Survey of Re-Routing Techniques in Traffic Light System

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ABSTRACT

To reduce the risk of accidents the traffic control system came into existence. One of the major challenges was to detect dangerous situations and react accordingly to mitigate accidents and divert traffic if possible. In order to accomplish this evolution in traffic, the situation is needed to be analyzed along with checking seriousness of the situation. This paper is a survey of existing methods used for prediction of traffic along with techniques used to judge severity of traffic so that rerouting may be suggested. The fault tolerance mechanisms utilized in prediction system also needs to be analyzed for stability. The proposed classification also defines trade-offs that exist between models and achievements that exist due to real time environment constraints.

Keywords:Traffic, Prediction, Accidents, criticality, re routing, fault, stability, classification, trade-offs, constraint.

INTRODUCTION

Traffic prediction is a corner stone required for safety and rerouting of traffic. Wang et. al.[1] proposed severity of traffic prediction is critical for preventing future accidents and damages to the vehicles. For performing required analysis prediction models are created which operates on datasets. The contribution of this paper is listed as under.

i. Data Collection and analysis: analyse the methods used to provide input to current systems which can be data collected over real time situations or through datasets.
ii. Prediction Accuracy: Accuracy of the system predicting traffic is analysed through this work.
iii. Fault Tolerant Capabilities: Fault tolerant capabilities possessed by the approach are comprehensively checked.
iv. Model and Data driven Approaches: comparison of model and data driven approaches used for the purpose of predicting traffic.

This paper introduces some important terms for the readers such as traffic prediction, fault tolerance and some key characteristics that must be considered while developing a new traffic model for prediction of traffic under real time situations.

The remainder of the paper is organised as follows. In second section, provide critical information regarding traffic prediction and forecasting system. In third section, key characteristics required to be considered in traffic prediction are described. In fourth section, fault tolerant capabilities possessed by the approaches are described. Section fifth provides details of data analysis tools used by the considered approaches. In sixth section, Comparison of various techniques is presented whereas section seventh, provide summary of analysed work.

RELATED WORK

J. Abawajyet. al.[2]in 2012 Congestion, accidents, risks, rerouting about fault tolerance capabilities are key characteristics that a traffic prediction system must consider. -This is generally accomplished by the use of management of existing infrastructure. Constant improvement of supply conditions is also compulsory. Supply condition improvement is required however involve high costing. It may or may not be possible to construct infrastructure in existing situations due to limited resources or constraints in real time situations. The modification to existing supply conditions may not always give optimal traffic flow as expected due to hidden traffic situations. Hence outcome may vary than expected.**Kliazovich et al[3]**proposed more accurate and possible approach is to use Active Traffic Management (ATM). Now days it is possible to continuously monitor and adjust road management strategies based on current traffic. ATM has many advantages. Along with advantages it suffers from some disadvantages also. It follows look and see approach which can greatly be affected by complex traffic situations. it cannot take preventive actions in case traffic is heavy. **Miorandi et al[4]** Two approaches exists for prediction one is model driven and data driven. Model driven approaches primarily used for long term planning related with infrastructure related facilities. Future traffic conditions are modelled in this case. real time information is not considered. The model driven approach is generally expensive as compared to data driven approaches. Proactive fault tolerance proposed by **J.liu et al.[5]**. The mechanism proposed how to handle the faults within cloud system and data is handled through the virtual machines. The fault tolerance thus increases the performance of the cloud in general.

CHARACTERISTICS TO BE CONSIDERED IN TRAFFIC PREDICTION

Tan et al.[7]discussed future risk detection on road can be accomplished using traffic prediction and forecasting system. Certain characteristics or properties are required in such regard. Collection of data is important for the success of traffic prediction and forecasting system. The metric chosen to compare accuracy of data collected is also important. These characteristics are considered in this section.

A. Data Collection

Gebresilassie et. al.[8]proposed a data collection is primary task on which entire operation of prediction is dependent. Real time collection is crucial in dictating the possible prediction system are going to follow. The main source of real time data is GPS, Surveillance, Location system incorporated in vehicles. Zhu et al and Pan et al.[9], [10]discussed essence to real time information, historic data also plays important role in prediction system. The historic data is generally represented in the form of dataset. The Data driven approach generally uses historic dataset. The preprocessing mechanism yield following data groups:

(I) Static observation data groups

Xu et al. and Min et. al. [11], [12]proposed static observation indicates the data obtained from a particular location within the network. Data is gathered through Surveillance, GPS enabled vehicle, loop controllers etc. The information drawn is region specific hence is of limited use.

(II) Route Specific observation data groups

This information is generally drawn from Smart phones. GPS monitoring etc. Hoong et al. and Zhou et al.[13], [14]proposed the metric drawn determines traffic, accident related information, queue length etc. This kind of information is useful in rerouting of vehicles in case of anomalies over road.

(III) Global System Observation data groups

Shafie et al and P. Et.al[15], [16]suggest information is drawn from secondary sources such as weather report, special events etc. Such information is used in the prediction of future events.While considering these sources or observation, uncertainty in generated information must be considered. The information source could be third party such as smart phones where information cannot be validated.

B. Parameters of Prediction

Depending upon the area of concern variables could be predicted through the used system. Sun et.al and Anon et.al[17], [18]Common output variables define state of the network in the future. Other parameter may include travel time and traffic at particular interval of time. The key aspect of prediction depends upon the input data. The accuracy of prediction grounded heavily on data being presented to the system. The network state is accurately predicted if relative error in collected data is less.

(I) Accuracy Prediction Mechanisms

system can be discovered which is reliable enough and can be used in future. For this purpose certain metric is needed to be established. The considered metrics are divided into categories as

(I) Relative Error

This metric is the ratio of difference between the predicted and true(actual) value to the true value. Higher the value of this metric zless accurate is the prediction system. Relative error is given as under

$$R_{Error} = \frac{|X - X_a|}{X} * 100$$ Equation (1)

(II) Mean Absolute Deviation or Error

This metric is the difference between actual value and approximate (Predicted) value. The difference taken is always positive.

$$R_{Absolute} = |X - X_a|$$ ***Equation (2)***

(III) Root Mean Square Errors

Discussed error corresponds to square root of mean of square of difference between actual and predicted values.

$R_{RMS} = \sqrt{|X - X_a|^2}$ ***Equation (3)***

These metrics are useful enough to indicate accuracy of prediction system. For accurate prediction system, value of error rate should be less. In other words there exist trade-off between accuracy of prediction and error rate. Out of the available metrics relative error is most cited metric.

C. Fault tolerant mechanisms

The existing research corresponding to fault tolerance capabilities are described in this section. Fault indicates deviation from actual result. Higher the deviation severe is the fault. Fault tolerant capabilities must be possessed by systems in order to overcome the problem of sudden die down. System must give enough time to the object of concern to take backup if necessary. Certain techniques under this category are emphasises as under:

(I) Reactive approach: Discussed fault tolerant system cannot handle changing environment in terms of policies and requirements. Reactive approach is proposed for this purpose. This approach reacts according to faults that exists or appear to exists with the system. Approach is useful and occupies less space as compared to redundancy based approach. In this approach checkpoint is established based on certain time interval.

(II) Proactive approach: These techniques include methodologies which are used to prevent the faults within the system [3] suggested approach which is useful for fault tolerance and security within the networks. Game theoretical approach and Link and router failure is handled through the studied approach. Redundancy based approach is one of the most widely used strategies to provide fault tolerance.The same data is kept at multiple locations in this approach.

D. Model and data based approach for data analysis

These data analysis tools are used in order to fetch the relevant data from collection of data. In other words filtering mechanism can be termed as analysis tools. In this section both Model based and data based approach is described.

(I) Model Based Data analysis tools

Model based approach is generally faster and prediction is generated accurately. Model based approach however is expensive approach. This approach is based on infrastructure related activities which are predicted to optimize traffic. Model based data analysis tools are described as under

(I) DYNAMIT

This approach is based on dynamic network assignment for management for information to travellers. This system requires both real time and offline data. Set of topologies are formulated using link, node and loading mechanism. User must provide historic data to this system along with real time data elements form surveillance, GPS etc. Integration of both gives prediction corresponding to traffic and network state in the future.

(II) ARIMA

This model is continuously used in traffic prediction. Time series analysis is conducted in three phases in this model. The first phase involves extraction of information from the time series presented. The second phase involve extraction of influence from previous values on

the current values. Third phase involve determination of error that occur in the current phase. Also effect of previous phase error on current values is analysed. ARIMA model is mostly cited and proffered model for traffic prediction.

(III)ARFIMA

This is a network traffic prediction model used to predict on the base of time series. The root mean square error and relative mean square error are metric introduced within ARFIMA to improve the result of ARMA model. Traffic prediction based on ARFIMA is more accurate as compared to exiting methodology. It is not effective in case of sampling but is more effective in prediction.

(II) Data driven model

Data driven model utilizes historic data for future prediction and cost encounter is minimum. Data driven models and classifiers are described in this section

(I) KNN

K Nearest neighbour approach is used to locate the nearest neighbour in order to find deviation from actual dataset. KNN approach is widely used in order to rectify the faulty data also Liu c[8]Multi label correlation is analysed between the data using KNN approach. Unseen instances within the data are discovered using this approach. The result of analysed approach is better in terms of deviation analysis.

(II)FCM

Fuzzy c means clustering technique is used for analysis of data in terms of clustering. To use this approach in prediction fuzzy rules are created and employed. Approximate results are generated in this case Yang S[9] Hybrid approach corresponding to prediction is used in this case. Hybrid approach involves features of both supervised and unsupervised learning approach.

E. EUCLIDEAN DISTANCE

The Euclidean distance approach is used in order to determine the closest values matching with the current value. The matched values having minimum distance from the checkpoint value is recorded. The accuracy of the system is more in case less deviation is present within the data being presented. Higher the deviation less accurate is the result. Hence trade off exists between the deviation and accuracy.

F. COMPARISON OF RELATED WORK

This section provides comparison of techniques used in prediction along with indicating whether fault tolerant capabilities they possess or not.

DATA REQUIREMENT	PREDICTION Technique	ACCURACY	Fault Tolerant
Real time	PROACTIVE	Low	Yes
Statistical	Combined Prediction Model	Intermediate	Yes
Historic Dataset	Fast Incremental Approach	High	Yes
Historic	Fuzzy Rule based Approach	Approximate	Yes
Dataset	DTN based Approach	High	Yes

Dataset	Crime Detection Model using KNN	High	Yes
Dataset	Tree based Approach	High	Yes
Time Series Dataset	Time series Analysis and deviation Prediction(ARIMA)	Depends upon accuracy of data presented	No
Time Series Dataset	ARFIMA	Depends upon accuracy of data presented	No
Dataset	SELINA	High Accuracy	No

Table 1: Comparison of existing research regarding prediction and fault tolerance

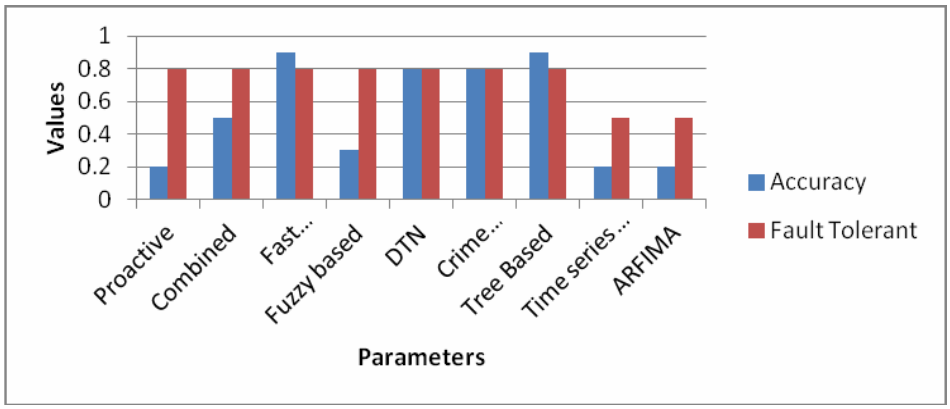

Fig 1 Comparison chart

CONCLUSION AND FUTURE SCOPE

Proposed work provides detail description of techniques and preliminary requirements for the prediction system. Data collection techniques are highlighted which is a building block of prediction system. Both real time and historic data are the source of information which can be explored by prediction system. Real time data is generated through sensors, loop back controller and GPS, malfunction in any of listed device can cause faulty data. To introduce accuracy in prediction fault tolerance mechanism can be utilized which are comprehensively listed in terms of proactive and reactive techniques. Research papers are analysed and concluded that proactive techniques are generally better, various classifiers such as KNN, Euclidean distance, FCM etc are described which data driven techniques are. These techniques are preferable as compared to model driven approaches since they are least expensive and future predictions are accurate. Overall this paper provide help in future research regarding prediction and fault tolerance.

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