Augmented Speed Enforcement
NRITS 2013

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Overview

- Sponsored by Rural Safety Innovation Program (RSIP) under the Research & Innovative Technology Program (RITA) at USDOT
- The project aimed to find technologies that would be able to slow traffic in rural work zones
- This project had one USDOT Grant with two Caltrans contracts to two universities
- USDOT Customer is Linda Dodge
Overview

- Each university designed and/or integrated off-the-shelf components to develop a system.
- Data was collected on SR152 near Los Banos, CA between mid May and Mid July 2012. There were two weeks of baseline, two weeks for each system individually, and two weeks with both systems working in the work zone.
- No data was collected during the July 4 holiday week.
Augmented Speed Enforcement (aSE)
Montana State University (WTI) Team

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- In May and June 2012, WTI deployed 28+ "Smart Drums" (sDrums) along a moving workzone on SR-152 in Central California to determine if they could improve safety by reducing speed in the work zone.
- Using ZigBee communication, the sDrums form a standalone, mesh network to provide warning to drivers via a synchronized light pattern triggered by radar detection of speed.
- Pagers are also incorporated into the system to notify workers of speeding vehicles.
WTI Subsystem

Function: Portable work zone hazard detection system for driver and worker warning that can be integrated with existing work zone infrastructure.

Worker
Belt unit on worker (e.g., belt) in proximity receive vibration alert from pylons.

Work Zone

Speeding Car

Smart Cones
Pylon sensors track car and estimate speed “tracer” lights to alert work crew (and driver)
Four sDrum Types:

Master / Data Logger:
- Radar
- Light
- Controller
- Power
- Communication (Zigbee)

Slave:
- Light
- Power
- Communication (Zigbee)

Pager:
- Pager Base Station
- Power
- Communication (Zigbee)

Repeater:
- Pager Repeater
- Power
Design

- Use Broadcast to flash all lights rather than use more advanced lighting patterns that would require point-to-point communication.
- Control lights via a single master cone with a radar sensor. Then communication will only consist of light messages.
- Log data via other (backup) master cones, also equipped with radar. Do not transmit this data.
- Other than the master cone, the order of placement of cones does not matter.
- The system could consist of a master cone alone, or a master cone and variable number of slave (light) cones.
- No vehicle tracking – the flash pattern in the relatively short length of layout for 28+ cones will not follow vehicles.
- Multiple master-slave subsystems could be used to provide finer granularity.
- No interaction with the other (PATH) subsystem.
Pilot Testing – Caltrans District 10
SR 152 Between Los Banos and Chowchilla
May-July, 2012
This is a representation of the standard layout of the WTI drums and the iCones.

Note that the third iCone is halfway between the third and fourth WTI drum.
Evaluation of Speed Data

WTI Only System

There is a reduction in the percentage of reads 60 mph or greater as one progresses through the work zone, even during the baseline weeks.
Topics for Further Research

- Light patterns and effectiveness
- Radio options for extended drum spacing or drum sets used 50 foot spacing x 28 drums, covers 1400 feet of work zone, 100 foot spacing would double that
- Radios and protocols for implementing complex light patterns
- Improving radar range (could see and warn cars sooner)
- Minimum number of drums and spacing to be effective
- Spacing of drum sets (e.g. 4 drum sets at ¼ mi spacing)
- Component alternatives to reduce cost and improve performance
- Custom designed paging system for transportation use
Augmented Speed Enforcement (aSE)

Project Overview & Field Test Results

Ching-Yao Chan, Somak Datta Gupta
California PATH Team
PATH Augmented Speed Enforcement (aSE) Functional Objectives

- For Drivers
  - Provide feedback if a vehicle is traveling over the speed limit before the active work area of the work zone
  - Offer enhanced alerts with identified license plate number and measured speed (your speed and license number on a portable message sign)

- For California Highway Patrol (CHP) officers
  - Provide alerts when there are vehicles traveling at excessive speeds
  - Speed enforcement the responsibility of the California Highway Patrol
PATH Augmented Speed Enforcement (aSE) System

Police Officer Downstream with Handheld Device

Changeable Message Sign (CMS)

Speed Camera Upstream in Buffer Zone

Wireless Data via DSRC and Cellular Communication
Actions at CMS:

Data transmission arriving via DSRC, received at CMS

CMS displaying speeding vehicle’s license plate number and measured speed prior to vehicle arrival
PATH aSE Components:
Data Access and Display for CHP

**Actions at Server and CHP:**
- Data transmission via Cellular Communication, received at Project Server maintained by PATH
  - Prepare and store data, ready for access in a web page format
  - Web page display updated periodically whenever there is new data
    - A higher speed threshold (70 mph) is used to filter data to avoid excessive display to CHP
- CHP sees display with a standard internet browser
  - CHP or other authorized users can be at any location and moving dynamically but still be able to monitor the operation.
CMS Field Setup

- CMS
  - Located ~300 meters from speed camera
  - Default “Work Zone Speed Limit 55 MPH”
  - Violator over speed threshold “License ABC123 65MPH”
PATH aSE Components
- Portable Device Display

Data include:

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Summary: Speed Data Observation

- iCone data reveals an effective reduction of higher speed vehicles
- Both WTI and PATH sub-systems showed reduction of high speed vehicles, when compared to the baseline scenario
- Radar data at CMS showed speed reduction
- In all, the PATH system achieved its primary objective of lowering the speed of vehicles in the work zone improving safety for the workers and the traveling public
Objectives of DSRC Testing for aSE project

- DSRC module performance in extended transmission range

- Data transmission in an alternative configuration with a relay
Pictures of Testing
CA-37 E, Petaluma, CA
Richmond Field Station - Elbow Configuration

389 m

497 m

Total
886 m = 0.550535 miles
DSRC Testing Summary: Point to Point

- Range of 1.1 miles was tested at CA-37E, Petaluma, CA, in a rural setting.
- A transmit power range of 17-20 dbm is adequate for successful transmission.
- This allow operation of radios with transmit powers comfortably below their stated maximum of 23 dbm.
- Testing in a suburban area proves the capability of the setup to work in harsher radio environment and still achieve a 1.2 mile long range.
DSRC Testing Summary: Relay

• Testing at Richmond Field Station proved effectiveness of relay in transmitting messages without any perceptible delay or loss of data.
• Directional antennas were used in the rural test. Omnidirectional antennas was used in the relay test.
• The downside of the relay configuration is the added complexity of deployment in the field.
• Nonetheless, tests demonstrated the feasibility of relay, when necessary, in locations with unfavorable road geometry.
Summary: PATH aSE System

• An aSE system that integrated technologies
• Observable reduction of speeding vehicles
• Demonstrated effectiveness in field tests
• Involvement and positive feedback from Caltrans and CHP to ensure usability
• Future studies can benefit from
  • Systematic and in-depth data collection
  • Evaluation of driver behaviors
  • Operation in diverse environment, such as incident zones and high-risk locations with speeding hazards
Field Data Collection
Work Zone Closure Notes:
1. Closure Set with standard cones at 50 foot spacing through taper, buffer zone, and first 45 cones in active work area.
2. After first 45 cones of active work area, cone spacing increases to 100 feet.
3. Cones 16 to 45 of active work area have a WTI Smart Cone placed beside, or just behind the standard cone.
4. Speed Signs located halfway between closure signs as shown.
5. iCones 1 & 2 as shown, iCones 3-6 evenly spaced from middle of Buffer Zone to end of Active Work Area.

Legend:
- CHP Vehicle
- Cone
  - WTI Smart Cone
  - PATH CMS
  - PATH Radar/Cam
- WTI Pager Cone
- Closure Orange Cone
- Speed Sign
- Lane Closure Sign
- PATH Repeater to CHP

Updated 06/05/2012
iCone Locations

Cone 1

Cone 2

Cone 3

Cone 4

Cone 5

Cone 6

29 WTI Smart Cones, 50' spacing

Remaining Cones at 100' Spacing

3 cones across closed lane every 2000'

2040' (0.3 Miles)

1500' (0.3 Miles)

1000' taper (0.2 Miles)

Buffer Min 750' (0.14 Miles)

Spacing to first WTI Cone 750' (15 cones)

Daily Closure Length ~ One Mile +/-
Overall Effects of Speed Distribution, Measured by iCones (1st 4 weeks for different scenarios)
Evaluation of Speed Data - Issues

- Multiple speed readings per vehicle – iCones and both systems
- Radar offset
- Traffic entering and leaving the closure via side roads
- MAZEEP location
- Maintenance workers and researchers location within the work zone- people and vehicles
- iCone pointing variation
- iCone and sDrum location variation
- Different Thresholds for the Two Systems
- Impact of Congestion Versus Free Flow – Traffic Volume
- Each system gathered independent data
- iCone data provided to both teams
Questions?
Thank You