Simulation of Urban Traffic System using Sumo and Optimization of Real Traffic Signal Model using OpenCV Image Sensing Module

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Abstract— Traffic flow analysis and modeling are an essential part of various traffic management applications (e.g signal control) and can provide a better insight into the state of traffic. The purpose of this work is to create a traffic simulation using real traffic counts gathered in a city. The subsequent simulation is created and analyzed with SUMO traffic simulation package. Traffic congestion is a condition on transport network that occurs as vehicle use increases, and increased vehicular queing. The most common example is the physical use of roads by vehicles. When traffic demand is great enough, the interaction between vehicles slows the speed of the traffic stream. This results in Congestion. Congestion occurs when the capacity of a road is less compared to the volume of traffic. This leads to negative impacts such as Delays, Wasting time of motorists, Inability to forecast travel time accurately, Higher chances of collision of vehicles. To enable smoother flow of traffic, we are developing simulation optimization algorithms for determining the traffic light signal by sensing vehicle density (congestion). The system performance is estimated via SUMO simulation and by using image sensing module of MATLAB/OPEN-CV Software. We perform numerical experiments to test the density of the traffic flow and also compare these results with previous model. To decrease the traffic congestion and avoid the time being wasted by a green light on an empty road.

Key words: Signal Control, Traffic Simulation, Vehicle Density, Congestion, Optimization

I. INTRODUCTION

Traffic congestion is a condition on transport networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queueing. The most common example is the physical use of roads by vehicles. When traffic demand is great enough that the interaction between vehicles slows the speed of the traffic stream, this results in some congestion.

As demand approaches the capacity of a road (or of the intersections along the road), extreme traffic congestion sets in. When vehicles are fully stopped for periods of time, this is colloquially known as a traffic jam or traffic snarl-up. Traffic congestion can lead to drivers becoming frustrated and engaging in road rage Traffic congestion occurs when a volume of traffic or modal split generates demand for space greater than the available street capacity; this point is commonly termed saturation. There are a number of specific circumstances which cause or aggravate congestion; most of them reduce the capacity of a road at a given point or over a certain length, or increase the number of vehicles required for a given volume of people or goods. Traffic flow analysis and modeling are an essential part of various traffic management applications (e.g. signal control) and can provide a better insight into the state of traffic. The purpose of this work is to create a traffic simulation using real traffic counts gathered in a city. The subsequent simulation is created and analyzed with SUMO traffic simulation package.

II. PROBLEM IDENTIFICATION

Traffic congestion is a condition on transport network that occurs as vehicle use increases, and increased vehicular queing. The most common example is the physical use of roads by vehicles. When traffic demand is great enough, the interaction between vehicles slows the speed of the traffic stream. This results in Congestion. Congestion occurs when the capacity of a road is less compared to the volume of traffic.

The following are the problems commonly faced:

1) Too many cars for the roadway due to inadequate mass transit options or other reasons.
2) Obstacles in the road causing a blockage and merger. These can be any of the following:

– Double parking - "Double parking" means standing or parking a vehicle on the roadway side of a vehicle already stopped, standing or parked at the curb.[1] This often prevents some of the vehicles in the first row from departing and always obstructs a traffic lane or bike lane (to the extent of often making the street impassable in one-way single-lane situations)
– Road work - Roadworks occur when part of the road, or in rare cases, the entire road, has to be occupied for work relating to the road, most often in the case of road surface repairs.
– Lane closure due to utility work – Any maintenance work taking place in the road be it sewage, pavement, potholes and so on. The roads will be blocked till the maintenance work is done or it causes a disturbed flow for traffic which in turn creates congestion.
– Road narrowing down – As the width of roads gets reduced or small than required the congestion of traffic increases unknowingly or with any circumstances.
– An accident – It causes lanes or sometimes the streets to be blocked till the damage caused by the vehicles to be retrieved back to normal as original, in the mean time the traffic congestion can be seen to peak levels in the surrounding areas of that street.

3) Traffic signals out of sync many times on purpose or occasionally when the computers are malfunctioning.
4) Inadequate green time
5) Too many pedestrians crossing not permitting cars to turn
6) Too many trucks on the road due to inadequate rail freight opportunities

7) Overdevelopment in areas where the mass transit system is already overcrowded and the road system is inadequate.

Now coming to the objectives since there are many to note down, we have come up with most important ones:

III. METHODOLOGY

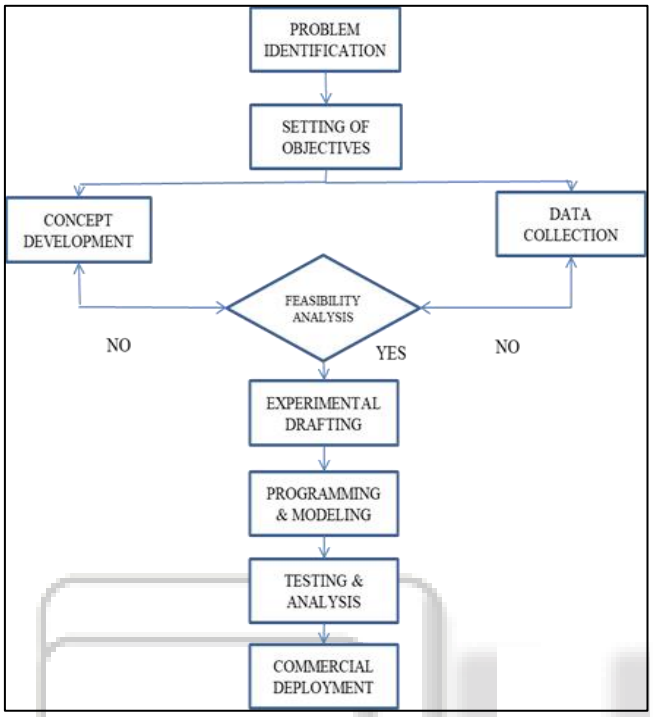

Fig. 1: Methodology

The above flowchart represents the basic methodology used in the project work. The steps are

A. Problem Identification

This step involves defining a problem; identifying causes; gathering information in the problem solving process. The main set off problems are analysed based on which the solutions are created or implemented, out of these the right solution can be an outcome of the whole process.

B. Setting of Objectives

As the problem is known and now the objectives based on accomplishing the solution to the problem are framed and generated. These are nothing but the goals to be achieved for the respective problem to be solved, based on the requirements the objectives are to be finally framed and they should be flexible enough for any changes at any point of time of the progression of the project.

C. Concept Development

These are nothing but set of activities that are to be carried in any of the engineering cycles, main part of this specific step is to collect data of various resources such as needs, challenges, developing alternative concepts and select one which meets the needs accordingly.

D. Data Collection

Data are usually collected basically through qualitative and quantitative methods. Qualitative approaches aim to address 'how' and 'why' based questions. It is the process of gathering and measuring information on targeted variables in an establishes systematic way, which enables one to answer relevant questions and evaluate outcomes.

E. Feasibility Analysis

It is an assessment of the practicality of a proposed project or system. An evaluation of a proposed project to determine if it is technically feasible or not.

F. Experimental Drafting

It is the basic preliminary step of the project written work where the development of more cohesive matter is started. This helps in developing core matter of the project or product, organizing of thoughts, examples or ideas, elaborating key ideas.

G. Programming and Modelling

This step makes use of mathematical models, particularly optimizing models, to assist in taking decisions. It is one of the OR techniques, it helps to find the best solution to the problem as modelled. Modelling is nothing but representing a real world phenomena as a set of mathematical equations.

H. Testing and Analysis

It is an investigation conducted to provide information about the quality of the product or service under test, it also provides the objectives independent view of software. It also involves the execution of a software component to evaluate one or more properties of interest. Coming to analysis, it is the systematic examination and evaluation of data or information by breaking it into component parts to know their interrelationships.

I. Commercial Deployment

Methodological procedure of introducing an activity, process, program or system to all applicable areas of an organization. It is all of the activities that makes a software system available for use. The general deployment process consists of several interrelated activities with possible transitions between them.

IV. DATA COLLECTION

Data collection is the process of gathering and measuring information on targeted variables in an established systematic fashion, which then enables one to answer relevant questions and evaluate outcomes.

Data collection as per our project was surveyed from Jaraganahalli junction at the respective times. As peak times will have high density traffic, the respective data has been noted and recorded.

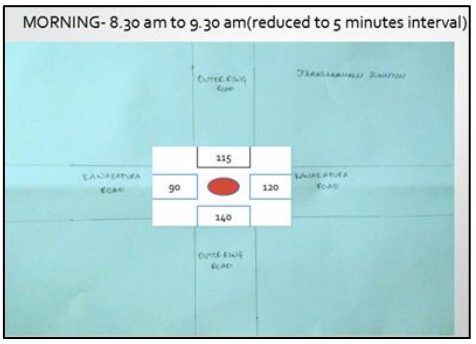

Fig. 2: Data collected at Jaraganahalli Junction

Data collected at noon around 1:30pm to 2:30pm. The respective image gives out the data for this particular time.

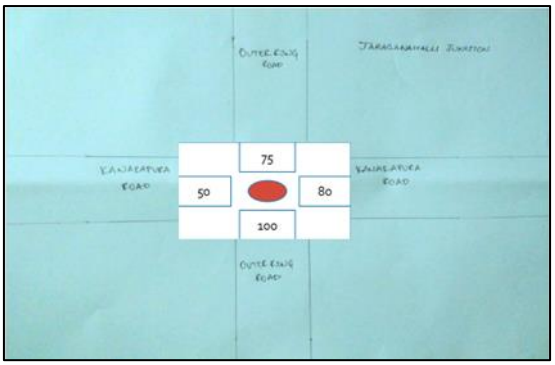

Fig. 3: Data collected at Jaraganahalli Junction

Now the data collected in the evening 5:30pm to 6:30 pm which is considered as Peak hour. The congestion happens in greater extent at this part of the day.

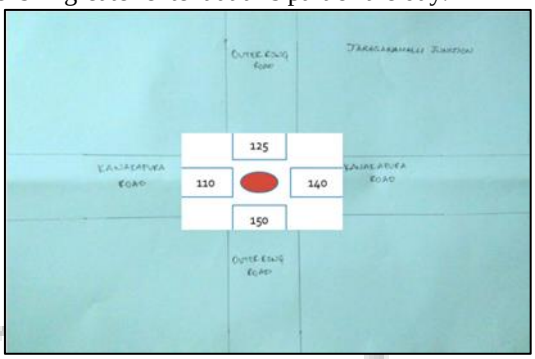

Fig. 4: Data collected at Jaraganahalli Junction

Conclusion: the traffic density is seen more in the evening time with more number of vehicles compared to morning and afternoon after the vehicular density survey is done.

V. RESULTS

A. *Time: Peak Hour before (Morning 9:00)*

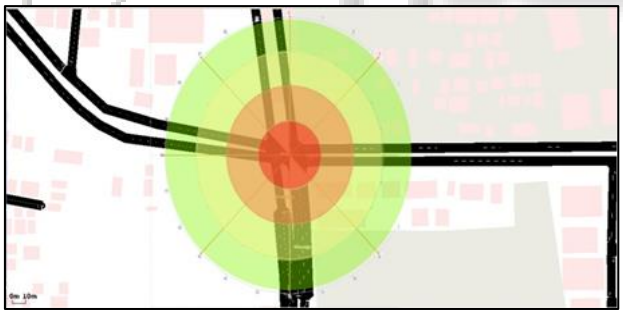

Fig. 5: vehicle density at morning

B. *Time: Peak Hour after (Morning 9:00)*

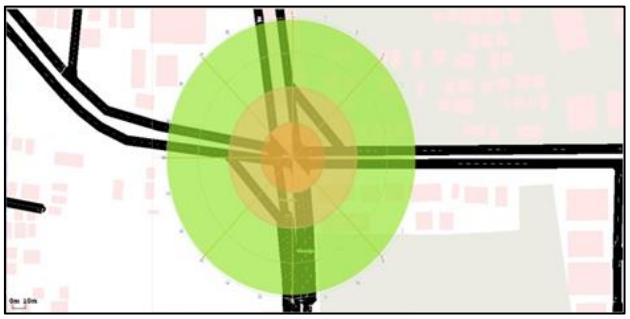

Fig. 6: (a) vehicle density after simulation module implementation

As we can observe the traffic density has been reduced in the above second figure which is after implementation of the simulation module. The traffic is much smoother flow than it was before implementation, the green colour specifies the lower in density of that part of the traffic area

C. *Time: Peak Hour Before simulation module implementation (Evening 6:00p.m.)*

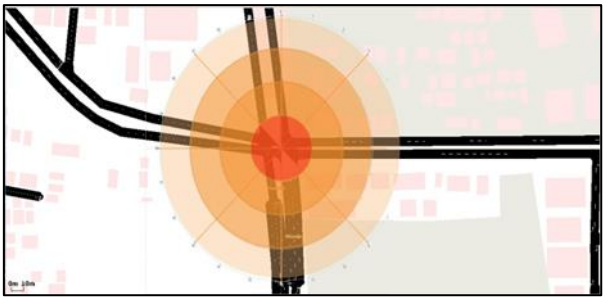

Fig. 7: traffic density at peak hour

D. *Time: Peak Hour after implementation of simulation module (Evening 6:00p.m.)*

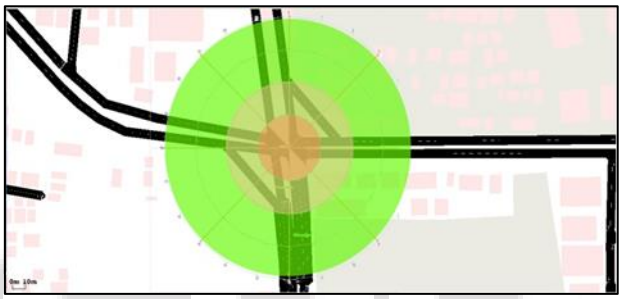

Fig. 8: Traffic density after implementation of simulation module

As we can see the traffic density is of lower level easily by the figure after the implementation of the module.

VI. SIMULATION OF URBAN MOBILITY

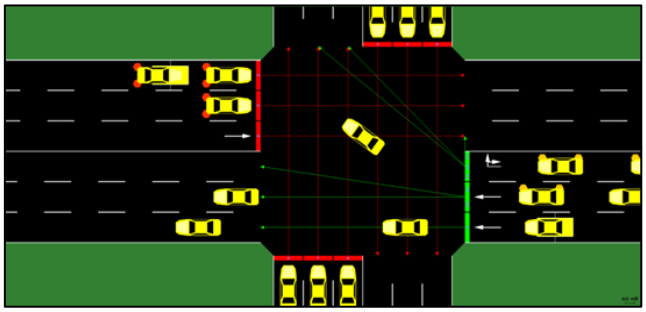

Fig. 9: Simulation of Urban Mobility

A. *Visual Studio Results*

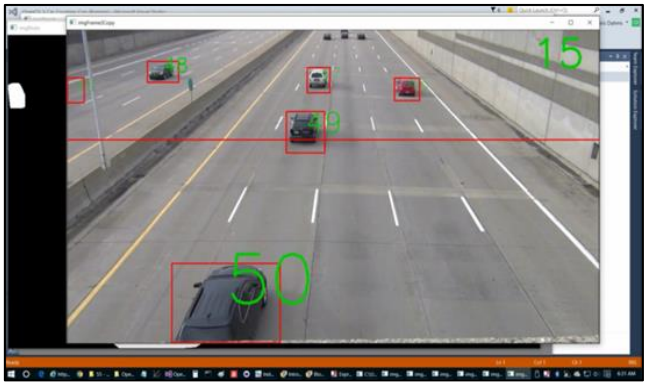

Fig. 10: Visual Studio Results

B. Contour Image:

Fig. 11: Contour Image

VII. ADVANTAGES AND LIMITATIONS

A. Advantages

- Reduced vehicular traffic congestion
- Smoother flow of traffic
- Reduce the time being wasted by a green light on an empty road
- Alternate path suggestion
- Can be used for regulation of traffic violations

B. Limitations

- Practical implementations is expensive
- Sometimes the camera may not work due to environmental variation
- System may not work due to technical issues

VIII. CONCLUSION AND FUTURE SCOPE

A. Conclusion

Individually using SUMO, VISUAL STUDIO and OPEN CV, the traffic could be optimized to certain extent but combined integration of all three used together, the output has come up with most efficient than the individual ones.

With the outputs recorded we can assure that the traffic density can be reduced to a greater percentage and without any congestion of the traffic at any junction in the city, not just limited to the junction we have chosen, but is applicable for any junction in the city.

B. Future Scope

As the traffic is increasing in an unexpected rate, the traffic will be denser in the future years but in the very near future all the cities are going to face congestion in many junctions. This is where our system will come to rescue to reduce the density and decrease the congestion.

Also, use of more and powerful processors and camera equipment will help in reducing the traffic congestion to a large extent.

Application and implementation of this system will help regulate traffic violations.

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