Driver Distraction State Recognition and Risk Warning System based on multi-source information fusion

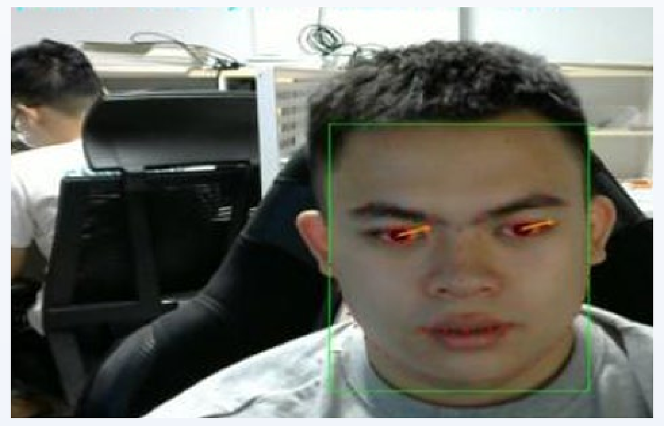
FORUM8

12th CPWC

FutureSight Driver Monitor Squad

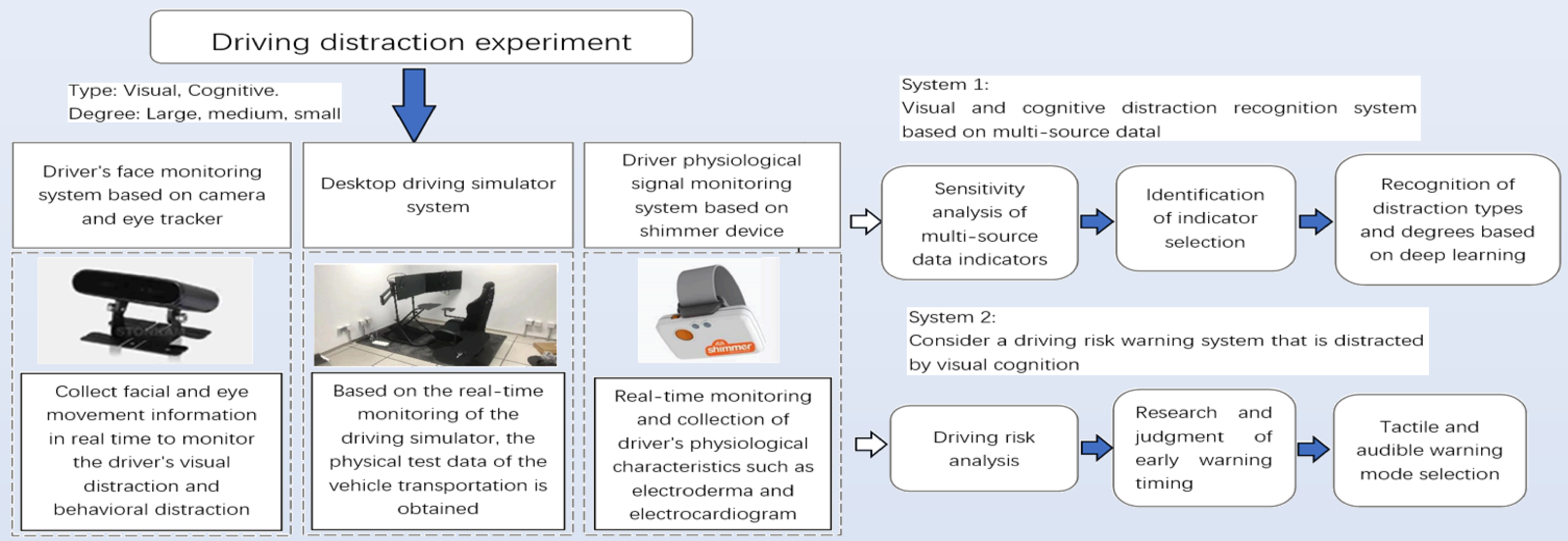
Overview

Currently, driver distraction monitoring systems on the market primarily focus on identifying fatigue driving, with incomplete detection and warning for distracted driving. These systems usually employ devices like cameras and sensors to gather driver behavior data for assessing driver fatigue and abnormal driving behaviors, but they suffer from a single data source and low recognition accuracy. This study's multi-source data collection approach offers a more comprehensive reflection of drivers' states compared to single-source monitoring systems, thereby enriching the data basis for subsequent distracted driving identification. Therefore, developing a system that can comprehensively detect the driver's distracted state can be applied to the active warning system of future intelligent vehicles, which can help improve the performance of the in-vehicle driver state monitoring system and promote the application of driving assistance systems. It can provide reference for the improvement of the theory of traffic accident causation and the formulation of relevant laws and regulations. At the same time, it is of great significance to reduce the incidence of traffic accidents and ensure driving safety.



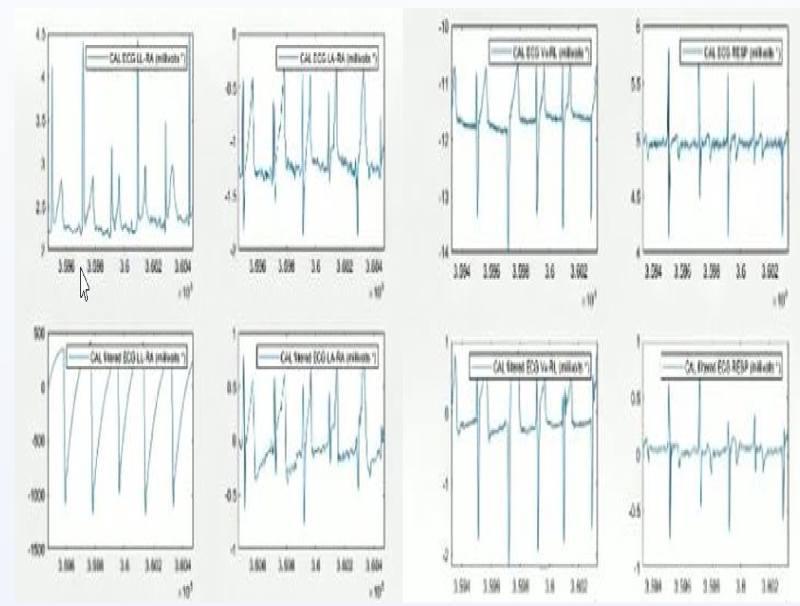
System Overview

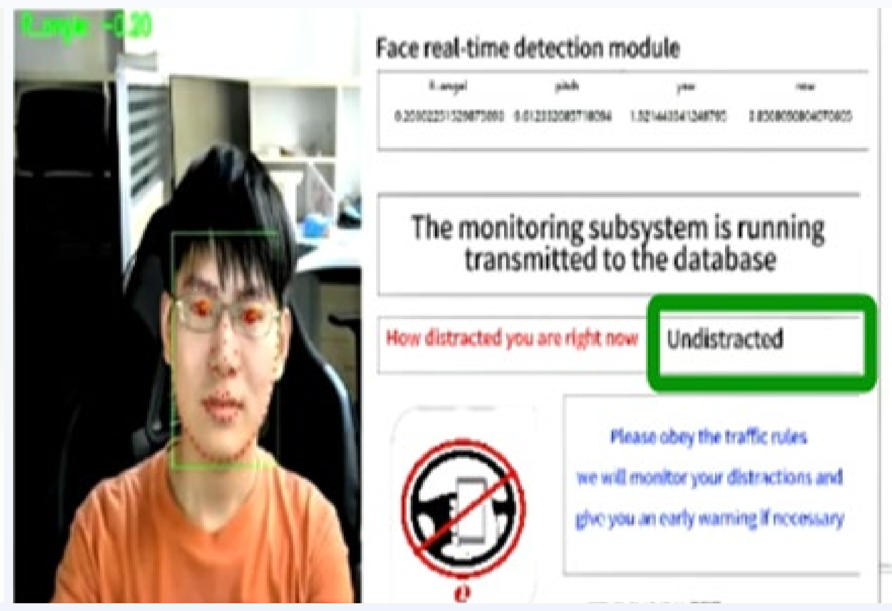
This system uses cameras, physiological feedback devices, and driving simulators to obtain multi-source data on the driver's head posture, line of sight orientation, psychophysiology, and driving behavior. We can accurately judge the driver's distraction state and trigger a voice alarm function when it is judged to be distracted in the trained driving distraction model, timely reminding the driver to adjust the state and ensure driving safety. We have developed an intuitive interface using PyQt, which can display the driver's head posture and line of sight orientation in real-time, providing users with clear driving status feedback. At same time, the system can also display real-time physiological data such as driver's electrocardiogram and electrocardiogram, helping users to have a more comprehensive understanding of their driving status. Open the driver facial monitoring module by running project.by to collect data on driver's head posture and gaze orientation. This activates the driver's cardiac and physiological status monitoring module by running Program GSR CG, which dynamically displays the driver's electrocardiogram and Transcutaneous Electrocardiogram in real-time. Finally, ready distraction recognition model.



Basic Functions

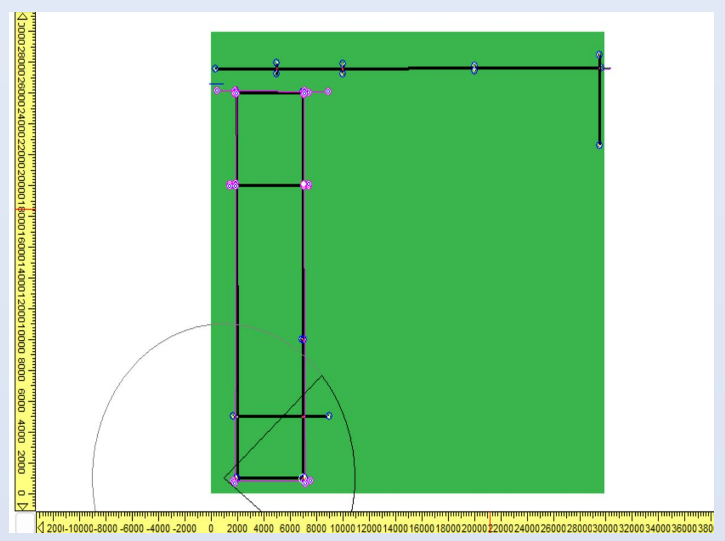
We have built a platform for synchronously collecting driving behavior, facial and eye movement data based on MySQL database, which can collect and store driving behavior data as well as facial and eye movement data in real time. Used Git to configure running environment Among them, driving behavior data is obtained in real-time using UC win/Road driving simulation software and received in real-time through UDP protocol based on Python; Facial and eye movement orientation data are captured in real-time by a camera, and eye movement and facial orientation data are obtained using deep learning based iris segmentation methods and Dilb and OpenCV, respectively; In addition, physiological data such as electrocardiography, electroencephalography, and respiratory rate are measured in real-time using a Shimmer physiological feedback device developed using Matlab. All the data will be inserted into database in real-time for the subsequent model to recognize the distracted state of the driver.





Experiment

We conducted an experiment on driver distraction during L2-level human-machine co-driving scenarios. The driving task involved monitoring an autonomous vehicle and taking over manual control in emergency situations on urban roads. The experiment also included tasks that induced Visual and Cognitive Distraction. At predetermined points before any events instructions were sent to driver (every 3km, 10 instructions).In response, the driver needed to send text messages from the phone. Instruction response are either of type send text or add and subtract. Based on this response data time, the distraction level is calculated. All male and female participants held C1 driving license and were in good health and mental condition. Overall experiment tested on a Bidirectional 6-lane round-shaped urban road divided into two scenes, each 30 km long. The driving scenes done in Autonomous Driving mode with speed of 60 km/h. In Scene 1, start from long side. In Scene 2, driving start from the short side to the end of long side. Brief drivers on the experiment's content and procedure, explain the distraction scale, and clarify instructions and feedback protocols. Sanitize and prepare equipment, outfit drivers with GSR and ECG sensors, calibrate, and initiate data collection. Enter the driving simulator, engage autonomous mode, and acclimate to driving controls before commencing a 5-kilometer baseline drive. Complete a 30-kilometer route, collect eye movement data, and follow the protocol for issuing instructions and obtaining the driver distraction feedback.



Task Type	Task Description	Code
Visual	Send a 1-digit text message	1
	Send a 4-digit text message	2
	Send an 8-digit text message	3
Cognitive	1-digit Addition and Subtraction	4
	2-digit Addition and Subtraction	5
	3-digit Addition and Subtraction	6

Distraction Level Classification Scale

Level	Driving Task Attention
1	10%
2	20%
3	30%
4	40%
5	50%
6	60%
7	70%
8	80%
9	90%
10	100%