Data Fusion Concept to Estimate Vehicle Trajectories on Urban Arterials

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Key words: *Data Fusion, Vehicle Trajectories, Urban Arterials*

Background

Fusion of Multi sensor Data

Data Sources
- Fixed Sensors — AVI, Loop Detector, Video Camera
- Mobile Sensors — Probe car

Limitations
- Temporal Coverage
- Spatial Coverage

→ **Data Fusion** →

Advantages
- Temporal Coverage
- Spatial Coverage
- Robustness

Applications
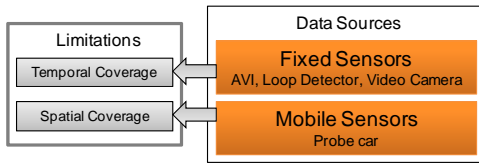- Travel Time Estimation
- Travel Time Prediction
- Signal Timing optimization
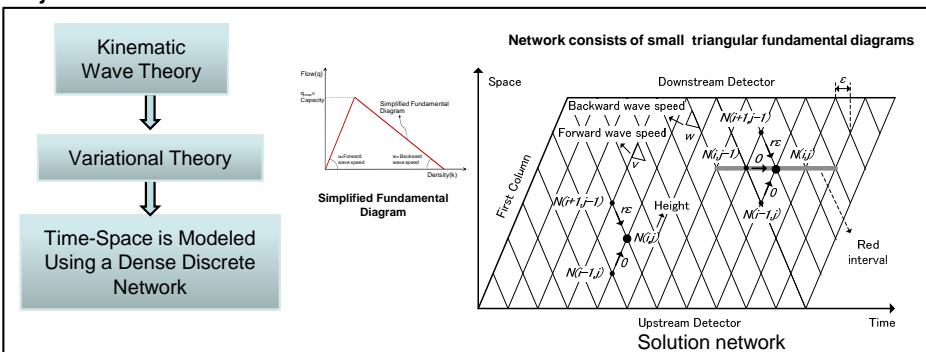- Emission Monitoring
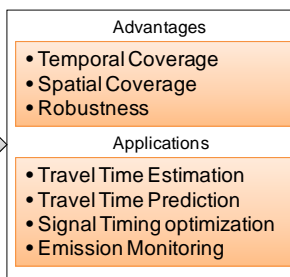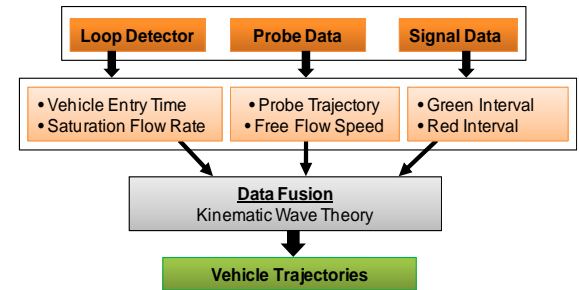
Drawbacks of Existing fusion Techniques :
- Based on statistical methods
- Do not consider traffic engineering concepts.
- Do not use rich probe trajectory data which represent traffic conditions in time and space.
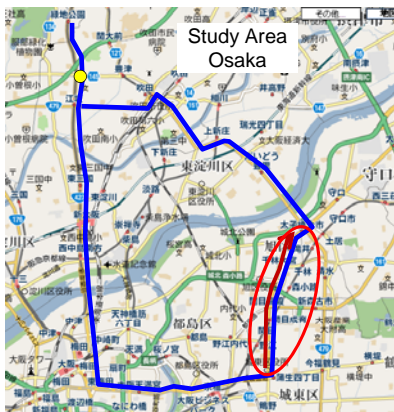
Method

In this research an original data fusion framework is proposed to estimate vehicle trajectories by combining probe, detector and signal timing data according to principles of traffic engineering. Proposed method is based on 3D kinematic wave theory and can efficiently use probe trajectory information to reproduce trajectories of all vehicles.


Kinematic Wave Theory → Variational Theory → Time-Space is Modeled Using a Dense Discrete Network

Simplified Fundamental Diagram

Network consists of small triangular fundamental diagrams

Solution network

Proposed Methodology

- **Loop Detector**
  - Vehicle Entry Time
  - Saturation Flow Rate
- **Probe Data**
  - Probe Trajectory
  - Free Flow Speed
- **Signal Data**
  - Green Interval
  - Red Interval

→ **Data Fusion — Kinematic Wave Theory** → **Vehicle Trajectories**
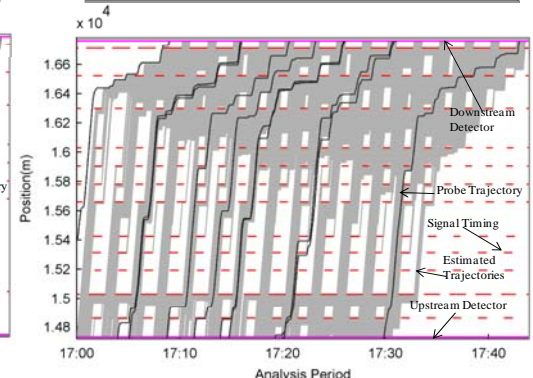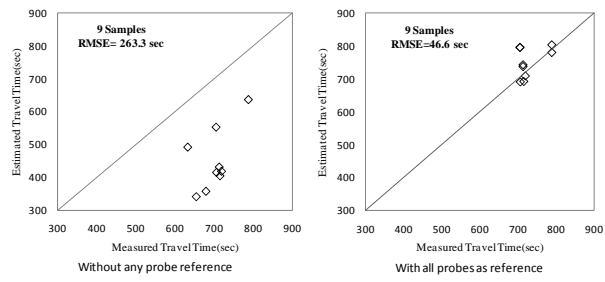
Results

Study Area Osaka

**Estimated trajectories without using probe data as reference**
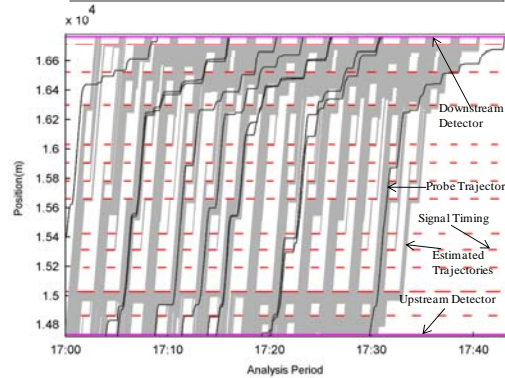
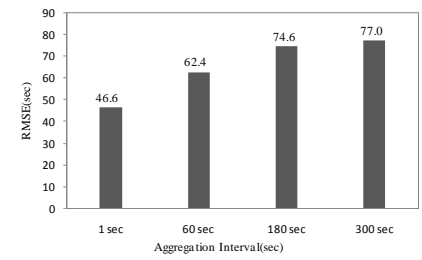**Estimated trajectories with using first probe trajectory data as reference**

Travel time estimation improves after using probe trajectories as reference

9 Samples RMSE= 263.3 sec — Without any probe reference

9 Samples RMSE=46.6 sec — With all probes as reference

Travel time estimation is not significantly affected by different probe data uplink frequency

Probe data uplink frequency(sec)	RMSE(sec)
1sec	46.6
30sec	47.0
60sec	45.7
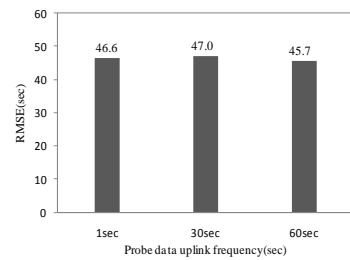
Travel time estimation errors increase with longer aggregation intervals

Aggregation Interval(sec)	RMSE(sec)
1 sec	46.6
60 sec	62.4
180 sec	74.6
300 sec	77.0

Application

The methodology has several applications such as Travel time estimation, Travel time prediction, Signal timing optimization and Emission monitoring.

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