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Road Traffic Management Systems: A Categorization, Assessment, Challenges and Potential Perspectives

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Abstract: *Traffic congestion is one of the major problems in most cities around the world and it leads to many other problems like pollution, waste of time, long traffic queues on roads and can lead to accidents. In real-life situations, the short-haul route to the destination attracts the most people and at times it can increase traffic jam conditions. Therefore, a real-time traffic information is required to make intelligent decisions to decide route preference. Also a system that considers the issue of distance toward the destination with real-time traffic conditions on the route that would add to the solution to the jammed problem. Here in particular water flow algorithm and capitalized vehicle routing problem and fuzzy based embedded systems are better discussed along with their results and condition. This paper outlines the combination of various traffic management techniques with fuzzy logic and there aspects.*

Keywords: Fuzzy Logic, DSS, heuristics, optimization.

I. INTRODUCTION

The massive growth of the population, along with the financial growth and equal monthly installment (EMI) provided by the financial institution, play a major role in the purchase of vehicles and individually. In addition, people use different vehicles to trap people from shorter distances which adds to the increased number of vehicles on the road. Increasing the number of vehicles causes a major problem. traffic congestion. Various other factors which are responsible for traffic congestion, inadequate road space, poor infrastructure and maintenance of roads. Maintenance of roads that have not been extended over time. Traffic congestion leads to fuel wastage, more time consumption and frustration to the driver and passengers. To overcome these problems, an intelligent transport system is required that may include factors such as an adaptive traffic system that controls the duration of the traffic signal according to the traffic present in the intersections, the adaptive route guidance system, and the correct traffic prediction system. We do. Different soft computing methods to model traffic, computing methods, machine learning based algorithms, fuzzy logic have been used. Traffic management are done by various ways which are

1. Traffic Signal Monitoring and controlling
2. Selection of best route by Fuzzy logic
3. Swarm based intelligence system
4. Genetic algorithm based system
5. Multi agent based system
6. Wireless sensor based system

The first technique is FWFA optimization based decision support system for road traffic engineering:

Road traffic engineering is one way to reduce the level of traffic congestion. Where, congestion is a common problem that needs an extraordinary way of solving it [1], especially in the main road network [2] of large cities. The implementation will see a high cost impact. Thus, the engineering strategy has to be executed impartially and preliminarily in a model domain before an actual implementation. Ideologically, several approaches have been introduced to respond to crowd problem research projects conducted in many countries. [3] proposed an approach to reduce motorway traffic congestion by installing an auxiliary lane. They develop a model to simulate the implementation of the solution. [4] implemented expert system for dynamic traffic light control to improve road traffic congestion. In addition, developed a quantitative system analytical model for traffic control. The model was predicted to improve air quality and solve the traffic congestion problem. In addition, [6] constructed an intelligent vehicle

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system to reduce traffic congestion. A method intended to maintain uniform vehicle movements in mineralizing construction. The system was practically based on a mobile device. In addition [7] proposed a solution strategy to reduce traffic congestion with diversion and lane restrictions. Finally, used binary logic models to reduce road traffic congestion and air pollutants.

Goal	Output	Activity	Method
Review Previous study and case	Previous studying and case understanding	Literature review	Research
Collect and analyze the data	Analysis data	Observation, survey and data collection	Specific data collection
Construct the FWFA Optimization Model	FWFA Optimization Model	Expert Judgments and model construction	Fuzzy Logic and Object Oriented Method, WFA

Table 1: Research Activities

This approach presents the creation of a decision support system (DSS) based on the fuzzy water flow algorithm (FWFA) that is used to reduce congestion by selecting a road traffic engineering strategy. Many researchers have previously used the water flow algorithm (WFA) as their main research method, especially in the computer modeling field. [4] began using WFA to optimize the problem of bin packing. Compared to the genetic algorithm (GA) method, WFA was proved to be more optimal. [10] applied the WFA algorithm to segment the text and locate the reference text line. The WFA method was the modified version, specifically the specified angle and unpredictable image frame function enhancement in the values of the expansion of the water flow. [11] also did his research in manufacturing. He used WFA to solve the problem in building the layout of the construction. WFA was sometimes driven to solve the problem of travel sales [12] and to find the shortest route. [13]. And finally, WFA was served as the main method of optimization model in response to road traffic congestion

The main method used in developing the system is the concept of WFA [9] [1] and fuzzy-logic [15]. The WFA operates to model the traffic situation and also to search for the best decision option (through the optimization process). Whereas, the concept of fuzzy-logic is used to standardize and prioritize all the included parameters in the model. Here, we found a decision to look at the urgency of decision choices coming from the point of view of experts. We needed a multi-expert decision and then converted it to a crisp-output value. Values are used as coefficients of decision options

The Object Oriented method [16] was used to document the construction system. The two diagrams explicitly used in this study are the use case and the square diagram. Use case diagrams are used to describe the communication patterns between the system and the actors. Where, actors can theoretically be human and / or system actors. Whereas, the class diagram shows the interrelationships between classes in the system that explain the behavior (characteristics and operations) of the classes.

FWFA is a method that combines the concept of fuzzy-logic and water flow algorithm method. It was used to develop an optimization model that is a part of the manufactured DSS. The best decision was proposed as road traffic engineering to reduce the level of traffic congestion; Where it is related to road traffic velocity. Furthermore, the concept of fuzzy-logic was practically used to improve the value of expert judgment in determining the instantaneous value of a decision option. It was technically linked to the WFA-based optimization model [1] to extend the model. And, the extended model was created to develop the DSS.

The second technique is a water flow-like algorithm for the capacitive vehicle routing problem. The goal of the capacitive vehicle routing problem (CVRP) is finding a useful vehicle route that is a fundamental issue of logistic management. CVRP consists of finding optimal routes to deliver various goods between customers and depots by a fleet of vehicles at minimum travel distances without exceeding the capacity of each vehicle. In many proposed schemes, the meta-heuristic algorithm is a well-known optimization method for solving non-deterministic polynomial-time problems.

Population-based meta-heuristics have shown the ability to achieve an excellent solution in many domains, but consume time. This is due to the nature of algorithms that have fixed multiple solutions, so they suffer from high computation time to reach the solution. Here we discuss water flow algorithms (WFA) to deal with CVRP. It is inspired

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by the natural behavior of water flowing from high level to low level, which is self-adaptive and dynamic depending on population size and parameter settings.

Capacitated Vehicle Routing Problem (CVRP) is a combinatorial optimization problem that has received considerable attention recently as finding an efficient vehicle is an important issue of logistic management. Therefore, effective transportation management can increase competition and reduce the environmental impact of organizations due to more optimal routes and shorter distances. The CVRP was designed for the first time and delivered a set of vehicles with the least cost possible to serve multiple customers with marked demands. The problem merged two non-deterministic polynomial-time (NP) hard problems, the traveling vendor problem and the bin-packing problem (BPP), so CVRP is also NP-hard [15].

Although precise algorithms such as dynamic programming , branch and bound, branch and cut, and branch and value are suitable for small-sized instances, as problems become large and heavily constrained. Not precise methods are long-term suitable for solving the problem and often fail to obtain an optimal solution for computational time [20]. On the other hand, approximate algorithms can achieve satisfactory solutions in competition time, but there is no guarantee of finding a global optimal solution. These algorithms can be classified as classical heuristics and meta-heuristics [12]. Meta-heuristic combines basic inference strategies in high-level frameworks to more efficiently detect search levels. Since these algorithms have good capabilities for locating the search space and indisputably to derive from the local optimum

Several meta-heuristic algorithms have been used to solve CVRP. Meta-heuristics are classified into two classes, single solution and population solution. The single solution analysis is annealing (SA), tabu search (TS) and greedy randomly adaptive search process (GRASP). These algorithms were designed as a single solution search. Population-based solutions are designed as multiple solution searches and their purpose is to direct the search into the state space to obtain satisfactory solutions; An example of population meta-heuristics genetic algorithm (GA) ant colony optimization (ACO) ,and ant colony system (ACS) . Single solution meta-heuristics uses a single solution to search the solution space step by step. Meanwhile, their search may be inefficient due to weakness in solution examination. Therefore, these algorithms are more suitable for problems that have a smooth solution space rather than problems with multiple local optima Population is related to a set of meta-heuristics solutions that can search solution space more efficiently and make space examination more powerful in the problem.

These algorithms are not fast enough to allow an efficient search solution to operate due to a predetermined number of solutions in its nature as a low number can increase the union of the algorithm and reduce solution usage, while a large number of Unnecessary computation and useless search ,because of the fruitless search . Furthermore, determining an appropriate population size during the optimization process is not easy because different problems require unusual parameter settings based on the size of the problem. However, human expertise and time are required to find good parameter values that are both expensive and rare.

Real Water Flow	WFA Algorithm	CVRP
Water Flow	One Solution	Trucks Path
Flow Move	Neighbor solutions	Move, Swap
Flow Altitude	Objective function	Solution distance
Geographic terrain	Solution Space of a Problem	Available Paths

Table: The Analogy between Real Water Flow and WFA Algorithm

This work has presented a basic WFA algorithm for CVRP, which differs from basic meta-heuristic algorithms due to the dynamic and self-adaptive population size of the solution and tuning parameters during the optimization process. This can overcome the drawbacks of both single and multiple solution based algorithms. WFA-CVRP uses random steps for initialization, implementing three neighborhood search strategies for segmentation and relocation, which are (move, swap, and 2-opt operators), and they are randomly selected to generate multiple neighbors from sub flows is basic solution. The experimental results suggest that WFA-CVRP is competitive compared to other algorithms in the literature based on the quality of the solution. WFA for CVRP has several rooms to improve exploration on the decision of segmentation and use after flow merger. For future work, we can use the neighboring neighbor heuristic to

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generate an initial solution. In addition, WFA can be hybridized with other local search algorithms to create a balance between intensification and diversification of the search process.

The third technique is an embedded fuzzy logic based application for density traffic control systems. The control of density traffic on a cross junction road is usually driven by human efforts or the implementation of automated traffic light systems. This system appears to be inefficient and with few challenges. The major constraints of this traffic control are as a result of the inability of most traffic control systems to allocate suitable waiting times for vehicles based on lane density. There is little or no consideration for the priorities of pedestrians, emergency and security agents. In view of this, using an intelligent density traffic control system (fuzzy logic), which is able to give priority to road users, depends on the density and emergency conditions. The system will achieve an estimated amount of respectable vehicle and pedestrian presence on each lane with the help of infrared sensors (IR) and siren detection systems for emergency and safety road users. The function of this system relies on the logic input rules given in the standard processing unit (sensor, S1 and S2), which helps the system generate a time sequence that relates the number of vehicles and pedestrians available on the lane at the point Is most suitable for in time. The obtained results indicate significant improvement, as the average response time of fuzzy rule based density traffic control is obtained, thereby eliminating interruptions or delays at the traffic junction.

The advent of traffic light control mounted on lanes or cross junctions helps to control motorist traffic and reduce road users collisions due to advance technology in the development and implementation of embedded traffic light control systems . Traffic can be defined as the movement of people and goods through a route from one destination to another. In order to meet the day-to-day movement of people through defined routes, the necessary development of an artificial intelligent traffic control system with specified rules that will control the operation of the control system reduces delays and chances of accident occurrence It will be done. Whenever vehicles from different roads try to reach other intersecting routes at the same time. The increase in population and the plight of roads in major cities gives rise to many traffic challenges that are beyond the control of human traffic agents or automated traffic light systems . Various methods have been adopted to ensure the smooth flow of traffic with the use of most common methods; Uniform traffic control agent and electronic traffic control system.

Several methods have been proposed in this area, but most of them have a range of others, leading to the addition of newly proposed techniques. An incorporated infrared (IR) sensor with newly embedded systems has been developed to manage the flow of vehicle traffic at road junctions. The system helps detect the presence of vehicles whenever signals are interrupted by the movement of vehicles between the IR transmitter and the IR receiver sensor. The microcontroller made the decision and updated the delay time based on the vehicle available on the lane. An emergency or safety road user is not well regarded as a pedestrian, proposed a fuzzy traffic control system using fuzzy logic rules and image processing approach to determine the vehicle volume during the red light waiting phase and the frequency of arrival during the GREEN phase. The input logic rule depends on the amount of automobiles on each lane up to the point of intersection using cameras, and the number of detected vehicles is transmitted to the controller for immediate action. Also, a minimum-maximum expulsion process and centroid diffusion strategy are employed to obtain values for the green-light time period as the output.

The number of vehicles on a particular road is determined based on the sensitivity of the position of the sensor in a particular lane. It proves to be efficient, accurate and intelligent based on fuzzy rules and chip programming that is adjustable and reprogramming, reflecting the result of fuzzy rule based traffic control system output at a pre-determined time. Number of vehicles on the road (high, medium or low) traffic scenarios and different times of 15 seconds for high density vehicles, 10 seconds for medium vehicles, 10 seconds for pedestrians, and specified empty lane sequences for different scenarios. For 0 seconds. In addition, priority is given for the arrival of emergency lanes or security convoys. As soon as the siren / sound arrives by interrupting the active lane time and assigns a moderate time of (10 seconds) for their movement, the system performs based on the fuzzy rule, analyzing traffic light control information. Shows a fuzzy logic result for low, medium and high density traffic conditions.

The fourth technique is traffic management using logistic regression with fuzzy logic. The proposed method discusses a machine based on logistic regression with fuzzy logic to make smart decisions about the preferred path in this

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technique. Since there may be a number of paths to reach the destination, first a system will obtain traffic information from Google Maps and route length for each possible path, in this model the user is manually given information about road conditions is. Based on these parameters, the probability for each path will be calculated using the logistic regression method. Fuzzy logic will then be applied considering various parameters of distance, weather conditions and location.

II. Conclusion and Future Work

There many approaches are currently working on road traffic management system some are ridicules according to their working phenomena and some are less effectively working. Therefore Fuzzy based some techniques are discuss here which are used various member function and various parameters. We can improve the techniques by changing the way of working and their method and also the concept of thinking with new trends according to the technology.

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