Automotive UI

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http://cpdm.iisc.ernet.in/PBiswas.htm

Indian Institute of Science I³D Lab

More than 100 years old

Initiated IIT, NIT and IISER systems in India

Only Indian university in the top 100 ranking and in the top 10 small (<5k students) universities

Intelligent Inclusive Interaction Design Lab

- Set up in 2016
- Undertakes research in Intelligent User Interface and Inclusive Design
- Automotive, Accessibility, Smart Manufacturing, Aviation
- Funded through Bosch, Microsoft, DRDO, DST, DBT

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Brief Bio

2004-06: MTech in Information Technology, IIT Kgp

2006-10: PhD in Computer Science, Cambridge University (Computer Laboratory)

2010-14: Research Associate in CUED (Engineering Design Centre)

2014-16: Senior Research Associate in CUED (EDC + Signal Processing Group)

2011-13: Vice Chairman at ITU-T Focus Groups

2013-16: Fellow (Governing Body Member) of Wolfson College, Cambridge University

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Project Experience

Gaze Controlled Applications for eInclusion of users with SSMI, **Microsoft Research** (Principal Investigator)

Cognitive and Auditory Rehabilitation for Elderly, **Department of BioTechnology (DBT, Govt of India)** (2018-2021) (Principal Investigator)

Next Generation Automotive Cockpit, **Faurecia Services Groupe**, France (Principal Investigator)

Faurecia Intelligent Design Support, **Faurecia Services Groupe**, France (Co - Principal Investigator)

IT4All, **DST SERB Early Career Fellowship**, Govt. of India (2017-2020) (Principal Investigator)

Reducing pilots' cognitive load by facilitating human machine interaction in military aviation environment by **Aeronautical Research and Development Board, MoD, India** (2017-2019) (Principal Investigator)

A Smart Manufacturing Test Bed for Biomedical Devices by **Robert Bosch Centre for Cyber Physical Systems** (2016-2019) (Co - Principal Investigator)

Evolutionary Human-Machine Interfaces (Evo-HMI) funded by the **British Aerospace Systems** (2013 - 2015) (Senior Research Associate)

MATSA project funded by **Jaguar Land Rover** (2015 – 2016) (Senior Research Associate)

India-UK Advanced Technology Centre of Excellence (IUATC), funded by **UK EPSRC** (2012 - 2015) (Senior Research Associate)

Gentle User Interfaces for Elderly (GUIDE), funded by the **European Commission** FP 7 Program(2010-13) (Research Associate)

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Why Auto UI

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What Auto UI offers

Environment Control
Navigation
Alert
Entertainment
Situation Awareness

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How is it different

Placement of sensors
Vibrating environment
Different lighting conditions
Integration to existing system
Feasibility for deployment

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Main Research Areas

Dashboard Control
New Interaction Techniques
Distraction and Cognitive Load Detection
Situational Awareness

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Dashboard Control

JAMA Guidelines

Installation Positions of Display Systems

Installation Positions of Display Monitors

General Display Function

Display and Content of Visual Information

Presentation of Auditory Information

Content and Display of Visual Information While Vehicle in Motion
- Map display function
- Information display to be prohibited
- Treatment of broadcasted information
- Dynamic display function

In the case of vehicles with the eye point measuring less than 1,700 mm from the ground, the upper end of the display monitor shall conform to the lower boundary requirements of the driver's 180° forward visual field stipulated in 90/630/EEC on the visual field of drivers.

In the case of vehicles with the eye point measuring equal to or higher than 1,700 mm from the ground, the upper end of the display monitor shall conform to the lower boundary requirements of the critical zone A stipulated in ADR 15/01 on demisters.

The screen of the display monitor shall be located within the range of inclination from the straight line which is the projection of the straight line connecting the JIS eye point and the center of the screen onto the Y-plane of the vehicle's three-dimension coordinate, provided that the angle of inclination is derived from the following formula:

Inclination [deg] = 0.013 ⍰ eye point from ground [mm] + 15

Present Status

Issues with Dashboard

Drivers take eyes off from road while operating dashboard

Dashboard requires physical touch

State of the art

Direct Voice Input

Gesture Recognition system

Hand/finger movement tracker

Existing Problem

- Accuracy of DVI changes for different languages and affective state
- Need to remember a set of gestures or screen sequence
- Intelligent prediction algorithm can not improve latency in infrared sensor

Case Study – Gaze Controlled Interface

Controlling dashboard just by looking at it

No need to take hands off from control

Can be configured as head down or head up display

In head up configuration, drivers can see through display

- P. Biswas, Interactive Gaze Controlled Projected Display, Indian Patent Application No.: 201641037828
- P. Biswas, G. Prabhakar, J. Rajesh, K. Pandit and A. Halder, Improving Eye Gaze Controlled Car Dashboard using Simulated Annealing, Proceedings of the 31st British Human Computer Interaction Conference (**British HCI 17**)

Clicks are in the Air

Sonja Rümelin, Thomas Gabler, Jesper Bellenbaum
BMW Group
Munich, Germany

Side view of setup to test ultrasonic feedback for virtual buttons.

1) Interacting hand

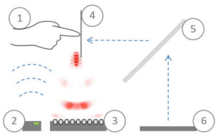
2) Gesture sensor

3) Transducer array

4) Virtual image

5) Optical array

6) LCD



Guiding Driver Visual Attention with LEDs

Gerald J. Schmidt
Opel Automobile GmbH

The illuminated LED unit is placed in the windshield. The red blocks show the position of the LED units to the left and to the right

Showed that drivers' attention can be directed efficiently and effectively with simple hardware and well-designed illumination patterns

Cognitive Load and Distraction Detection

Distraction

NHTSA Guideline says

no more than 15 percent (rounded up) of the total number of eye glances away from the forward road scene should have durations of greater than 2.0 seconds while performing the secondary task

the mean duration of all eye glances away from the forward road scene should be less than 2.0 seconds while performing the secondary task

Vehicle, Tuning Method, and Lead Vehicle Speed Profile	Total Glance Time to Task (sec.)	Total Eyes-Off-Road Time (sec.)	Mean Glance Duration (sec.)	Duration of Longest Glance to Device (sec.)	Total Number of Data Points (--)
Cadillac STS-Knob Tuning-Constant Speed	15.9	16.3	1.7	2.9	21
Chevrolet Impala-Button Tuning-Constant Speed	13.2	13.9	1.3	2.4	41
Chevrolet Impala-Knob Tuning-Constant Speed	7.8	8.1	1.4	2.2	41
Chevrolet Impala-Button Tuning-Varied Speed	11.5	12.3	1.2	2.3	20
Chevrolet Impala-Knob Tuning-Varied Speed	8.4	8.5	1.4	2.4	20
Infiniti M35-Button Tuning-Constant Speed	17.6	17.6	1.7	4.5	21
Mercedes R350-Button Tuning-Constant Speed	15.4	16.6	1.4	2.6	22
Toyota Prius-Knob Tuning-Constant Speed	10.3	11.1	1.4	2.4	21
Toyota Prius-Knob Tuning-Varied Speed	11.3	11.3	1.6	2.7	21
All VTTI Data	11.6	11.8	1.5	2.5	228

State of the Art

Intrusive
- Physiological sensors – Heart Rate, Skin Conductance , EEG
- Mechanical – Dead Man's Handle

Non Intrusive
- Facial Expression
- Ocular Parameters
- Acoustic Analysis of Voice

ocular parameters
- Blink
  - Rate
  - Duration
- Pupil dilation
  - Amplitude and maximum power component from Fourier and Wavelet Transforms
- Saccadic intrusion (SI)
  - Rate
  - average velocity

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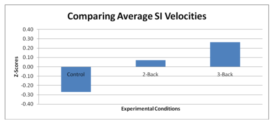
Psychological Tests

Blink rate increases with higher cognitive load

Hike in Pupil dilation with higher cognitive load

SI is higher for 3-back task compared to 2-back task and control condition



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Our Work

We are focusing on the distraction of drivers while operating secondary tasks.

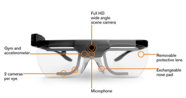
EEG is tracked to detect cognitive activity

Measure of Cognition due to Distraction (MCD) similar to ICA of Marshal

Head movement tracked for Roll, Pitch and Yaw

[Gowdham and Pradipta 2018] found significant results in eyes-off-road distraction from yaw of Kinect

We used pupil dilation from Tobii Glasses 2, yaw from Kinect, and EEG (T7 electrode value) from Emotive tracker.

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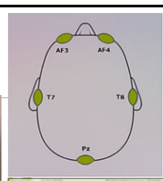
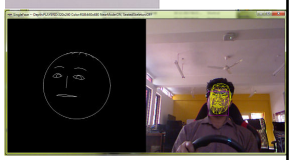
Design

Participant wearing Tobii Glasses and EEG tracker and the Kinect on the table



EEG Electrodes



Face tracking Visualisation from Kinect

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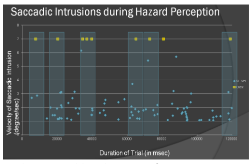
Temporal Association



Evaluated temporal localization of SI w.r.t. oncoming road hazard

SI and exogenous blink significantly correlate with perception of oncoming hazard

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Summary

STFT of pupil signal and average velocity of SI can be used to detect cognitive load and distraction

Ocular parameters conform to measurement from EEG tracker

Average velocity of SI increases with perception of oncoming road hazard

Sensor data will be directly fed to an expert system to generate multimodal (visual, auditory, haptic) alerts

- P. Biswas and G. Prabhakar, Detecting Drivers' Cognitive Load from Saccadic Intrusion, Transportation Research Part F: Traffic Psychology and Behaviour 54
- P. Biswas, V. Dutt and P. Langdon, Comparing Ocular Parameters for Cognitive Load Measurement in Eye-gaze Controlled Interfaces for Automotive and Desktop Computing Environments, International Journal of Human-Computer Interaction 32(1), Taylor & Francis, Print ISSN: 1044-7318

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Demo Video of Pupil Dilation – Distraction and Drowsiness Detection

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