CROWDSOURCING REAL-TIME TRAVELER INFORMATION SERVICES

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INTRODUCTION

TRAVELER INFORMATION
• Current systems depend on physical sensors
• These sensors are expensive, both for installation and maintenance
• The sensors also suffer from low coverage and unreliability

CROWDSOURCING
• Participatory paradigms of information collection and sharing are gaining in popularity
• Individuals are the source of information
• Cooperation between travelers and information providers
• Wide coverage, redundancy of data, real-time and cost-effective
2-3%

Ref: Evaluation of traffic data obtained via GPS-enabled mobile phones, Herrera et al 2010
CROWDSOURCING ISSUES

• Quality and validity of the data
• Algorithms and approaches for synthesizing the data
• Behavior of the participants

RESEARCH OBJECTIVES

• In order to address some of the issues faced by crowdsourcing projects, a research project is currently underway
• The primary research objectives are threefold
  – Characterizing crowdsourced data
  – Synthesizing crowdsourced data
  – Understanding crowdsourcers
RESEARCH APPROACH

- Deploy a crowdsourced project for providing real-time transit information
  - Provide information to users about the UConn shuttle system
  - Has on-board GPS tracker system which can serve as a baseline for comparison of crowdsourced data
- In addition to providing the schedule information, algorithms will be developed for predicting arrival time based on location of buses and prevailing conditions
- A survey will be deployed to understand the motivation of the participants and capture the values they derive from participation
CONCEPTUAL OVERVIEW OF FRAMEWORK FOR PREDICTING TRAVEL TIME

App Deployment

Raw GPS Data

Data Cleaning

Cleaned Data

Road Center Lines

Map-Matching

Correct Road segment

Traffic Data Extraction

Historical Traffic Data Repository

Travel Time Estimation Model

Travel Time Prediction
PRELIMINARY RESULTS

- The project is currently underway
- Preliminary results will be presented here related to
  - App solutions and technologies
  - Quality of the data collected from crowdsourced projects
  - Map Matching algorithm implementation
SMARTPHONE APPS FOR SHARING LOCATION

- A number of open-source and freely available smartphone applications (and server side software) were explored
- Two Android solutions are currently being evaluated for adoption in the research effort
  - Traccar
  - GPS Logger
PRELIMINARY RESULTS

LOCATION TECHNOLOGIES EMPLOYED BY SMARTPHONE APPS

— GPS
  • Stand-alone
  • High accuracy
  • Takes longer to obtain fix

— Assisted-GPS
  • Augments GPS by providing quick fix
  • Requires a data connection

— Cell-tower
  • Low in accuracy
  • Sparse

— Wi-Fi
  • Low in accuracy
  • Sparse
In order to assess the applicability of the apps for adoption, data was collected using both the candidate smartphone applications.

Data was collected using different location technologies supported by the apps including:
- GPS
- Network (Cellular Tower)
- GPS and Network

The above exploration also helped qualitatively and quantitatively assess typical issues of data quality associated with smartphone location data.
PRELIMINARY RESULTS
QUALITATIVE COMPARISON OF SPATIAL DISTRIBUTION
RED – SMARTPHONE GPS POINT
BLUE – SHUTTLE GPS
PRELIMINARY RESULTS
QUALITATIVE COMPARISON OF SPATIAL DISTRIBUTION
RED – SMARTPHONE GPS POINT
BLUE – SHUTTLE GPS

Bus Line #1
PRELIMINARY RESULTS
QUANTITATIVE COMPARISON OF PHONE GPS TECHNOLOGY AND SHUTTLE GPS

Smartphone GPS Distribution

Shuttle GPS Distribution

Bus Line #1

Bus Line #2
PRELIMINARY RESULTS
QUALITATIVE COMPARISON OF NETWORK LOCATION TECHNOLOGY AND SHUTTLE GPS
RED – SMARTPHONE LOCATION FROM WIFI/CELL NETWORK
BLUE – SHUTTLE GPS
PRELIMINARY RESULTS
QUANTITATIVE COMPARISON OF NETWORK LOCATION AND SHUTTLE GPS

Cell/WiFi Distribution

Near Distance (meter)

Frequency

0% 20% 40% 60% 80% 100% 120%

0 20 40 60 80 100 120

Bus Line #1

Shuttle GPS Distribution

Near Distance (meter)

Frequency

0% 20% 40% 60% 80% 100% 120%

0 2 4 6 8 10 12 14

Red
Cellular Only
20140218

Bus Line #1

Cell/WiFi Distribution

Near Distance (meter)

Frequency

0% 20% 40% 60% 80% 100% 120%

0 10 20 30 40 50 60

Bus Line #2

Shuttle GPS Distribution

Near Distance (meter)

Frequency

0% 20% 40% 60% 80% 100% 120%

0 0.5 1 2 3 4 5 6

Bus Line #2

Bus Line #1
PRELIMINARY RESULTS
QUANTITATIVE COMPARISON OF TRAVEL CHARACTERISTICS

Speed Profile from Phone GPS

Mean = 3.62
SD = 5.43

Speed Profile from Shuttle GPS

Mean = 3.88
SD = 4.30
MAP MATCHING

• We have seen GPS points are ballpark estimates of actual locations and may not fall on correct road link

• This non-trivial correction problem can be addressed in two ways
  – Snapping the point to closest link: Trivial
  – Sophisticated Map-Matching Algorithms

• We implemented a map-matching algorithm in Python (Newson and Krumm 2009)

• Performs well even at 1 minute interval between successive GPS points
MAP MATCHING ALGORITHM

RAW SMART-PHONE GPS POINTS

X MAP MATCHED POINTS (ACTUAL PATH)

Bus Line #1
10 sec interval

Bus Line #2
60 sec interval
CONCLUSION

• Phone location technologies are promising
• Not all phone location technologies are applicable
• Phone GPS location technology is comparable to commercial GPS solutions
• Map Matching can effectively obtain the actual path
• Currently work is underway to develop algorithms for processing historical data with real-time data for providing travel time prediction

• Develop a complete Open-Source crowd-sourced traveler information system available to the agencies and stakeholders

• Deploy the system and conduct survey on the users to understand the motivations for participating and explore how the data is utilized
THANK YOU

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