An Investigation of the Use of Aerial Video for Traffic Data Collection

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Introduction

- Where are we coming from?
- Where are we now?
- What does the future hold?

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History

- 1927: Aerial photography measures highway congestion
- 1940s - 1970s: Traffic research from airborne platforms
  - Data collection methods: strip vs. time-lapse photography, oblique vs. vertical views, fixed-wing vs. helicopter
  - Applications areas : traffic flow theory, platoon behavior, intersection operations, accident analysis, parking studies, O-D flow estimates, network performance assessment
  - Manual data reduction
- Since 1970's: Limited work due to cost of data

Background

- National Consortia on Remote Sensing in Transportation (NCRST)
- Flows (NCRST-F): Develop, demonstrate, and disseminate cost-effective remote sensing techniques for application to transportation flows
- Other consortia: Infrastructure, Environment, Disaster Assessment and Safety and Hazards (DASH)
- In Year 2 of initial 4-year effort

NCRST - F

Rationale for the research:

- Current sensors and image processing technology
- Wide spatial coverage
- Mobility and non-intrusiveness of sensors
- Quality and quantity of data

Goal:

Improve efficiency of transportation systems by integrating remotely sensed data with ground-collected data

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Research Themes of NCRST-F

- Traffic Monitoring
- Traffic Management
- Freight and Intermodal Analysis
- Common Methodological Issues

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Traffic Monitoring and Management

- Use remotely sensed data *on-line* in real time/near real time to reduce traffic congestion

- Use remotely sensed data *off-line* for performance monitoring and to develop strategies in response to recurring traffic congestion

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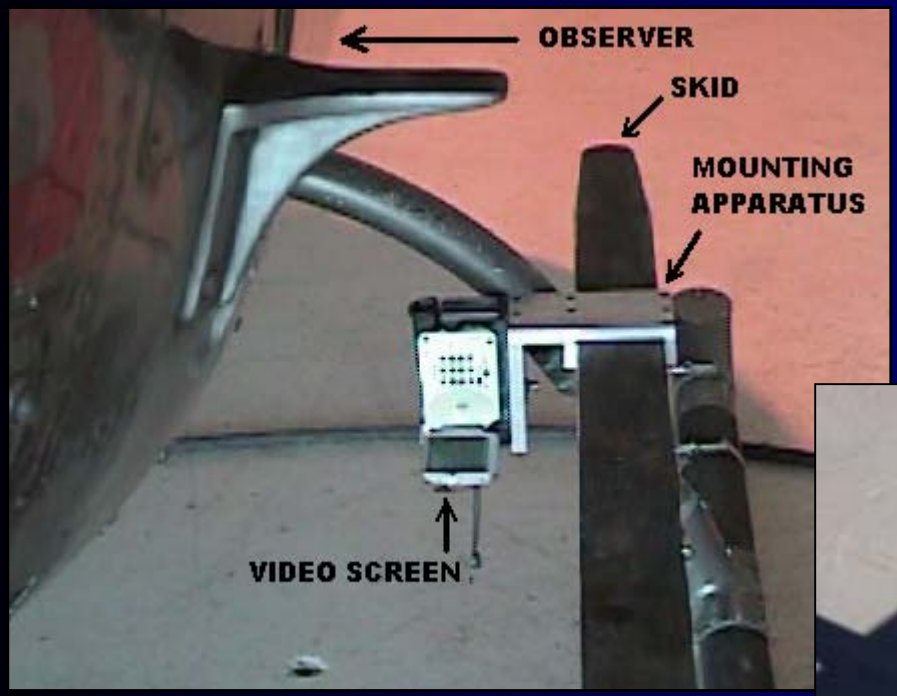
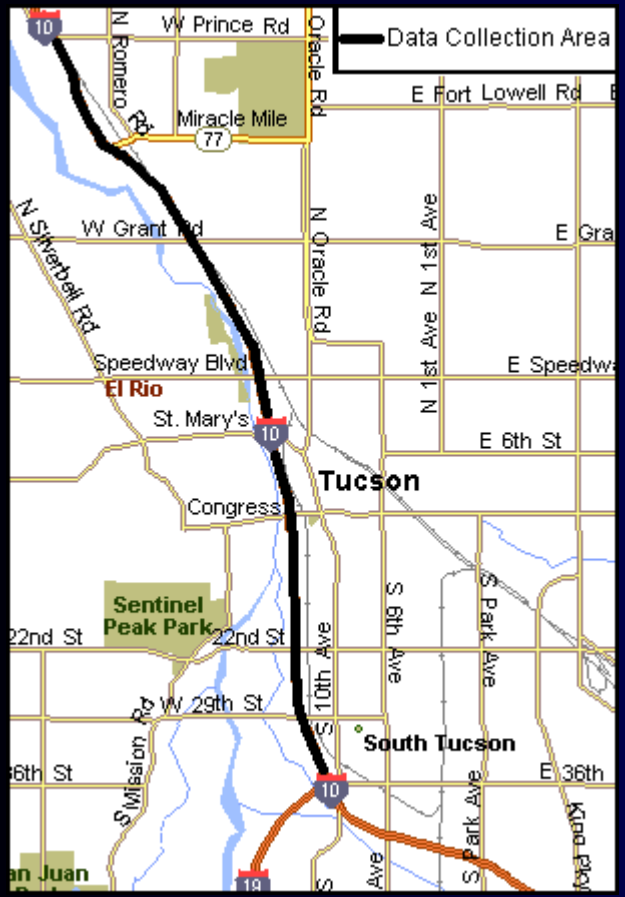
Technology Capabilities

- Video and still digital cameras
  - GPS used to geo-reference data
  - Inertial navigation systems to capture camera position
- Real-time image transmission to ground
- Automated (?) image processing

Experimental Setup



Freeway Experiment



Source: Yahoo! Maps

- 6.1 mi along I-10
- Morning peak
- Helicopter, video camera, GPS
- Aircraft speed ~ 65 mph
- Aircraft height ~ 1000 ft
- Field of view ~ 900 ft

Freeway Video Clip

Analysis of Freeways

- Level of service measure: Density (pc/mi/ln)

- Proposed method measures LOS directly:
  - Identify freeway segment types
  - Determine number of lanes, number and mix of vehicles
  - Compute density and LOS directly

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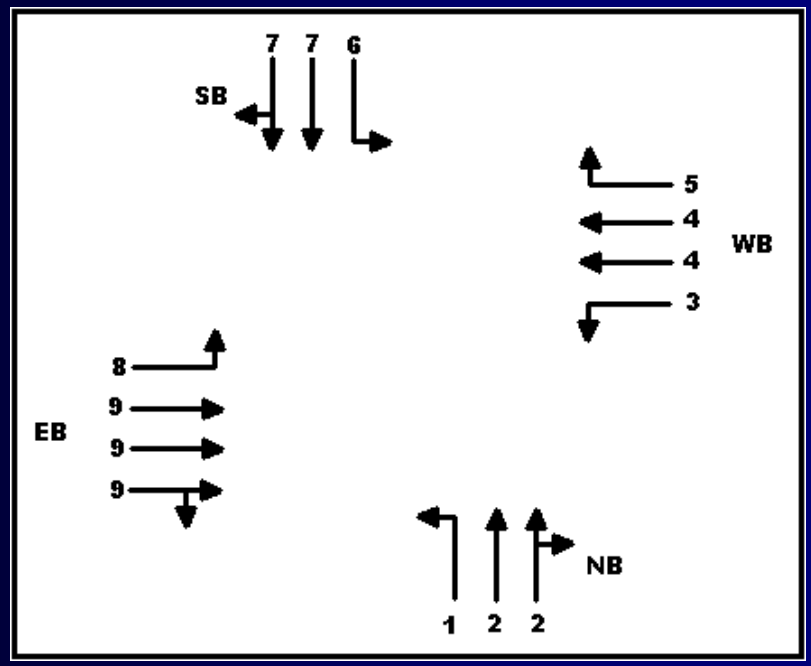
Freeway LOS Results

Type of segment	Location	Sample Size	Density (pc/mi/ln)	LOS
Basic	Prince	1	18.7	C
Weaving	Miracle Mile -Prince	2	16.5	B
Basic	Miracle Mile	3	22.3	C
Weaving	Grant-Miracle Mile	2	31.0	D
Basic	Grant	4	21.1	C
Ramp On/Off	Speedway -Grant	1	42.2	E
Basic	Speedway	4	28.0	D
Ramp On/Off	Mary's	3	35.9	E
Basic	Congress	2	34.5	D
Ramp On/Off	22nd -Congress	2	44.9	E
Basic	22nd	4	30.4	D
Weaving	29th	3	31.5	D
Basic	I-19	1	8.1	A

Signalized Intersection Experiment

- Site: Speedway Boulevard and Euclid Avenue
- 3 minutes study period (2 cycles)
- Time: 8:15 a.m.
- Field of View: ~ 1250 ft
- 10 sec vehicle counting interval



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Intersection Video Clip

Analysis of Intersections

- Based on field data procedure from ITE
- Hovering or fixed-wing aircraft

Intersection LOS Results

Approach	NB		WB			SB		EB	
Movement	L	T-R	L	T	R	L	T-R	L	T-R
Lane group	1	2	3	4	5	6	7	8	9
Number of lanes	1	2	1	2	1	1	2	1	3
Total stopped veh., Vs	0	65	121	163	2	33	50	43	103
Total departing veh., V	1	17	14	63	8	10	39	10	84
Lane group stopped delay (s/veh)	-	38.2	86.4	25.9	2.5	33.0	12.8	43.0	12.3
Lane group control delay (s/veh)	-	49.7	112.4	33.6	3.3	42.9	16.7	55.9	15.9
Lane group LOS	A	D	F	C	A	D	B	E	B
Approach control delay (s/veh)	46.9		43.7			22.0		20.2	
Approach LOS	D		D			C		C	
Intersection control delay (s/veh)	30.7								
Intersection LOS	C								

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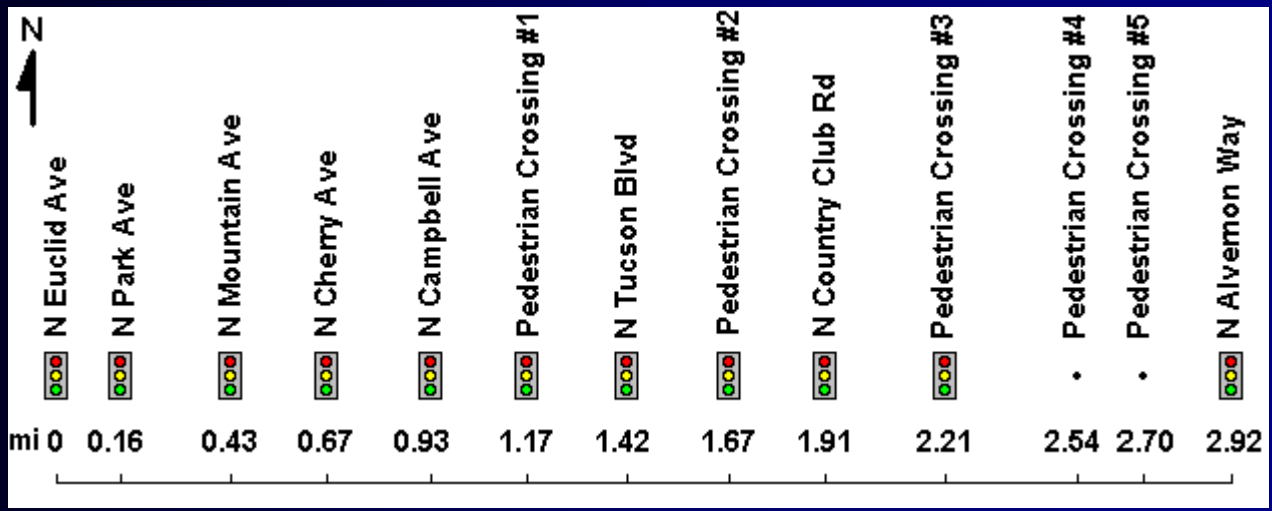
Urban Arterial Experiment

- Site: Speedway Boulevard.
- Time: Shoulder of peak (8:30-9:00 a.m.)
- Field of view: ~ 800 ft
- Simultaneous ground travel time data collection: test car and video cameras at end points



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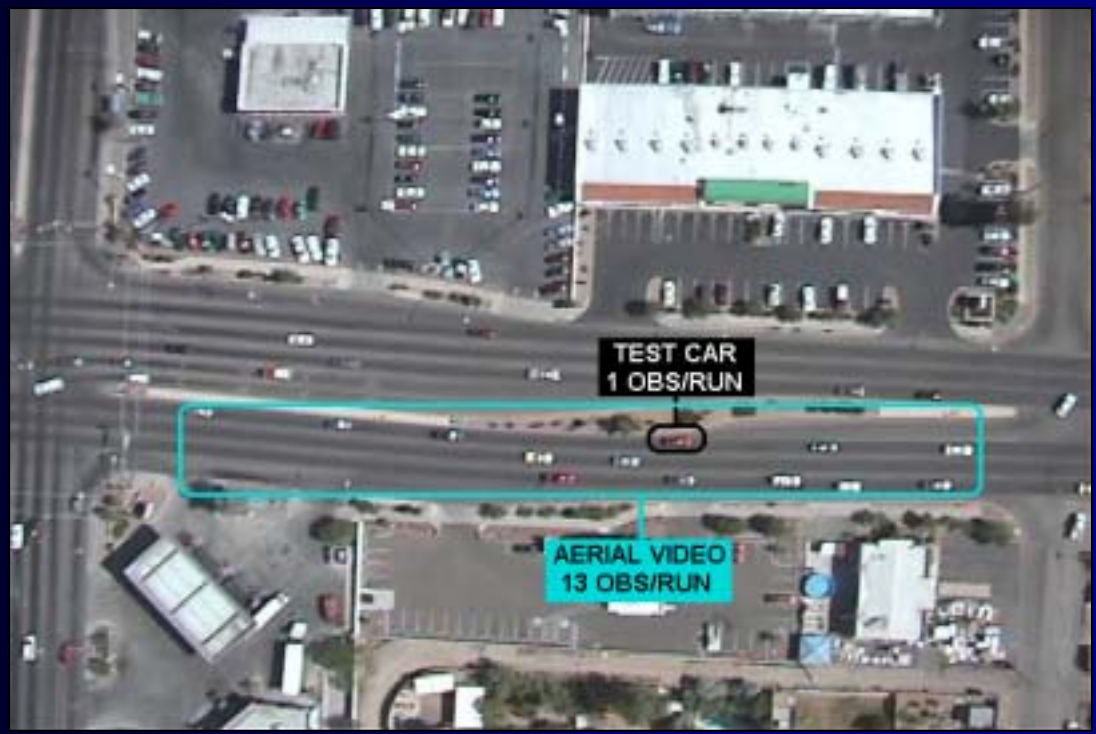
Arterial Methodology

- Produces higher number of observations than test cars
- Eliminates driver subjectivity
- Captures within-platoon, between-platoon variability



Arterial Video Clip

Arterial Travel Time Results

Checkpoint	Distance (mi)	Travel Time	Cumulative Avg. Speed (mph)	Link Speed (mph)	Cumulative LOS	Link LOS
Euclid Ave.	-					
Park Ave.	0.16	0:01:03	9.4	9.4	F	F
Mountain Ave.	0.43	0:02:18	11.1	12.6	F	F
Cherry Ave.	0.67	0:02:43	14.9	35.5	E	A
Campbell Ave.	0.93	0:04:11	13.3	10.5	E	F
Ped Crossing #1	1.17	0:04:31	15.6	43.3	E	A
Tucson Blvd.	1.42	0:04:58	17.2	33.3	D	B
Ped Crossing #2	1.67	0:05:21	18.7	38.6	D	A
Country Club Rd	1.91	0:05:51	19.6	29.1	D	B
Ped Crossing #3	2.21	0:06:21	20.9	36.7	D	A
Ped Crossing #4	2.54	0:06:47	22.5	45.7	C	A
Ped Crossing #5	2.7	0:07:00	23.1	41.6	C	A
Alvernon Way	2.92	0:07:36	23	22.2	C	C

Other Applications

Additional traffic information from the aerial video:

- Turning volumes
- Lane utilization
- Vehicle spacing
- Vehicle trajectories
- Incident effects and queuing

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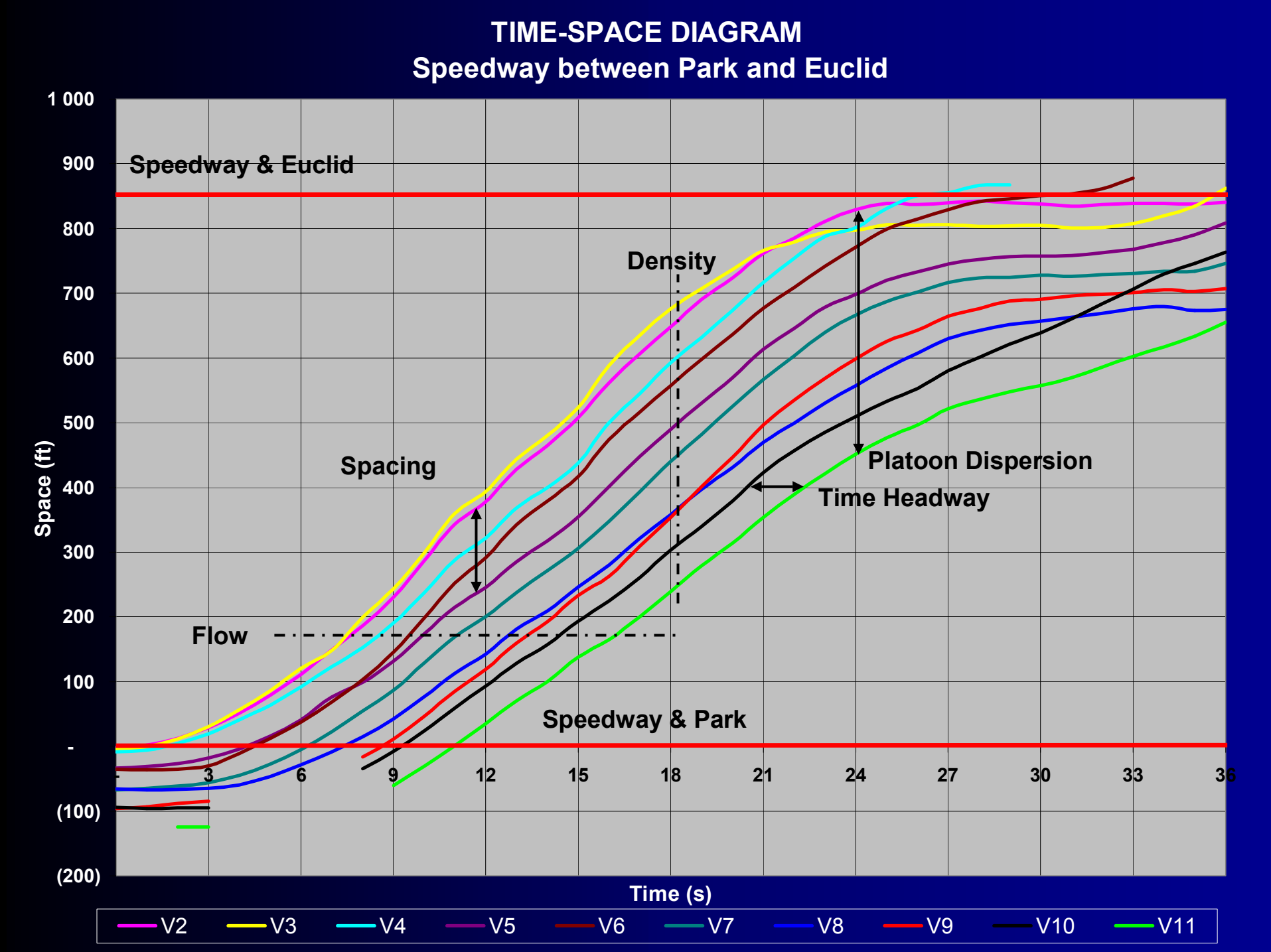
TIME-SPACE DIAGRAM
Speedway between Park and Euclid
1 000
900
800
700
600
500
400
300
200
100
-
(100)
(200)
Space (ft)
Speedway & Euclid
Density
Spacing
Platoon Dispersion
Time Headway
Flow
Speedway & Park
3
6
9
12
15
18
21
24
27
30
33
36
Time (s)
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11

Incident Management

Future Activities

Orthographic data with GPS, INS

Unpiloted aircraft

http://www.geodatasystems.com/

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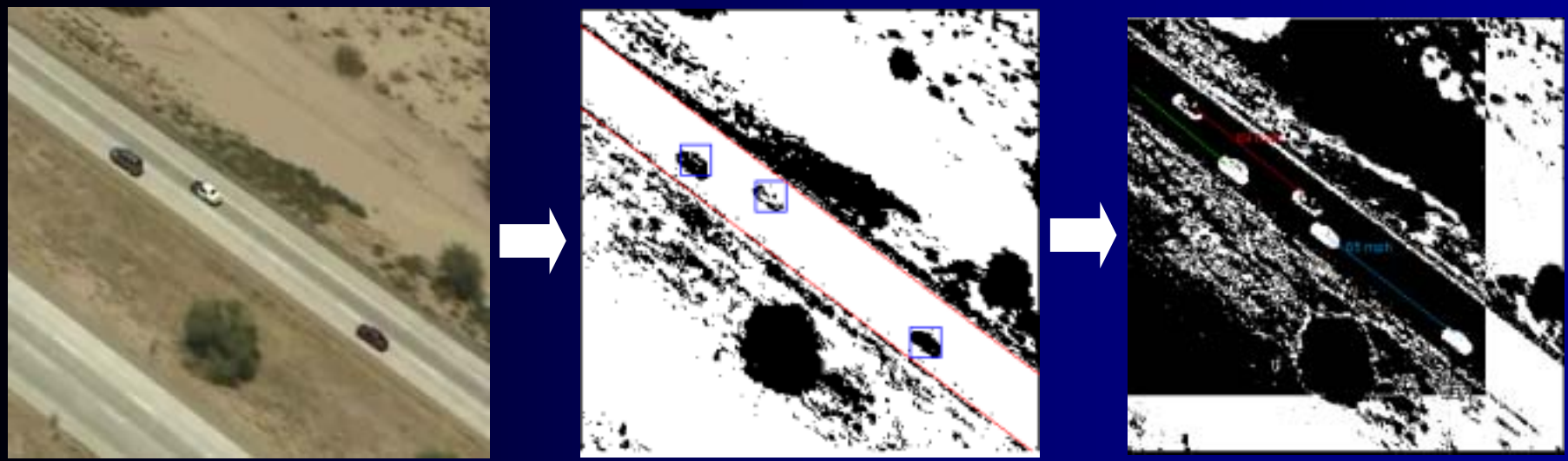
Future Opportunities

- Image processing automation
- Applications
  - Vehicle trajectories and speed estimation
  - Vehicle tracking (O-D information, etc.)



What does the future hold?

- Technology capabilities
  - Methodology exists, is now being automated
  - Some technology is mature, others are maturing

- Costs
  - Equipment is dropping in price
  - Automating data reduction can cut costs significantly
  - Aerial data provides information on many traffic variables
  - Aerial imagery can be competitive, especially in terms of *cost per unit of traffic data*