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Evaluating Driver Fatigue Measures

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SIDNEY KIMMEL MEDICAL COLLEGE

Evaluating Driver Fatigue Measures

Mia Belovsky

Stanton B. Miller MD



Jefferson
Thomas Jefferson University

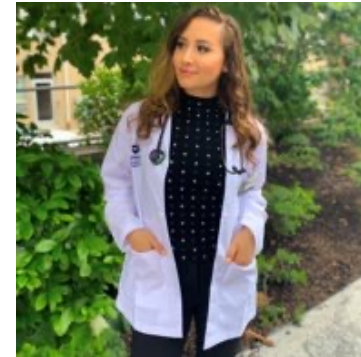
Our Team

Stanton B. Miller, MD, MPH

- Clinical Associate Professor of Surgery & Emergency Medicine
Executive Director, Jefferson Center for Injury Research and Prevention (JCIRP)
Trauma Advocate and Liaison, Division of Acute Care Surgery
- Jefferson Medical College - 1980
MPH: Johns Hopkins University - 2003

Mia Belovsky

- SKMC Class of 2024
- Penn State University grad
- PEL+ Co-Director
- Interested in digital health, clinical informatics and data science
- Not quite sure about a specialty yet!



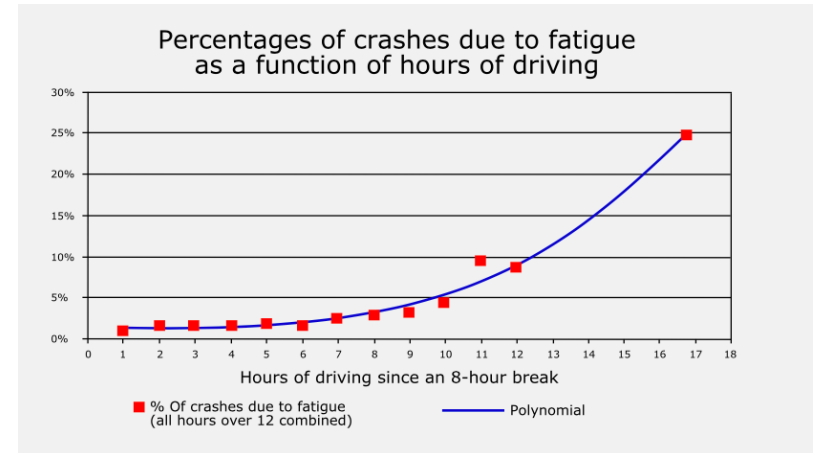
Case Study



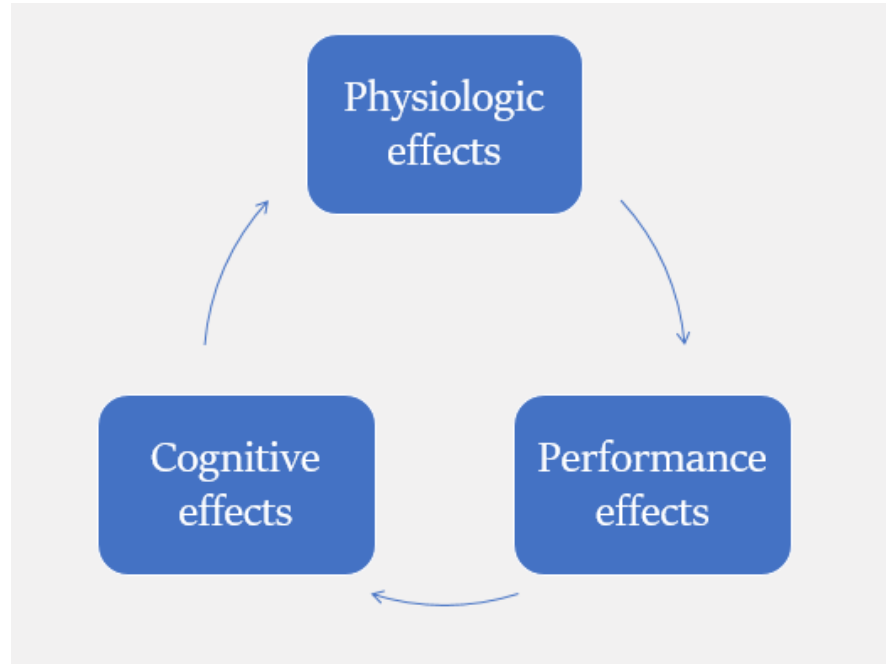
- This is Sam, a resident physician
- Commutes to work by car every day
- Works 36 hour shifts
- What is the riskiest part of Sam's day?
- *His commute.*

Background

- Driver fatigue is the leading cause of accidents in the United States
- 31% of drivers suffer from driver fatigue
- 328,000+ accidents
- 109,000+ injuries
- 6,400+ preventable deaths/year
- 3x more likely to get into an accident
- Widespread effects on the body



Background



Goals

1

Explore current driver fatigue sensing technologies

2

Evaluate most effective way to measure driver fatigue

3

Develop a system that can accurately monitor driver fatigue

Literature Search

Search

- PubMed
- Google Scholar

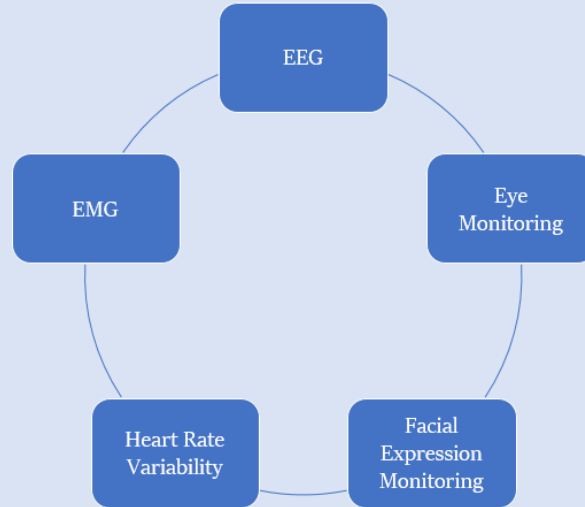
Inclusion
Criteria

- Adults, automobiles/trucks, quantitative validation, device inside vehicle, English, last 5 years

Total

- 39 PubMed articles
- 147 Google Scholar articles

Driver Fatigue Measures



- Others: salivary cortisol, steering wheel angles, respiration signals, lateral lane position variability, posture, vehicle acceleration

Driver Fatigue Measures: Accuracy

EEG: 73.65%-98.6%

*Eye Movements:
84%-99%*

*Facial Movements:
84.89%-97.06%*

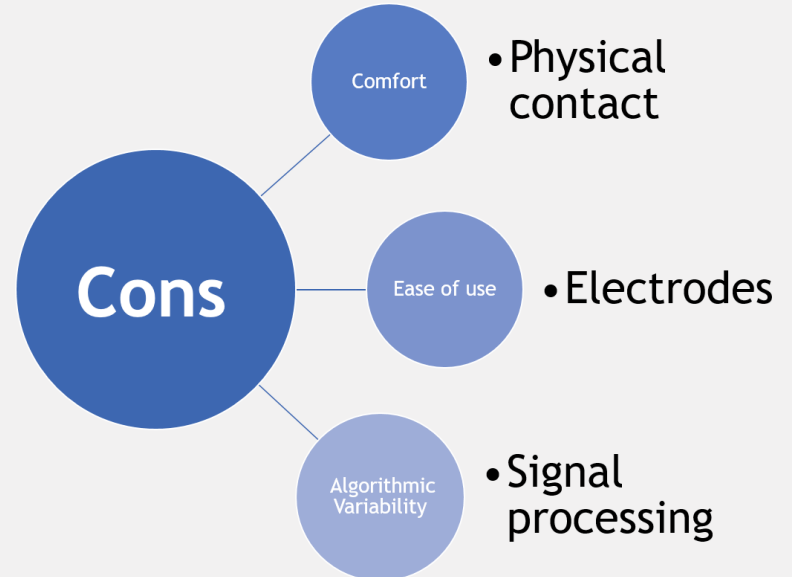
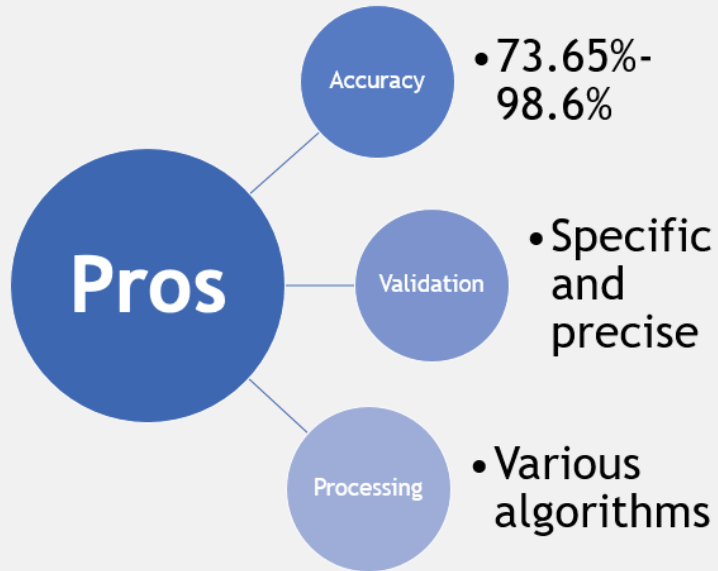
*Heart Rate
Variability: 63%-
96.6%*

EMG: 90%

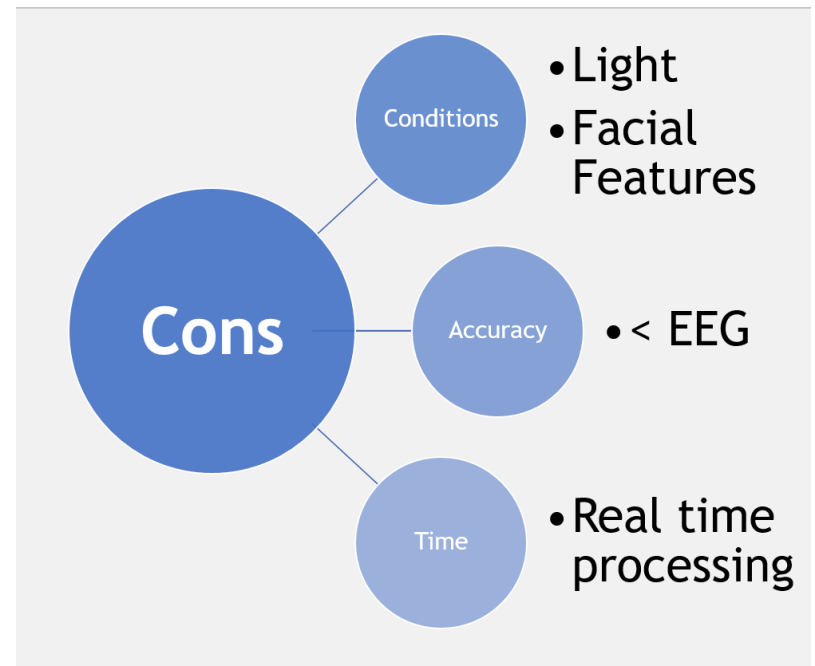
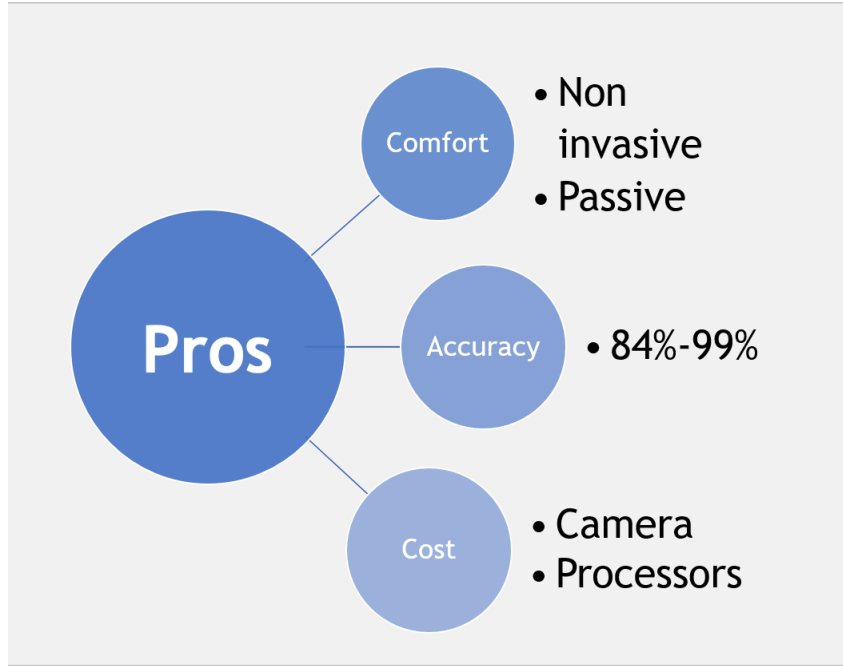
*Motion Sensors:
78.01%-90.4%*

*Salivary Cortisol:
<0.05 Correlation
to PERCLOS*

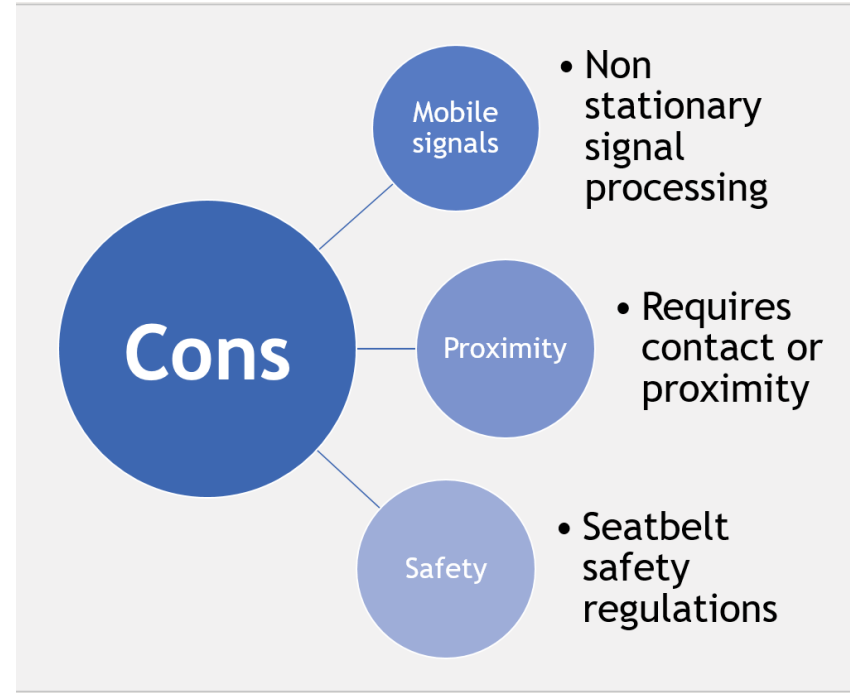
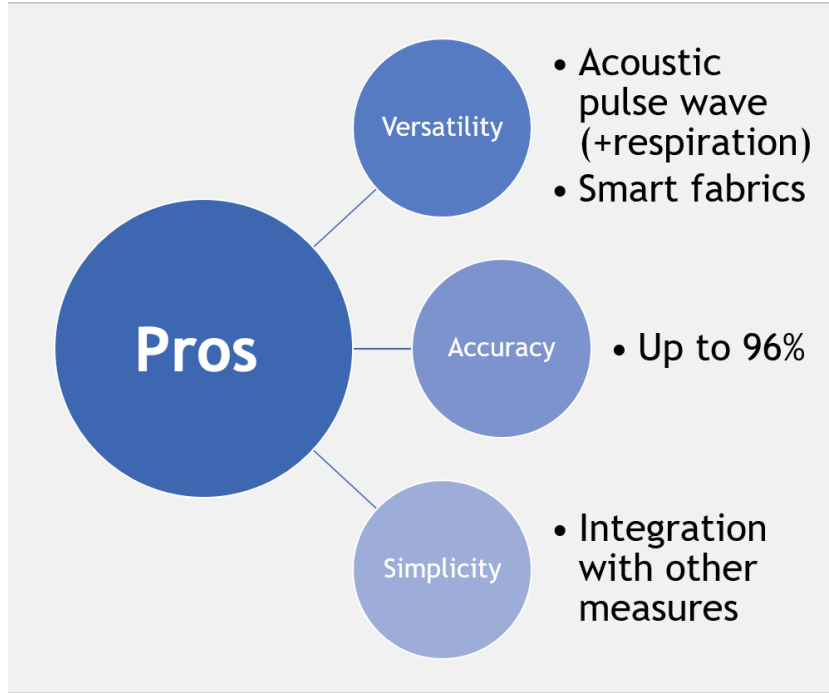
EEG



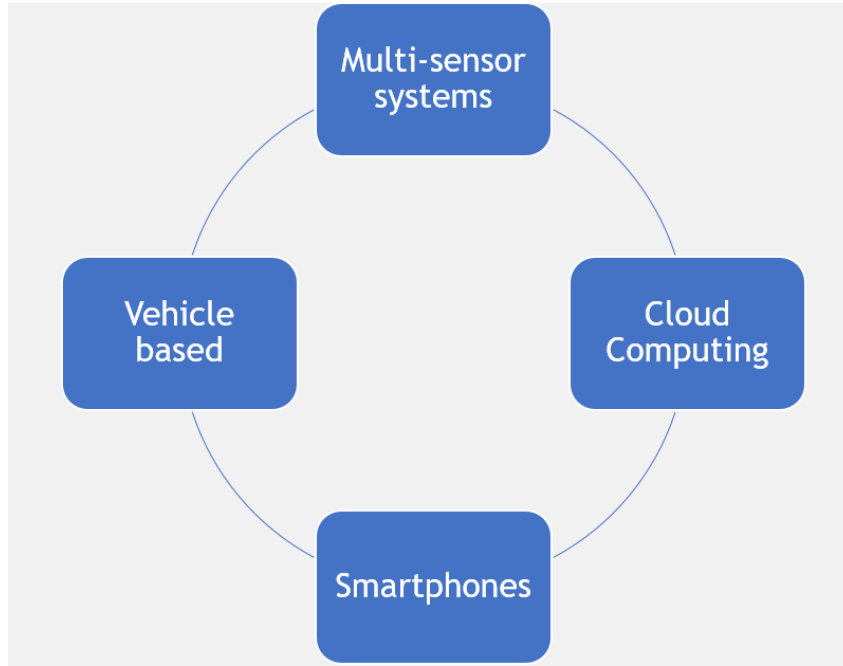
Facial and Eye Monitoring



Heart Rate Variability/ECG



Current Trends



- Patent Search:
 - 1976-Present
- Fatigue AND seatbelt: 307 results
- Drowsiness AND seatbelt: 196 results
- Total: 503 patents

Current Trends

- **Single sensor:**

- Infrared wave eye sensors
- Lane detection systems/Driving analytics/Vehicle environment detection
- Facial detection via neural networks
- Head position via camera
- Force on steering wheel
- Wearable devices that communicate with the car

- **Multi-sensor:**

- Heart rate + motion + weight sensors (seatback)
- Pressure sensor + pulse rate + hand location + vehicle sensors (steering wheel) + visual and vibratory alarms
- PERCLOS + driver metrics
- Pupils + lane departure via camera
- Vital sign detection device + image detection device + vehicle deviation detection

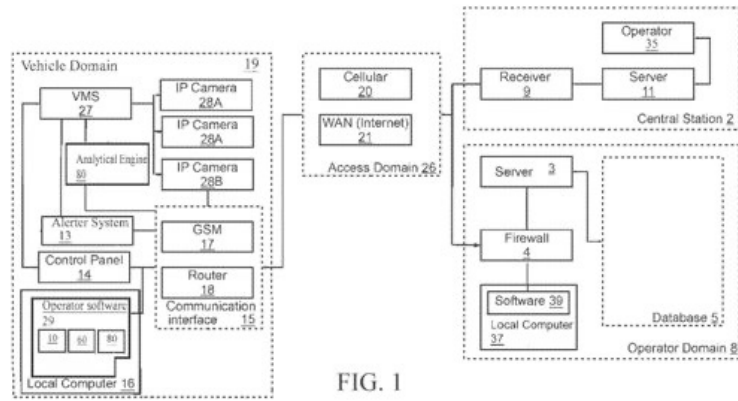
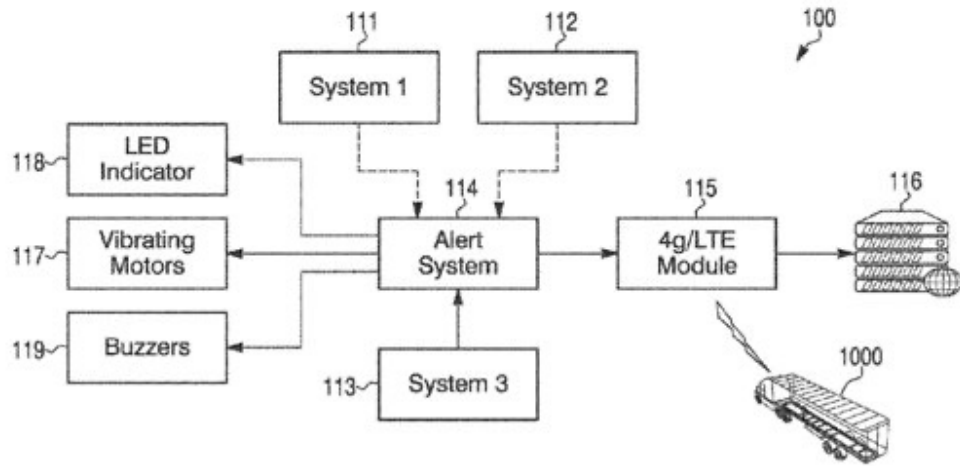
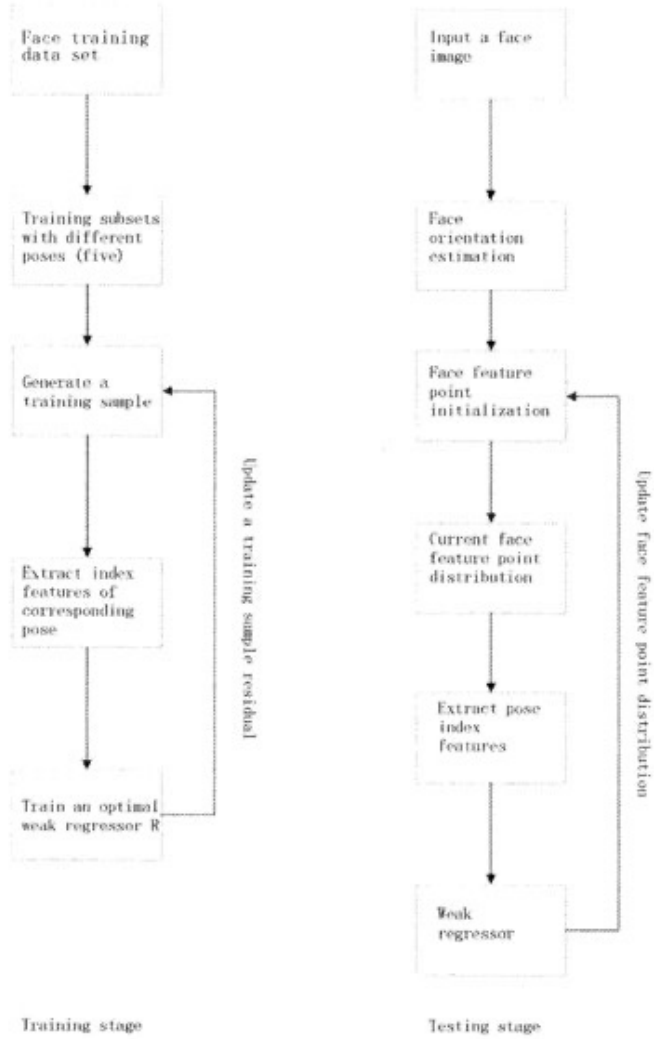


FIG. 1



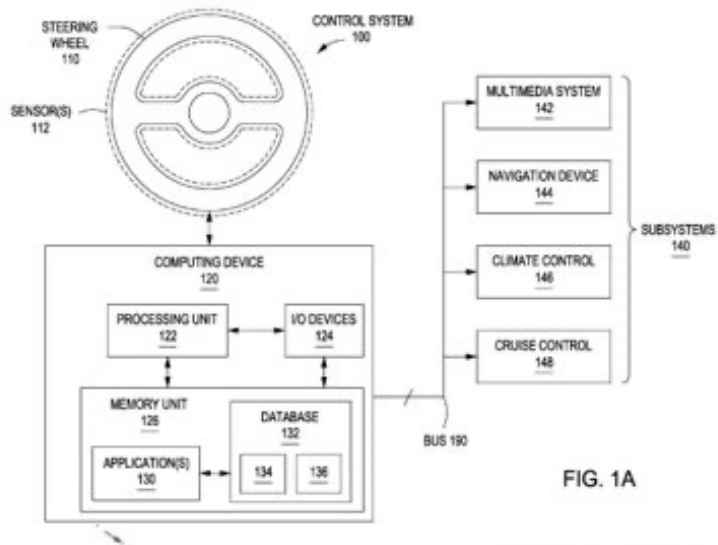


FIG. 1A

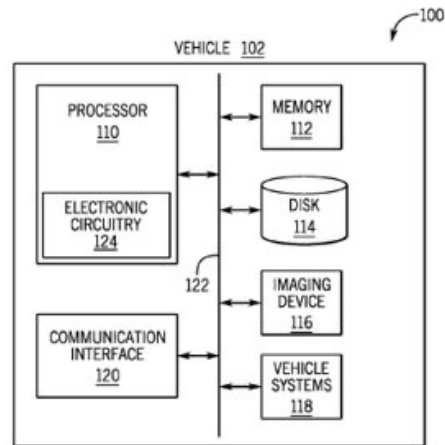


FIG. 1A

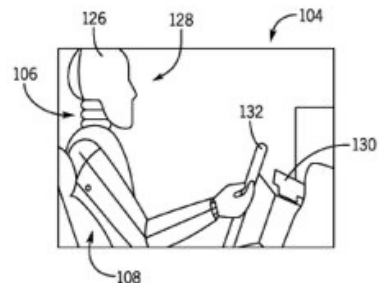
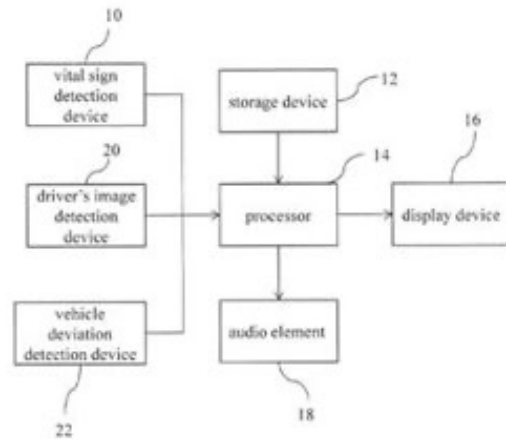
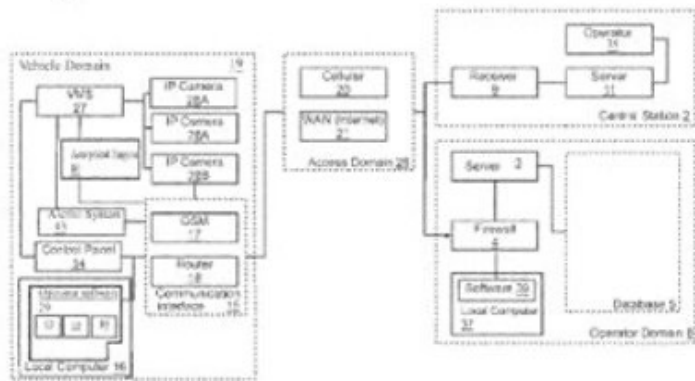


FIG. 1B



Goals for a new fatigue detection device

Accurate

Passive

Noninvasive

Cheap

Non-bulky

Real-time computing abilities

Previous Seatbelt Strain-Gauge Design



SEAT BELT WITH SENSOR

FIG 1

DROWSY SLEEP - SENSOR ACTIVATED

FIG 2

SENSOR WITH CONTAINED CIRCUITRY

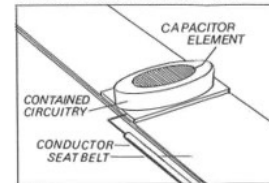


FIG 3

SENSOR WITH REMOTE CIRCUITRY

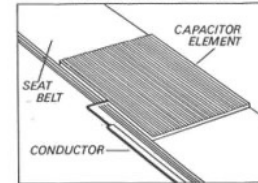
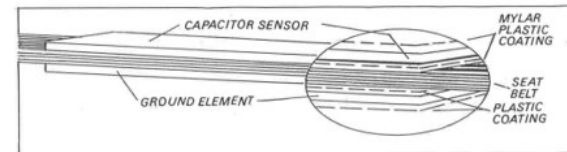
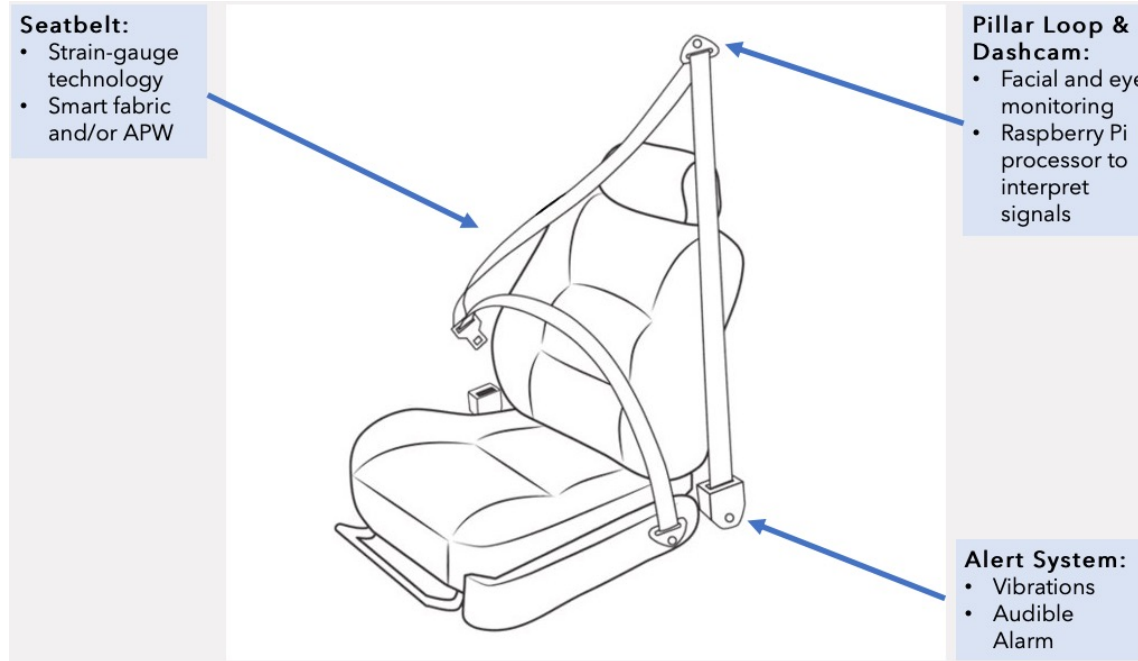


FIG 4



Our New Design



Proposed Workflow



Next Steps

- Smart fabrics v Acoustic Pulse Wave
- Camera specifics
- Algorithm selection
- Other sensors

Sources

- <https://trafficsafety.ny.gov/drowsy-driving-statistics>
- <https://www.nsc.org/road-safety/safety-topics/fatigued-driving>
- <https://www.nature.com/articles/s41598-019-55599-5>
- <https://www.theguardian.com/healthcare-network/2016/jul/26/two-in-five-doctors-fallen-asleep-wheel-night-shift>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2656292/>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1978335/>
- ***Full list of sources used in literature review available upon request***

Patents

- [illegible]

- Questions?

