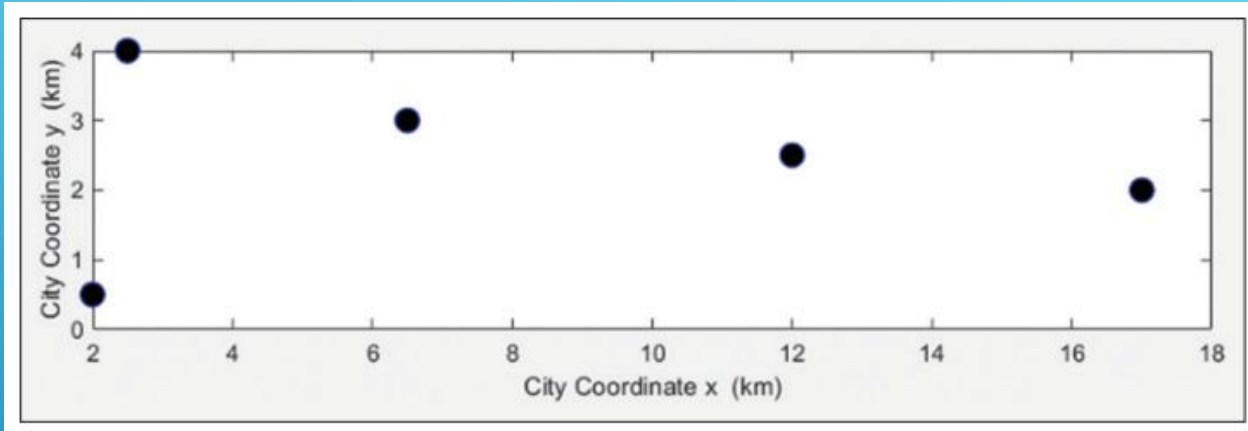
Figure (4): 2D Grid graph

Weight directed graph and bi-directional graph

▸ In graph theory, a directed graph (or digraph) is a graph that is made up of a set of vertices connected by directed edges, often called arcs. Weight directed graph is used for multiple destination route discovery protocols.

▸ A bi-directional graph is a graph in which each edge is given an independent orientation (or direction, or arrow) at each end.

Tree structure

▸ The tree structure is used with data mining and cluster strategy. A new proposal for tree network which is a three-dimensional tree structure is used in modern analysis for network.
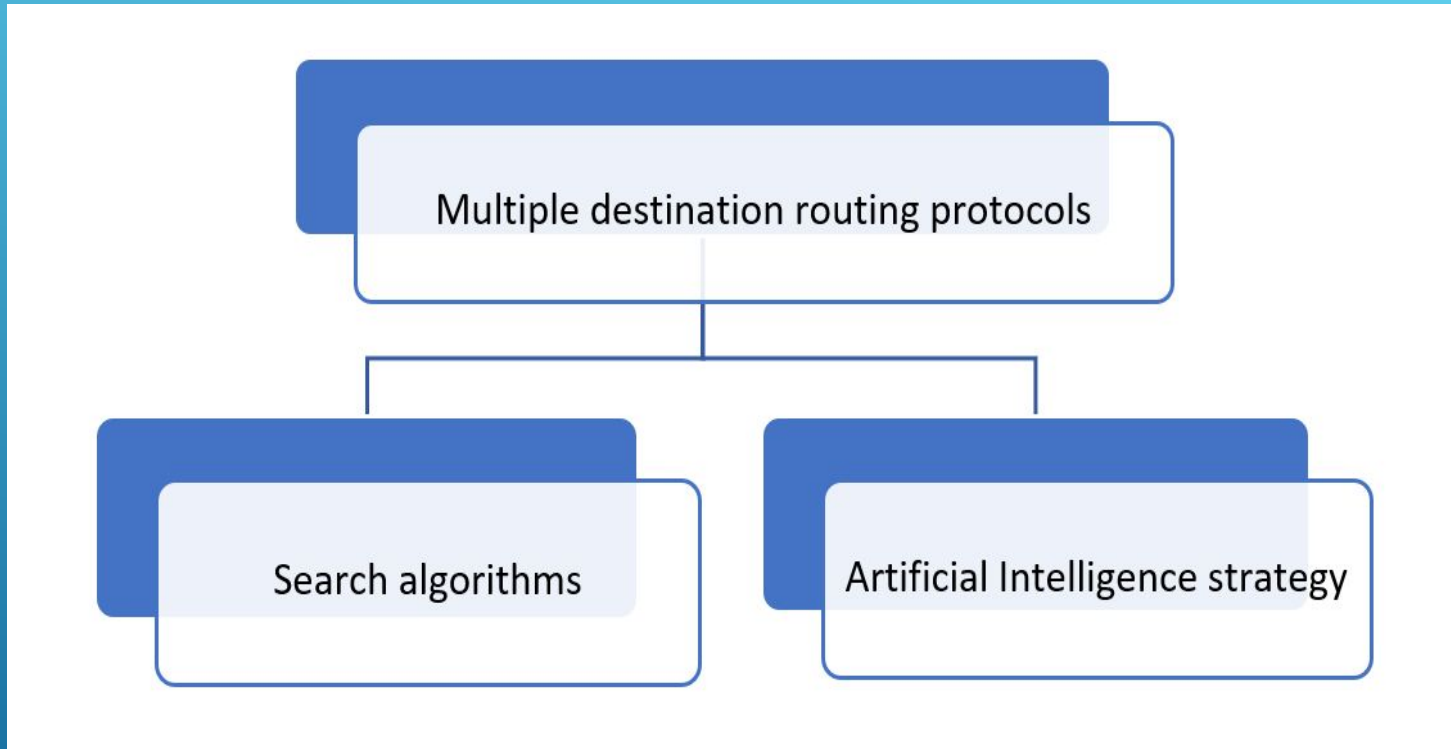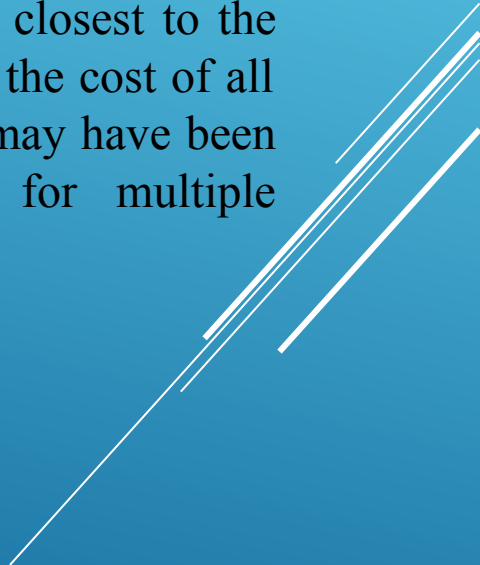
Figure (5): Routing Approaches

SEARCH STRATEGIES

DIJKSTRA ALGORITHM

The Dijkstra's algorithm is an algorithm that finds shortest distance in a given path between the source point to the destination point. Dijkstra's algorithm is an iterative algorithm that choose the source node as the root of the tree, then the node selects one node, among all nodes not in the tree, which is closest to the root, and adds this to the tree. After this node is added to the tree, the cost of all other nodes not in the tree needs to be updated because the paths may have been changed. The researches used modified Dijkstra algorithm for multiple destinations.

A* SEARCH ALGORITHM

It is a searching algorithm that is used to find the shortest path between an initial and a final point in a graph. It will be used for the shortest 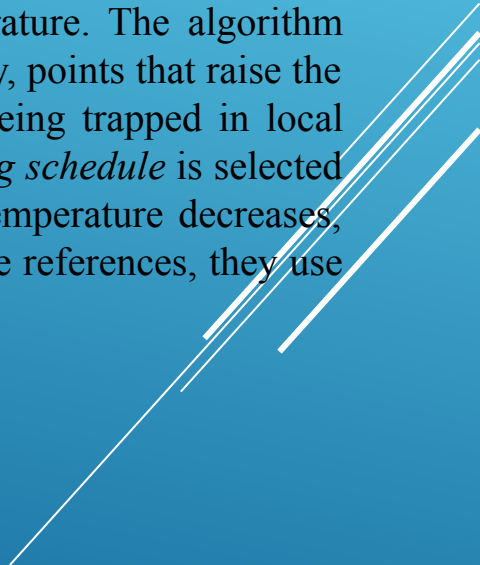path finding. It is an extension of Dijkstra's shortest path algorithm (Dijkstra's Algorithm). In some researches they use A* algorithm.

SIMULATED ANNEALING

Simulated annealing is a method for solving optimization problems. The method models the physical process of heating a material and then slowly lowering the temperature to decrease defects, thus minimizing the system energy. At each iteration of the simulated annealing algorithm, a new point is randomly generated. The distance of the new point from the current point, or the extent of the search, is based on a probability distribution with a scale proportional to the temperature. The algorithm accepts all new points that lower the objective, but also, with a certain probability, points that raise the objective. By accepting points that raise the objective, the algorithm avoids being trapped in local minima, and is able to explore globally for more possible solutions. An *annealing schedule* is selected to systematically decrease the temperature as the algorithm proceeds. As the temperature decreases, the algorithm reduces the extent of its search to converge to a minimum. In some references, they use this concept to find the shortest path with multiple destinations.

TECHNIQUES FOR ARTIFICIAL INTELLIGENCE
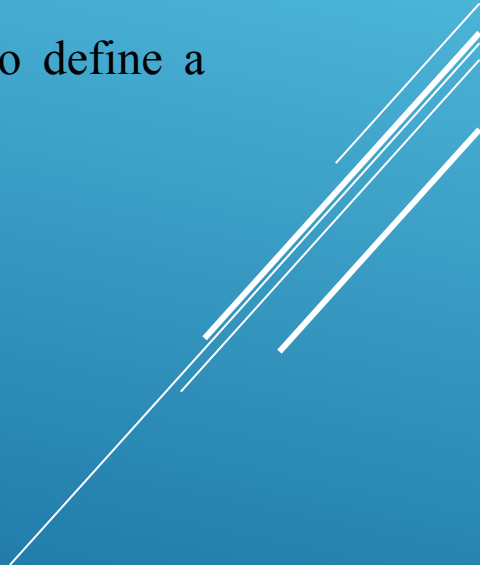
ANT COLONY OPTIMIZATION (ACO) ALGORITHM

Ant colony optimization (ACO) is used to solve optimization problems; then, it is developed to be used for artificial intelligence applications. ACO is based on behavior of ants for finding food. During the ant walk, it deposits pheromone on the ground in order to mark the favorable path and the density of pheromone deposition increases when the ant returns back to the source point with food. In ACO algorithm many ants will travel on different paths at the same time and the optimal path will be found when it has the maximum pheromone deposition. ACO is used in finding the optimal path when multiple destinations are available.
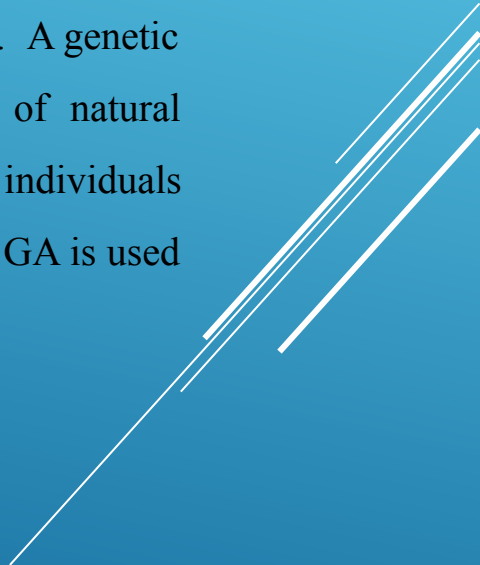
PARTICLE SWARM OPTIMIZATION (PSO)

Particle swarm optimization (PSO) algorithm is based on the natural behavioral observation of birds when they fly and travel as swarm. It uses an iterative methodology to optimize randomly initialized particles to define a path from the initial position to the goal.

GENETIC ALGORITHM (GA)

Genetic Algorithm is a search-based optimization technique based on the principles of Genetics and Natural Selection. It is frequently used to find optimal or near-optimal solutions to difficult problems which otherwise would take a lifetime to solve. It is frequently used to solve optimization problems, in research, and in machine learning. A genetic algorithm is a search heuristic that is inspired by Charles Darwin's theory of natural evolution. This algorithm reflects the process of natural selection where the fittest individuals are selected for reproduction in order to produce offspring of the next generation. GA is used with PSO to implement multiple destination route discovery.

SIMULATION AND TOOLS

► MATLAB software

► JDK1.8

► Java Development Kit (JDK)

► Pseudo code
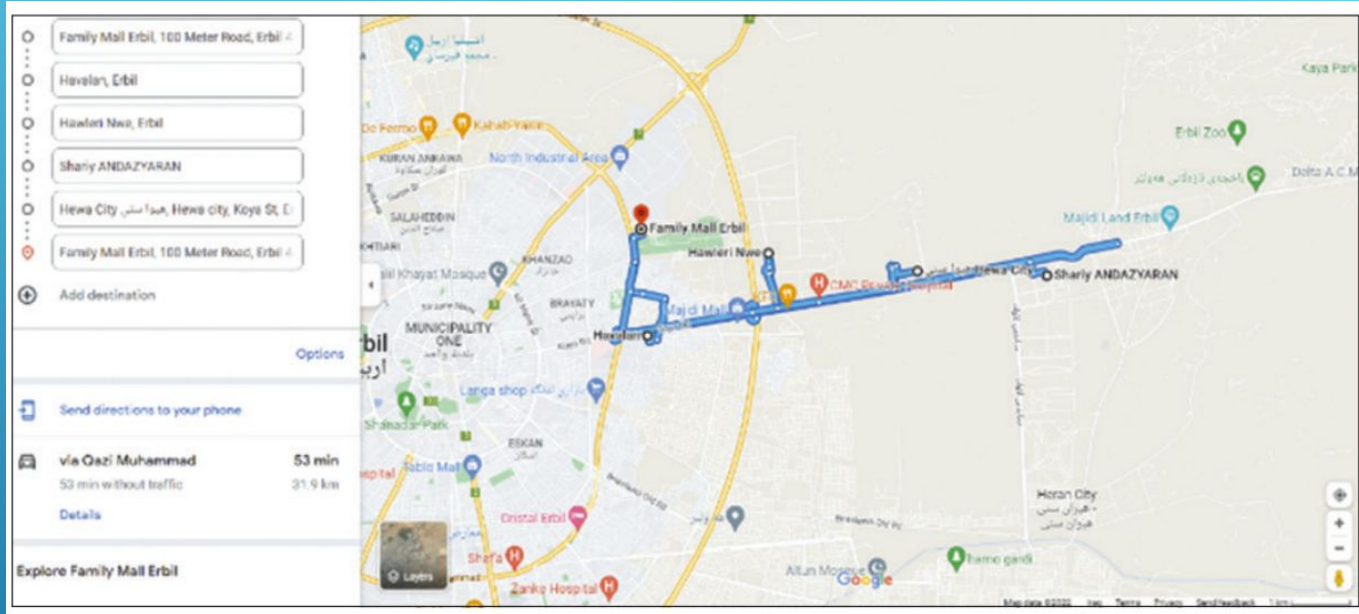
Figure (6): Different multiple path route for five cities from Google map
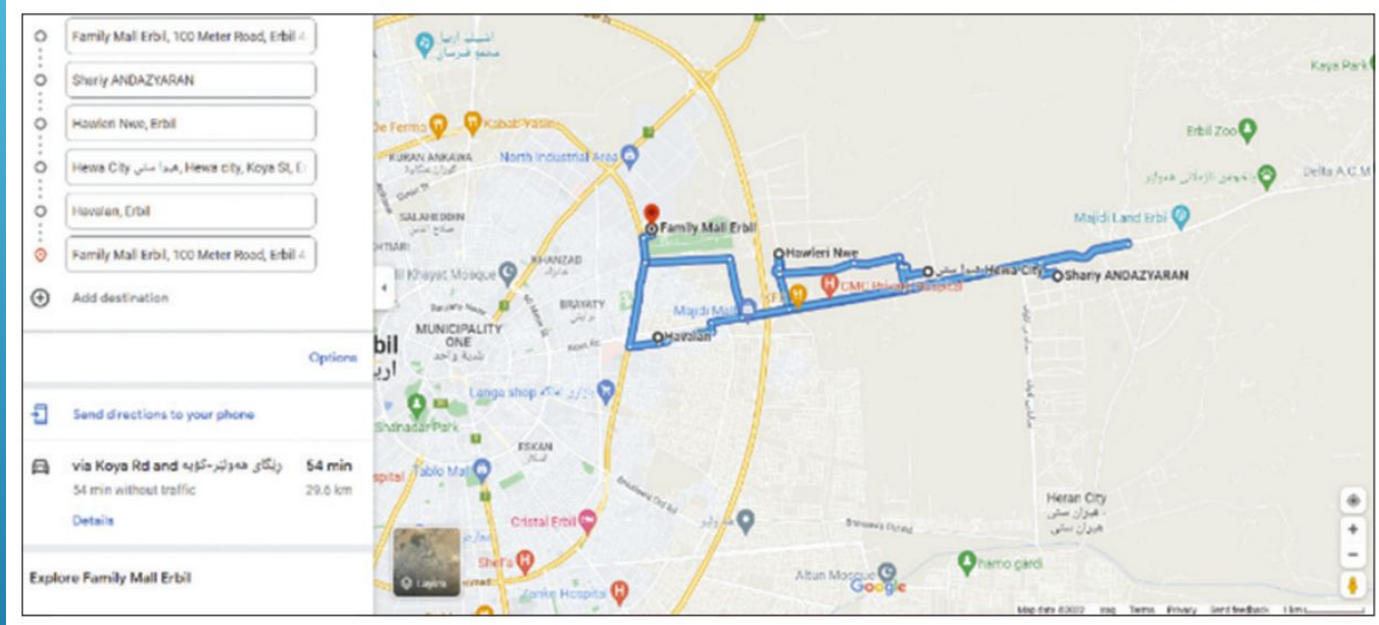
Figure (7): Different multiple path route for five cities from Google map
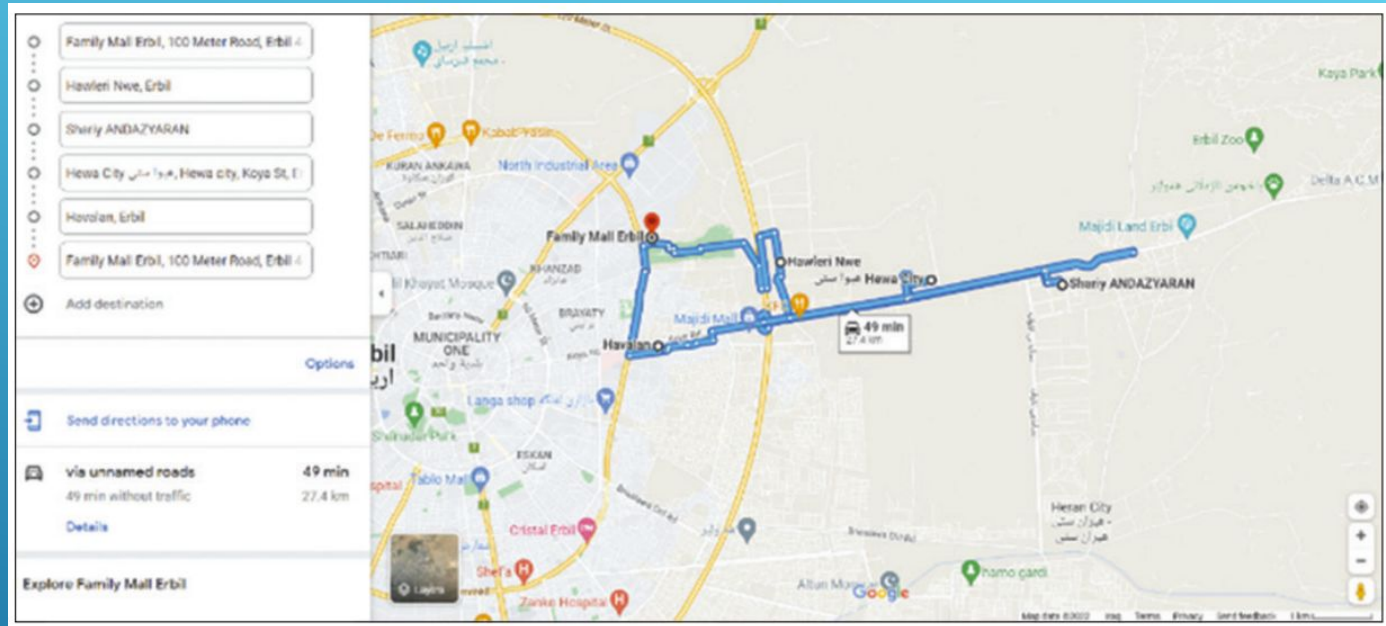
Figure (8): Different multiple path route for five cities from Google map

Route	Multiple destination route	Total distance (km)
Google Map path 1	Havalan, Hawleri New, Shariy ANDAZYARAN, Hewa City	31.9
Google Map path 2	Shariy ANDAZYARAN, Hawleri New, Hewa City, Havalan	29.6
Google Map path 3	Hawleri New, Shariy ANDAZYARAN, Hewa City, Havalan	27.4
ACO *Algorithm for Multiple destination route planning path 4*	Hawleri New, Hewa City, Shariy ANDAZYARAN, Havalan	26

No.	Authors	Aim of Research	Mapping Model	Consider Artificial Intelligence Yes/ No	AI / Search Technique	Consider Optimal Route Yes/ No	Simulation and Tools
1	Reem et al., [4] 2022	Improve Google Map application with artificial decision to develop the route discovery for multiple-destination for the citizen in Erbil city, Iraq	2D graph	Yes	Ant colony optimization (ACO) algorithm	Yes	MATLAB software
2	Timothy et al., [5] 2022	Consider moving obstacles avoidance in the environment when the robot moves and find shortest overall path length for each waypoint to waypoint	Graph- based map	Yes	Improved Particle Swarm Optimization (IPSO) algorithm	Yes	Pseudo code

No.	Authors	Aim of Research	Mapping Model	Consider Artificial Intelligence Yes/ No	AI / Search Technique	Consider Optimal Route Yes/ No	Simulation and Tools
3	Ky Phuc et al., [6] 2021	Solve multiple pickup and multiple delivery vehicle routing problem with time window and heterogeneous fleets	Mathematical model	Yes	Ant colony optimization (ACO) algorithm	Yes	Pseudo code
4	Huang et al.,[7] 2021	Satisfy user multiple requirements relate to cost and time with deadlines	Multi-weight dynamic directed graph	No	Best-first search algorithm	No	JDK1.8

No.	Authors	Aim of Research	Mapping Model	Consider Artificial Intelligence Yes/ No	AI / Search Technique	Consider Optimal Route Yes/ No	Simulation and Tools
5	Zhuang et al.,[8] 2021	Consider obstacles in the environment when the mobile robot finds the optimal path of multiple destinations	2D graph	No	Simulated annealing strategy	Yes	MATLAB software
6	Asaduzzaman et al.,[9] 2021	Consider indoor environment to find the shortest path for multiple destination like in warehouses or libraries when a customer needs multiple items to search	A bi-directional graph	No	Dijkstra algorithm	Yes	Pseudo code

No.	Authors	Aim of Research	Mapping Model	Consider Artificial Intelligence Yes/ No	AI / Search Technique	Consider Optimal Route Yes/ No	Simulation and Tools
7	Abeer et al.,[10] 2019	Consider real-time traffic conditions in the city and free parking places for drivers	Weight directed graph method	Yes	A* search algorithm	Yes	Pseudo code
8	Shushang et al., [11] 2019	Optimize the path of unmanned express vehicles to achieve the shortest logistics path in multiple destinations	2D graph	Yes	Particle swarm optimization (PSO) and genetic algorithm (GA)	Yes	MATLAB software

| No.	Authors	Aim of Research	Mapping Model	Consider Artificial Intelligence Yes/ No	AI / Search Technique	Consider Optimal Route Yes/ No	Simulation and Tools
9	Yu. et al., [12] 2017	Multi destinations route planning with deadlines and cost constraints	Weight directed graph method	Yes	A* search algorithm	Yes	Java JDK 1.8
10	Eric et al., [13] 2011	Use cluster strategy to cluster the destinations into several destination clusters	Tree structure	No	Data mining: Cluster-Based Approximation Strategy (CBAS)	Yes	Java JDK 1.5

CONCLUSION AND FUTURE WORK

► As a conclusion most algorithms used artificial intelligence techniques or hybrid algorithms to improve the planning for multiple destination route discovery.

► MATLAB software is the most simulation software that is used to implement the multiple destination route discovery protocols in addition to Java JDK.

► To measure the efficiency of multiple destination route discovery protocols many metrics could be considered such as: the impact over variate numbers of destinations, the impact of average time interval and the impact of total distance.

► The survey will give a good background to authors to work on new research for multiple destination route discovery protocols.

► For future works, multiple destination route discovery protocols could be used to enhance the mobile applications used for GPS navigator or delivery service in smart city applications.

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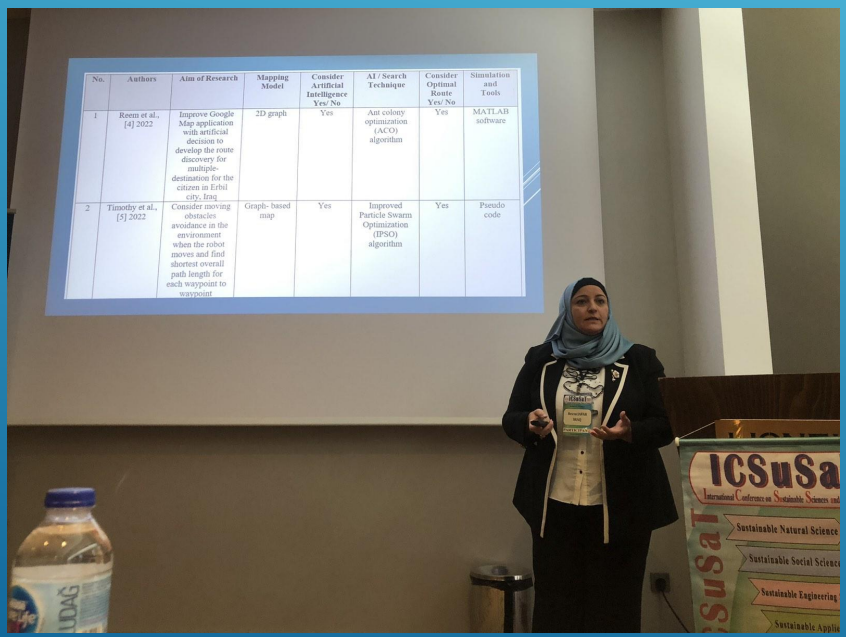
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Dear authors,

Reem Jafar, Sara Raouf and Israa Tahseen

I am pleased to inform you that your paper detailed below has been accepted after peer review processes for presentation in ICSuSaT-2023 and it will be published in abstract book. The conference will be taken place in İstanbul-TURKEY during 14-16 July 2023.

I thank you very much for your interest to ICSuSaT and I look forward to meet you in İstanbul-Turkey.

This letter can also be used for possible financial support from your University-Company, as well as for VISA application in Turkish Embassy.

Title: *Survey of Multiple Destination Route Discovery Protocols*

Theme: *4*

Abstract No: *101*

Presentation type: *oral*

Sincerely yours,

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Prof.Dr. İskender AKKURT
Chair and Organizer of ICSuSaT

THANKS FOR LISTENING