Traffic Analysis : A comprehensive review

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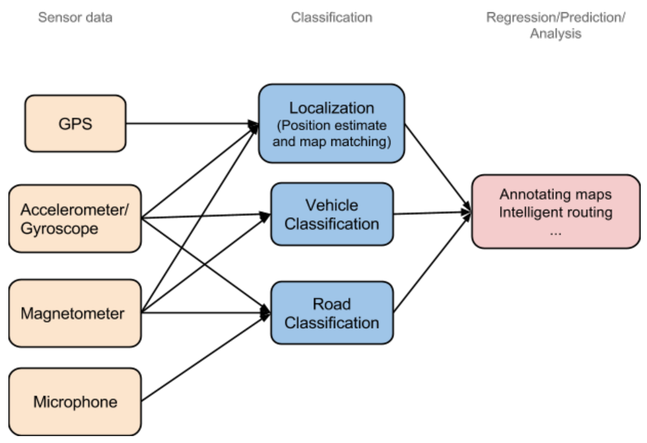
INTRODUCTION

The project aims to analyze and model road traffic conditions. The goal of such analysis is to be able to predict and learn how to issue adequate traffic recommendations to ease travel conditions.



LITERATURE REVIEW

Various projects attempt to analyze traffic and road conditions. Some of them are listed below

Nericell **:** Using GPS, Accelerometer and Microphone on a smartphone, estimate road and traffic conditions. Identify potholes and bumps using simple threshold heuretic on accelerometer data after reorienting with respect to vehicle's axes. Identify honking by checking for more than two energy spikes in frequency domain. Uses triggered sensing to save power.

Wolverine **:** Uses similar approach as Nericell. Uses magnetometer for reorientation. Use machine learning techniques for identifying potholes/bumps. Initially partition the data using K-means clustering into two classes for labeling. Use SVM classifier to classify after training.

CloudAtlas **:** Use GPS traces for map building. Initially GPS points are matched to road segments using Viterbi algorithm. The system is modeled as a Hidden Markov Model. Infer whether the trace is matched or not. After repetition of unmatched traces new roads are inferred.

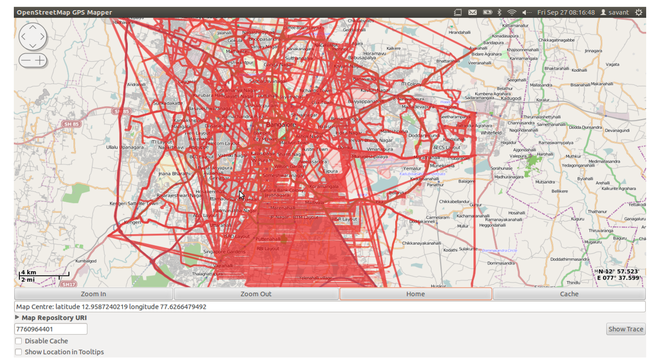
Driving Coach **:** Obtains sensor data from CAN bus. Extract various features such as minimum, average and maximum of acceleration, velocity, instant fuel consumption and engine rpm, time vehicle has stopped. Classify into fuzzy outputs based on intuitive decision. For a specific set of driving hints, assign fuzzy likelihood values. Defuzzify using center average method and give the maximum likelihood hint.

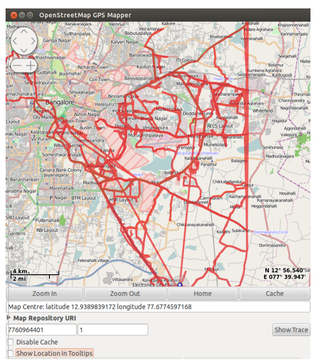
VTrack **:** Uses sparse GPS and WiFi for delay estimation. Initially does HMM based map matching using Viterbi algorithm with interpolation, outlier removal and bad zone detection. Wardriving database is created and used to map WiFi APs to position estimates. Use the travel time estimates to detect hotspots and for real time route planning.

SignalGuru **:** GLOSA (Green Light Optimal Speed Advisory) using windshield mounted phone camera to estimate traffic signals by performing image processing on video frames. Opportunistic collaboration through WiFi connection. Estimates adaptive signals using SVR (Support Vector Regression) models.

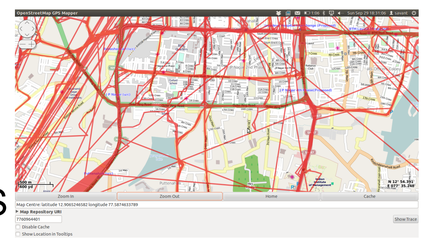
GPS TRACES ANALYSIS

GPS traces data is from about 170 vehicles for a duration of one month. The figure on the right shows paths for all vehicles in one single day. The figure below is are the traces for one particular vehicle on 30 days.





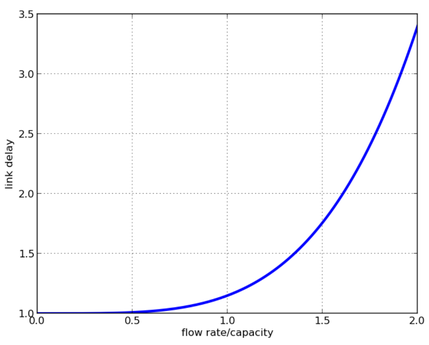
Consider a link on the given road network. Build velocity profile of a link using velocity estimation on the GPS trace data.



For unimodal traffic, time delay vs capacity is

$$t_a(f_a) = t_a^F \left[1 + 0.15\left(\frac{f_a}{u_a}\right)^4\right]$$

where
f_a is flow on link a
t_a^F is free flow travel time on link a
u_a is flow capacity of link a



FUTURE WORK

- Extending the link delay model to multimodal traffic
- Studying the effects of say, two wheelers on delay of four wheelers and heavy vehicles
- Temporal estimation and learning of source destination traffic matrix in a given road network
- Analysis of probe vehicle-based sampling for realtime traffic information and using GPS enabled mobile phones as probes
- Simulation of traffic movement models and evaluation of routing algorithms. Pedestrian simulation models for a complete traffic analysis

BIBLIOGRAPHY

- Mohan, Prashanth, Venkata N. Padmanabhan, and Ramachandran Ramjee. "Nericell: rich monitoring of road and traffic conditions using mobile smartphones." *Proceedings of the 6th ACM conference on Embedded network sensor systems*. ACM, 2008.
- Bhoraskar, Ravi, et al. "Wolverine: Traffic and road condition estimation using smartphone sensors." *Communication Systems and Networks (COMSNETS), 2012 Fourth International Conference on*. IEEE, 2012.
- Wang, Yin, et al. "CrowdAtlas: Self-Updating Maps for Cloud and Personal Use."
- Araújo, Rui, et al. "Driving coach: A smartphone application to evaluate driving efficient patterns." *Intelligent Vehicles Symposium (IV), 2012 IEEE*. IEEE, 2012.
- Thiagarajan, Arvind et al. "VTrack: accurate, energy-aware road traffic delay estimation using mobile phones." Proceedings of the 7th ACM Conference on Embedded Networked Sensor Systems. Berkeley, California: ACM, 2009. 85-98.
- Koukoumidis, Emmanouil, Li-Shiuan Peh, and Margaret Rose Martonosi. "SignalGuru: leveraging mobile phones for collaborative traffic signal schedule advisory." *Proceedings of the 9th international conference on Mobile systems, applications, and services*. ACM, 2011.
- Ban, Xuegang (Jeff, et al. "Delay pattern estimation for signalized intersections using sampled travel times." *Transportation Research Record: Journal of the Transportation Research Board* 2130.1 (2009): 109-119.
- Bureau of Public Roads (1964). Traffic assignment manual. U.S. Department of Commerce, Urban Planning Division, Washington, DC.
- Sherali, H.D., Sivanandan, R., Hobeika, A.G., 1994. A linear programming approach for synthesizing origin destination (O–D) trip-tables from link traffic volumes. Transportation Research B 28, 213–233.
- Haklay, M.; Weber, P., "OpenStreetMap: User-Generated Street Maps," Pervasive Computing, IEEE , vol.7, no.4, pp.12,18, Oct.-Dec. 2008
- Amin, Saurabh, et al. "Mobile century using gps mobile phones as traffic sensors: A field experiment." (2008).
- Visualizing and analyzing GPS trace data : https://github.com/sksavant/traffic-analysis
- xlsx to csv converter : https://github.com/dilshod/xlsx2csv
- GTK widget for map display : https://github.com/nzjrs/osm-gps-map

Thanks to Vishnu Navda, Researcher, Microsoft Research, Bangalore for providing GPS traces dataset.