A Microscopic Traffic Simulation Model for Transportation Planning in Cyprus

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Abstract

Traffic management has become an issue of big concern in the last few decades. Especially nowadays living in the information age and the networked digital society the issue of traffic management becomes the main problem of computer networks as well. Traffic simulation is an important tool for analyzing and solving the problem of traffic congestion. Further any suggested solutions regarding traffic control and Intelligent Transportation Systems may be tested using traffic simulation prior to their implementation.

This paper presents the microscopic simulation model development of a major traffic network of Nicosia, Cyprus. Further, the first steps towards validating the model are illustrated. Finally, this paper demonstrates a wider spectrum of understanding on the principles of traffic flow theory and how a traffic flow simulation model is developed and utilized for transportation planning.

1. Introduction

The demand for traffic flow management becomes greater as traffic congestion is causing an increasing number of economic, social and environmental problems in city centers, where a traffic jam is an everyday reality. On a daily basis we are confronted with rush hours, road accidents, air pollution and driver-stress.

Traffic congestion constitutes a complex dynamical problem. It comprises of many complex processes, and incorporates many elements interacting with each other. In such a complex problem situation a simulation modeler can be a very effective tool by providing evaluations for various traffic conditions. It can help policy-makers understand and analyze traffic, assess current problems and propose plausible solutions. Traffic simulation can support transportation planning, and traffic management decision making, for effective corrective actions. The new solutions and techniques can efficiently be tested in a "virtual reality" environment, in the comfort of ones office, without disrupting the road traffic or having to leave for field trials. Effective traffic management and control strategies though, require up-to-date valid simulation test results.

This paper presents the current progress and lessons learned towards the modeling and simulation of an urban traffic network. The work presented in this paper is part of the Trafbus research project, a collaboration between the University of Cyprus and the University of Southern California partially funded by the Cyprus Research Promotion Foundation. The Trafbus research project is concerned with the modeling, simulation and analysis of traffic flow for a major traffic network in Nicosia, Cyprus. Further, the use of automatic control systems, are to be evaluated and tested in a simulated environment for increasing the level of service of the bus transport and optimising traffic flow.

In particular, a simulation model for Strovolos Avenue is developed, which is a main transport artery of the highest significance, since it serves as the connector between Nicosia and a large and heavily populated area of urban and rural communities including Strovolos which is the largest municipal area, Lakatameia, Tseri, Deftera and others.

The Trafbus project is of interdisciplinary nature drawing knowledge from Mathematics, Engineering, and Computer Science and Management. In particular vehicle dynamics and various scenarios of microscopic models of traffic flow including "dedicated bus lanes" and Bus Rapid Transit (BRT) Systems, are to be studied using computer simulation for the purpose of designing more effective and safer traffic networks.

2. The Problem of Traffic Congestion in Cyprus

In 2005 there were more than 500,000 registered vehicles in Cyprus approaching the number of people of the island. This happened as a result of the rapid economic development in Cyprus as well as the concentration of population in urban communities. Further, people turned away from using the bus and use their own private car for daily transportation. As a result, Cyprus cities have serious traffic congestion problems in main arterials and signalized intersections.

According to a recent traffic survey carried out by the newspaper “Politis” the average resident of Nicosia (the Capital of Cyprus) drives for 1 hour and 40 minutes per day for relatively small distances. Further, 76% of the survey respondents declare they have never used a bus. The promising finding was that 57% declare they would use a bus if its quality of service was better.

Even though the Public Works Department of the Ministry of Communications and Works builds more and more roads in order to meet capacity demands the traffic congestion problem becomes worse. And the reason is that we use more and more cars for our everyday transportation. Figure 1 below shows the increasing number of registered cars each year. As seen in Figure 1 the last three decades there was an unprecedented increase the number of vehicles. The number of registered vehicles has increased from 100,000 in 1980 to more than 500,000 by the year 2004, which represent more than a 500% increase in 20 years.

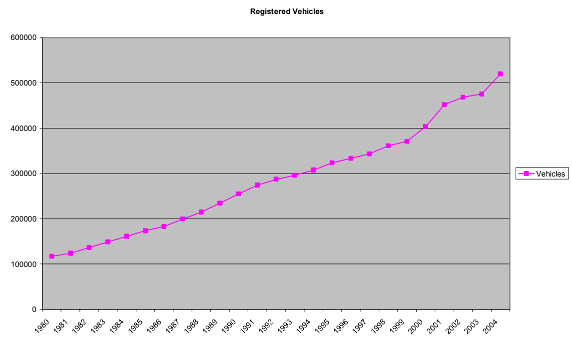

Figure 1: Registered Motor Cars in Cyprus (source: Ministry of Communications and Works, Cyprus).

In addition to the increased number of cars, Fig. 2 below vividly illustrates the problem facing the bus transport mode. From 13 million passengers during the year 1981 we are down to 3 million for the year 2004. This represents more than a 400% decrease in the bus transport use.

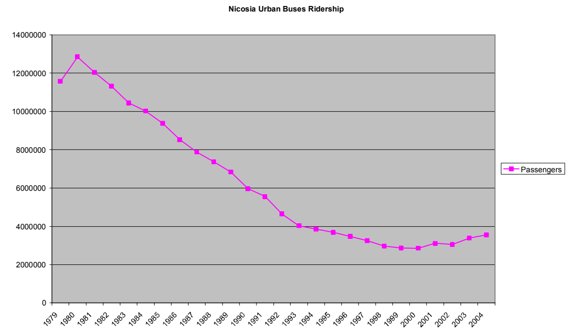

Figure 2: Annual Bus Passengers (source: Ministry of Communications and Works, Cyprus)

Bus passengers are sharply decreasing at the same time as the urban population is increasing. Further, at the same time interval the number registered vehicles is increasing.

Realizing that by building more roads the traffic congestion problem gets worse, the Government of Cyprus and particularly the Ministry of Communications and Works aim for a more modern transport policy. The policy involves restraining the use of private cars, the enhancement of the urban bus transport system and betterment of its level of service, the promotion of alternative means of transport such as the bicycle, and the construction of a modern urban road network.

The traffic congestion problem situation will remain, unless the traffic flow trends and needs are understood and analyzed for deriving effective solutions. Traffic congestion constitutes a highly complex dynamical problem, which consists of combination of factors such as the lack of a modern public transport system, the dependence on the private car, the town structure and the urban environment, the radial road system and the incomplete primary road infrastructure, where simple mental models are not adequate for its analysis [1]. There is a need for more advanced mathematical methods and models in order to analyze the dynamicity and chaotic behavior involved in the traffic congestion problem situation. The following section describes the development of traffic flow theories, which aim to analyze the traffic congestion problem.

3. Traffic flow theory

The mathematical study of traffic flow, and in particular vehicular traffic flow, is carried out with the aim of understanding and assisting in the prevention and remedy of traffic congestion problems. The first attempts to give a mathematical theory of traffic flow dated back to the 1930s [2,3], but even until today we still do not have a satisfactory and general mathematical theory to be applied in real traffic flow conditions.

This is because traffic phenomena are complex and nonlinear, depending on the interactions of a large number of vehicles. Moreover, vehicles do not interact simply following the laws of physics, but are also influenced by the phsychological reactions of human drivers. As a result we observe chaotic phenomena such as cluster formation and backward propagating shockwaves of vehicle density [4]. Further, large fluctuations in measured quantities such as the velocity of vehicles occur depending on the traffic conditions.

Mathematical models for traffic flow may be classified as: Traffic Stream Characteristics Models, Human Factor Models, Car Following Models, Continuum Flow Models, Macroscopic Flow Models, Traffic Impact Models, Unsignalized Intersection Models, Signalized Intersection Models and Traffic Simulation Models.

Traffic Stream Characteristics [5] theory involves various mathematical models, which have been developed to characterize the relationships among the traffic stream variables of speed, flow, and concentration.

Mathematical modelling of Human Factors [6], deals with salient performance aspects of the human element in the context of the person-machine system. These include perception-reaction time, control movement time, responses to traffic control devices, to the movement of other vehicles, to hazards in the roadway, and how different segments of the population differ in performance. Further, human factors theory deals with the kind of control performance that underlies steering, braking, and speed control. Human factors theory provides the basis for the development of Car Following Models.

Car following models [7], examine the manner in which individual vehicles (and their drivers) follow one another. In general, they are developed from a stimulus-response relationship, where the response of successive drivers in the traffic stream is to accelerate or decelerate in proportion to the magnitude of the stimulus.

Car following models recognize that traffic is made up of discrete particles and it is the interactions between these particles that have been developed for fluids. Continuum models [8] are concerned more with the overall statistical behaviour of the traffic stream rather than with the interactions between the particles.

Macroscopic Flow Models [9], discard the microscopic view of traffic in terms of individual vehicles or individual system components (such as links or intersections) and adopt instead a macroscopic view of traffic in a network. Macroscopic Flow Models consider variables such as the distance travel per unit area, the length or area of roads per unit area of city and the weighted space mean speed.

Traffic Impact Models [10] deal with traffic and safety models, fuel consumption models and air quality models. Traffic and Safety Models describe the relationship between traffic flow and accident frequency.

Unsignalized Intersection Theory [11] deals with the gap acceptance theory and the headway distributions used in gap acceptance calculations. Traffic Flow at Signalized Intersections [12] deals with the statistical theory of traffic flow, in order to provide estimates of delays and queues at isolated intersections, including the effect of upstream traffic signals.

Traffic simulation modelling [13] deals with the traffic models that are embedded in simulation packages and the procedures that are being used for conducting simulation experiments.

Further, traffic flow simulation should be viewed from the perspective of incorporating the use of automatic control systems in the modelling process [14]. In an interesting discrete event traffic flow model Chien et al [15] design analyze and simulate a macroscopic traffic density controller for an automated highway system for optimising traffic density.

To summarize, the problem of traffic flow may be approached mathematically in mainly three ways, corresponding to the three main scales of observation, microscopic, macroscopic, and mesoscopic.

In a microscopic scale every vehicle is considered as an individual, and therefore for every vehicle we have an equation, that is usually an Ordinary Differential Equation.

In a macroscopic scale we use the analogy with fluid dynamics models, where we have a system of Partial Differential Equation which examines properties such as the density of vehicles or their mean velocity.

In mesoscopic or kinetic scale, which is an intermediate level, we define a function f(t,x,V) which expresses the probability of having a vehicle at time t in position x which runs with velocity V. This function, following methods of statistical mechanics, can be computed solving an integro-differential equation, like the Boltzmann Equation.

The choice of the appropriate model depends on the level of detail required and the computing power available. As a result of the advent in computer technology today the trend is towards utilising microscopic scale mathematical models, which utilize human factors and car following models according to the above classification.

Traffic simulation software modellers exist corresponding to the above three scales as discussed in the next section. For a more detailed review on mathematical models of traffic flow please refer to [16].

4. Vissim a Microscopic Software Simulation Modeler.

Vissim is a simulation tool for the design of traffic actuated control systems. It is a part of PTV Vision Suite which includes Visum, a macroscopic simulation software tool. Vissim is a microscopic tool, since it employs individual vehicle modelling. It has many applications, but it is mainly used to analyze traffic of various alternative road designs which include both urban and highway configurations. Further Vissim is capable of modelling various vehicle types such as cars, buses, light and heavy rail, trucks, bicyclists and pedestrians.

The system architecture of Vissim consists of two separate programs, the traffic flow model and the signal control model, as shown in Figure 3.

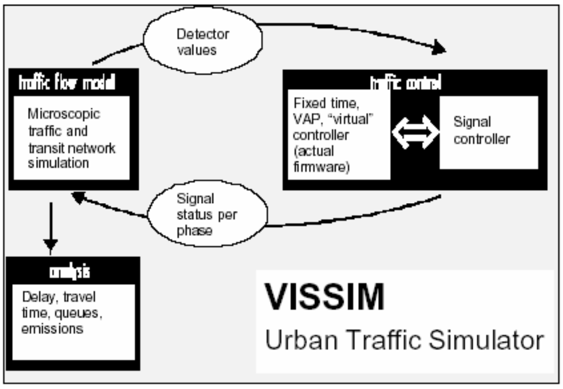

Figure 3: System Architecture of Vissim (source: PTV AG)

Major areas of application of Vissim are in transit signal priority studies, and intersection design and operations [17]. Other applications include the development of vehicle actuated signal control strategies and evaluation of different traffic network layouts involving public transport, which is the main subject of the model developed in this paper.

The traffic flow model in VISSIM is a discrete, stochastic, time step based, microscopic model with driver-vehicle-units as single entities. The modeller incorporates a psycho-physical car following model for longitudinal vehicle movement and a rule-based algorithm for lateral movements. Vissim was developed during the 1970s, in the University of Karlsruhe in Germany. It is based on the model of Wiedemann [18, 19] as shown in Figure 4 below.

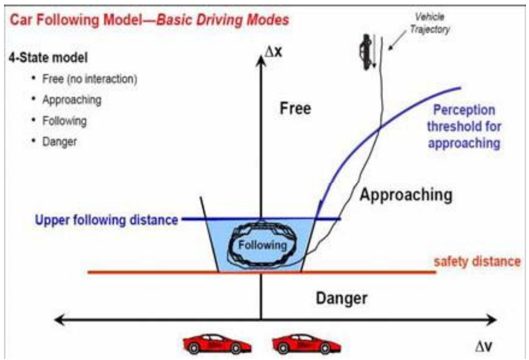

Figure 4: Wiedemann Psycho-physical Model (source: PTV AG)

The basic idea of the Wiedemann model is the assumption that a driver can be in one of four driving modes: the free driving mode, the approaching mode, the following mode and danger or brake mode.

In the free driving mode the driver is not influenced by the preceding vehicles observable. In this mode the driver seeks to reach and maintain a certain speed, that's the driver's individually desired speed. In reality, the speed in free driving cannot be kept constant, but oscillates around the desired speed due to imperfect throttle control.

In the approaching mode the driver's own speed is adapted to the lower speed of a preceding vehicle. While the driver is approaching a preceding vehicle, the driver applies a deceleration so that the speed difference of the two vehicles is zero in the moment the desired safety distance is reached.

In the following mode, the driver follows the preceding car without any conscious acceleration or deceleration. The safety distance is kept more or less constant, but again due to imperfect throttle control and imperfect estimation the speed difference oscillates around zero.

Finally in the danger or braking mode, the driver exercises medium to high deceleration rates if the distance falls below the desired safety distance. This can happen if the preceding car changes speed abruptly, or if a third car changes lanes in front of the driver.

For each mode, the acceleration is described as a result of speed, speed difference, distance and the individual characteristics of the driver and the vehicle. The driver switches from one mode to another as soon as he reaches a certain threshold that can be expressed as a combination of speed difference and distance. For example, a small speed difference can only be realized in small distances, whereas large speed differences force approaching drivers to react much earlier.

The ability to perceive speed differences and to estimate distances varies among the driver population, as well as the desired speeds and safety distances. Because of the combination of psychological aspects and physiological restrictions of the driver's perception, the model becomes a psycho-physical car-following model.

Essential to the accuracy of a traffic simulation model is the quality of the actual modelling of vehicles, that is, the methodology of moving vehicles through the network. The basic concept of Wiedeman's model is that the driver of a faster moving vehicle starts to decelerate as he reaches his individual perception threshold to a slower moving vehicle. Since the driver cannot exactly determine the speed of that vehicle, his speed will fall below that vehicle's speed until he starts to slightly accelerate again after reaching another perception threshold. This results in an iterative process of acceleration and deceleration.

Stochastic distributions of speed and spacing thresholds replicate individual driver behaviour characteristics. The model has been calibrated and validated [18, 20] through multiple field measurements in Germany and other countries. Periodical field measurements and their resulting updates of model parameters ensure that changes in driver behaviour and vehicle improvements are accounted for.

The Vissim traffic simulator allows drivers on multiple lane roadways to yield for two preceding vehicles, as well as two neighbouring vehicles on the adjacent travel lanes. Furthermore, approaching a traffic signal results in a higher alertness for drivers at a distance of 100 meters in front of the stop line.

Further, Vissim simulates traffic flow by moving "driver-vehicle-units" through a network. Every driver with his specific behaviour characteristics is assigned to a specific vehicle. As a consequence, the driver behaviour corresponds to the technical capabilities of his vehicle. Attributes characterizing each driver-vehicle-unit can be discriminated into three categories as follows.

Firstly, technical specifications of the vehicle which includes its length, maximum speed, potential acceleration, actual position within the network, actual speed and acceleration. Secondly, behaviour of the driver-vehicle-unit, which includes psycho-physical sensitivity thresholds of the driver (ability to estimate, aggressiveness), memory of the driver, acceleration based on the current speed and the driver's desired speed. Third, interdependence of driver-vehicle-units, which includes reference to leading and following vehicles on own and adjacent travel lanes, reference to current link and the next intersection, and reference to the next traffic signal.

The various parameters discussed above are quantified and specified using a graphical user interface in Vissim. Figure 5 shows the configuration table where the various car following model parameters are specified.

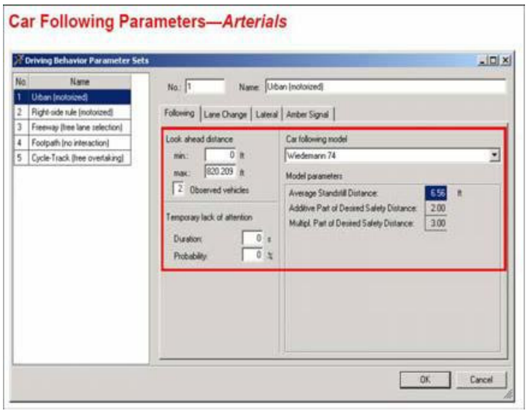

Figure 5: Car following parameters configuration

Using the notation of Wiedemann (1974), average standstill distance (ax) defines the average desired distance between stopped cars. It has a fixed variation of ± 1m. The Additive part of desired safety distance (bx_add) and Multiplicative part of desired safety distance (bx_mult) affect the computation of the safety distance.

The distance d between two vehicles is computed using the following formula:

$$d = ax + bx \qquad (1)$$

Where
ax is the standstill distance
bx = (bxadd + bxmult * z) * sqrt(v)
v is the vehicle speed [m/s]
z is a value of range [0,1] which is normally distributed around 0.5 with a standard deviation of 0.15.

5. The Proposed Traffic Modeling and Simulation Method

As described in the previous sections traffic phenomena constitute a chaotic dynamical problem situation, which make traffic modelling, and simulation a very complex, iterative and difficult process. In order to increase our chances for a successful simulation model the following methodology is proposed, which is applied for modelling the Strovolos Avenue traffic network as described in the next section.

The proposed traffic modelling and simulation method is based on the suggestions of Lieberman and Rathi [13]. As shown in Figure 6 below, the first step is to identify and clearly define the problem. Here caution should be taken not to just deal with the symptoms of the problem but to find the real cause of the traffic congestion problem.

Having defined the problem, together with specifying the problem's extent and significance, the next step is to define the model objectives. In other words what is the purpose of the simulation model to be developed should be specified. Again here caution should be taken to investigate whether the stated objectives would really solve the problem as well as take into consideration any "side effects" that may occur as a result of specific proposed solutions.

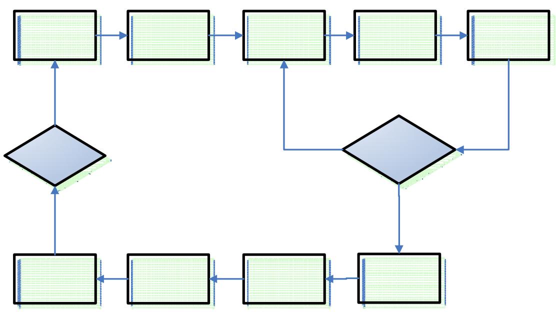

Figure 6: The Proposed Traffic Modeling and Simulation Method

Next, we have the definition of the system to be studied. Here the major components of the system need to be identified as well as the boundary of the domain of the system needs to be defined. Further the interactions of the various components need to be analyzed. Finally, the necessary information to be used as input to the model has to be identified.

Once the system to be studied is defined the next step would the development of the model. Here, the level of complexity needed to satisfy the stated objectives should be identified. It might be for example that a macroscopic model would be adequate for the current problem. Therefore the model is to be classified and its inputs and outputs should be defined.

During model development an appropriate software modeller based on the model objectives should be selected. It is important therefore to carry out an assessment of a number of software for traffic simulation and investigate there capabilities and limitations. In case the selected model is not adequate for the model objectives then enhancements should be carried out with some further software development. In this event the flow of data within the model as well as some functions and processes of the model components need to be defined. Further, the calibration requirements need to be determined. Mathematical, logical and statistical algorithms of each inadequately represented (by the selected software modeller) system component with its activities and interactions should be developed. The logical structure for integrating these model components needs to be created to support the flow of data among them. Then the software development method should be selected as well as an appropriate programming language, user interface and the presentation format of model results. Finally the design logic and all computational procedures should be documented and the software code should be developed and debugged.

The next step which partly belongs to the model development process is model calibration. Here the necessary data should be collected or acquired in order to calibrate the model. Then, this data should be introduced into the model. Further, especially for the case of software development enhancements we should verify that the software executes in accordance to the design specifications.

Model development and calibration are part of an iterative process as shown in Figure 4 that leads to validating the model. Model validation includes the collection or acquisition of data as well as reduction and organizing for purposes of validation. That is, gathered data should be reduced and structured in such a way so that they are in the same format as the data generated by the model. Further, validation criteria should be established stating the underlying hypotheses and selecting the statistical tests to be applied.

The iterative process of model development, calibration, verification and validation is completed once it is established that the model describes the real system at an acceptable level of accuracy over its entire domain of operation. Here, the use of statistical testing methods will prove to be very useful. In more detail the validation process may include experimental design development, identification of the causes for any failure to satisfy the validation tests and repairing the model accordingly. As differences between the model results and real world data emerge the developer must repair the model and then revalidate. In order to validate a traffic simulation model considerable skill and persistence are needed.

Once the model is validated that is, it adequately represents the real system, then the simulation part of the method commences. This involves scenario preparation, testing the various scenarios via simulation, evaluation of the results and implementation of the emergent solution.

Simulation tests should be viewed as performing rigorous statistical experiments. A prerequisite for the tests is that the simulation model is at a state where it properly represents the initial state of the current traffic environment. Further, the changing input conditions which describe the traffic environment need to be specified. For example, the distribution of traffic flows over the period of time where the experiments will be carried out need to be determined.

Finally, animation displays provided by the simulation model should be analyzed to identify any anomalous results as well as cause and effect relationships. For example, the creation of queues when traffic conditions are under-saturated would represent an anomaly. Further, sensitivity tests may be carried out by varying key variables and observing model responses. The animation snapshots may easily reveal the causes for many traffic congestion problems.

Extra care should be exercised when interpreting the simulated results. As very well Lieberman and Rathi [13] state: Given the complex processes taking place in the real-world traffic environment, the analyst must be alert to the possibility that

- the model’s features may be deficient inadequately representing some important process;
- the input data and/or calibration specified is inaccurate or inadequate;
- the results provided are of insufficient detail to meet the project objectives;
- the statistical analysis of the results are flawed;
- the model has “bugs” or some of its algorithms are incorrect.

One final remark is that a simulation model is a sampling experiment implemented on a computer and it needs appropriate statistical techniques for its design, analysis and implementation. Therefore measures of effectiveness such as traffic flow, travel times, queue encounters, delays etc. should preferably be derived from a set of simulation runs using independent random seeds.

6. Traffic Modeling and Simulation of Strovolos Avenue

As shown in Figure 6, the first step of the proposed approach is to identify and define the problem. In our case the symptoms of the problem which are attributed to traffic congestion manifest themselves as increasing travel times. Even though the Public Works Department builds more and more roads the traffic congestion problem becomes worse. And the reason is that we use more and more cars for our everyday transportation as noted in a previous section of this paper. For a more detailed analysis of the traffic congestion problem situation in Cyprus see ref. [1].

The main causes for the problem of traffic congestion in Nicosia consist of the increasing number of vehicles and the decreasing use of the bus transportation system. Therefore the long term solution to the problem is to turn around the situation that is to decrease the number of vehicles and increase the public transportation occupancy.

The question then becomes how do we change our bus transportation system and make it more attractive. This is what we aim to investigate in the Trafbus project concentrating on providing a faster and better quality level of service for our bus passengers. The objective therefore in our modelling and simulation method is to examine various scenarios such as dedicated bus lanes and Bus Rapid Systems, that would provide a better level of service for the bus transportation system. Meanwhile, we need to anticipate and assess any side effects of to the rest of the transportation system.

For this reason as part of the Trafbus project a simulation model of Strovolos Ave. which is the main arterial road of Nicosia is developed whereby the various scenarios will be tested.

Specifically the aim of the Trafbus Project is to examine the use of simulation modelling in order to formulate strategies for improving the traffic flow of the current and future layouts of a major traffic network, in Nicosia the capital of Cyprus. In fact, the whole traffic network of Strovolos Avenue with its intersections and side roads is studied in detail. The proposed model examines Signal Control Strategies and Bus Rapid Transit methods in a microscopic simulated environment. The rational is to attract more people to use the public transportation network and therefore reduce congestion and the negative effects on human safety as well as reduce pollution of the natural environment.

In particular, simulation tests are carried out for a variety of signal control strategies in relation to a number of scenarios regarding plans to include dedicated bus lanes. Various Bus Rapid Transit (BRT) systems scenarios are simulated, tested and evaluated. Further, safety issues that arise due to dedicated bus lanes and BRT systems are analysed and optimization algorithms for bus motion and signal timing are incorporated.

The results from the simulation experiments are to be evaluated in cooperation with the Ministry of Communications and the Transportation Planning Section of the Public Works Department. Based on the evaluation, optimum solutions are derived, with respect to certain measures of effectiveness including safety and efficiency of the traffic network as well as the impact on the natural environment.

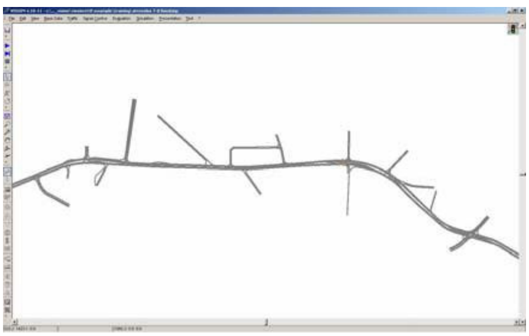

Figure 7: The Simulation Model of Strovolos Avenue Traffic Network

Therefore based on the above model objectives, the development of a simulation model of Strovolos Avenue is carried out. Strovolos avenue consists of many traffic parameters that need to be taken into account. These include traffic control signals, priority rules, routing decisions, pedestrian crossings, signalized and unsignalised intersections and so on. A helicopter view of the Strovolos Avenue simulation model is depicted in Figure 7 below.

The various traffic data that we need to incorporate in our model can be classified it terms of static data and dynamic data. Static data represents the roadway infrastructure. This data is required for both simulation and testing of a traffic actuated signal control logic. Static data includes also the following. Links with start and end points as well as optional intermediate points; links are directional roadway segments with a specified number of lanes. Connectors between links are used to model turnings, lane drops and lane gains. Location and length of transit stops. Position of signal heads/stop lines including a reference to the associated signal group. Position and length of detectors. Location of transit call points

Dynamic data is only to be specified for traffic simulation applications. It includes the following information. Traffic volumes including vehicle mix (e.g. truck percentage) for all links entering the network. Location of route decision points with routes (link sequences to be followed), differentiated by time and vehicle classification. Priority rules (right-of-way) to model unsignalized intersections, permissive turns at signalized junctions and yellow boxes (keep-clear-areas). Location of stop signs. Public transport routing, departure times and dwell times.

Having introduced most of the above static and dynamic data in our model, currently we are in the iterative process, which consists of model development calibration and validation of the model. Going through several iterations in developing the model, we are in a position to present some optimistic results concerning the validity of our model. A snapshot of the simulation model is seen in Figure 8 below, which depicts a central signalised intersection with a pedestrian crossing.

Fig. 8. A central signalised intersection of the simulated traffic network.

Figure 9 below shows the real Vs simulated traffic flows of the various vehicle movement directions for the central intersection of our traffic network, that of Perikleous, Chryseleousis, Strovolou. As seen in the graph below the traffic flows of real measurements obtained recently (21/03/06) and those of simulated results, are quite comparable. In fact we get an average error in traffic flow of 10% for all directions. In certain directions as shown in Figure 9 below the error ranges from only 2% to 5%. We believe that with some further verification and calibration we can bring our model even closer to reality.

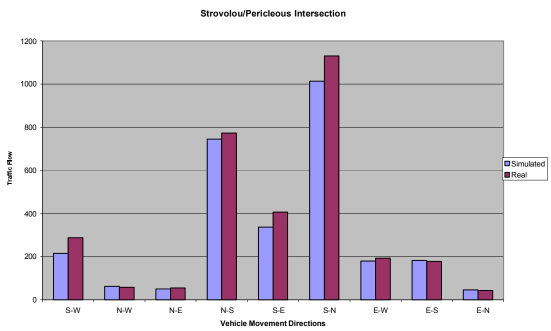

Figure 8: Preliminary Model Validation

Further, our simulation model demonstrates somewhat the queues that we encounter in reality and especially the one at Athalassas Ave intersection where there is no exclusive right turn lane. Figure 10 shows the simulated resulting animated queue at the signalized intersection of Strovolos Avenue and Athalassas Avenue. This is the main queue that a driver will encounter while going north towards the centre of Nicosia between 7:00 and 8:00 o'clock in the morning.

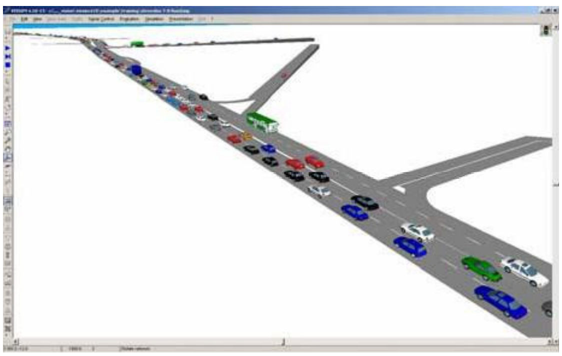

Figure 10: Queue Encounter

7. Conclusions

Computer simulation proves to be a very powerful tool for analyzing complex dynamical systems. This paper provides a review of the current state of research regarding traffic simulation. Further, an approach to modelling and simulating traffic networks is proposed.

The proposed approach goes through various stages, which include problem identification, model objectives, model development, model calibration, model validation, scenario preparation, simulation experiments and simulated results evaluation. The proposed approach is applied in the case of developing a microscopic traffic simulation model for the Strovolos Avenue (Nicosia, Cyprus), traffic network.

The preliminary validation process shows that the model simulates traffic flows in various vehicle movement directions intersections with an average of 90% accuracy. The next step would be a rigorous validation statistical test which would incorporate a number of simulated experiments.

Once it is verified that the model adequately represents the real system the various scenarios which will take the form of simulation tests will be carried out. The various scenarios for improving the attractiveness of the bus transportation system include the following:

- Bus Lane with Restricted Use
- Signal pre-emption
- Extra Traffic Light
- Bus Rapid Transit Systems

Further, safety analysis based on the above scenarios will be carried out, and the traffic flow effect on the traffic network will be assessed. Depending on the evaluation results from the simulation model policies and plans will be developed and implemented by the Public Works department of the of the Ministry of Communication and Works of the Republic of Cyprus.

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