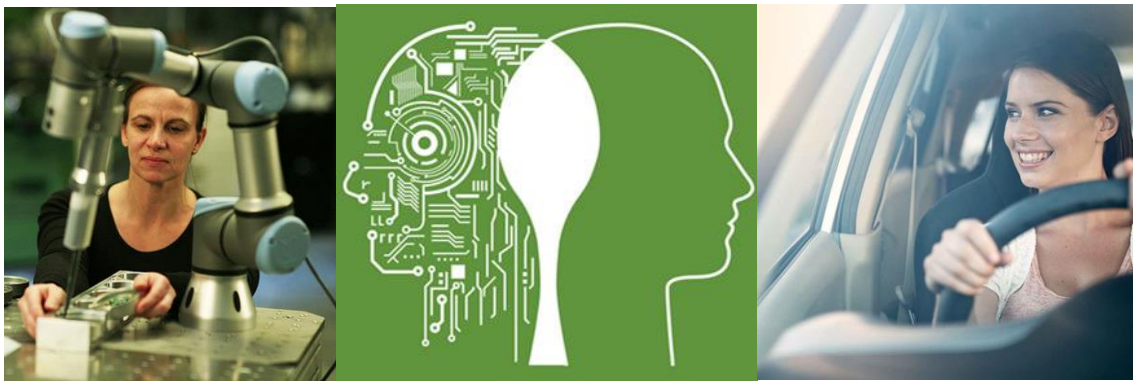
MSc Project Description
Supervisor: Pinar Boyraz Baykas (PhD, Assoc. Prof.)
Industrial Partner: Veoneer / Annika Larsson (PhD, Senior Researcher)
Project Title: Design and integration of an open-source human intent-recognition system for safety-critical human-machine interactions and shared control
Background/Problem Definition

Most of the automation systems nowadays require a co-operative interaction between human and machines (i.e. collaborative robots, partially automated vehicles). The interaction patterns between different levels of automation in the machines and the ever-adapting human is still open to investigation. The behavioral changes and adaptation to automation systems can be examined in terms of cognition, perception, sensory-motor or control perspectives. In designing automation or control systems, engineers should not only consider the efficiency but also the overall safety of the system. In this MSc project, to facilitate the safe design of the co-operative human-machine systems, a human intent-recognition system will be designed and integrated based on off-the-shelf, low-cost devices such as eye-trackers, open brain-computer interfaces and any type of interaction/control signals between the man-machine interface (i.e. steering and brake/gas pedal in driving context). The aim is to integrate the devices into a multi-modal data acquisition platform and design an algorithm to recognize the intent of the human in relation to collaborative task (i.e. driving a partially automated vehicle or working with a co-bot).



Images: Courtesy of Robotiq Blog, Frontiers in Robotics and AI, and Australian Driver-Vehicle Services

Research Methodology

Expected Outputs

1. Selecting the components of a low-cost platform based on the interaction and task
2. Integrating eye-tracker, open computer-brain interface and ad-hoc sensors related to the task and selected environment (automated-vehicle or co-bot).
3. Identification of drawbacks with existing metrics and suggestions of new metrics after cluster analysis and probabilistic modeling.
4. Based on findings (correlation between metrics and analysis of metric change vs time) a driver attention tracker/ internal state recognition system can be suggested. This system can become part of a shared-control algorithm to indicate (i) the internal state of the driver so that the automation system can be re-adjusted/modified, (ii) the level of 'uncertainty' from the driver in the input to the shared-control/combined system to determine the level of disturbance rejection by the system.

Number of Students: 2

Work-distribution: Student-1 will be responsible for selecting the components and integrating the low-cost platform and Student-2 will be designing the human-machine interaction set-up (a mock-up PC-based automated system is also acceptable). Both students will analyze the data and formulate mathematical/quantitative models for intent recognition and uncertainty level quantification in shared-control structure of the designed HMI set-up.

Requirements: Students with background in Mechatronics, Automotive, Complex-Adaptive Systems and Bio-medical Engineering will be preferred but others are welcome to apply. You need to be comfortable using MATLAB and should enjoy working on system-integration and data analysis.