Smart Traffic Management System (STMS) using data analytics

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Abstract : Due to increase in vehicle population, everyone face a lot of problem in their day to day commutation, and traveling from one place to another is a major challenge. In this huge world, we have huge number of road networks via which a huge number of population travels every day, facing a lot of traffic issues. The whole world depends upon the traffic lights or on traffic police to control and handle the traffic. It is a very common and tedious issue in big cities which causes a lot of stress and unnecessary burden. The basic aim is to develop a system to estimate density of Traffic in various situations using Data Analytics which is the Smart Traffic Management System (STMS).

***IndexTerms* - Traffic Density, Data Analytics, Smart Traffic Management System (STMS).**

I. INTRODUCTION

Regulation of traffic in the urban areas where the traffic density is high due to increase in the number of vehicle on road is a herculean task. To monitor the daily traffic in urban areas there has to be a centralized traffic monitoring system with sensors which regulate huge amount of traffic flow in a systematic and smooth way. Henceforth we require a Smart Traffic Management System (STMS) that would self regulate the traffic flow on the roads based on the monitory rules that are devised to realize the above said system. In building a STMS there goes various modeling techniques and rule based algorithms that would help system design. The STMS design would be efficient enough to realize the following goal:
i. Replace the traffic light pole systems that are legacy systems with smart sensors that would capture the statistics of the vehicles on the road on a dynamic environment.
ii. Use that statistics collected by the sensors in identifying the flow heuristics of the road.
iii. Build an application that would map the flow dynamics to the traffic estimation model.
iv. The traffic estimation model would help in flow control based on the rule based learning.
v. Thus achieve the aim of STMS.

The implementation of STMS has the following listed advantages to the urban dwellers:
i. Lower the traffic congestion in areas that are densely populated by vehicles.
ii. Smooth flow of traffic in the peak hours.
iii. Lower the pollution levels in the traffic signal junctions as the traffic flow is not constricted in the junctions.
iv. City traffic shaping is allowed here by prioritizing the vehicles based on the space they occupy on the roads.
v. More efficient methods would arise as the response for any incidents in traffic is attended instantaneously.

STMS is amalgamation of traffic sensors and data analytics which is the most required innovation of the hour. The usage of dynamic data of traffic and applying an algorithm to shape the traffic is a powerful method to avoid unnecessary traffic conditions. In the present day scenario, helping a cab driver identify traffic in a particular route and build an alternate route immediately and guide him to the destination would make wonders. The system is built such that then data analytics in STMS would guide the driver to the alternate route that will also help reduce the piling up of traffic in already congested area. In future if this projection is also displayed in the city centers the congestion rates would come down drastically. Thus making the nature pure by letting less fuel to it. Let us understand the need of SMTS with the help of these three use cases:

Use case 1: How would the data analytics lower Traffic Congestion on a densely populated road by vehicles
• The sensors that are interfaced with the STMS flush the data onto the servers that would help tracking the of vehicle density on roads.
• The data analytics module acquire that dynamics traffic data updated from the sensors within a given area.
If the vehicle density reaches the threshold, the STMS would alert all the signals nearby about the traffic congestion.
• The drivers who are using the road would under the traffic statistics and divert from the congestion area.
• This result in lowering the traffic density in the congested area and thus efficiently mange traffic. When number of vehicles at signal decrease below threshold, message

Use case 2: How does the STMS save life from harsh traffic incidents through data analytics.
• Assume there is a traffic congestion on road and there is an ambulance driving an emergency case with high speed.
• The data analytics module in the STMS would be aware of the dynamic traffic condition and flush the data to the nearby signals to have a clear path to the nearby hospital.
• As said in the previous use case the ambulance driver in well in advance intimated about the traffic statistics and thus he would re-route the vehicle to a less congested road.
Use case 3: How does the STMS help in crime investigation?
• Assume a terrorist keeps a bag on road side.
• There would be a CCTV camera that captures all the activities.
• If we flush this dynamic data to the central surveillance which would have the database of all the criminals and allows them to take instantaneous decision based on the intensity of the issue.

II. LITERATURE SURVEY

Vehicles structured at the not so distant future are probably going to contain on-board radio units for Ad Hoc organizing purposes. This makes it conceivable to incorporate many vehicles conversing with one another on travels. Subsequently, novel Vehicle-to-Vehicle (V2V) correspondence administrations are relied upon to encourage street wellbeing, blockage control, course arranging, among different applications. So as to plan vehicular correspondence frameworks to accomplish ideal execution, it is basic to have an exact comprehension of the engendering component. Various ongoing investigations are dedicated to demonstrating the V2V correspondence channel. There additionally exist a few recreation models as of late proposed.
On account of V2V correspondence, the ruling spread condition is the surface street, with various vehicles acting all the while as accomplices or hindrances in correspondence. Reciprocal to the detailed examinations, this paper shows a recreated street condition to investigate the impacts of vehicles going about as impediments, in a continuous V2V security application dependent on street activity [1]. Data fusion is one of the recent approaches in traffic analysis for the accurate estimation and prediction of traffic parameters. In this approach, the parameters are estimated using the data from more than one source for better accuracy. This paper discusses a model based approach to estimate the parameters of heterogeneous traffic using both location data and spatial data using data fusion. The proposed method uses the Kalman filtering technique for the estimation of traffic density. Traffic density is a spatial parameter which is difficult to measure directly from field and can be measured only using aerial photography. Hence, it is usually estimated from other easily measurable parameters such as speed, flow, etc., or from a combination of such parameters. The present study estimates density using the flow values measured from video and the travel time obtained from Global Positioning System (GPS) equipped vehicles. The study also reports density estimation using flow and Space Mean Speed (SMS) obtained from location based data alone without fusing with spatial data, using the Extended Kalman filter technique. The estimates are corroborated using actual values and the results show data fusion performing better while estimating density [2]. The congested driving conditions of urban street is one of the imperative issues of normal worry to the global network, which influences the productivity and nature of city life. So as to unravel the urban street activity clog issue, this paper assembles data and information around a five forks by the Work Sampling and picture examination technique. At that point, as indicated by the lining model of M/M/1, these parameters as the normal landing rate, normal administration rate and line length are estimated. From that point forward, the paper breaks down the street activity clog reasons by the bustling rate and free rate of each intersection. In view of the reasons, the countermeasures to unravel activity clog are advanced. The outcomes demonstrate that the enhancement to the five forks can viably diminish the line time of intersection vehicles [3].

III. STMS MODELLING

The STMS works according to the design that has been discussed below which has been divided into three phases namely:
1. Data collection through the mobile application that is developed.
2. Gradient values updating
3. State matrix algorithm
The below section would provide a clear understanding of the STMS.

1. Data collection through the mobile application that is developed:
The STMS works on the principle of data analysis acquired in the dynamic traffic environment. In this part of the model the STMS has to collect data from different users. The data collection would help build the data in there server. To start with the application a trail run in the data collection was done by collecting different real time data from various location. To ensemble this an app was designed to collect the information of the user such as name, location, time and number of vehicles as a rough estimate on that point of time. The collection of this simple data has helped to build the further model of the STMS. The collection of this simple data has allowed the authors to realize the following points:
Name of the user: Each user is provide by an username which is automatically generated.
Location: Each the user is logged into the application his location details are fed automatically on to the system.
Time: The user is then tracked on the real time to enable the dynamic flush of traffic data both to the server as well as the user.
Number of Vehicles: Each time the user logs onto the STMS the approximate number of vehicles must be selected so that the estimation can be done on a rough hypothesis.
The data collection is done in the following steps:
A. Collect the user information and update in the database.
B. Each user has to enter the vehicle statistics on the road.
C. This statistics are analyzed through the “Data Parse Table”
D. The analysis of the data and the output of the table enables us to build the Gradient value matrix

Serial no	Time stamp	Vehicle Count	Gradient Value [T(V)]
1	9.00	5	29
2	10.00	20	30
3	10.30	9	30.5
4	12.45	15	32.75

Table 2: Data Parse table

2. Gradient values updating:

In this segment the data that was collected from the app is fed onto a data processing software for the further processing of information obtained. The software used for data processing is WEKA which helped to understand the traffic parameters. The traffic parameters are analyses as:

Density of Vehicles: This would allow the STMS to know what the amount of vehicles on the road is in any given time.

Nature of traffic: Once the density is obtained the intensity of the traffic is mapped to various categories such as low, medium and dense.

Maintenance of the road: This parameter would provide the statistics of the physical appearance of the road. Later some of the other parameters which are secondary in nature are also considered such as: Signal delay on the junction, Types of vehicle and Flow of traffic.

Once all the parameters are acquired with the data, the Eigen matrix is formed

Eigen matrix values:

Cell value= number of vehicles/number of cells.

Lambda= Threshold-Ts+1. Ts= Timestamp.

T(v)= Lambda*Eigen Matrix.

For each of the T(v) generate the state:

Timestamp	T(v)	Calculation of vehicle count	State
9.00	29	Increasing	Moderate
10.00	30	Decreasing	Moderate
10.30	30.5	Increasing	Block
12.45	32.75	Decreasing(assuming difference in vehicle is decreasing)	Moderate

Calculation:

if T(v)<Threshold and difference of vehicle count is increasing then state is Moderate

if T(v)=Threshold and difference of vehicle count is increasing then state is Block

if T(v)>Threshold and difference of vehicle count is increasing then state is Block

if T(v)=Threshold and difference of vehicle count is decreasing then state is Moderate

if T(v)>Threshold and difference of vehicle count is decreasing then state is Moderate

if T(v)<Threshold and difference of vehicle count is decreasing then state is Easy flow

Difference in vehicle count:

Number of vehicles at Ts - Number of vehicles at Ts+1

3. State matrix algorithm:

The algorithm and its description could be given as in the table 3:

Instruction	Input/Statement	Purpose
1	Variable M	Holds the Eigen matrix values in the binary format
2	Variable D	Distance of the vehicles covered the road
3	Variable Thresh	Threshold variable gives the accuracy limits
4	Variable V	Vehicle identification variable while value is set default.
5	Variable Count	Count variable tracks the number of vehicles on the road.
6	Variable State	The state parameter depicts the status of the road. There are three fixed states of road which are: low traffic, medium traffic an dense traffic.
7	If state==low	count is set to 0
8	else if state== medium	count is incremented and Thresh is reduced
9	else	count is incremented and Thresh is reduced and beyond V the state has to be reset.

Table 3: Algorithm of SMTS.

IV. RESULTS AND STIMULATION

The application mentioned in the paper is developed using MIT app Inventor and the tool that is used for data analysis is WEKA. MIT App Inventor is a natural, visual programming condition that enables everybody to construct completely utilitarian applications for cell phones and tablets. Those new to MIT App Inventor can have a basic first application going in under 30 minutes. What's more, in addition, our squares based apparatus encourages the making of perplexing, high-affect applications in fundamentally less time than customary programming conditions. The MIT App Inventor venture looks to democratize programming improvement by engaging all individuals, particularly youngsters, to move from innovation utilization to innovation creation. Waikato Environment for Knowledge Analysis (Weka) is a suite of machine learning programming written in Java. Weka contains a gathering of perception devices and calculations for information examination and prescient displaying, together with graphical UIs for simple access to these functions. The unique non-Java rendition of Weka was a Tcl/Tk front-end to (generally outsider) demonstrating calculations executed in other programming dialects, in addition to information preprocessing utilities in C, and a Makefile-based framework for running machine learning tests. This unique rendition was principally structured as an instrument for investigating information from horticultural spaces

The data analysis was done using WEKA and then the algorithm was applied to reduce the delay in the congestion and the results are as shown in the figure 4.

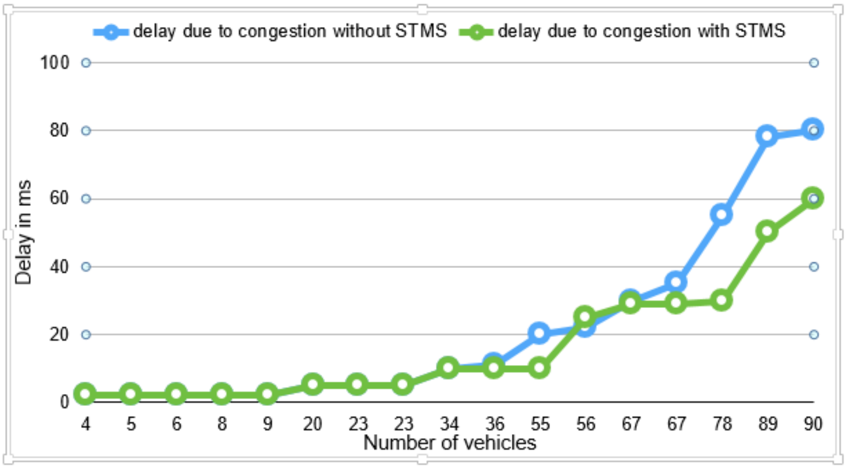

Figure 4: Comparison on delay in the congestion with and without STMS.

V. CONLUSION

The research paper talks about how traffic issues can be solved using data sciences, to be specific data analytics. Here, we are making the vehicle learn the traffic itself before the actual driving starts and also when it is driven between the traffic. A model is developed and demonstrate through an application. This application takes care that the vehicle itself learn the traffic and can make decisions on its own and hence choosing the shortest and the best path or way to travel. At every moment the application would be updated with the traffic on the same road and also on the other roads related to the destination, at any moment of time; if the application gets to know that the there is a better path available for the driver to take, it would be intimated via a pop-up. The future scope of the paper would be in developing unsupervised rule based learning algorithm to handle the traffic in a smarter way.

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