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Short Term Traffic Flow Prediction Methodologies: A Review

Pregya Poonia[1], V K Jain[2], Anil Kumar[3]

[1]Reasearch Scholar, Department of Computer Science and Engineering, Mody University of Science and Technology, Lakshmangarh, Rajasthan
[2]Dean, College of Engineering and Technology, Mody University of Science and Technology, Lakshmangarh, Sikar, Rajasthan-332311
[3]Professor, Department of Computer Science and Engineering,Engineering, Mody University of Science and Technology, Lakshmangarh, Sikar, Rajasthan-332311

[1]pinta22pragya@gmail.com, [2]drvkjain72@gmail.com, [3]dahiyaanil@yahoo.com

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Abstract: Successful traffic speed forecasting is an intact component for traffic management agencies. It has great grandness for benefit of road users. Intelligent traffic management system provides time based traffic flow information, so that travellers can reach their destination at an estimated time. In previous few years a series of traffic speed prediction applications have been formulated, in which most of the approaches are relied on short-term speed prediction which includes some traditional models and machine learning techniques. The traffic flow has greatly increased due to the current system and existing methods are still unsatisfying. This composition examined few of the current short-term traffic speed methods.

Keywords: Machine Learning, Speed Prediction Methods, Deep Learning.

1. INTRODUCTION

Cumulating high quality traffic, data information is the key factor to attain the performance of Intelligent Transport System (ITS). Prefiguring the future patterns in traffic flow turns into highly vital in Advanced Traffic Management (ATM) and advanced Traveller Information System (ATIS). Currently, prefiguring the traffic speed is the main fundamental study in the area of traffic research community [1]. By using the forecasted data, such as travel time data, traffic condition entropy and traffic volume data, travellers can replan their travelling ways to save the time and cost. Basically, predicting the speed of traffic is a part of the traffic information prediction. On the basis of present and past traffic experiences, the traffic speed can be predicted using two-terms:

Short-term traffic flow forecasting: it includes forecasting of traffic mass in the following time interval generally in the compass of five minutes to one hour. And long-term traffic flow prefigure is founded on few hours, days, and months and on years.

Short-term flow prediction is the paramount research issue in the sphere of TMS. Numerous researchers are showing their efforts in this field from past two decades. The count of vehicles moving at a point per unit time is a case of random procedure which comprises of a set of distinct variables hoarded over time. Traffic engineering analyses the deportment of traffic and also design better adeptness for a safe, economical and smooth traffic operation [4]. Presently, relevant researches primarily divided up into two different sections: parametric modelling and non-parametric modelling. As the flow of water, traffic flow also has several parameters allied within it.

The growth in traffic in evoluting countries is epidemic and will be sustaining to be so in coming years. Smart cities have radiated latest technologies to gratify the necessarily of travellers through effective navigation. As per to a recent study nearly 60% of population will start living in cities by 2050 and as an outcome, millions of vehicles (cars and two wheelers) will move on the roads [6]. The basic feature of ITS is dynamism of phenomena and the dynamism is an aftermath of the transport system properties: elevated level of complexity, substantial number of users, occurrence of complex and random traffic phenomena and susceptibility to external factors, these are the natural features of ITS [7], [8].

In this composition we will canvas the multistep forecasting functioning of dissimilar models.

2. LITERATURE REVIEW

Short-term traffic prediction

In smart cities it has become an important subject of research in transport engineering and the urban logistics system in the past decades. The main aim is to uprise intelligent traffic control methods, create

advanced passenger information system and applications which facilitate the deliveries of goods in the municipal road network. Except this the other reason which we can consider is growing traffic in urban areas and the development of data acquisition and processing technologies [3].

As an integral part of ITS, Short-term traffic prefigure concludes future value of parameters such as traffic volume, density, and speed or estimated travel time in divisions of the urban road networks. Such prediction has the time horizon spanning which can go from a few seconds to maximum a few hours.

Review of traffic flow prediction technologies

Traffic flow has to major methods involved for foresee, they are Parametric and Non-Parametric techniques. The famous technique is non-parametric and being highly used in current research studies. Many technologies are there including statistical models and machine learning approaches.

Among many parametric techniques, linear Auto-Regressive Integrated Moving Average (ARIMA) and some other models have been experimented in various research surveys. At starting, the ARIMA was first launched in traffic information forecasting to inquire the stochastic character of traffic system [2], [5]. The subset ARIMA, ARIMA with explanatory variables and seasonal ARIMA were submitted involving diverse characters of the traffic flow, these are developed for the extension of ARIMA. Seasonal ARIMA is used in India in a recent research work by S. Vasantha Kumar (2015), Lelitha Vanajakshi (2015). SARIMA model used only special input data to forecast the short-term traffic flow. For this Chennai's 3-lane roadway was selected, three days data study was used for the model evolution using SARIMA. Later, the autocorrelation function (ACF) and partial autocorrelation function (PACF) were plotted to recognise appropriate sequence of SARIMA model. The proposed model was formalised by performing 24 hrs leading forecast and the prediction flows were equated with the actual flow values. Short term traffic flow prediction was done on the basis of historical and actual time data during the peak periods of morning and evening times. The equated mean absolute percentage error (MAPE) of real and predicted flow showed in the compass of 4-10 which is admitted in most of the ITS applications. The highlighted issue with this model was database.

Various Machine Learning techniques are involved in traffic flow prediction and multiple Deep Learning models have been proposed in this area. A Deep Learning method, Deep Belief Network was introduced by Yuhan Jia et al. (2016) for short-term traffic flow prediction. The DBN model is trained in a greedy unsupervised method and fine-tuned by labelled data. Data is gathered from one arterial in Beijing, China. DBN is comprised of a stack of RBM, which is considered as the family of belief networks. On the tip of RBMs, there is a BPNN regarded as the output layer, which can fine-tune the entire model by using back-propagation algorithm. Three forecasting time horizons are elected in this study, including 2-minute, 10-minute and 30-minute horizons. Three performance measurements are selected: (a) the Mean Absolute Percentage Error (MAPE), (b) the Root Mean Square Error (RMSE), and (c) the Normalized Root Mean Square Error (RMSE). Problem occurs when the prediction horizons are longer; more stochastic features are missing from the DBN results and evening's peak hours performance is poor.

Han Jiang et al. (2016) examined the multistep ahead prediction functioning by using eight dissimilar models and took the collected data of 2-minute travel speed from three Remote Traffic Microwave Sensors which is situated on a southbound segment of 4th ring road in Beijing, China. This model was based on the theory of machine learning and statistical. Five machine learning models were considered: Back Propagation Neural Network (BPNN), Nonlinear Autoregressive Model with Exogenous Inputs Neural Network (NARXNN), Support Vector Machine with Redial Basic Function as kernel function (SVM-RBF), Support Vector Machine with Linear Function (SVM-LIN), and Multilinear Regression (MLR) as candidate. Three statistical models: Autoregressive Integrated Moving Average (ARIMA), Vector Auto Regression (VAR), and Space-Time (ST) model are also selected. The following meaningful outcomes were found from the predicted results: (1) Speed deteriorates prediction accuracy increases for all models, (2) two statistical models can clearly be outperformed by the BPNN, NARXNN and SVM-RBF, they are: ARIMA and VAR, (3) ANN has superior prediction performance rather than SVM and MLR, (4) the ST model can give the lowest MAE comparing with ARIMA and VAR. This case study supplies useful applications of speed prediction and comparisons of prediction performance.

Zhiheng Yu (2015) proposed two combinational prediction models which rely on GM, ARIMA and GRNN. GM (Grey Model) is, to gain important knowledge via the partly known information processing and extending. This model was designed so that the accuracy of traffic flow forecasting can be reformed. For certain distribution GM does not need big samples on the data to be subjected. ARIMA is a method of a time series prefigure. It can foreshow the curve for short-term and long-term forecast and this gives very less prediction error. GRNN (generalized regression neural network) which is based on non-parametric regression has a nonlinear mapping power which solves the curve fitting issue. GRNN can distinguish the concealed rules from big amount of data and then integrate this learning information into

the linking weights between neurons, but it gives poor prediction accuracy when the training sample is very small. The outcome of recently developed combinational forecast model was analyzed by taking 54 pieces of main road traffic data on Chongzun of China. The grey system theory modelling software 3.0 and MATLAB R2012b are used in these observations. This comparison showed either combinational model has mellow prediction accuracy than any other model. But still, how to opt the earmark model for combination is a question.

A current research paper by Daniel Kubek (2016) presented an approach to robust optimization which shows the logistics vehicle routes in urban areas on the basis of figured short-term traffic time forecasting in a particular selected area of the urban road network. Spectral analysis model had been used to specify the calculated values of optimization parameters. In urban network the robust routes for logistics vehicles are used to determine with the help of the shortest path problem. The uncertainty set is forged on the basis of prefigure travel times in chosen divisions, estimated by means of spectral analysis. The classic approach has been equated with the attained data wherein it is contemplated that the optimization parameters are certain and authentic [9], [10]. The quality of conclusive results is affected with the function of forecasting proficiency with robust optimization models. Transport and logistical companies can take the advantage of this approach in their practical operation.

In the past few years many researchers are being attracted towards deep learning including academics and industries. Recently, deep learning neural network algorithm is used to formulate three models for traffic flow prediction. These models were designed by Sivabalaji Manoharam (2016), this was a research project. In this project a multi layered structure was used to extract meaningful data through a deep learning algorithm and the data used in this process was weather data along with traffic flow pattern. The processing data was taken from United Kingdom website which is an opened data source website. The traffic data consists of 23 loops and the weather data is acquired on an hour time break and it stationed near to Leeds city. In the following step the weather and traffic data were combined. The functioning of the model is measured by Root Mean Square Deviation (RMSE) and lowers the value results in higher accuracy. The superior support vector machine model and the envisioned deep neural network model are correlated, and the deep neural networks have the higher accuracy.

3. RESEARCH GAP

ITS and many researchers have been processed multiple methods to predict the traffic flow but still a masterful method which can meet the real-world traffic problems have not been discriminated. Now the question is, how can we resolve the problem of traffic flow using Deep Learning approach??

4. CONCLUSION

In recent year's number of intelligent traffic speed prediction techniques have formulated, where most of the algorithms are relied on machine learning and statistics theory. Successful traffic flow forecasting is of great grandness for the benefit of road travellers and intelligent transportation system. In order to overcome to the traffic issue, many scientists and researchers have evolved a series of speed forecasting approaches. This paper introduces a brief introduction of some of the short term traffic flow prediction models and techniques. Nevertheless, current techniques are still unsatisfying due to the hardness of reflect the stochastic traffic flow characteristics. Finding a worthy method or technology in the study of traffic flow is still a challenge.

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