Airborne Traffic Flow Data and Traffic Management

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Outline

• Basics of airborne traffic data
• Macroscopic traffic flow characteristics
  – Historical perspectives
  – Current applications
• Microscopic traffic flow characteristics
  – Historical perspectives
  – Current research activities
• A look ahead
Basics of Airborne Traffic Data

• Use video and camera images, and in some cases automated methods, to measure traffic variables

• Develop analysis techniques and measures of flow based on spatial characteristics of traffic patterns

• **Goal:** Improve efficiency of transportation system by *integrating* airborne data with ground-collected data
Basics of Airborne Traffic Data

Major Characteristic: We are no longer restricted to point detection, and we can use a spatial detection paradigm.

Media: Video and camera images

Research effort: Use video and camera images, image processing and algorithms to measure traffic variables.
Macroscopic Flow: Historical Perspective


Johnson was Dean of Engineering at the University of Maryland and was investigating the traffic impacts of widening of the two-lane highway between Baltimore and Washington.
Johnson’s Aerial Photography

Source: Johnson (1928)
Historical Perspective: Johnson

Source: Johnson (1928)
Historical Perspective: Johnson

Source: Johnson (1928)
Historical Perspective: Greenshields

“[H]igh altitude haze, shadows of buildings, trees, and the movement of the blimp are difficulties which, it is believed, are overshadowed by the complete and accurate record of all that happens within the area studied” (p. 291)

“It is felt that several hours of such observations will reveal more than days of less complete data. From this standpoint it could well be that aerial photographs will prove comparatively cheap” (p. 297).

Historical Perspective: Wagner and May (1963)

Traffic density contour maps from helicopter observations
Historical Perspective

Research to identify macroscopic characteristics:

- Forbes and Reiss (1952): traffic flow from video
- Jordan (1963): freeway speed, flow, density
- Rice (1963): urban traffic congestion due to access, incidents
- Cyra (1971): freeway volumes and speeds
- Makigami et al. (1985): freeway speed, density, bottlenecks
- Angel et al. (2002 onward): travel times, intersection delays
- Chandnani and Mirchandani (2002): speeds
- Agrawal and Hickman (2004): queue lengths
- Coifman et al. (2004, 2006): origin-destination flows, intersection delay, parking lot utilization
- Etc.
Technology

UAS’s (or UAV’s): Coifman et al. (2004, 2006)

Source: Coifman et al. (2006)
Microscopic Flow Characteristics from Airborne Data

Source: Hickman and Mirchandani (2006)
Microscopic Flow: Historical Perspective

Manual data reduction
• Treiterer et al. (1966 onward)
• Smith and Roskin (1985)

Automated data reduction
• University of Arizona / ATLAS and the Ohio State University
• Technical University of Delft
• DLR
Microscopic Flow: Treiterer

Source: Treiterer and Taylor (1966)
Vehicle Tracking in Imagery

- Combination of short-term and long-term tracking of connected components ("blobs") in registered imagery
- Short term: Components are investigated to detect moving vehicles and screen out false positives
- Long term: Once identified, a blob should not be "lost" in the image sequence; a location predictor is also used
Registered Video with Tracking

Aerial Video

I-10 at Elliott in Phoenix, AZ
University of Arizona / Ohio State University

Current research:

• Investigating of truck movements at border crossings and at work zones

• Using ground counts, selected vehicle identification (GPS or license plates), and airborne observations

• Investigating of travel times, delays, queuing in order to develop strategies for improved operations
I-10 Work Zone, Tucson AZ
DLR: ANTAR and TrafficFinder

Source: Ruhe et al. (2007)
Source: Hipp (2006)
Congested flow
Synchronized flow
Impeded free flow
Free flow

Source: Ruhe et al. (2007)
A Look Ahead

• Airborne imagery has a long history in traffic analysis
  – Spatial paradigm for data collection
  – Allows collection of a wide variety of performance measures

• Macroscopic flow characteristics are regularly collected this way today

• Tools for individual vehicle tracking and analysis are available
A Look Ahead

• Mechanisms for data collection and reduction exist
  – Macroscopic flow characteristics
  – Microscopic flow characteristics

• Applications
  – Congestion studies
  – Real-time traffic management
  – Understanding of traffic flow
  – Calibration of traffic simulation models