Security and Privacy on the Road

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WINLAB Research Review
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Very Hard (and Fun!) Problem

- Is it possible to track you when we just know your:

  - Starting location

  and

  - Your driving speed with timestamps?
Elastic Pathing: Speed is Enough to Track You

Ground Truth  Predicted Path

1 Mile 2 km

Fraction of traces with this error or better

Distance from Start (Miles)

Error (miles)

Originating from Grocery Store  Originating from Residential Area

Published by MIT
Additional Motivation:
Usage-Based Automotive Insurance

• Some companies claim to only collect speed data to preserve privacy

• Examples
  – PROGRESSIVE: Snapshot device
  – Allstate: DriveWise device

• Starting location: home address known by insurance companies
Key Idea: Elastic Pathing Algorithm

- Accumulate distance from speed
- Include all the possible paths while matching
- Priority First Search:
  - First explore the candidate path having smallest overall error
  - Drop the path if current speed is way beyond the speed limit
  - Sort the possible path according to the overall error
  - Repeat until complete
Demo
Finding: Accuracy Differs with Drivers

New Jersey Dataset

Seattle Dataset
Summary

- New Jersey dataset
  - 14% traces: error less than 250 meters (0.16 miles)
  - 24% traces: error less than 500 meters (0.31 miles)
- Seattle dataset
  - 13% traces: error less than 250 meters
  - 26% traces: error less than 500 meters

- More information and full demo video at:
  - http://elasticpathing.org/
Accuracy Differs with Drivers?

New Jersey Dataset

Seattle Dataset
• **Car theft: a major problem**
  
  – FBI’s estimate for 2013: “just under 700,000 units” stolen vehicles just in the United States
  
  – Only 42.6% of stolen vehicles were recovered in 2008

• **Solution : Authenticate drivers by driving behavior**
  
  – Use driving data
  
  – Distinguish between drivers based on their driving habits
Ignition

DAS collects driving data from ECU

User claims their identity

Enter ID

Authorized driver!
Level of confidence: 95%

Unauthorized driver!
Level of confidence: 15%

DAS decides on authenticity of driver

DAS sends the appropriate signal to ECU via immobilizer.
• System Architecture
• **Design Considerations**

  – **Number of people**
    - How many people drive the car?
  – **Lending your car**
    - Friend, rental cars etc
  – **Variable driving patterns**
    - Changes in driving behavior at different times
  – **Environmental effect**
    - Changes in weather conditions, road obstruction, etc.
  – **Regional effect**
    - Changes in driving behavior in different cities
- Formal study with 30 participants

Study was conducted in late morning and early afternoon weekdays.
- Route A includes only urban areas with high traffic.
- Route B includes mostly highway with less or no traffic.
- These routes were selected to test various driving maneuvers.
- 9.8 miles drive in one driving session, totally driving 19.6 miles.
### Individual Analysis of Drivers Equal Error Rate

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<th>Driver# 1</th>
<th>Driver# 2</th>
<th>Driver# 3</th>
<th>Driver# 4</th>
<th>Driver# 5</th>
<th>Driver# 6</th>
<th>Driver# 7</th>
<th>Driver# 8</th>
<th>Driver# 9</th>
<th>Driver# 10</th>
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<tr>
<td>EER (%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6.67</td>
<td>6.67</td>
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<td>Driver# 17</td>
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<tr>
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<td>Driver# 27</td>
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<td>Driver# 30</td>
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<tr>
<td>EER (%)</td>
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<td>0</td>
<td>10</td>
<td>0</td>
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<td>3.33</td>
<td>0</td>
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</tr>
</tbody>
</table>

- Unfamiliarity with route: inconsistent driving
- Road obstruction
Summary
Thank you!