



Development of a smart vest for real-time measurement of physiological data

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Outline



Background

Wearables

CSEM's smart vest

Live demonstration

Conclusion

Background

- Many safety critical domains rely on human operators (**Air traffic control, Aviation**, Maritime, Rail, Military, Medical, etc.)
- Need to know when human operators are approaching the **edges of acceptable performance**, e.g. when should automation take over?
- One way to track human operators' performance is to **monitor significant physiological signals**.
- Equip operators with **wearables containing sensors**.
- **Evaluate** measured signals **and alarm in critical situations**.



Wearables

- Sensor-equipped «clothing»
- **Glasses** which monitor the eyes
- **Chest belt** which records heart activity
- **Bracelet** which measures body activity, heart rate
- **Shoes** which record running efficiency
- **Comfortable, inconspicuous**



CSEM's smart vest



- **1-lead electrocardiogram (ECG):**
 - Heart rate
 - Heart rate variability
 - ...
- Trans-thoracic **bio-impedance**
 - Breathing rate
- **Skin temperature**
- **Activity**
 - Posture: Sitting/Lying/Standing
 - Walking/Running/Rest
 - Steps/Cadence
 - Energy Expenditure
- **Photoplethysmography (PPG)**
 - SpO2
 - BP
 - ...



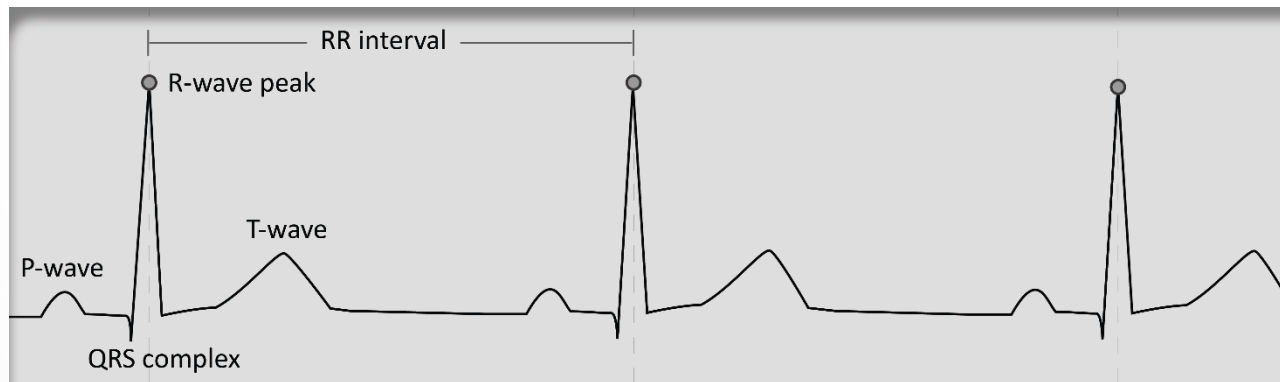
Live Demonstration

Project #6
HUMAN
PERFORMANCE
ENVELOPE



Live Demonstration

- Parameters to watch:
 - Heart rate
 - Heart rate variability
 - Breathing rate



Conclusion

- In FSS, monitoring relied mainly on **cardiovascular signals** such as heart rate and heart rate variability (both **extracted from ECG**).
- CSEM's sensor vests measure **more physiological signals**:
 - Breathing rate
 - Skin temperature
 - Activity
 - PPG (SpO2, blood pressure, ...)

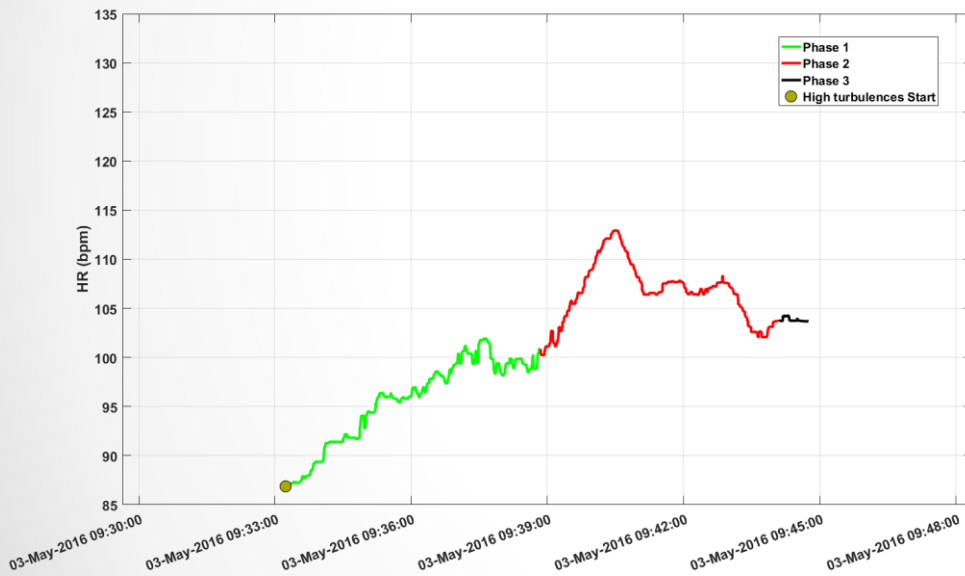
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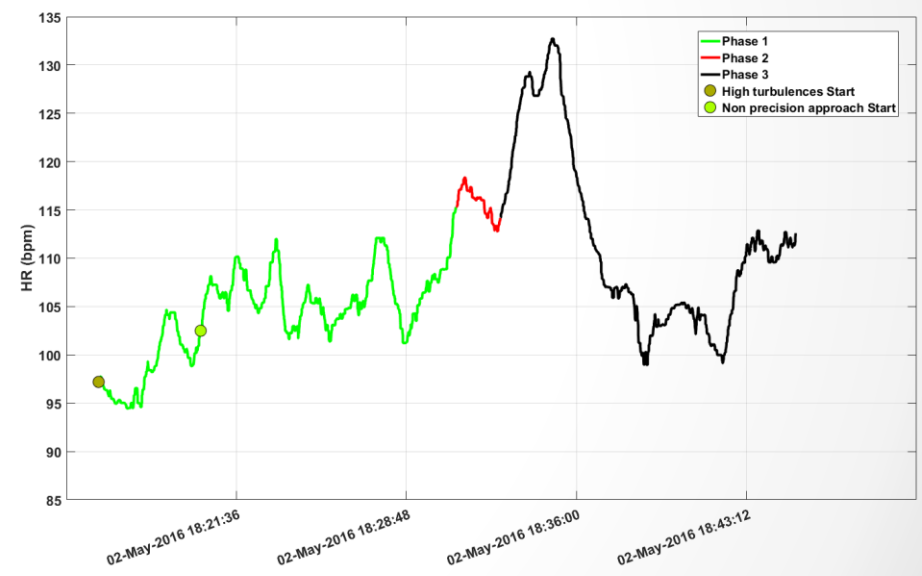
Thank you

Results on a single pilot

Run 3: High workload



Run 4: Very High workload



Conclusion



- Physiological measures such as HR, SDNN, HF, LF and VLF can be sensitive to an increase in workload and/or stress.
- Run 6 (High/reduced SA) was very often not significant to the baseline.
- HR and SDNN were particularly sensitive to the increase in workload.
- HRV features derived from the spectral analysis (HF, LF and VLF) showed a significant response to the increase of stress as well.
- Normalization of the HR is important in the group analysis. However, a good “quality” of the baseline is important to obtain reliable results.