USING INFORMATION TECHNOLOGY TO REDUCE TRAFFIC JAM IN A HIGHLY TRAFFIC CONGESTED CITY

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Abstract: The Traffic Jam in many highly congested cities has been the most annoying and harmful problems to the residents and travellers of the city. Traffic jams have many diversified harmful effects on the social, cultural, political and even on the economical and financial stability and prosperity of a country. Hence, traffic jam should be prevented at any cost. This paper has proposed a convenient, cost-effective solution to the traffic problems in a highly traffic congested city using today's computing power and information technology. We propose four principal motives such as a simulation, a sensor network, a real-time web site and a data mining approach. First, simulation will consider all the vehicles, public roads, peoples, offices, educational institutions and so on. The simulation will study the nature, cause and time of people's movement and will find an appropriate schedule of the vehicles and routes also suggest the working hours of different institutions so that traffic jam is reduced. Second, a real time sensor network (connected to the internet) will find the traffic density and jam of different routes all the time. Vehicle drivers will use this system (through car navigation system or display boards) to know the current traffic status of different routes and can select the best route. Third, using a web accessible web site, users will see the current traffic and jam status to plan their trip. Besides, the web site will provide a jam less shortest route from the source to the destination. Fourth, a data mining approach will use statistical data on jam and traffic status so that historical trends about the traffic and jam status of different roads can be used to reschedule vehicles. We hope a proper design and implementation will lessen the traffic problems in a flexible and cost-effective way.

Computer Simulations: The simulation will provide a schedule for the public vehicles, and routes along with the schedules of the opening time and ending time of different institutes that will distribute the movement of people evenly to indirectly help in reducing traffic jam. Since, the vehicles and the passengers are continuously moving with time, an event based continuous simulation model is appropriate in our case. The vehicle movement will be simulated in time and the jam condition will be detected on the fly. The possible events in the simulation can be the leaving of a vehicle from a vehicle stop, stopping at the intermediate stops, overtaking other vehicles, reaching very close to another vehicle, lane change, take a turn in the crossings, traffic signal, a jam condition, an accident, some unusual incident, and so on. The simulation will be run over a long period of time and jam conditions and causes will be studied. The components of the simulation model are Routes, Bus Stops, Vehicles, Institutes, Traffic Signals and so on. Firstly, we need to define a simulation model where the distribution functions of all its input parameters need to be defined using mathematical or logical expressions. Vehicle leaving rate and passenger arrival rate at different bus stops, the vehicle speed on a road, traffic signal interval should be expressed using a distribution function. The passenger arrival rate will vary depending on the institutes schedule on the road, on the day of the week and so on. We can use IDM (Intelligent Driver Model) for the simulation model. Different turning points can be mapped as queueing systems such as m/m/1, m/m/m. Initially using an efficient shortest path finding algorithm all the shortest routes will be determined. At the start of the simulation, the vehicles will be placed randomly in different bus stops and the timer would be initialized to the morning of a day. The vehicles would leave stops using a distribution function. The vehicles will use the information about the positions, speeds, accelerations of other surrounding vehicles along with width of the road to decide it's own speed. At turning points the traffic lights will be turned on and off using some schedule and variable time interval. The vehicles need to know the traffic signal status also to decide their speed, waiting time, and turning. Within the simulation runtime, we have to measure the density of the vehicles at different places, waiting time of the vehicles at different places. The density and the waiting time will indicate the traffic jam condition. Also tracking information regarding unusual events such as accidents can help. As the system is a huge system we can simulate route by route initially.

To determine the proper schedule of the vehicles we have to test various schedules. We have to vary the input parameters to see the effect on the jam status, and determine the proper value of the input parameters. The analysis of the simulation output data will provide the value of different output parameters such as total number of public vehicles needed for a jam less city, vehicles needed per route in different time of the day or in different day of the month, schedules for public vehicles, guide lines for the private vehicles to avoid jams, schedules for different organizations and shopping malls, schedules and orientations and timings of traffic signals, vehicles service time at different bus stops depending on the passenger density/arrival rate and current jam statistics.

Sensor Networks: Sensor networks along with computer simulations will provide data to reduce or avoid traffic jam on the fly. Usually the inductive loop detectors are used in most traffic surveillance system which are not suitable for large scale deployment as the have have a high cost of installation and maintenance. However, the proposed sensor networks have the potential to revolutionize traffic surveillance technology because of its low cost and ease of deployment. We recommend Berkeley mica2 sensor motes in TinyOS platform for detecting vehicles that use some magnetic technology to detect vehicles. The motes are relatively cheap, easy to use and reliable. Besides, mica2 have the potential to do vehicle classification and road conditions monitoring. The primary goal of utilizing TinyOS sensor networks is to use signal strength readings to infer the distance between the motes. The utilization of this

signal strength data helps to detect a sensor less object along with an object having sensors to make the sensing task easier. The optimal placement of sensors is important to get best possible data, and least amount of power usage (using minimum data transfer). The standard sensor placement problem is a NP-complete task assignment problem that is centralized and depends on information from global nodes. However, Bonfils and Bonnet propose a decentralized (each node should only maintain information about close-by or local nodes) and adaptive(operators and detections between nodes can be altered at any time, in an ad-hoc fashion) and local solution to the sensor-placement problem. The theory is based on cost and the algorithm progressively refines the placement of nodes towards an optimal placement. They desire the flattest sensor network topology to reduce cost. They also define an oriented sensor network graph (SNG) for the purpose. Besides, A direct tradeoff exists between power consumption and the accuracy of sensed data. Turning on only the required sensor nodes can save energy though it leads to uncertainty of the data. Pattem et al. analyze these energy-quality tradeoffs by first proposing a quality metric and an energy metric, and then using those to develop four main tracking strategies (we would utilize them in our system). It would be best if all the TinyOS micaboard sensors could be equipped with intelligent packet-routing capabilities that would allow them to communicate the next area/location of where a car is headed and intelligently decide which nodes should be turned on or off.

The vehicle stops need to be sensor equipped specially the exit and entry points. The sensors will detect the exit and in of the vehicles. The vehicles can be tagged with it's identification and destination. The sensors will be centrally connected to a base station (PC) through a gateway (sensor). The base will be connected to the Internet. The database, our suggestion is to be distributed per group of interconnected routes as the query response time should be a minimum. Besides, all the intermediate bus stops should be sensor equipped to know the exact movement of the buses. Also, the well known jam places should be sensor equipped over a large surrounding region to detect jam also the length and timing of the jam. Moreover, the major turning points/traffic signal area can be sensor equipped. The sensor nodes would also be installed in the middle of each lane of traffic at periodic locations along the roadway. For some nodes there will be a gateway. The gateways would provide a wide-area network connection from the sensor network to the data center. By aggregating traffic flow in a fine-grained and highly distributed manner across all lanes, including any egress or ingress lanes, we may be able to accurately identify traffic state changes in near real-time. At any moment, all the jam status, vehicle distribution and movement status can easily be found. Current jam area and the probable jam area in next few minutes/hours will be determined. Hence, car drivers can take alternate route. The data can be centrally analyzed by the traffic department using some software (AI approach) and some forecasting about the near traffic jam area or suggestion to the car drivers how to take the proper route. Using some display boards at major crossings we can draw driver's attention of the jam and free area. The traffic polices can also use the display board information to guide the vehicles. Besides, the traffic department analyzing current data can take important decisions that will be propagated to the traffic police on roads to guide the vehicles. At the university of Berkeley a way is developed to get updates on traffic hot spots, alternative routes, and travel times up to an hour in advance via the Internet or cellular phone.

Web Enabled Services: A web site will show the schedule of the vehicles depending on the computer simulation. The web site will be integrated with the sensor networks so that the web site will be able to show current jam areas, how many vehicles are there, how much time will be needed to recover the jam, also probable alternate routes of the jam area with some statistics of that route. The driver's can consult web site to plan the route from source to destination using a congestion free area. All vehicle drivers while on the roads are able to use the display boards to decide their routes. Cars can be internet enabled using some wireless technology to use the web site. The web site will provide data on the number of vehicles in a region, vehicles density, congested and free area, statistics about vehicle velocities in the route, is there any jam on the road, the jam statistics, how many cars in jam, the length of the jam, duration of the jam, warning to the cars in jam, warning to the cars who are going to that jam area. The warnings can be used by the travellers and drivers to reduce traffic jam.

Data Mining Approaches: The volume of data collected by sensor networks will be analyzed using data mining approaches to study the traffic jam characteristics. This will lead to rescheduling of the vehicles. The parameters to be studied are locations where jams occur frequently, frequency of jam in different locations, time and density of jams, causes for traffic jams, length of a jam and so on. We recommend clustering and classification data mining for traffic data analysis. Initially, clustering data mining can be applied where based upon the supplied metrics, relationships among the data, input parameters and target parameters will be discovered. In classification data mining, several traffic jam classes such as severe jam, lengthy Jam can be defined based on our purpose where each class will have predefined values of the parameters. Hence, different types of traffic jams, and their causes, locations, time, density, frequency would be identified easily. This would help us to make decisions where and how to change the schedule of the vehicles. Besides, different incidents in urban areas contribute around 50 to 60% of the total congestion delay. Data mining can reveal many hidden treasure and understandings in the data to better manage incidents that otherwise can not be found. The application of data mining tools, along with statistical clustering techniques, can also help to develop a superior traffic signal timing plans.

Conclusions: We are working on to build a prototype system that includes all the approaches to study the fruitfulness of our approach. Besides, an in depth analysis of socio-economic factors and the influence of the system to the people will be done. Moreover, a technical and financial feasibility study will be done to make the approach really fruitful.