Algorithms And Techniques on Travel-Time Prediction Systems

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Abstract **-** The need of current condition of traffic in roads in huge cities, which are very vital for getting exact traffic prediction, regularly suggests high computational unpredictability because of the implicated network topology. Consequently, focal strategies are needed for managing the city system complexity, minimizing the execution necessities that are related to the classical network search techniques.

By studding historical traffic information, one can get valuable insights into traffic behaviour. Many existing applications have been proposed by many researchers. This survey analyses such methods also lists there pros and cons.

Keywords—*Fuzzy Data processing, Graph theory, Time series analysis, Travel time prediction.*

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I. INTRODUCTION

In metro cities congestion of traffic is the most accepted transport issue. Huge traffic jams can effects in different ways like delays, unknown time of travel, maximization of fuel consumption as well as road rage. For instance, the aggregated delay in travel time was nearly 13 billion hours from year 2010 to 2014, which makes use of nearly six million tons of excess fuel in metropolitan areas in US (Texas A & M Transportation Institute).

Numbers of countries makes utilization of Intelligent Transportation Systems (ITSs) for giving integrated road traffic related services. ITS centrally gather all information and also stores the same information known as traffic sensor data which is collected from multiple heterogeneous sources which are concentrated on real time traffic data to shows the issues by traffic congestions. South Korea based Busan ITS center records traffic information after each five minutes for every segment of road as well as concentrated on coming up with real time traffic data. The traveler's data website of Seattle gives real time traffic cases as well as time to travel via city. Many of the traffic data services are depending on information gathered from ITS system.

Continuous historical traffic sensor information is created only one time the real-time utilization of these information is complete. By making use of stored historical traffic information, developer had taken it as valuable information, like travel time predictions, traffic bottleneck analysis, and survival analysis.

When the present systems and methods can properly gives limited analysis outcomes, but they are not able to deal with many of analytical queries. In day to day life there are many needs for peoples leaving in cities regarding with traffic patterns on specific days or specific time in traffic as well as modification of roads. Peoples of metro cities may have various queries related road traffics like, what kind of traffic events may have on road last week? Or which road links are the most rushed on a specific day?

For providing such questions there is a need to specifically study the traffic data suggests the need for an interactive traffic query system which plays a key role in semantic applications for smart cities.

In this survey, Following section gives the Review on datasets, Literature review for such systems and also list there pros and cons, Experimental setups, Result analysis and Conclusion.

II. REVIEW ON DATASETS

In paper[1] the data gathered from Second Ring Road in Beijing city with help of the traffic sensors information pre-processing. In paper[2] The data used in time prediction algorithms is collected by the UK' Highways Agency (HA) as part of its Motorway Incident Detection and Automatic Signalling (MIDAS) system. MIDAS includes a distributed network of traffic sensors, mainly inductive loops, which are designed to facilitate the detection of incidents allowing inter alia variable message signs and advisory speed limits to be set with minimal human intervention. In paper [3] author make use of previously stored traffic data of the total high ranking Austrian roads. If the case of missing data of the traffic travels time is predicted with deviations from typical historical speed time series. In this paper[4] the LS-SVM method is tested utilizing current travel time information from a bus route in Melbourne, Australia. The data of a bus route in Melbourne, Australia is selected in this as dataset. In this paper[5] author apply two datasets for experimental simulation. One is TDAD

dataset from the ITS Research Program, University of Washington . And the other is the traffic data of the inner-ring elevated road in Wuxi, Jiangsu Province, China. In paper[7] the forecasted bus travel time of the system assessed with information of transit route 69 in Guangzhou between two bus stops. In paper[8] Developed TTP model and use a small traffic network located in the east and north district of Tainan City, Taiwan. In paper[9] An exploratory analysis is first performed to compare these two rules, based on the information provided by a set of commuters interacting over 24 days through a simulated traffic system. In paper [11] Travel time information is a important component of many intelligent transportation systems (ITS) applications. The major source of data collection is automatic vehicle locators and GPS are more predominant because of the fact that they can track buses continuously and give location details, which results in a more accurate arrival time prediction. In paper[12] a graduation ceremony is chosen as case study. The Global Positioning System (GPS) test vehicle technique is used to collect after events travel time data. In paper[13] real time traffic data is used and collected through a probe-car system. Probe-car system is an upcoming data collection method, in which a number of vehicles are used as moving sensors to detect actual traffic situation. It can collect data concerning much larger area, compared with traditional fixed detectors. In this paper[14] the detailed data are collected on a real-time basis from a large part of the road-network (both freeway as well as provincial and urban roads).

III. REVIEW ON ALGORITHM AND TRAFFIC PREDICTION MODEL

In paper [1] authors developed a travel time analysis and prediction model mainly for urban road traffic sensors information depending on the change point analysis algorithm and ARIMA model. At start time series of travel time parameters are clustered by making use of change point mining algorithm then the traffic sensors information pre-processing. After that a travel time prediction model was created depending on ARIMA model.

In paper [2] authors has explained the implementation of a predictive model for vehicle journey time on highways. Authors have also designed the spatiotemporal distribution of travel times by utilizing local linear regression. Authors used real time data which is very specific for small travelling. For optimizing balance they made use of local linear regressions for historical and real time information. The main aim of the authors is the to upgrade the local linear model with grater order autoregressive travel time variables, known as vehicle flow data as well as density data. The data used in time prediction algorithms is collected by the UK' Highways Agency (HA) as part of its Motorway Incident Detection and Automatic Signalling (MIDAS) system. MIDAS includes a distributed network of traffic sensors, mainly inductive loops, which are designed to facilitate the detection of incidents allowing inter alia variable message signs and advisory speed limits to be set with minimal human intervention.

In paper [3] authors given a different case analysis of transit period for personal cars as well as heavy goods vehicles is predicted having data driven, hybrid method by making use of previously stored traffic data of the total high ranking Austrian roads. While studding data related to the traffic is provided, travel time is predicted using kernel predictor searching for same speed density pattern. If the case of missing data of the traffic travels time is predicted with deviations from typical historical speed time series. The steps taken in pre-processing of traffic data the hybrid prediction technique and the outcomes for selection of chosen road are given.

In paper [4] authors have developed Least Squares SVM (LS-SVM) technique which support the training process by clarifying the quadratic programming issue by making use of the prediction outcomes a Genetic Algorithm (GA) is utilized to find the optimal set of model parameters. The GA depending on LS-SVM method is tested utilizing current travel time information from a bus route in Melbourne, Australia. The data of a bus route in Melbourne, Australia is selected in this as dataset.

In paper [5], authors have developed novel prediction technique by implementing the particle filters algorithm. Different traffic parameters of the highway are gained depending on the interval velocity measurement framework as well as created a state model with the help of gained association parameters for travel time estimation. Then the Bayesian theory is used for simulating provability of the system state. Developed technique adopts the system state transition model depending on the history information retrieved from interval velocity measurement system also the use of particle filters maximizes the developed technique for handing of dynamic as well as uncertainty of the framework.

In paper [6] authors have developed personalized online travel time prediction model is presented. The developed system concentrates on urban road traffic problems from individual commuters' perspectives. System is able to find the critical prediction factors which may lead to high prediction accuracy depending on a proposed prediction effectiveness function. Personalized prediction is performed at the time of getting high accurate prediction outcomes consolidated with prediction lead times are used to personal commuters.

In paper [7] authors developed a Markov transfer matrix for predicting the traffic state, as well as put the estimate state value into the joint distribution of bus travel time as well as

state, the real time bus travel time forecasted value can be retrieved.

In paper [8] authors are making attempt of forecasting to predict travel time by consolidation of VD and PV data sources by a dynamic weighted fusion system. The weights of the data sources are runtime calculated by the distance weight system for maximizing the accuracy of the prediction.

In paper [9] authors examines two heuristic rules proposed for describing urban commuters' predictions of travel time as well as the adjustments of departure time in response to unacceptable arrivals in their daily commute under limited information. It is depend upon on the notion that the magnitude of the predicted travel time depends on each commuter's own experience, including recallable travel time, schedule delay, and difficulties in searching for a satisfactory departure time.

In paper [10] author implements the fuzzy inference system, DENFIS, for building both online and offline knowledge-based, adaptive learning systems. Both DENFIS online and offline models are based on the Takagi–Sugeno fuzzy inference system. They use the highly activated fuzzy rules to dynamically compose an inference system for calculating the output vector for a given input vector. The proposed systems demonstrate superiority when compared with Neural gas , RAN , EFuNN , and ESOM in the case of online learning, and with ANFIS , and MLP in the case of offline learning.

In paper [11], authors developed an advanced public transportation systems (APTS) are one of the most important ITS applications, which can considerably improve the traffic situation in India. This application will provide accurate information about bus arrivals to passengers, leading to reduced waiting times at bus stops. This needs a real-time data collection technique, a quick and reliable prediction technique to calculate the expected travel time based on real-time data and informing the passengers regarding the same.

In paper [12] author focuses on the study of the arterial travel time prediction using the Kalman filtering and estimation technique. Based on the real-time data collected, a discrete-time Kalman filter is then applied to predict travel time exiting the area under study. An assessment of the performance and its effectiveness at the test site are investigated. The approaches to further improve the accuracy of the prediction error are also discussed. The test vehicle technique has been used for travel time data collection

In paper [13] author developed a technique to predict travel time of a vehicle for an objective road section, it is depend on real time traffic data. The prediction technique is based on statistical analysis using AR model with seasonal adjustment and MDL (Minimum Description Length) criterion. Seasonal adjustment is used to handle periodicities of 24 hours in traffic data. The data collected in probe-car experiment which has been conducted in Nagoya Metropolitan Area by ``Internet ITS Project.

In paper [14] author developed a system that manages traffic information so-called dynamic route information panels on freeways. Central in this framework is a so-called state-space neural network SSNN model, which learns to predict travel times directly from data obtained from real time traffic data collection systems. They show that by using an ensemble of SSNN models also measure for the reliability of each prediction can be produced. This enables traffic managers to monitor in real time the reliability of this system without actually measuring travel times.

As shown in table 1, literature review of various papers has been listed, giving possibility of research gap.

Table 1. Survey Of Algorithm

Sr no.	Techniques	Advantages	Research gap
1.	change point analysis algorithm and ARIMA model	Provides high accuracy	more appropriate point weight function can be used
2.	Local linear regression	significantly improves predictive performance	---
3.	kernel predictor searching	pre-processing steps and results for selected rode is provided	construction sites and adverse weather conditions for travel time prediction can be given
4.	SVM	Produces accurate results	other Meta Heuristic methods such as PSO or ACA can be used to improve efficiency
5.	particle filters algorithm	better prediction performance than some traditional method	Algorithm can be improved
6.	POTTP (personalized online travel time prediction)	provide commuters with accurate travel time prediction	---
7.	Bayesian Networks	proposed model is feasible	accuracy of the algorithm is low

Experimental setups:

In paper[1] Four different weight functions were used to fit the travel time series . True travel time values of moments and, the predictive values fitted by four different weight functions based on ARIMA model were collected for error analysis of the fitting accuracy. In paper[2] they can setup data on long link of Cambridge. And observe the results. The data is used this link have duration of 383 days. In paper[3]The traffic pattern base covered about 5 months (October 2013 to March 2014), the evaluation period was one month (April 2014). Traffic patterns were stored in binary file format (Hierarchical Data Format (HDF5)), in order to keep calculation time for all 916 sections below 5 minutes. In this paper[4]author divide datasets within 4 test bed and training and testing are take place on this four bed. In paper[5] The route travel time is approximated by the division of the interval distance and the mean traffic velocity. The traffic data on June 15 and June 22 (Friday), 2007, from the dataset. The state transition model with associated parameters is learned based on the data on June 15, and the data on June 22 is used for the simulation and comparison of the proposed method and the other ones. In paper[6] 1.Traffic data for fusion and processing Settings.The traffic data including IDL and traffic lights data from acity centre intersection (8 directions) in the city of EnschedeNetherland are used.2. Commuter Settings.18 commuters are predefined, corresponding to 18 types,which can be derived from defined commuter classes. 3. Prediction with M5 Tree Model .a decision tree technique called M5smodel tree is used for data fusion and processing. In paper[7] Take bus line 69 in Guangzhou as the application object, Algorithm is applied to predict the bus travel time between the two stations of Changgang west road and Xinhe square in ChanggangZhong road, and then compare with the actual travel time. Test time is 10 days, and time from 9 days the data training time of the model. In paper[8] author apply the three TTP models to Tainan city, VD database is collect from traffic bureau of Tainan city government, and PV raw data is provided by Taxi fleet management system from Chunghwa telecom. Co. Ltd. In VD data, it includes timestamp, vehicle speed, road volume, and lane data; and in PV data, it includes timestamp, OBU id, GPS latitude and longitude, vehicle moving direction, vehicle speed, and vehicle status. The experiment raw data are collected from 10months. In this experiment, raw data from Jan. to Oct. are applied as historical data for training, and data in Nov. is used for verification. The selected experimental network are
located in East and North district in Tainan City. In paper[9] airport parking use for experiment which can accommodate 1,000 vehicles .

Result analysis

In this paper[1] they compared results using time and accuracy parameter. In this paper Error Analysis For Predictive Results can compared with help of weighing function. Such as Square root weight function, Squared weighting function , Growth curve weight function , Linear weighting function .and compared with true value, predictive value and mean absolute percentage error. In paper[2] the parameters used are low traffic density and vehicle speed (free flow). Also find mean average error over different forecast intervals. The error increases as the forecast intervals increase. In this paper[3] author analyzed the results by using the parameter speed, density and time. Due to weather like mild or dry winter, the pattern base did not comprise situations with severe weather events like snowfall, heavy rain. Therefore impact of severe adverse weather events on travel time could not be explore. Further analysis will focus on construction sites and adverse weather conditions for travel time prediction. Traffic patterns will be labelled, and a separate traffic pattern base for special cases will be formed. In this paper[4] the parameter like Day of peak, AM peak, Mid day off peak, PM peak, late night of peak, Whole day are compare with Root mean error square, mean absolute percentage error. In paper[5] author analysis

Result with 5minute interval,10 minute interval,15 minute interval,30minute interval with help of mean relative error (MRE), maximum relative error (MMRE) and root mean square error (RMSE) between the prediction and the actual travel time .

In this paper[7] author compared the results by using the parameters like bus travel time and other factors affecting the state except the average road speed, in order to improve the accuracy of prediction . In this paper[8] the experiment results indicate that the proposed model can reduce uncertainty of information and enhance accuracy as well as stability of travel time prediction. In this paper[9] author investigating the expected number cars in the parking lot. The comparisons between the analytical results and the numerical results have been performed in parking scenarios. In this paper[12] predicted travel time at each time instant is compared with the corresponding observed travel time. The predicted travel time at current time instant is basically determined by both the observed and predicted travel times at the previous time instants. In this paper[14] they analyzed result by using departure time, travel time and accuracy . Use different classifier and compare result with precision and recall.

CONCLUSION

This paper analyses various techniques used for Travel-Time Prediction. Also given the advantages and drawbacks present in the different studies performed by various researchers. Mainly for travel time prediction author use ARIMA model. In the datasets they are mainly collected from GPS. In experiment they use one month training datasets and testing datasets. If in case of datasets is not available sometimes author need to simulate datasets with respect to their system. In this survey for result analysis mainly use RMSE,MRE,MMRE,PRECISION AND RECALL.

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