Result Analysis for Visual Exploration of Passenger Flow using Transportation Data

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Abstract— People daily uses public transportation system for their day work and for their travel in new cities. The accessibility and usability of information that are applicable to the traveller are very useful for the system to be easy to use. So, as complexity of public transportation network and the needs of travellers increases, the designing of the visualization and exploration of these system become crucial task. The various aspects which will affect the working of transportation System are discussed in this paper. I surveyed the literature related to the visualization of public transportation network data. I discussed the common datasets which has been used for visualization of transportation data, the results of implemented work and at the end the challenges in this area that must be researched are discussed.
Key words: Transportation, Transportation Data

I. INTRODUCTION

Transportation is the backbone of our culture, civilization and cities invest a lot of money for maintenance and developments of public transport system. The research in this area is more important for development of sustainable cities and for that it is essential to take several factor into account Form financial perspective, the administrative departments are look for the low cost solutions that increase its efficiency. From social perspective the, Public transportation system must insure or guaranties that the passenger are able to travel without any difficulty. From environmental perspective, transportation system must be eco-friendly and smart to save energy compared to private transportation. There are lots of opportunities are available in visualization field that help to solve Public transportation problems. On one hand the system must be as simple for passenger to use and the visualization should provide them information suitable for their plan for journey. On other hand the urban travellers and researchers seek for the patterns in flow of passengers to improve system capability.

Most of literatures are written on the techniques to focus on the visualization which helps to explore the usage and used for urban planning, rather than to improve usability and accessibility. The efficient way finding within transportation network is defines the overall quality of it.

Research in transportation network has variety of techniques and concepts from different fields, like cartography, human psychology and graph theory. The 3D visualization of geo-referenced time dependent data is used for detection of spatio-temporal view, to identify trends, outliers etc. This data with geographical context is used to display the data on maps to easily understand the dependencies and effect of any event on transportation network. Many researchers contribute in the visualization of transportation network to solve many real-time problems of system. Some of them worked to improve transportation system and some of them used transportation system data to analyse and used for future prediction for emergency event handling.

II. RELATED WORK

Christian Tominski et al. [1] proposed "3D Information Visualization for Time Dependent Data on Maps". In this paper they visualize the time dependent data on 3D map. In 3D view we get additional dimensions to represent the additional information where on dimension depicts time. They used event based approach by defining interesting events, detection of events, and representation of only events rather than whole dataset. They used Pencil icons and Helix icon for linear time and cyclic time respectively. They faced problems in visualization because the 3D cause closure of information and the use of map causes change of data view so they used simple icon positioning algorithm, separates map and icon interaction and used tunnel view.

Sidharth Thakur and Andrew j. Hanson [2] proposed "3D Visualization of Multiple Time Series on Maps". They present visualization technique that solves challenges to visually explore and distribute geo-spatial time varying data. The developed pictorial view based on space time cube metaphor and represents various profiles of time varying quantities. They used techniques like Data mapping to various attributes of geographical icons or glimpse, Data transformation is set of data processing and manipulation methods to explore useful patterns in data, and Data filtering which not just visual analytical process but also it reduces complexity of the 3D view. The Data transformation uses aggregation and Data abstraction where multiple data points are replaced by some few data points, clustering identifies subsets that contains similar types of items, and correlation analysis that used for understanding relationships between data sets by examining correlation of different attributes in data. Gennady Andrienko et al. [3] "From Movement Tracks through Events to Places: Extracting and Characterizing Significant Places from Mobility Data". They proposed visual analytics procedure to analyse movement data, i.e. tracks of moving objects. This type of data is collected by using GPS, RFID, Radars, etc. They are intended to analyse place which significantly make certain types of events reputedly. The used four steps like extraction of event form trajectories, clustering of event and finding repetitive places, use of events or trajectories in spatio-temporal aggregation, and analysis of this aggregated data.

Real time simulation is also one research area where transportation data is analysed. Many applications are used real traffic data simulation, focuses on traffic surveillance system to improve the traffic management in cities. This simulation used in planning and implementing new roads.

Real–time simulation of transportation becomes tough task while adjusting the simulation to meet the traffic conditions and requirements. Liu et al. [4] provide modern way of data mining approach to collect geo-spatial

information about transportation network, traffic and drivers behaviour to put as input to simulation system. It World [6] who is geographic visualization expert developed time lapse animation for public transport based upon NPTDR data. They use time table schedule of every service for its origin to destination and show flow of trains, buses over the course of the day. The Mapumental society [7] developed many online applications for public to quickly analyse the best location to stay based on the travel time, housing prices, and scenic community. The traffic flow analysis helps us to visualise the behaviour in realistic way on complex network.

Crnovrsanin et al. [8] presented a proximity based visualization approach on spatial layout. GeoTime displays the 2D and 3D space to provide detailed descriptive view of the geographical as well as temporal changes in movement data. Visualization allows us to graphically explore data, however the interaction with system should be smooth and dynamic, Huaxing et al. [9] introduced smooth interaction by using double buffer graphics. Visualization of geo-spatial data with the traffic data able experts to analyse with new dimension, Harrison et al. [10] have developed an application to inspect heavy weight vehicle, and provide optimum sites of vehicle safety facility with alternative scenarios.

Temporal attribute of traffic data and working on it is one of the key challenges. Aigner et al. [11] take time as new dimension and they used it as principal component for data abstraction and visualization of event-driven as main feature.

The incident driven traffic data visualization is also an interesting research to enable user to understand occurring of repetitive events during specific traffic incident.

III. VISUALIZATION OF PASSENGER FLOW

The Public Transportation System (PTS) like buses, railways and metros are intended to increase their resilience to the various situations which may affect their working. The PTS is mostly used in mega cities for daily travel and it is life line of that city. Many factors like natural disasters, public gathering or accident may cause defect or disturbs the system. So, to overcome and to tackle these situations the visualization methods are used to visualise and analyse the transportation data to predict the flow of passengers during week days and weekends. As well as the flow of passenger during any accident will help us to identify the behaviour of the passengers. This visualization we can use for future prediction and can make arrangements before any known event to make PTS immune to that situation.

Masahiko Itoh et al. [5] proposed "Visual Exploration of Changes in Passenger Flows and Tweets on Mega-City Metro Network". They implement this visualization system using three things:

1) Exploring unusual phenomena i.e. strange situation from variety of visualization aspects
2) Understanding change in flow of passenger's and effect on network
3) The cause of event by real voice of passengers using social media data.

They integrate 3 visualization techniques: Heat Map view, Animated Ribbon view and Tweet Bubble view.

The authors used smart card data from Tokyo metro which contains 28 lines data with 540 station and 350 million trips. It doesn't contain any passenger's personal information. This data is from March 2011 to May 2014.

A. Extraction of Passenger Flow

The authors calculate shortest path by calculating t which is total time contains total time taken to walk to reach to the platform, waiting time for metro and the time to reach to destination. The passengers always take shortest path so they use Dijakstra algorithm to calculate shortest path.

The unusual phenomena are identified by using following methods

- Estimate the excogitated path
- Calculate the passenger's number
- Calculate simple moving average (SMA)
- Estimate standard deviation

The SMA reflects daily cyclical patterns of passenger's flow. The unusual patterns are calculates by previous data logs stored containing the passenger flow details.

IV. OUR CONTRIBUTION

Masahiko Itoh et al. proposed three visualization methods whereas we used one visualization method which is HeatMap View and integrate with Line Chart view which shows the passenger density on particular Metro Line, which helps us to get knowledge about Passenger Flow on Metro Network.

A. Pre-processing

In this phase the given dataset is analysed and the only required fields are extracted from dataset. We used WMATA's dataset of October 2014 Quarter hour data which contains origin to destination trip data. Each row contains origin, destination, and average ridership, Number Rider Sum, Quarter Hour Interval and Average Travel Minutes etc. In pre-processing phase we calculate rider matrix and line matrix where rider matrix contains origin to destination passenger density and line matrix contains metro line passenger density data at each station at 15 minutes time interval.

B. Heat Map View

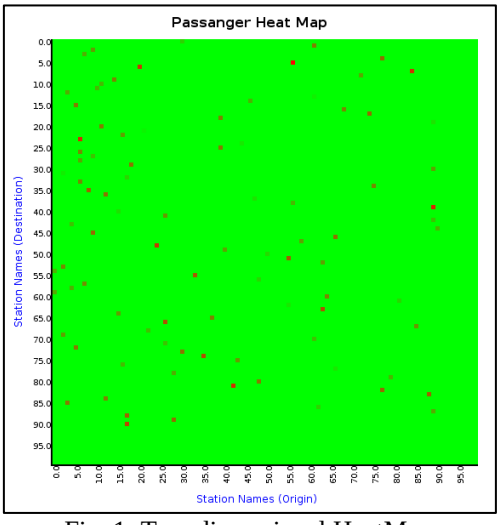

Fig. 1: Two dimensional HeatMap

The heat map view shows origin to destination passenger density in colour shades. In our implementation we used green shade for low density and red for higher density. The

HeatMap is useful to gain exact idea about which station have how much passenger density and we can take corrective actions on it.

The above figure shows two dimensional HeatMap to display status of more than 90 stations. The x- axis shows origin stations and y-axis shows destination stations.

1) Line Chart View

In this view the status of the metro line is shown with the help of two dimensional line charts. The dataset we used, it contains data about daily metro trips starting from 5.00 am to 11.30 pm in weekdays. The Line Chart shows deviation in passenger density at each 15 minutes interval on metro line.

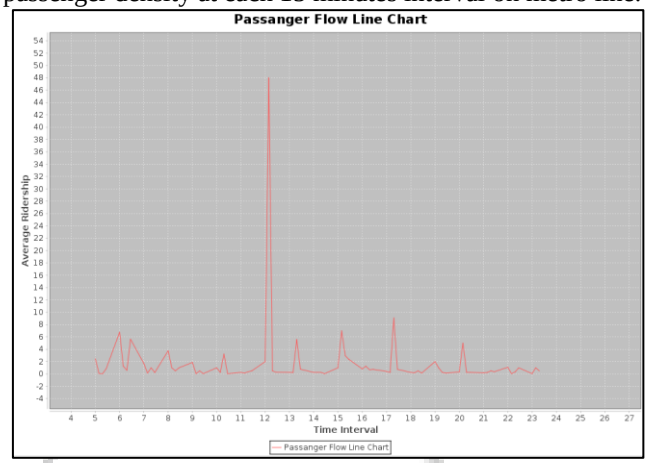

Fig. 2: Line Chart View

The above figure shows Line Chart View Where the x-axis shows 15 minutes time interval and Y-axis shows average ridership.

V. CONCLUSION

This paper takes short overview on various features of transportation data and our contribution and result analysis. The visualization system is become more useful to handle emergency situations. The system allows us to learn the behaviour of the passenger. The visualization shows the effect of any unusual situation on transportation network. In future implementation we are going to implement line chart with multiple metro line view on chart.

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