Development and Demonstration of a Cost Effective In-Vehicle Lane Departure and Advance Curve Speed Warning System

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Outline

• Background
• Project Overview and Goals
• Development Status
• Field Tests and Results
• Summary and Next Steps
• Questions/Discussion
Background

Problem:
- Horizontal curves crash rate is three times higher than that of the tangent road sections
- Half of the fatal accidents occur on curved roads

Existing Solutions:
- Lane departure warning systems (rumble strip, video/sensor/GPS based solutions)
- Advance curve speed warning systems (warning signs, rumble strip)

Problems with Existing Solutions:
- Expensive (implemented on high end vehicles)
- Performance (severe weather, clear road marking signs)

Proposed Project Overview

Features:
- Cost Effective (not uses video, differential GPS or high resolution maps)
- Performance (weather proof, will not rely on road markings)
- Easily Implementable (as a smartphone app or as a feature in navigational devices)
Goal 1: Lane Departure Warning

Lane departure detection and warning algorithm

Goal 2: Advance Curve Speed Warning

Start of the curve

Distance from the start of the curve

Advance curve speed warning algorithm
Implementation Plan

- Receives position information from GPS Receiver
- Accesses road curvature information from a mapping database
- Detect lane departure and issue warning signal

Reference Angle From Mapping Database

- Shape Point
- Spurious Shape Point
- Valid Shape Point
An Example of Reference Angle

A Freeway Example

Department of Electrical Engineering
**Constant Yaw and Steering Angle**

\[ \theta_n = \text{veh} \_ \text{heading} - \theta_{\text{ref}} \]

**Lane Departure Detection Algorithm**

Threshold

Accumulative Lateral Distance

Distance

Threshold
**Lateral Distance Threshold**

Max Deviation = 1 m (Normal Driving)

Lane Width = 3.6 m

Distance (m)

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<tr>
<th>Distance (m)</th>
<th>Lateral Distance (m)</th>
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<tbody>
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</table>

**Advanced Curve Detection Algorithm**

Safe Distance

Starting point of curve

\[ h_1 \]

\[ L \]

\[ h_2 \]

\[ h_2 - h_1 \]
Field Tests

Field Tests on Rice Lake Rd.

- Ref heading (deg)
- Distance (m)
- h1
- hn
Field Tests on I-35

![Graph showing ref heading vs distance](image)
Next Steps: Reference Angle via Past Trajectory and/or V2V Communication

- First time traveling vehicle on this road
- Frequently traveling vehicle on this road

V2V Communication
Summary

On-Board Unit

GPS Receiver

Warning Signal

GPS Antenna

Concept
- Algorithm design
- Software development

Proof of Concept Demo
- Patent/licensing
- App development

Product Development

A Sample Result: Rice Lake Rd

Accumulative Lateral Distance (m)

Distance (m)

0 300 600 900 1200 1500 1800 2100 2400 2700 3000

-3.5 -2.5 -1.5 -0.5 0.5 1.5 2.5 3.5

Rice Lake Rd
A Sample Result: I-35 Interstate

[Graph showing accumulative lateral distance vs. distance (m) with a false alarm marked]