UTDrive

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In-Vehicle Systems: CU - Move

Robust Speech Processing for Route Navigation

CSLR — CU

DARPA

MOTOROLA

Motorola, Human Interface Lab
(Schaumburg, IL)

HRL LABORATORIES

TOYOTA CRDL., INC.

CU-Move Corpus License Members

Visteon

Infinitive Speech
Systems
(Visteon Corporation)

IBM

Siemens

VoiceSignal

Voice Signal
Technologies
(Woburn, MA)

SpeechWorks

Mitsubishi

Mitsubishi Electric
Research Labs (MERL)

Panasonic

Panasonic Speech
Technology Lab
(Santa Barbara, CA)

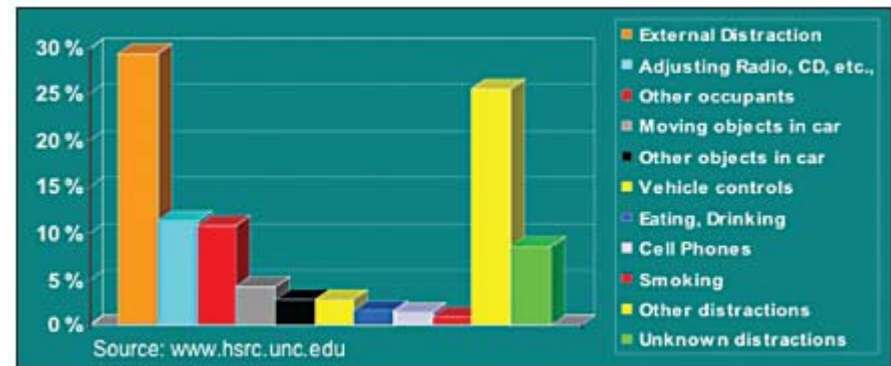**UTD**

In-Vehicle Systems: CU - Move
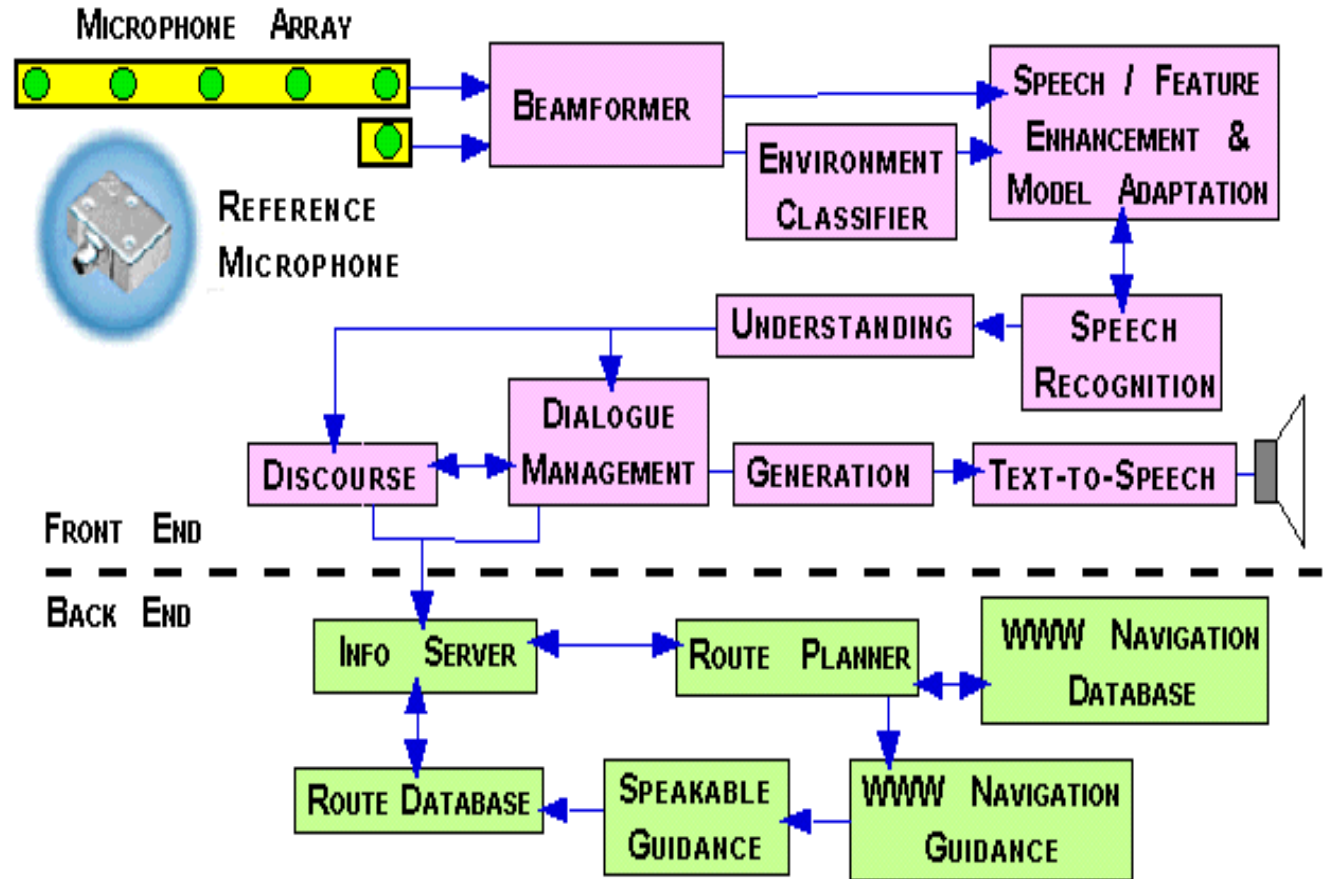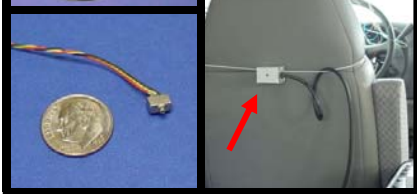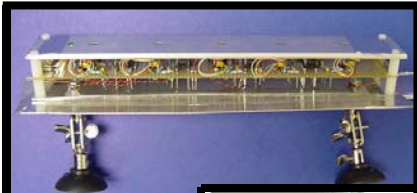
UTDrive

www.utd.edu/research/utdrive/

NEDO
Funded Project
"Driving Behavior"

In-Vehicle Systems: UT-Drive

Two Cameras

Microphone Array

Close-Talk Mic.

Hands-free

GPS

Distance Sensor

Heart-rate& Blood Pressure

Brake & Gas Pedal Sensors

OBD-2 (CAN-Bus)

Data Acquisition Unit

In-Vehicle Systems: UT-Drive

Speech

Driving Behavior

Route Info

Distraction Tasks

◈ **Speech –voice dialog in car, information access**
◈ **Driver –actions (head, hands, eyes, etc)**
◈ **Car –exterior (context of road conditions, weather, etc)**
◈ **Car –CAN-bus (steering angle, vehicle speed, brake, acceleration,..)**

UTDrive: Distraction Detection

- **Data: 8 Drivers**
- **Two GMMs: Neutral vs Distraction models**
- **Two modes:**
  - **Route-Dependent: Train & Test on the same leg of the route**
  - **Route-Independent: Train & Test with the whole route**
- **5 seconds worth of data/token**

Route-Dependent Model
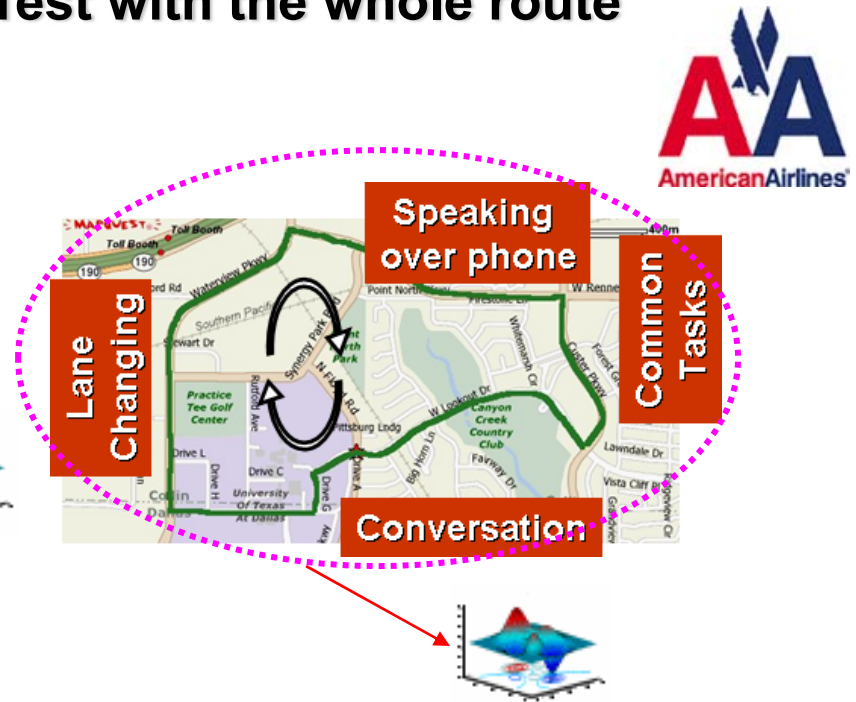
Route-Independent Model

UTDrive: Distraction Detection

Response Delay for American Airline Dialog System

Pause Distributions for AA Dialog Questions
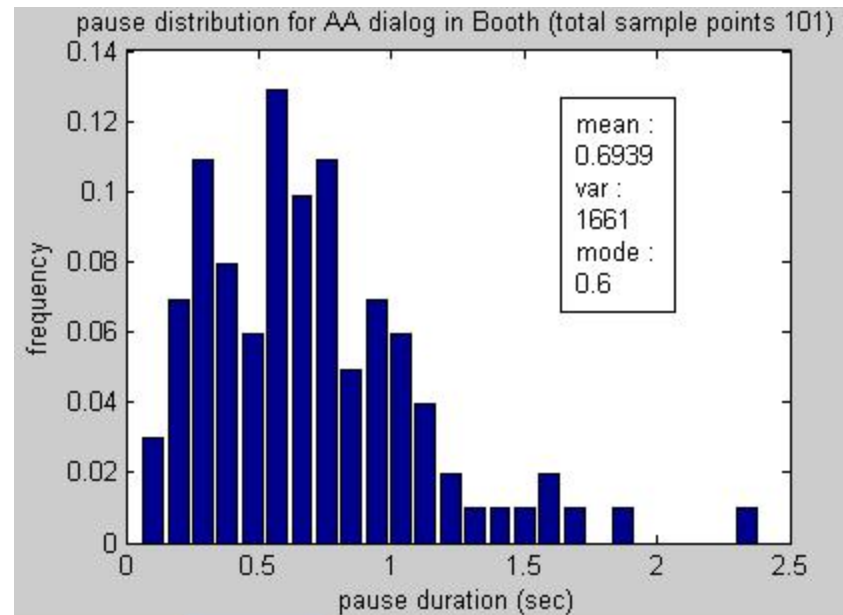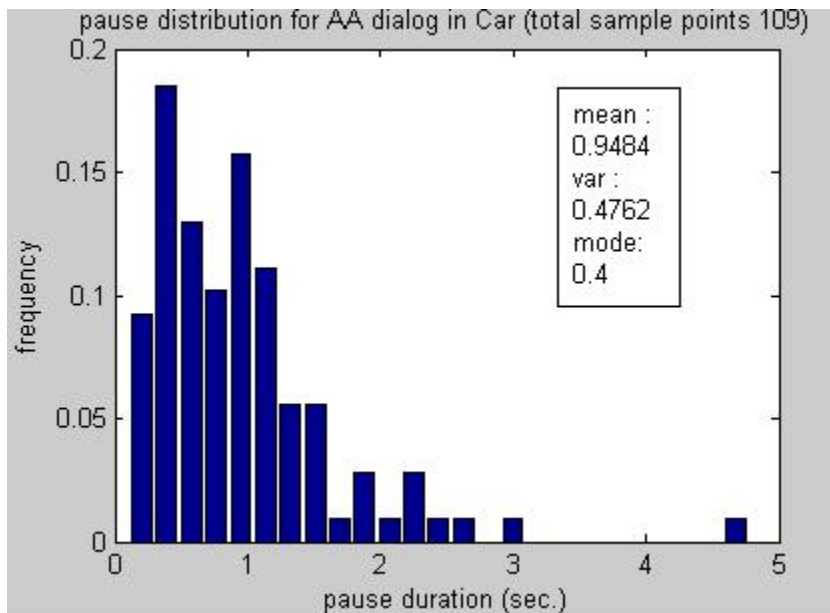
In a Vehicle – Driving Case

Mean: 0.948 sec

In a Booth – Neutral Case

Mean: 0.694 sec

+26.8% Increase in Pause Duration w/ Driving Distraction

UTDrive: Distraction Detection

Steering Angle

Normalized Short-term variance = 1.21

Neutral

→ 30 sec

Normalized Short-term variance = 0.27

Neutral

→ 80 sec

Control Radio

Time[sample]
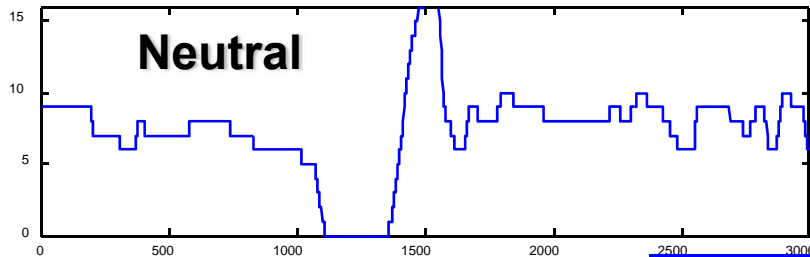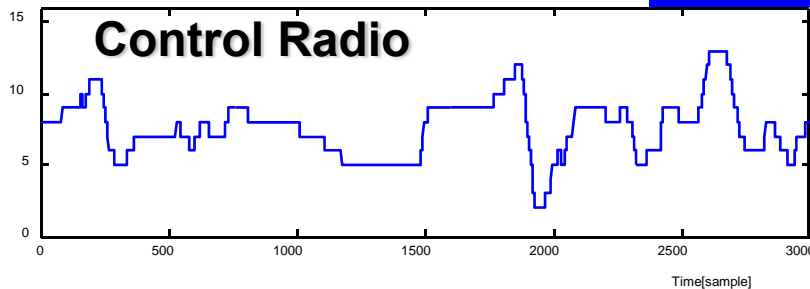
Normalized Short-term variance = 1.69
Increase 40% σ^2

Conversation

Time [sample]
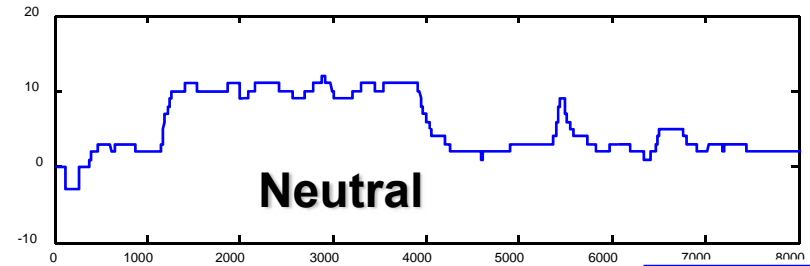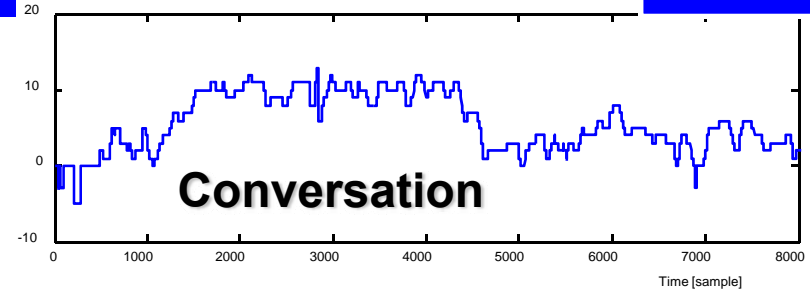
Normalized Short-term variance = 0.82
Increase 203% σ^2

◈ **Driver maintains smoother steering degree in neutral vs. distracted driving**

UTDrive: Distraction Detection

KL2 Distance & Distraction Level

KL DRIVER	LC	CO	MP	CT
1	10.6436	16.1577	18.5362	19.0907
2	14.2011	14.6433	19.6111	15.5726
7	15.8742	30.2861	14.4747	25.8047
8	12.9468	12.4495	14.5173	12.7812
AVG	14.1566	16.7162	20.1272	18.4377
Result	NO	LOW	HIGH	MEDIUM

Neutral Model − **Distraction Task Model** = △
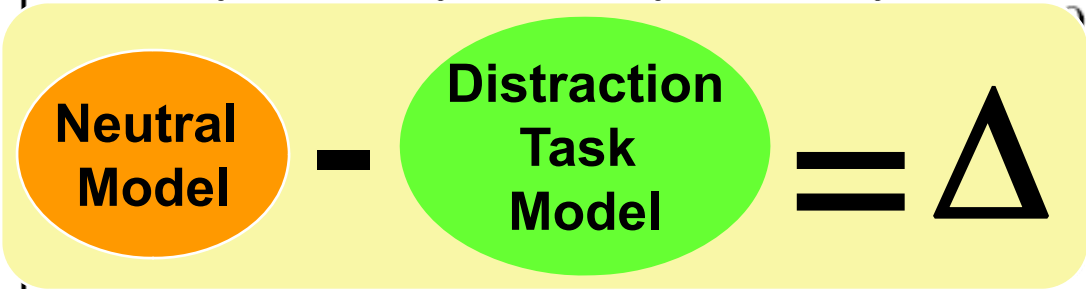
$$KL(p,q) = \sum_i p_i . \log_2 (p_i / q_i)$$

p - reference probability distribution
q - arbitrary probability distribution

1-8 Drivers included
DISTRACTION TASKS
- ◈ LC – Lane Changing
- ◈ CO – Conversation
- ◈ MP – Mobile Phone
- ◈ CT – Common Tasks

IEEE ICASSP 2008 Panel Session:
Human behavior signal processing for vehicular applications

Organizers:
Hakan Erdogan, Sabanci University, Turkey
and
Kazuya Takeda, Nagoya University Japan

Panelists

◈ **John H.L. Hansen, UT Dallas, USA**

◈ **Mats Viberg, Chalmers Institute of Technology, Sweden**

◈ **Toshihiro Wakita, Toyota Central R&D Lab., Japan**

◈ **Shane McLaughlin, Virginia Tech, USA**

◈ **Juan Carlos De Martin, Politecnico Torino, Italy**

Moderator

Huseyin Abut, San Diego State University (Emeritus)

& Sabanci University, Turkey

Organizers

Hakan Erdogan, Sabanci University, Turkey

Kazuya Takeda, Nagoya University Japan

In-Vehicle Publications
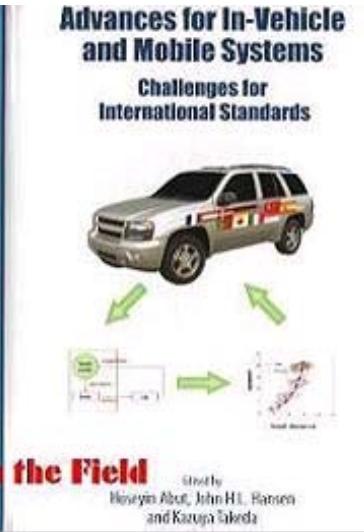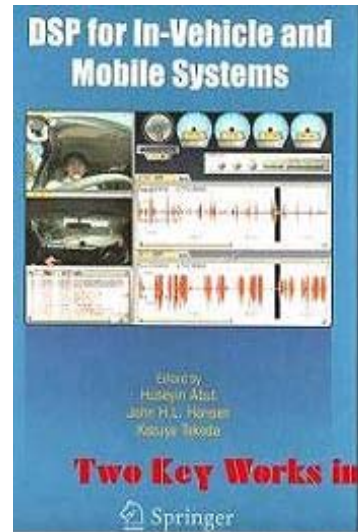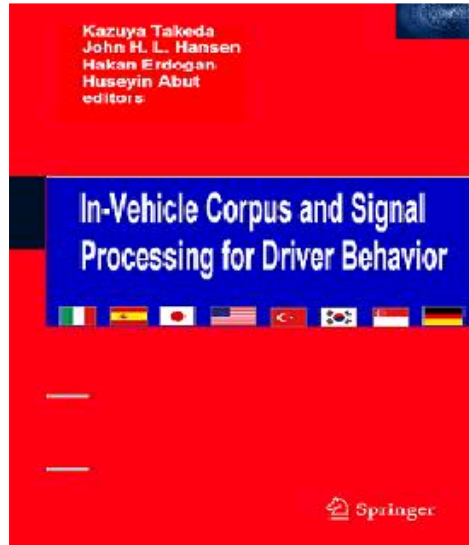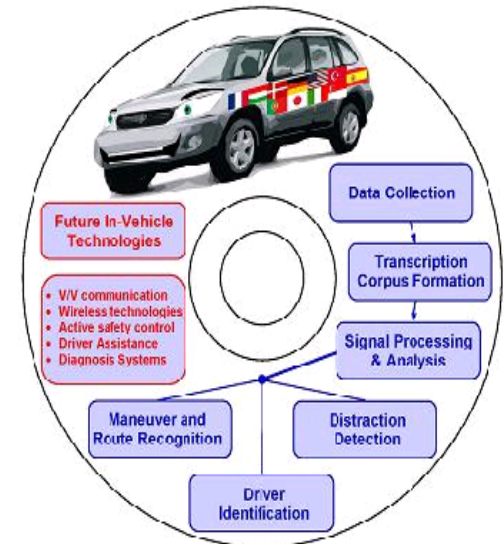
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DSP for In-Vehicle Systems & Safety

4th Biennial on DSP for In-Vehicle Systems and Safety, Dallas, USA, June 2009

❖DSP technologies in adaptive automobiles

❖Driver status monitoring and distraction detection

❖In-Vehicle dialogue systems and human machine interfaces

❖Challenges in video and audio processing for in-vehicle products

❖Multi-sensor fusion for driver ID and robust driver monitoring

❖Vehicle to Vehicle, Vehicle to Infrastructure wireless technologies

❖Human factors and cognitive science in enhancing the safety

❖Transportation engineering venues

❖Bio-mechanics and accident research

IMPORTANT DEADLINES

Extended abstract submission (1-4 pages)	November 1, 2008
Notification of acceptance	February 1, 2009
Full paper submission	March 1, 2009
Workshop date	June 26-28, 2009

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[4] J.H.L. Hansen, X.X. Zhang, M. Akbacak, U.H.. Yapanel, B.Pellom, W. Ward, P. Angkititrakul, "CU-MOVE: Advanced In-Vehicle Speech Systems for Route Navigation," Chapter 2 in *DSP for In-Vehicle and Mobile Systems*, Springer Publishing, 2004.

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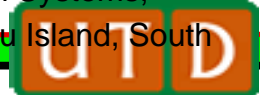
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