UNSUPERVISED ANNOTATED CITY TRAFFIC MAP GENERATION

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OBJECTIVES

Develop an intelligent data logging module for smart-phones and a server side processing mechanism to extract roads and bus routes information. We develop **CrowdMap**, which provides the following features:

1. Uniquely identifies if the user is in a bus and logs required data.
2. Automatically sense route signatures or landmarks like speed breakers, turns, etc and tags them
3. Generates a trajectory of the route travelled by the user

INTRODUCTION

Bus transports in the cities of many developing countries are marred with severe problems, like information unavailability, bad road and bus conditions, lack of proper scheduling and timing. An information service can become extremely handy for the travelers in countries with emerging economy, where public traffic systems are generally riddled with uncertainty. The penetration of smart-phones in everyday life could be exploited to find possible solutions.
Essentially, real time commute information may facilitate the commuter in route selection, on the fly, based on the comfort level and travel time.

SYSTEM ARCHITECTURE

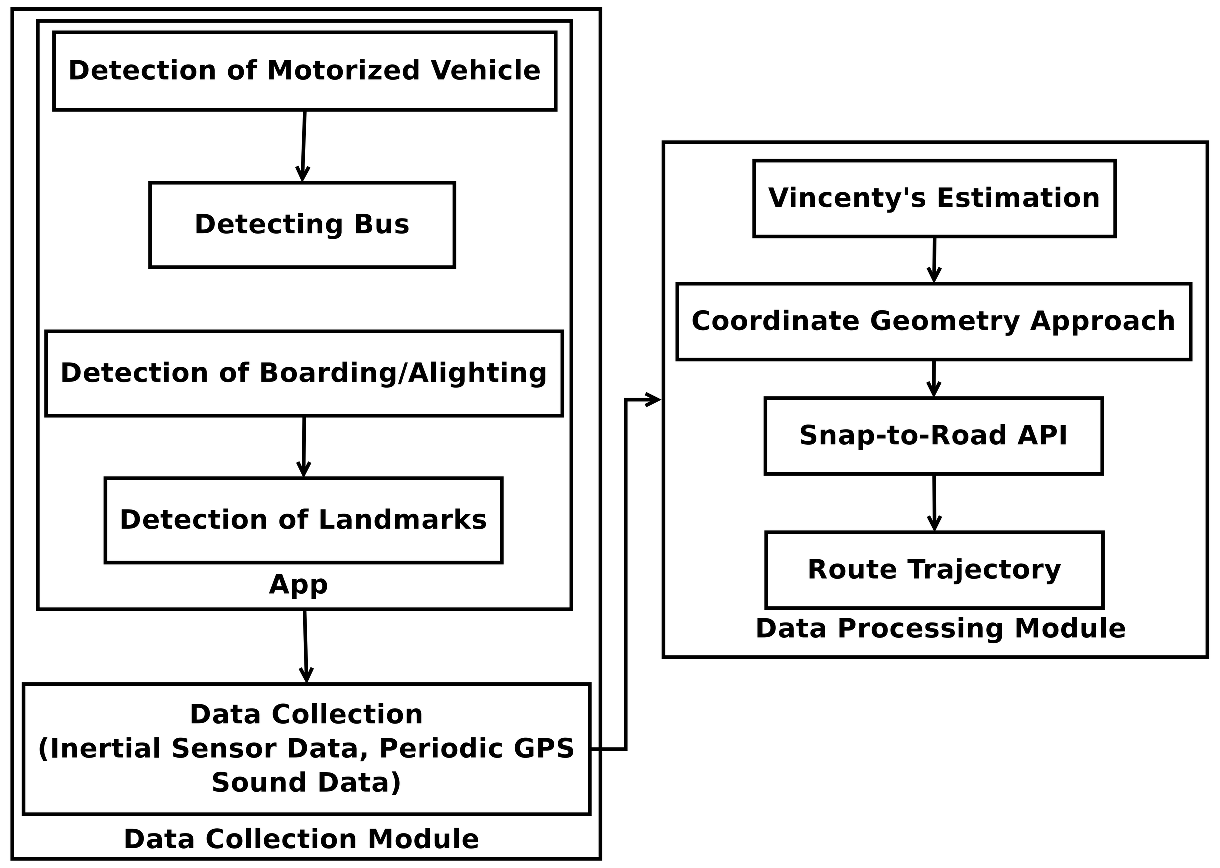

Figure 5: System Architecture

Broadly, CrowdMap has two major modules, as shown in the figure;

1. Data collection module that runs on smart-phones,
2. Data processing module that runs on the CrowdMap server.

DATA PROCESSING MODULE

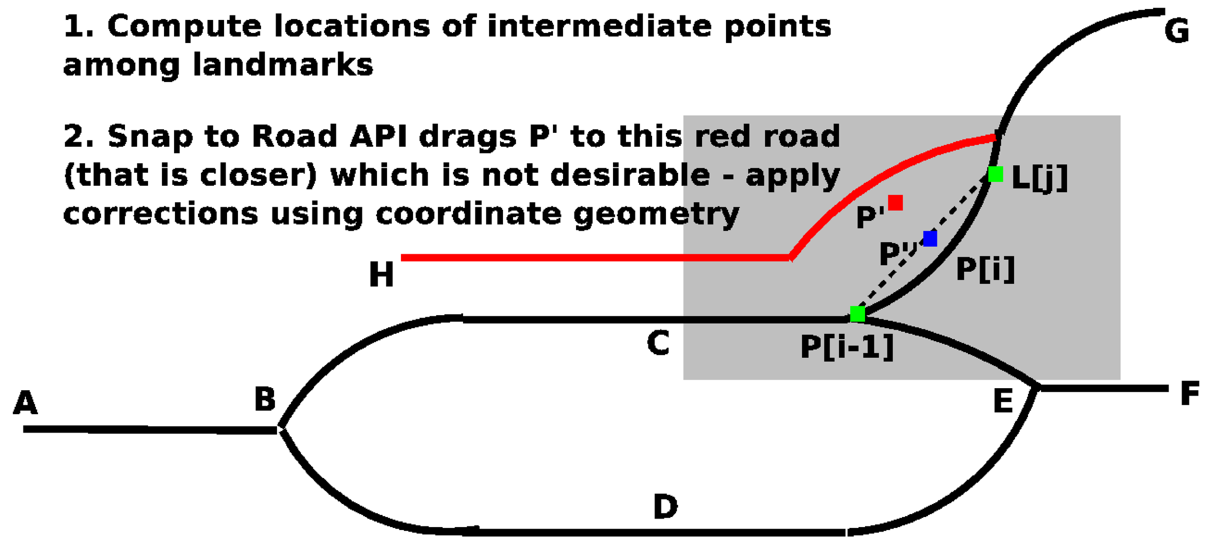

Figure 6: Trajectory generation procedure

CrowdMap generates the travel trajectories from the sequence of opportunistic GPS annotated landmarks. The algorithm can be divided into two steps;

1. Estimating the approximate coordinates of intermediate points from the location of landmarks
2. Eliminating the estimation error.

DATA COLLECTION ON SMART-PHONES

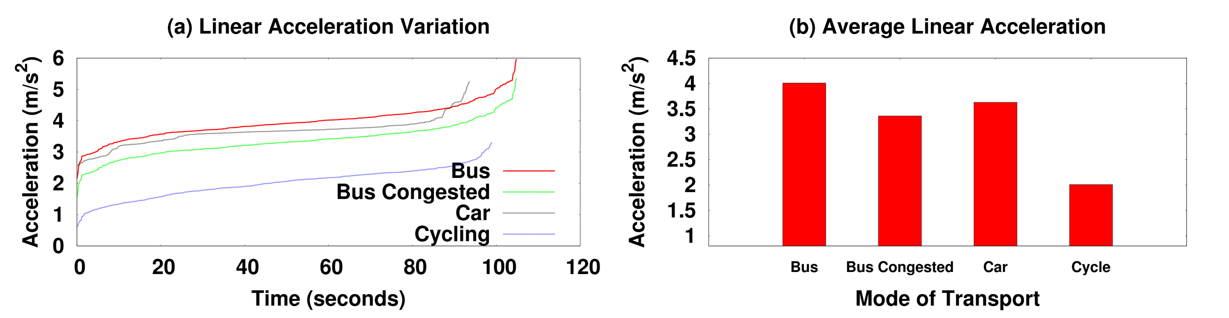

Figure 1: Acceleration variation for motorized vehicles versus cycling; (a) signature of the acceleration along y-axis for different modes (b) Average value of the acceleration along y-axis calculated over the first 2 minutes

In CrowdMap, we log the smart-phone sensor data only when the commuter travels on a bus. This smart data logging activity gets accomplished by first recognizing that the commuter is traveling in a motorized vehicle from the initial accelerometer trace and then leverage on the sound sensor data to classify whether the motorized vehicle is a bus.

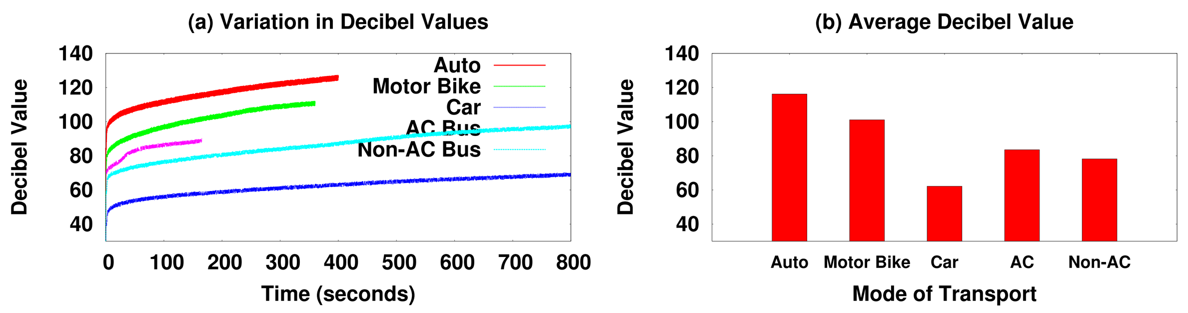

Figure 2: Variation in sound data for different motorized vehicles; (a) Signature of the sound data for different modes (b) Average value of the sound data calculated over the first 4 minutes

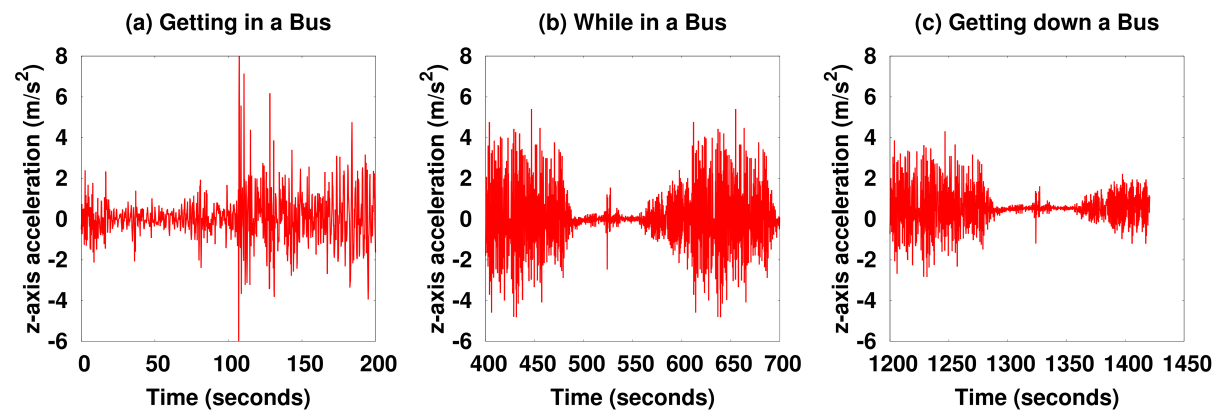

Figure 3: Vertical acceleration values to identify the events when the user is traveling by a bus: (a) the user boards in at 100 secs, (b) she is inside the bus when the bus takes a stop at 500 secs, (c) she gets down from the bus at 1280 secs

In order to initiate the data logging activities, one needs to identify the location of bus stops and commuter boarding and alighting on a bus. The detection of boarding (and alighting) on the bus can be done through observing the acceleration reading in z-axis. The key idea is, the vertical acceleration inside a bus, due to the jerking, is much higher than while walking or standing, which commuter is supposed to do either before or after the trip. In CrowdMap, we primarily follow the proposed methodology in [1] to detect the landmarks in a route.

EVALUATION

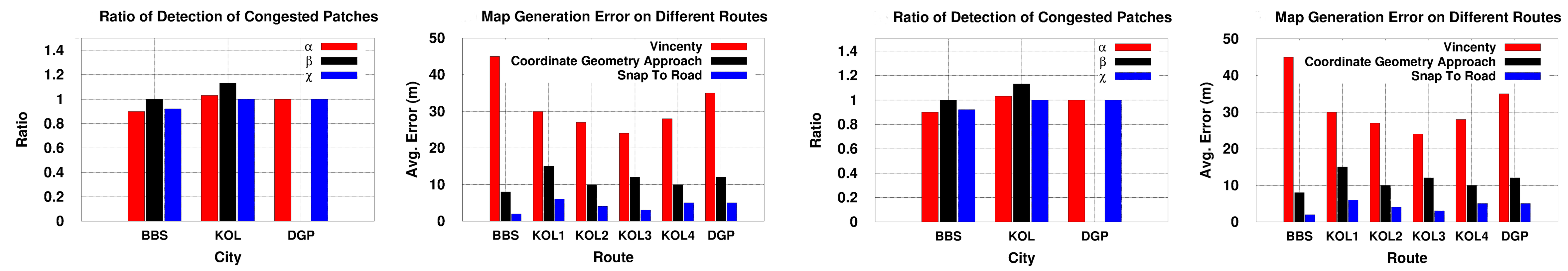

Figure 4: Bad road patch detection accuracy; Energy consumption analysis; Detection of congested patches; Travel trajectory estimation accuracy

REFERENCES

[1] Rohit Verma, Aviral Shrivastava, Bivas Mitra, Sujoy Saha, Niloy Ganguly, Subrata Nandi, and Sandip Chakraborty. UrbanEye: An outdoor localization system for public transport. In *Proc. of INFOCOM 2016*, 2016.

CONCLUSION

We design and implement an Android based crowdsourcing application named CrowdMap, which automatically identifies unique road signatures (like potholes,bad road patches) at zero user intervention. With a 3-month study, we observe that CrowdMap can detect these landmarks with an average accuracy of 95% and embeds the route segments on real map with an error of 6 meters at worst case. This study is a first step towards developing a public transport recommender system based on users preference.

MORE INFORMATION

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Web cnerg.org/crowdmap