Identifying Driver's Cognitive Distraction Using Inductive Logic Programming

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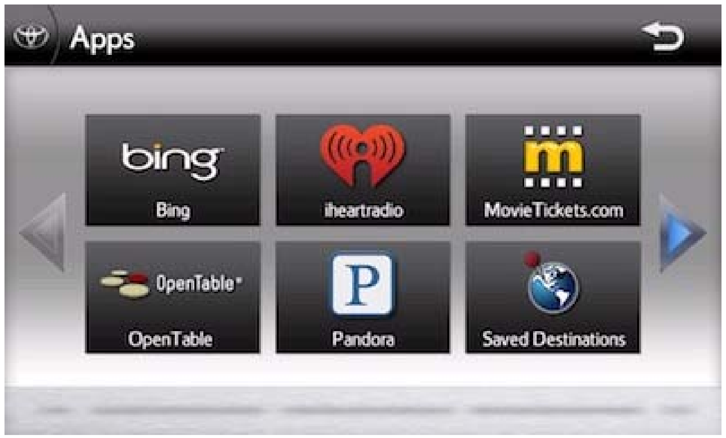
Background

- Next Generation Services in Car
  - Telematics
    - Entune, G-BOOK
  - Services in Cooperation with Smartphone

  - Common Internet Services



Toyota Entune

Denso NaviCon

Purpose of the Study

- New research topic to Traffic problem
- To detect distracted driving

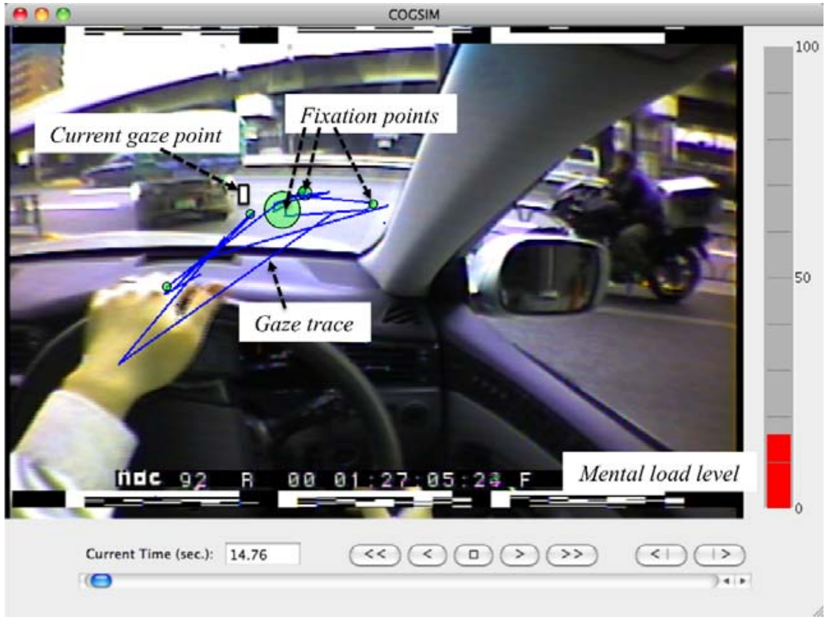
  Inside car services causes distracted

  driving, cell phone, media players, navigation

Real time driving experiments

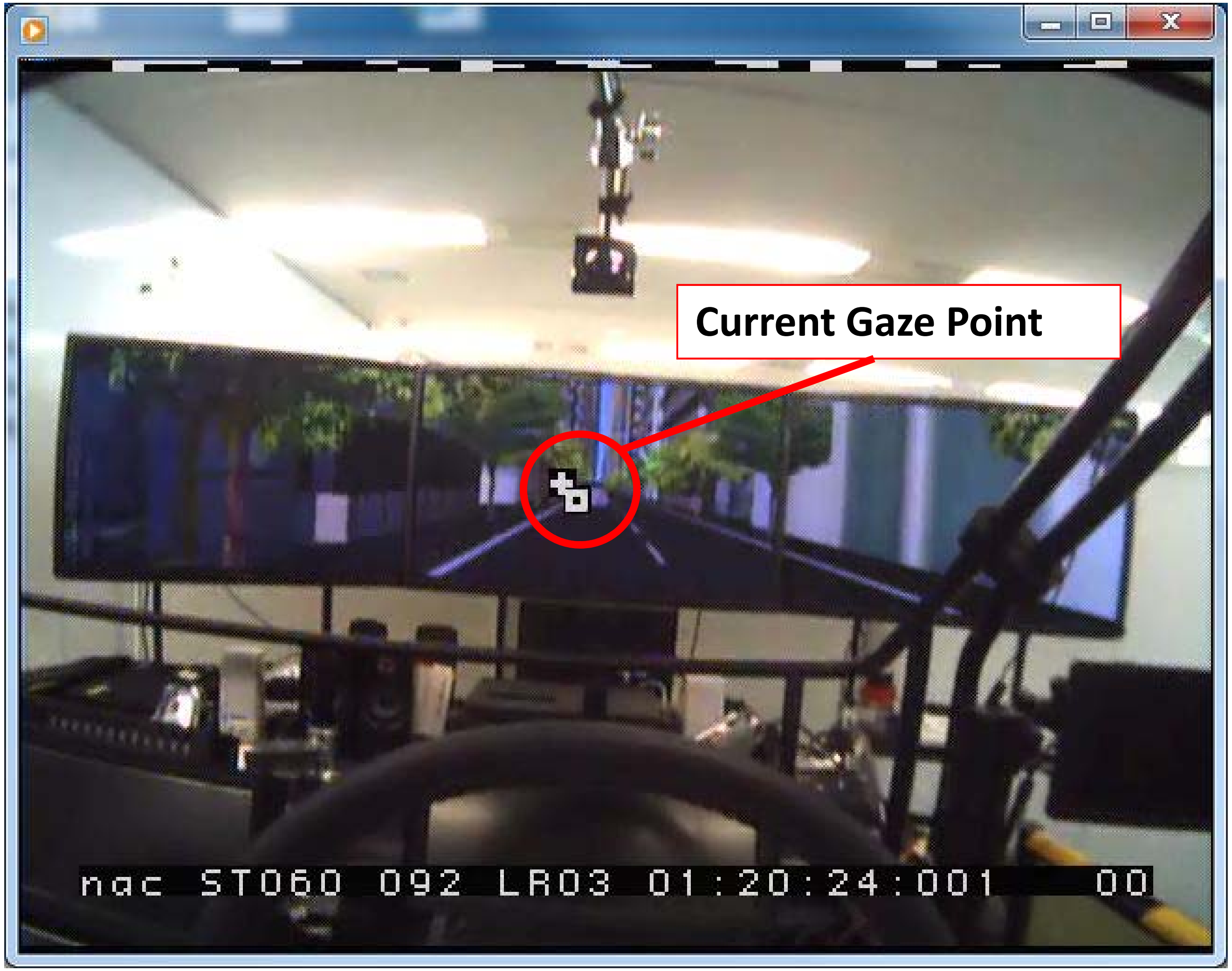
Cognitive Qualitative SIMulation on Eye Movement

- Using QSIM: Qualitative SIMulation
- Analyzing real data
  - Eye Movement
  - Driving Data



Real street experiments:
Limits of subjects numbers

Driving Simulator to Collect Experimental Data



Experimental Setting

Participants:

19drivers（female 9 male 10）

Age: 30～50s
Experience: 5～over20 years
hours/week: 1～30 hours

Two 15min. same route drives for each participants

1. First Driving （without mental load）

- **normal driving**

2. Second Driving（with mental load）

- **mental arithmetic task (load driving) every 8 seconds**

Data Collection

1.Eye movement using EMR-9

Position of Eye move(X,Y)

2. Driving data using vehicle sensors from Simulator

- accelerator depression data （0～100）
- steering data（－1～＋1）
- braking signal（0 or1）
- velocity data（km）
- front vehicle (0 or 1)

Obtain 60 data points per second

Data Transformation for ILP learning

Transform raw data at constant time intervals to qualitative data

(About 900 sec: 54,000 times) ***(5 sec)***

From Eye movement data

On move direction and distance

1. the counts of saccade and fixation
2. total eye movement distance

From driving data

1. Data average and standard deviation
2. Add difference attribute values

Example of qualitative data

bigHigh
bigMiddle
bigLow
average
smallLow
smallMiddle
smallHigh

Add new information on before event (interval)

Background knowledge

Types	Predicates
Qualitative value	accele(+ID, #Val), brake(+ID, #Val), velocity(+ID, #Val), steering(+ID, #Val), gazeX(+ID, #Val),gazeY(+ID, #Val), front(+ID, #Val), **sacCount(+ID, #Val), fixCount(+ID, #Val), eyeMove(+ID, #Val)**
Qualitative state difference	accele diff(+ID,#Val), brake diff(+ID,#Val), velocity diff(+ID,#Val), steering diff(+ID,,#Val), gazeX diff(+ID,#Val), gazeY diff(+ID,#Val), front diff(+ID,#Time,#Val), **sacCount_diff(+ID, #Val), fixCount_diff(+ID, #Val), moveCount_diff(+ID, #Val)**
Information on before event	**Before_event(+ID, -ID)**

Mode declaration: + input type   - output type   # constant

Positive/Negative Examples

Positive examples：mental arithmetic task
(more half time of driving)

Negative examples：Nomal driving
(only first driving data)

Data example：F01（femal, age30, experimences10years, 5hours/week)

State	Time(sec.)	The number observation of raw data	The number of examples	Positive examples	Negative examples
Normal	917	55020	183	0	183
Arithmetic	934	56220	186	119	0

Obtained ILP Rules

Rule generation by Parallel ILP engine

[Nishiyama & Owada 2015, Owada & Mizoguchi 1999]

・2sets ６CPU computers
（Intel(R) Core(TM) i7-5820K CPU @ 3.30GHz 16.0GB 64bit）
・6sets ４CPU computers
（Intel(R) Core(TM) i7-4790 CPU @ 3.60GHz 8.0GB 64bit）

Total time： 4615 sec. (1.28 hours)
Rule generations：22sets

Examples of Rule（driving data F01）

Driving and Eye movement Rules（{（include）positive :negative}）

{23,4} class(A) :- steering(A, straight), eyeMove(A, average),
before_event(A, B), front(B, notClear).
{21,3} class(A) :- front(A, notClear), before_event(A, B),
steering(B, straight), eyeMove(A, average).

Each rule means this driver follows a car in front, going straight and eye-movement is average

Checked normal driving video

In normal driving: eye-movement is almost high moving
(No mental arithmetic task)

'Average eye-movement' means this driver don't gather front information

Not fixation, not saccade

Conclusions

*Using Driving Simulator,we have obtained cognitive distraction with inductive rules.

*Parallel ILP engine is useful for the identification of distraction.

*The rules verify distraction in terms of eye-movement data,sac and fix.