Drowsiness Detection

Advanced Mobile Computing Class

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Introduction

- Driving is a common task done by countless people everyday.
- A big portion of accidents on road is caused by fatigued, drowsy drivers.

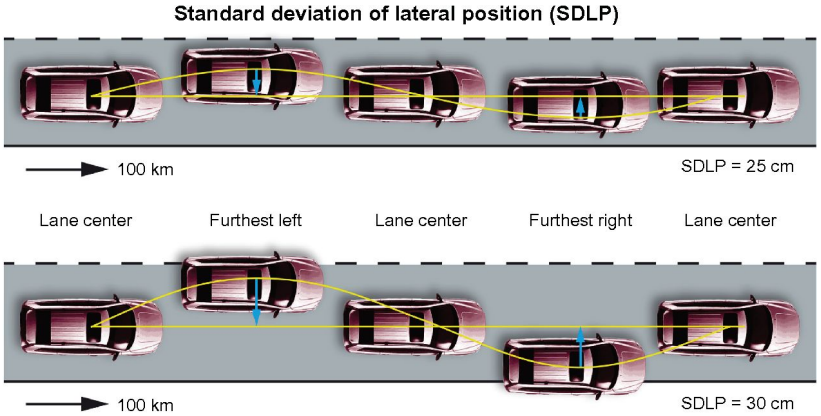


Related Works

- A lot of different methods have been proposed to fight driver drowsiness
  - Vehicle-based measures
  - Behavioral measures
  - Physiological measures

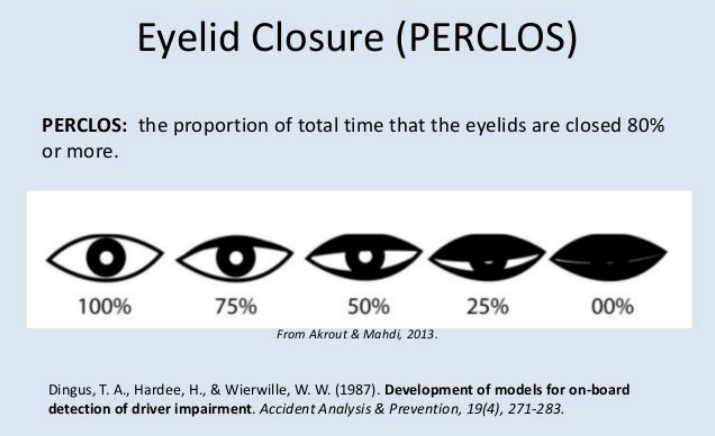
Related Works

- Vehicle-based Measures
  - Steering Wheel Movement (SWM)
  - Standard Deviation of Lane Position (SLDP)



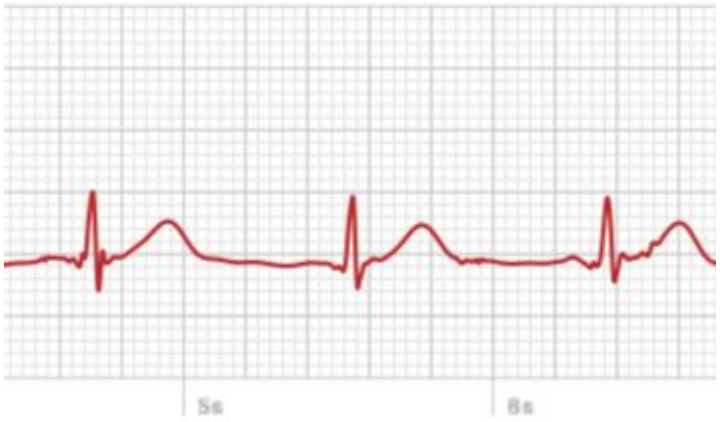
Related Works

- Behavioral Measures
  - PERCLOS
  - Facial actions



Related Works

- Physiological Measures
  - EEG / ECG / EoG



Characteristics to Drowsy Driving

- Researchers found several characteristics linked to drowsy driving [1][2]:
  - Occur late at night (0:00 am–7:00 am) or during mid-afternoon (2:00 pm–4:00 pm)
  - Occur on high-speed roadways
  - Driver is often alone
  - Change in eye blink duration

Possibility of Sensing & Detecting Drowsiness from Driver

- By carefully observing drivers' seat:
  - Drive-aid smartphone applications are prevalent among drivers (ex. Google Maps, T-map)
  - Phones are attached in the place where they don't impede drivers' vision, faced towards drivers at the same time

→ Possible to use front cameras, proximity sensors

Detecting Both Time of Day and Companion

- Utilize the system time available on the mobile phone to detect time of day
- Check if the time of day is between 0:00 am–7:00 am and 2:00 pm–4:00 pm
- During this time period increase sensing interval
- Use the microphone sensor to detect if anyone else is in the car

Driving Location

- All mobile phones current have GPS and accelerometer sensors
- Use GPS and accelerometer sensors to detect when a user is driving and where their location is (check if their driving on high-speed roadways)

Eye Blinking Detection

- Using a time interval, we will record the driver's eyes and count the number of blinks
- Using the Karolinska Sleepiness Scale (KSS), we will determine is the driver is drowsy or wide awake.

Karolinska sleepiness scale (KSS).

Rating	Verbal descriptions
1	Extremely alert
2	Very alert
3	Alert
4	Fairly alert
5	Neither alert nor sleepy
6	Some signs of sleepiness
7	Sleepy, but no effort to keep alert
8	Sleepy, some effort to keep alert
9	Very sleepy, great effort to keep alert, fighting sleep

Expected Challenges

- Power Issue
  - Vehicles retain chargeable USB ports and most drivers connect USB on their phone while driving

    → Able to appropriate the power resource of the phone until battery of the vehicle runs out

- Processing Load
  - Real-time image processing may result overhead

    → With the phone being charged, processing images is not a heavy load

    (Still, your miniature friend is a pretty good computing device!)

- Brightness
  - Capturing image will be impossible if there is not enough light

    → Any suggestions? (Placeholder)

After Detection

- Turn up a music (May not affect driver that much)
- Ring an alarm (May surprise the driver and lead to an accident)
- Call another one automatically (Let driver choose which one to call)
- TTS something like, “Mommy/Daddy, come home safe” (Emotional marketing)
- Connect and interact with automobile CAN(Control Area Network) to enter autonomous driving mode (appliable in long term, cf. Tesla autonomous driving)
- Induce driver to pull up in sideways / rest area
- Induce to swith driver on Buddy system (driving with fellow passenger)
- Report Drowsy driving to company server in case of enterprises like transport comanyrt

Schedule and Role

Advance Mobile Computing Project Schedule		3월				4월				5월				6월	
		1	2	3	4	1	2	3	4	1	2	3	4	1	2
Oh Hyun Seok															
1	Discuess Idea & Make Presentation														
2	Setup Development Enviroment														
3	Read research paper about drowsyness														
4	Create setting page where user can designate the person to call														
5	Utilize android phone call api to make phone call automatically														
7	Work on middle presentation														
6	Detect unanswered phone, reattempt phone call														
8	Testing and debuging														
9	Work on final presentation														
Kang Phil Goo															
1	Discuess Idea & Make Presentation														
2	Setup Development Enviroment														
3	Read research paper about drowsyness														
4	Use android accelerometer to create a scale to determine type of movement														
5	Use accelerometer and use scale to detect movement is driving														
8	Work on middle presentation														
6	Utalize phone GPS sensor to detect current location														
7	Juxtapose google's map with current GPS location to detect on highway														
9	Testing and debuging														
10	Work on final presentation														

Schedule and Role

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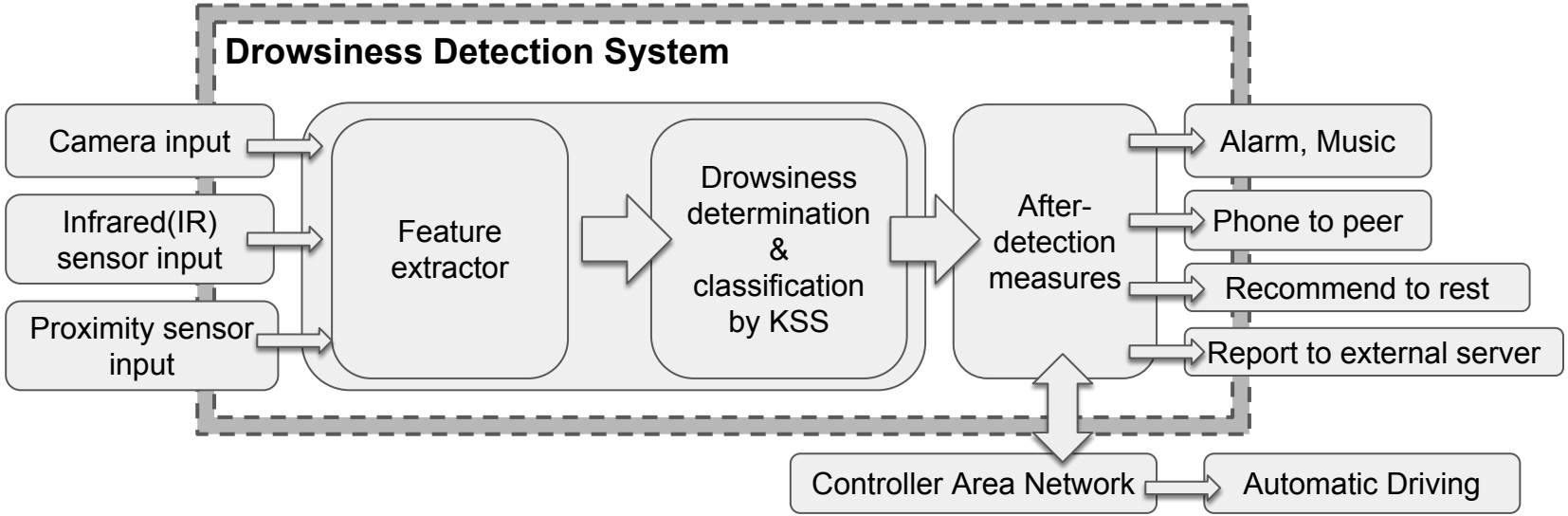
		1	2	3	4	1	2	3	4	1	2	3	4	1	2
Yoon Do Il															
1	Discuess Idea & Make Presentation														
2	Setup Development Enviroment														
3	Read research paper about drowsyness														
4	Use android system thread to poll the current time														
5	Create a class that uses mic sensor to detect people talking														
6	The mic class must be able to ignore music, radio audio														
7	Work on middle presentation														
8	Use the custom class to detect if user is alone in the car														
9	Testing and debuging														
10	Work on final presentation														
Kim Hyun Ik															
1	Discuess Idea & Make Presentation														
2	Setup Development Enviroment														
3	Read research paper about drowsyness														
4	Create a polling system the turns the camera sensor on to capture eyes														
5	Use a image processing system to find eye's in the video stream if camera														
7	Work on middle presentation														
6	Count number of blinks per time period T and determine drowsy level														
8	Testing and debuging														
9	Work on final presentation														

Final Deliverable

Mobile-embeddable drowsiness detection system which inputs sensor data like camera, IR, proximity, extracts feature, determine drowsiness and operates corresponding after-detection measures. This system could also interact with automobile controller area network (CAN) for after-detection measures.



Success Criteria

- Drowsiness detection is successful if sleepiness state estimated from features match actual sleepness state
- ANOVA or paired t-test to determine correlation between features and drowsiness measure(KSS) (Ingre et al., 2006)
  - P-value (t-value significance level) : the smaller, the more related feature to drowsiness
- Classification accuracy for multiple classes of KSS (Hu et al., 2009)
  - K-fold cross validation
  - Confusion matrix
    - Hu et al. got 83%, 86%, 100% for three classes (Alert, Sleepy, Very sleepy) with SVM

Reference

[1] Drowsy Driving and Automobile Crashes. National Center on Sleep Disorder Research and the National Highway Traffic Safety Administration; Howe, TX, USA: 1998.

[2] Ingre M., ÅKerstedt T., Peters B., Anund A., Kecklund G. Subjective sleepiness, simulated driving performance and blink duration: Examining individual differences. J. Sleep Res. 2006;15:47–53.