

Fuzzy Knowledge Base System For Floating Car Data On SUMO

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Abstract— The importance of transportation lies in our daily life in terms of facilitating the transition of people or merchandise from one place to another. Transportation problems (TP) are not easy problems to deal with. The choice of time and means of transportation has become confusing, especially in the periods of study and work in any city where the number of outings and congestion increases, especially at peak hour at the day. So transportation problems cause wasting time, reduces production, and a significant amount of adverse effects on society and residents. These problems are bus scheduling problems, truck routing problems, truck transportation problems, vehicle directing issues, and so on, which cause air pollution, busy roads, and unsuitable roads. There is much research to solve these problems. Our proposed model offers a solution to solve transportation problems using a fuzzy logic technology with traffic simulation. Simulating traffic and transportation and give a fuzzy expert system (FES) helps in finding the best road, the best time of the trip, and avoids some traffic and transportation problems.

Keywords—*transportation problems (TP), fuzzy expert system (FES)*

I. INTRODUCTION

In the past few years, there has been a growing interest in solving traffic problems either by establishing new roads or by providing solutions to avoid congestion. That is considered one of the reasons leading to the rise of the economic situation, also providing a proper traffic system and control of car exhausts.

The problem of transportation is a general problem that we aim to solve to achieve the goal of saving time and effort and reducing the expense of transferring things from one place to another. There are various sorts of transportation problems [1] like maritime transportation, air transportation, land transportation, rail transportation, space transportation, and intermodal transportation. These classes of traffic have a generic name called transportation problems, which have resources, location, and transportation mode as the general parameter of TP. Transportation problems' parameters are as the following:-

- Resources. The resources of those components that can be shipped from sources to goals. Instances of variation assets are merchandise, apparatuses, individuals, payload, machines; associated assets incorporate vitality, fluids, and cash.
- Locations. The locations of purposes of supply, recollection, stop, hubs, railroad stations, transport

stations, stacking port, seaports, air terminals, refueling warehouses, or school

- Transportation modes. The transportation modes are shipping a few assets to areas. The transportation modes us street, water, air, rail, space, and cable.

This paper works on one kind of transportation problem, which is land transportation. Land transportation conveys assets over long, medium, and small good ways from areas to different areas utilizing routes by vehicle or comparative methods for land transportation.

Working on land transportation as an intelligent transportation system means that we work with sensors and other communication technology. However, it is challenging to work in the real-world as it cost much money also lacks users' experience in using the internet of things(IoT) [2]. The proposed model works on the problem throw three main axes simulating traffic using SUMO, Fuzzy Logic expert system, and the combination between fuzzy logic and SUMO.

Simulation traffic using SUMO: Traffic simulation is one of the best ways to give solutions to traffic problems due to the difficulty of following the traffic on nature because of the high cost of the material and technological. So SUMO is the solution of working on transportation with high accuracy as it provides making a network of real roads and works on it.

Fuzzy logic expert system: A fuzzy logic expert system is a gathering of membership functions and rules that are used to think about data. In contrast to the conventional expert system, which is predominantly traditional thinking, a fuzzy logic expert system is going to deal with numerical processing. The rules in a fuzzy logic expert system are generally of a structure like (on the off chance that x is low and y is high, at that point z = medium). Where x and y are input factors (names for realizing data values), z is a yield variable (a name for a data incentive to be figured).

The combination of fuzzy logic and SUMO: In this part, we take the output data of the SUMO as input data to the expert system -we use corvid exsys- to get the expected output, which considers our solution in the proposed model. SUMO executes XML sheets of the simulated network, and we convert it to rules which are considered an input to the corvid expert system tool.

The remainder of the paper will be organized as follows: First, a literature review of the previous work in section II, in section III our proposed model of traffic problem using sumo and fuzzy logic expert system, section IV defines our Results and analysis, and finally the conclusion and future work in section V.

II. LITERATURE REVIEW

Trying to work on traffic and transportation problems is not a natural attempt. It includes many challenging problems and also many attempts to solve it. Many types of research work on an intelligent transportation system depending on the internet of things (IoT), which costs a considerable budget to cover a large area. Also, some of these related work depend on SUMO in the following some of the previous work on the domain of transportation.

Axel et al. [3] address the problem of application-centric mobility-oriented evaluation of VANETs, which influence vehicle movement during runtime by proposing TraCI: Traffic Control Interface, which enables the control of mobility attributes of each simulated vehicle created by the SUMO simulator. It also creates a generic API for controlling a traffic simulator so that a road traffic simulator can be coupled with a network simulator or any other simulator that needs to monitor the road traffic.

Laura et al.[4] build iTETRIS ("An Integrated Wireless and Traffic Platform for Real-Time Road Traffic Management Solutions") determining the state of the traffic in the city of Bologna depending on simulating the area on VISSIM and import the network to SUMO and get data from municipality of Bologna.but it lacks to making control on the traffic of Bologna.

Marie et al. [5] create a realistic SUMO simulation of a small area of Europarc roundabout in the town of Creteil, France, as it finds it difficult to work with real data. It represents an area of 1:1km² around the Europarc Roundabout using OpenStreetMap and works on it, which causes differences between the realistic and the simulated model.

Karl et al. [6] give an outline of monitoring traffic system arrangement of the state Upper Austria, including different information sources from calculated, taxi, and rescue vehicle organizations, just as by the Austrian highway authority. They also use speed samples and traffic counters to generate traffic; the system uses SUMO for providing traffic data on roads where real-time traffic information is unavailable.

Lara et al. [7] build the Luxembourg SUMO Traffic (LuST) is a framework that provides realistic mobility patterns in a mid-size city. This framework depends on public data about the traffic characteristics over the recent seven years and uses SUMO to build a real network much closer to the map, which had been obtained from OpenStreetMap.

Amrita et al. [8] present a new definition in using fuzzy logic with transportation, also discusses some applications of Fuzzy Logic in transport planning like trip generation, trip distribution, The third phase of transport planning named as modal split is intended to know which modes of transportation (bus, train, etc.) are used by how much fraction of people, Route choice and finally Traffic assignment.

Amir et al. [9] propose a calming traffic project using a fuzzy logic expert system. He depends on collect data about the traffic, streets, number of vehicles, and Combines rules, which consisted of four conditional statements connected with 'AND.' The AHP technique was employed to estimate the normalized weights of the variables. Finally, get reports to help decision-makers.

III. PROPOSED MODEL

The proposed model goes to simulate the transportation problems using SUMO (Simulation of Urban Mobility) [10] and support a fuzzy expert system using exsys corvid tool, which gives different solutions for different cases of roads trips. Also, the proposed method introduces a new way of a monitor, manage the traffic of real network from SUMO and TraCI and get information about the vehicles on the network like minimum and the maximum speed for every car on the road, exhaust ratio of each vehicle and which lane on the network that the vehicle takes.

We explain the overall system to implement a realistic simulation of the traffic and transportation system. There are main four axes in the system include traffic simulator, real Roads network, real transportation data, and expert system advisor.

A. Traffic Simulator

SUMO (Simulation of Urban Mobility) [10] is an open-source microscopic traffic simulation package that is widely used in many transportation and vehicular networking projects [11]. In SUMO, vehicle movement is mostly simulated using queue approaches, and single cars are moved between such queues. Also, SUMO offers great grained control over vehicles on the network via the Traffic Control Interface (TraCI). TraCI is a technique for interlinking road traffic and network simulators. It licenses us to control the conduct of vehicles during simulation runtime; TraCI enables us to recover esteem, for example, vehicle speed and fuel utilization, and to manage their states, for example, speed and path evolving [12]. SUMO models driving practices practically with the goal that any significant level control direction would be executed in a manner that complies with severe physical restrictions to keep away from the crash or running the red lights. SUMO uses its NETCONVERT tool to import the OSM map and convert it to the network and keep in mind preserving the features of the roads such as network structures, road grades and estimated speeds (Fig. 1), (Fig. 2).

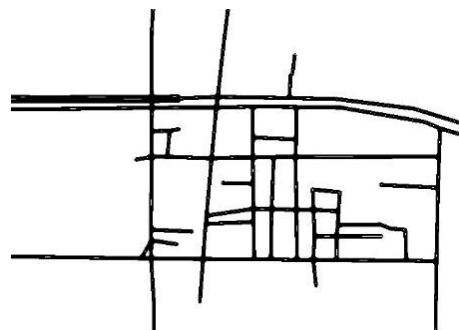


Fig. 1 standard sumo network

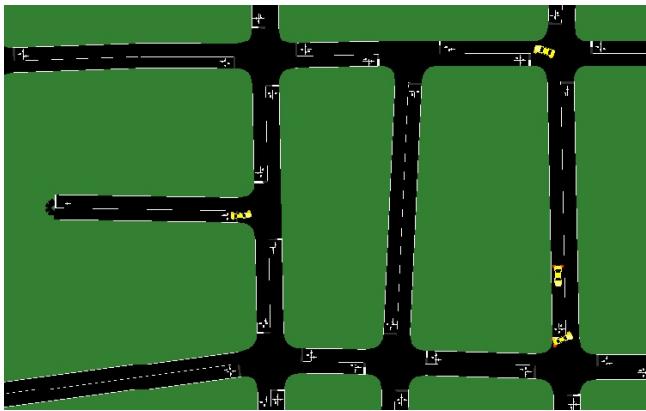


Fig. 2 real-world SUMO network

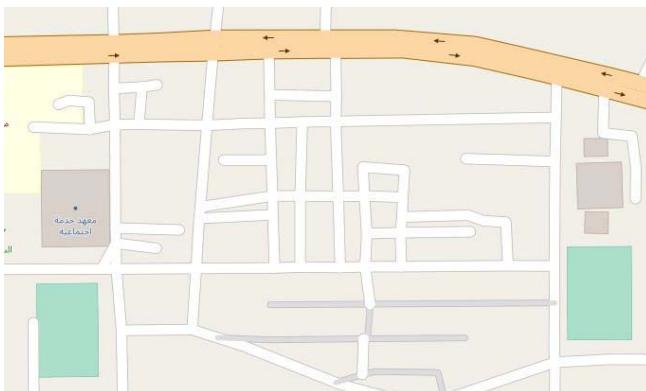


Fig. 3 benha map from OSM

B. Real Roads networks

To simulate traffic and transportation models, we can create a not real network and suppose the number of vehicles, its information, and their trips from node to the other on the network, but we work on a real road network imported from OpenStreetMap (OSM).

To export a map from OpenStreetMap, we go to the site <https://www.openstreetmap.org> determine a region of the place you want and export it in your device (.OSM) (fig. 3), after that use the NETCONVERT [13] command to convert it to SUMO network to start work on it.

C. Real transportation data

To simulate realistic traffic on the sumo road network, we need a real dataset about the region we were imported from OpenStreetMap, but Unfortunately, there are not any datasets about the region we work on. So, we use Quadcopter [14]to collect data about the area like the number of vehicles in the collected roads in the network and the time of traffic conditions.

D. Expert system advisor

After we represent the roads network for real traffic areas using SUMO also, detect and monitor the traffic conditions in this area using Quadcopter, we have two options either get reports for decision-makers or working on management of traffic with TraCI and SUMO. Actually, in this paper, we prefer to help decision-makers using a fuzzy logic expert system [15].

An expert system is like a computer application, and this application is an Artificial Intelligence (AI) application. The role of an expert system is to simulate the human expert in decision-making processes.

Fuzzy expert [16] systems are a mix of input/output guidelines and rules that are utilized to coordinate certainties and data against the given rules. A fuzzy logic expert system usually uses IF THEN rules to think and judge on the processes. Because of the nearness of vulnerability and imprecision in the more significant part of computer engineering fields, fuzzy logic is a helpful technique for building up a specialist framework.

In this paper, we use exsys corvid tool as an expert system tool. in this research we divide the variables are being given to the corvid tool into:

- Static variables like the source, destination and trip time.
- Numeric variables like the number of cars on the roads, cars' velocity and amount of gas in the car tank.
- Confidential variables are the variables that fuzzy logic is depended on like traffic conditions and favorite roads for cars in the network.

Finally, after getting the map from OpenStreetMap and convert it to the SUMO network, the proposed model depends on the output of SUMO as an input to the expert system. It converts the XML Sheets output from SUMO to some of the rules and provides them to the corvid expert system tool (fig. 4) to get the desired output.

The result of this expert system depends on the rules created on the corvid tool, which IF part depends on users given data and THEN calculated using fuzzy logic and, in our system. Large positive confidence numbers express the desired results. For example, see (fig. 5) the probability of taking road1 conf = 80.0. 80.0 means that the best road the cars can take is road one and so on in the following results.

IV. RESULTS AND ANALYSIS

In this section, we will show a sample of the result on the expert system corvid and analysis of floating car data on sumo (fig. 6),(fig. 7).

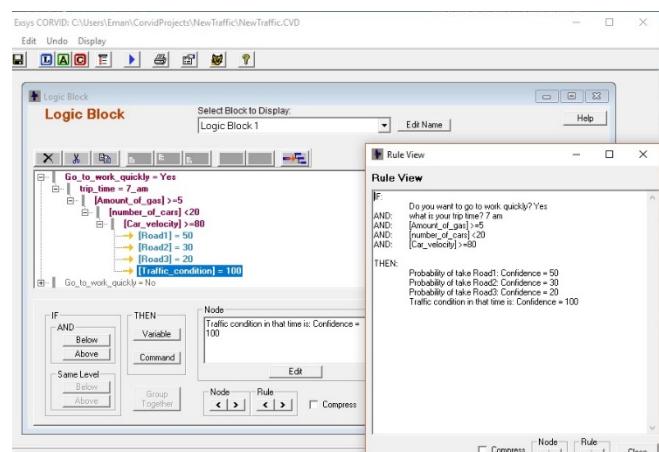


Fig. 3 examples of the logic rule used in fuzzy logic expert system

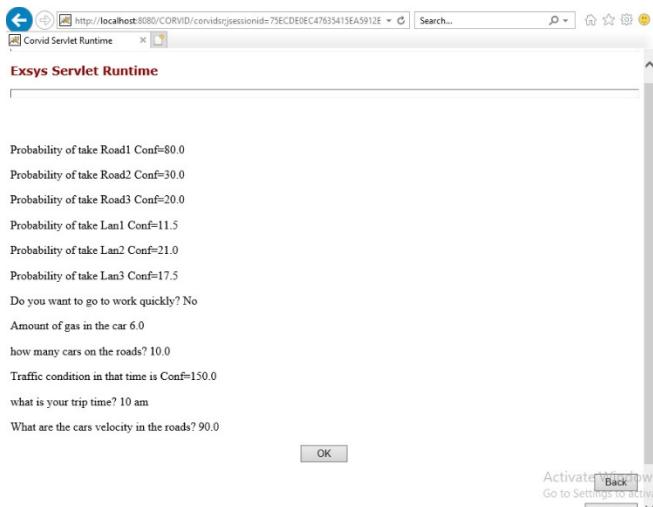


Fig. 4 sample run of corvid expert system

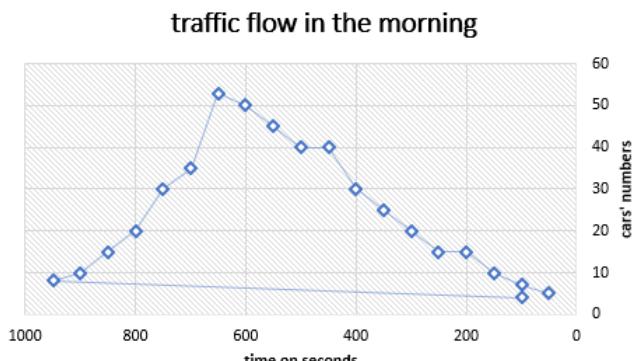


Fig. 5 traffic flow in the morning

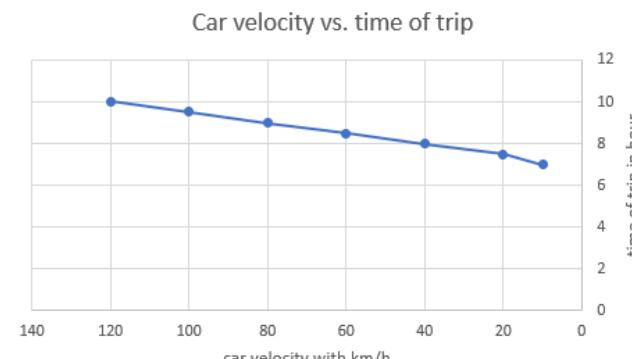


Fig. 7 car velocity vs. time of the trip in the morning

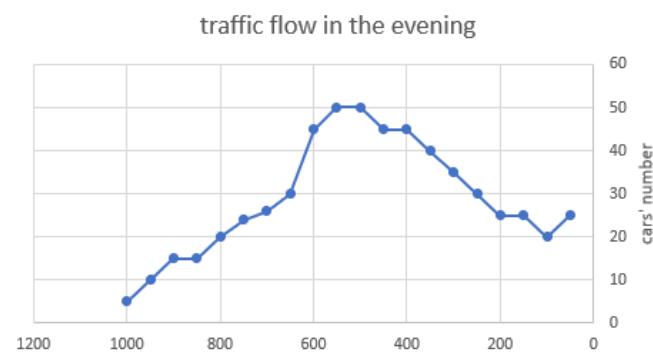


Fig. 8 traffic flow in the evening

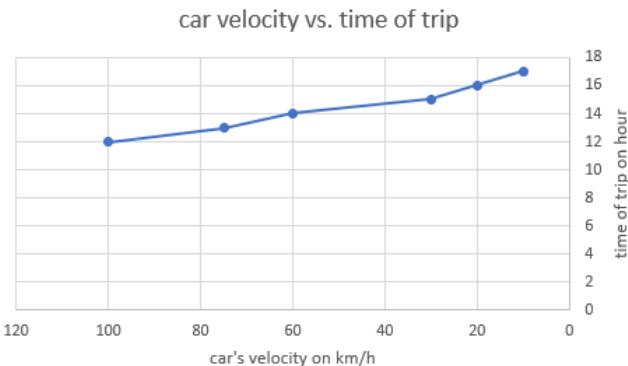


Fig. 9 car velocity vs. time of the journey in the evening

V. CONCLUSION AND FUTURE WORK

Our proposed model works on traffic from a different perspective than all previous researches. We have combined traffic simulation with a fuzzy logic expert system that has enabled us to work on real traffic maps that we get from OpenStreetMap. Then convert it to the SUMO network then assign it with real transportation data given from QuadCopter. Finally, save the simulation output to IF-THEN rules to be an input to the expert system.

In the future, we aim to work on the part of manage traffic and transportation using SUMO and TraCI to develop the algorithms of vehicles' movements.

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