Connected Vehicle Technology Applications for Dilemma Zone Warning System

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Our Project Team

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Intelligent Automation Inc.
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Project Location

US 301 & Croom Station Rd, MD
65mph = 95.3 fps

Distance needed to stop with 0.3 g = 514 ft

Distance a vehicle can travel during max yellow of 5 sec. = 476.5 ft

Dilemma Zone

Consequence of being trapped in DZ:
1. Running Red Light
2. Stopping with >0.3g Deceleration Rate
3. or causing a rear end crash
Conventional Warning System
The Major Technical Issues with the Existing DZ Warning System

1. The warning flasher is NOT coordinated with the signal timing
2. The flasher timing can not accurately service all types of vehicles with various speeds
3. Drivers do not have the trust in the warning signal
The Project Goal

- Using the recently developed Connected Vehicle technologies to address the technical issues in DZ warning Systems
Connected Vehicle Technologies Used in This Project

- **SPaT** (wirelessly broadcasting signal timing data)
- **RSU** (wirelessly broadcasting signal to OBUs)
- **OBU** (receiving RSU data, processing CV data)
- **DSRC** (wireless, 5.9 GHz, exclusive for DOT use)

- **Other Technologies**
  - Microboard (processing SPaT data, Sensor data, remote switch for flashers, and communication to RSU and OBU)
Roadside Unit (RSU)
Signal Phasing and Timing Unit (SPaT Unit)
Basic System Configuration

- SPaT Unit
- Control Computer
- Battery-Solar cell system
- Microwave Radar Detection
- DSRC

Basic System Configuration:
- 350 - 700 ft
- 600 - 1000 ft

Diagram shows:
- Traffic lights
- Road intersections
- Microwave Radar Detection
- Control Computer
- DSRC
- Battery-Solar cell system
- RSU

Distance:
- 350 - 700 ft
- 600 - 1000 ft
The detection system accurately measures the vehicle speed and vehicle type.

The timing data, detection data are input into the microboard for processing.

When warning time is calculated and due, the system will broadcast the warning signal to OBUs, meanwhile switch on the roadside warning flasher.
Testing and Data Collection at TFHRC
Artificial Intelligence Applications for Traffic Operations

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Delaware DOT TMC
The Project Goal

Developing an AI based tool, which can assist the TMC engineers and operators to handle the large scale, very complex tasks.
Applying The AI Tool to Support Delaware DOT’s TMC Operations
Project Team

Intelligent Automation Inc.

Saber, Wang, and Associates, Inc.
What Is Artificial Intelligence (AI)?

**Artificial Neural network** (ANN) and **Expert Systems** are the two major Types of AI technologies.

Now it is a popular trend Internationally to use AI in transportation engineering.
Artificial Neural Network (ANN)

Human Neural Network

ANN

(Methodology: First, learning by training, and then applying the learned knowledge)
Expert Systems

WHAT ARE EXPERT SYSTEMS?

Expert systems are computer systems, comprising both hardware and software that mimic an expert’s thought processes to solve complex problems in a given field (domain).
However, if the network is large, or there are too many cases, with huge amount of data – especially when the Connected Vehicle data are available;

**No human brains can process such big data and make multiple decisions timely!**
Key Features/Advantages:

- Network-wide data analysis
- On-line decision support or offline training
- Fast and accurate response
- Emulate human reasoning and problem-solving capability; learn and become smarter over time
The Problem

- Left-turn movement on MD 175 to US 1 is heavily congested
- Unusually long queue at the intersection of MD-175/US-1
- Traffic of other approaches are fine
- Time of day (TOD) : AM peak
- Day of week (DOW) : weekday

What caused the problem and how to deal with it?
Expert System queries US-1 and MD 267 data, and then freeway I-95 data.

(Downstream detectors on I-95 beyond the MD-175 exit ramp, low volume, low speed and high occupancy for station #172 and high speed, low occupancy for station #173 for the right two lanes, suggesting an incident might have happened between the two detection stations.)

Expert System reasons that traffic detour to US-1 via the exit MD-175.

Then Expert System provides operator a set of options on signal timing on US-1 corridor.
# Example: Performance Evaluation

US 1 Northbound  
Signal Delay, Travel Time, and Travel Speed

<table>
<thead>
<tr>
<th>Condition</th>
<th>Corridor Travel Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>700</td>
</tr>
<tr>
<td>Incident /Existing Timing (150s cycle)</td>
<td>1200</td>
</tr>
<tr>
<td>Incident /Proposed Timing (210s cycle)</td>
<td>790</td>
</tr>
</tbody>
</table>

The Tool suggested the plan (210 s cycle) performs much better than Do-Nothing.
Welcome to Visit TFHRC

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Questions?

Thank You!