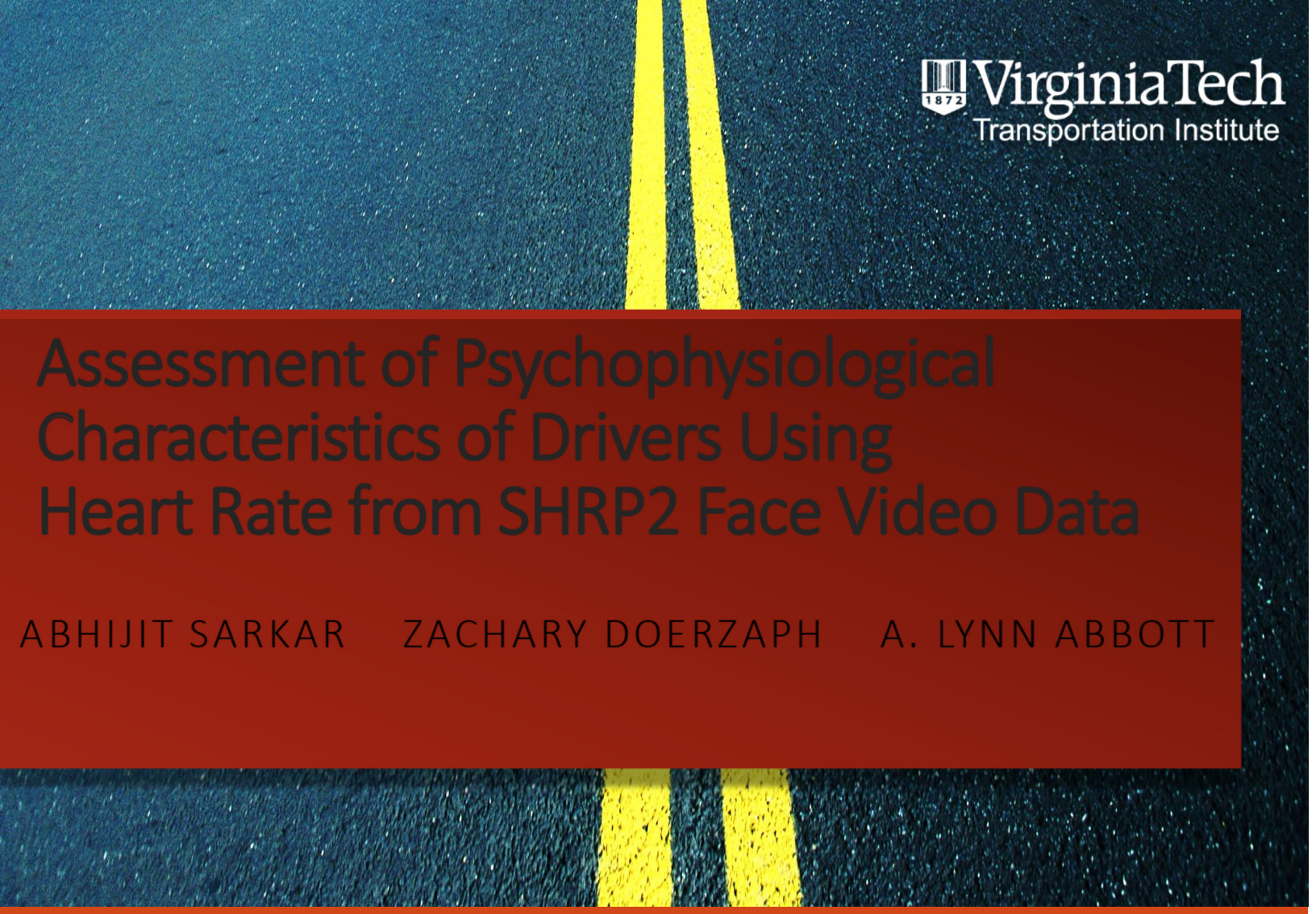


Assessment of Psychophysiological Characteristics of Drivers Using Heart Rate from SHRP2 Face Video Data

ABHIJIT SARKAR ZACHARY DOERZAPH A. LYNN ABBOTT

Background and motivation

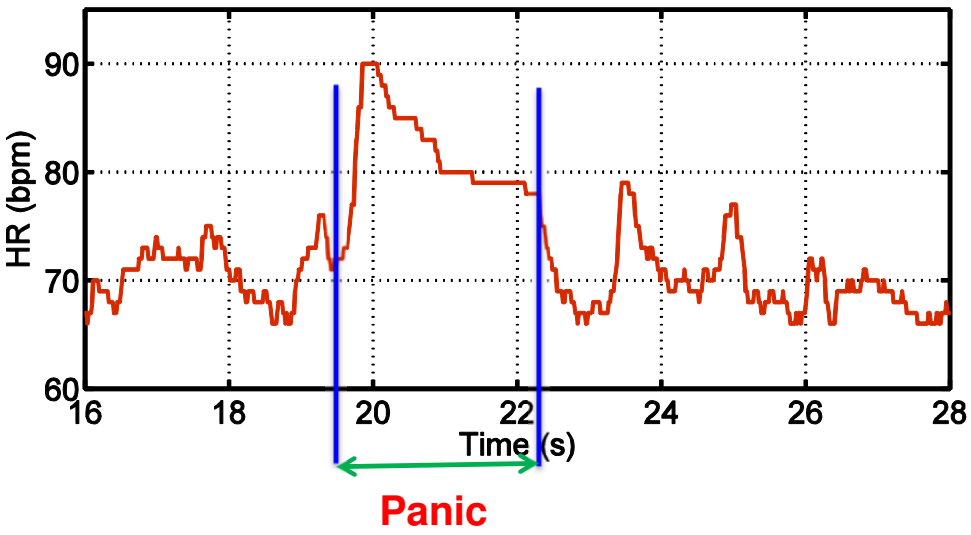
- Drivers' performance and behavior in traffic safety
- SHRP2 naturalistic data
  - Potentiality of video data
  - No direct measurement of physiological variables
    - Blood pressure, heart rate, respiration rate
- Limited work with non intrusive heart rate measurement using naturalistic data

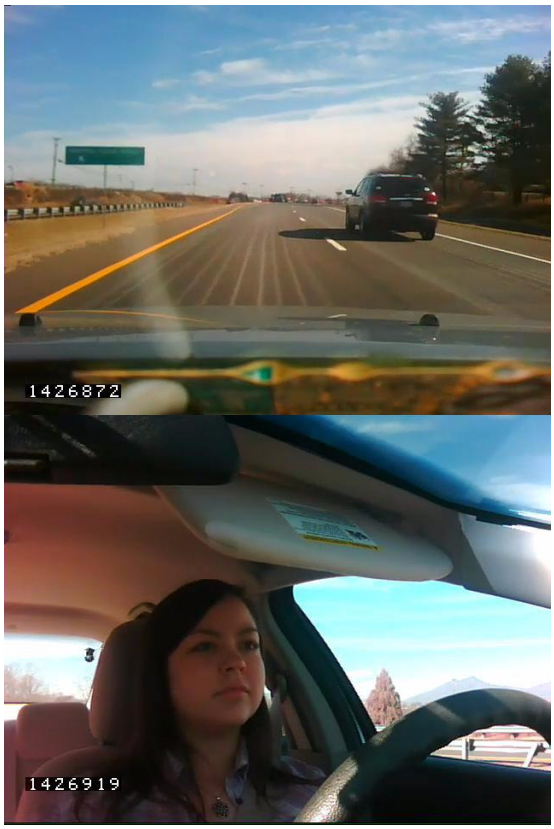
Background and motivation

- The goal is to
  - Extract heart rate from face video
  - Understand the behavior of driver, e.g. cognitive load, panic attack, drowsiness, DUI.
  - Develop automatic video reduction technique
  - Device a tool for future

Heart Rate - What It Reflects

Average heart rate





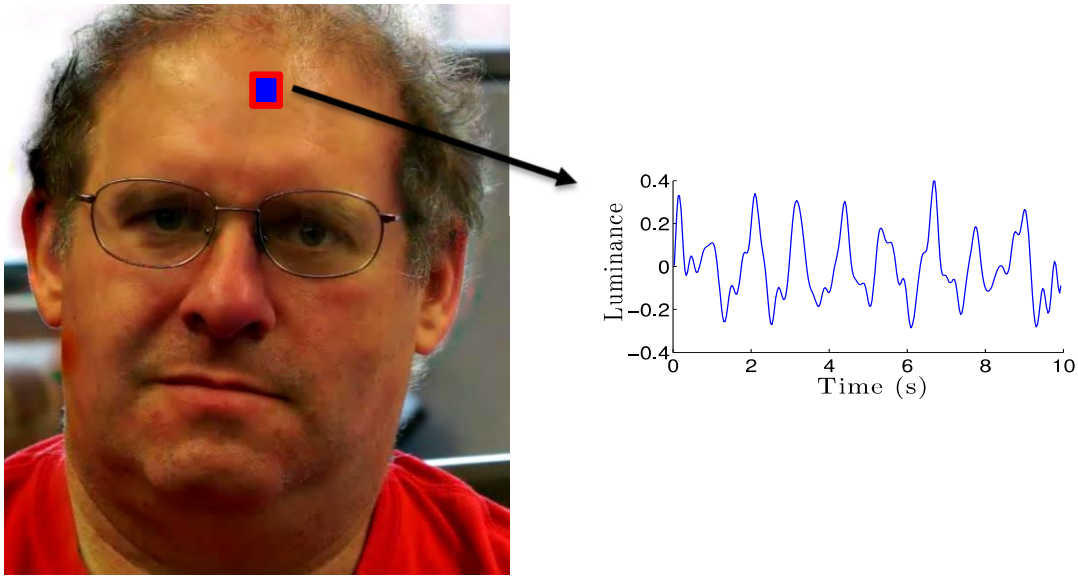
What is Video Magnification

- Blood volume pulses are imperceptible to normal vision

Wu et al. SIGGRAPH 2012

What is Video Magnification

- Video magnification helps to visualize pulse rate



Wu et al. SIGGRAPH 2012

Video Magnification(VidMag)

- Application
  - Fast algorithm
  - Provides average heart rate in restricted condition
- Task
  - Test VidMag in naturalistic condition to extract heart rate
  - Find relation between heart rate and psychophysiological behavior of driver

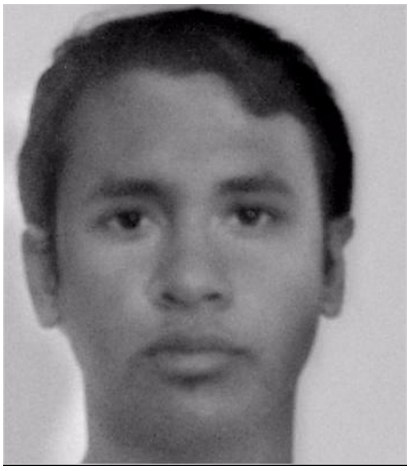
Challenges

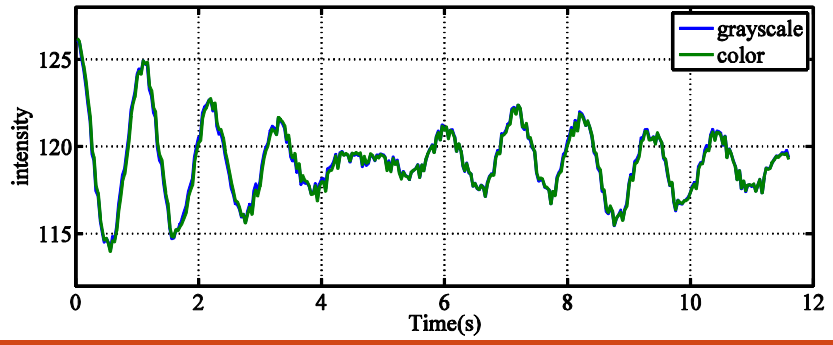
- Constraint from video
  - No color information
  - Low frame rate – 10 to 15 fps
- Naturalistic constraints
  - Natural head movement
  - Effect of ambient Illumination and reflections

Test with Grayscale Video

RGB video

Gray scale video



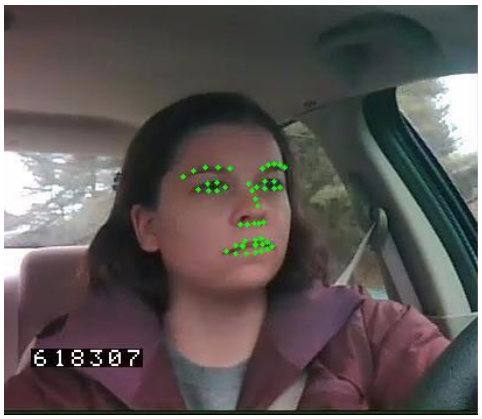


Low Frame Rate

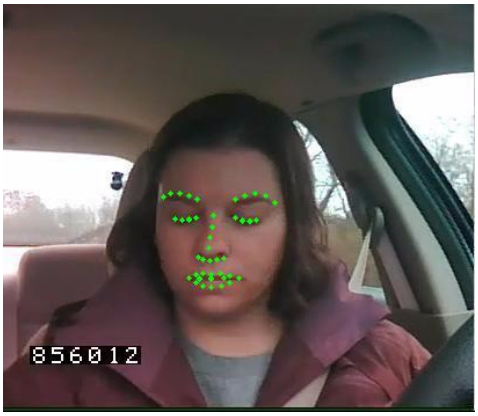
- Nyquist criteria
  - HR ranges from 0.6 to 4 Hz
- Post processing of pulse signals during peak detection
  - Resample to increase HR resolution
  - Smoothing helps eliminate false peak

Natural Head Movement

- More than 80% of the time drivers look forward
- Goal: Automatic selection of video sequence with minimum face movement
  - tracking facial landmark



Below threshold sequence



Above threshold sequence

Xiong et al. CVPR 2013

Validation

- Garmin Forerunner 620 with HR monitor
  - Records heart rate every second
  - Synchronized with MiniDAS GPS time
  - Non-intrusive to naturalistic driving

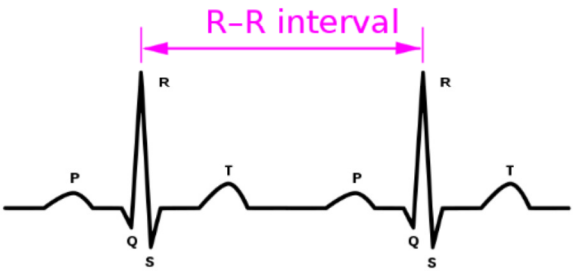
Wrist wearable data recorder

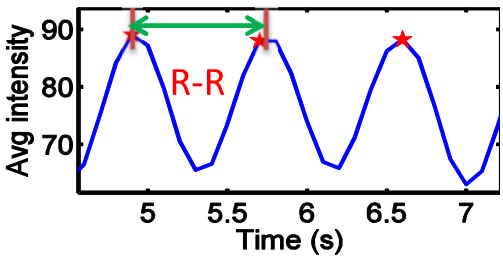
Chest wearable HR sensor

Image : http://www.garmin.com/en-AU

Heart Rate Variability (HRV)

- HRV is the variation of RR intervals in ECG signal





- Reflects the behavior of the sympathetic and parasympathetic nervous system
- Indicates condition of a driver
  - Drowsiness, panic, cognitive load, mental state.
- Open source software available

On going efforts

- Change in illumination

- Inconsistency in different part of the face
- Automatic skin detection
- Validate behavior of interests

Conclusion

- Promises shown
  - Low processing time
  - Matlab platform
  - Face video can indicate instantaneous heart rate with good accuracy
  - This method is nonintrusive to driver performance
  - HRV is a good indicator of the psychophysiological condition of the driver
  - Effective tool on top of kinematic variables

Conclusion

- Challenges
  - Night vision is more challenging, difficult to find faces
  - SNR during night is very low
  - Shadows and change in illumination
  - Sensitive to small movement of face

Questions

Thank you

Acknowledgements

- John Hankey
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- Participants

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Thank you