Cars, Drivers and the Road

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Outline

- Semi-Autonomous Vehicular Control using Driver Modeling
- Driver Modeling as a function of human body parameters as well as the environmental influences
- Modeling the micro-scale traffic situation as a network of heterogeneous autonomous, semi-autonomous and driver driven cars
- References

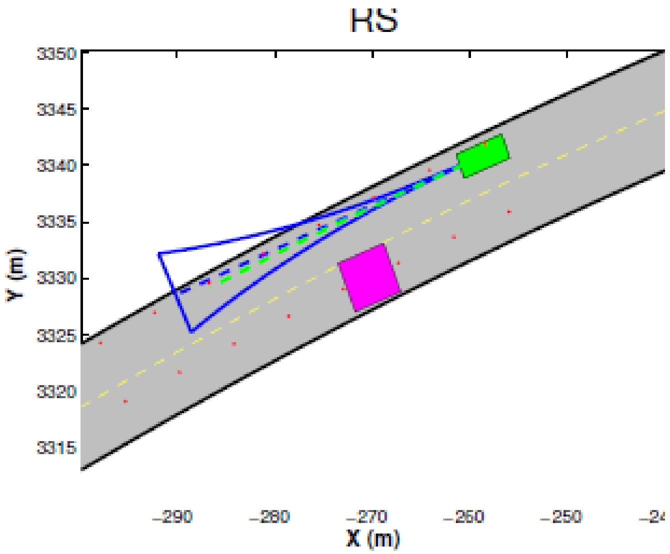
Semi-Autonomous vehicle system

- This is the case when the driver and the car share the control of the vehicle.
- The assumptions are: we have the model of the car and we also have model of the driver.
- The interaction between the car and the driver is modeled via Hybrid System.
- We compute the reach set (the safety region) of the car based on the situation on the road and modify it via the model of the driver.

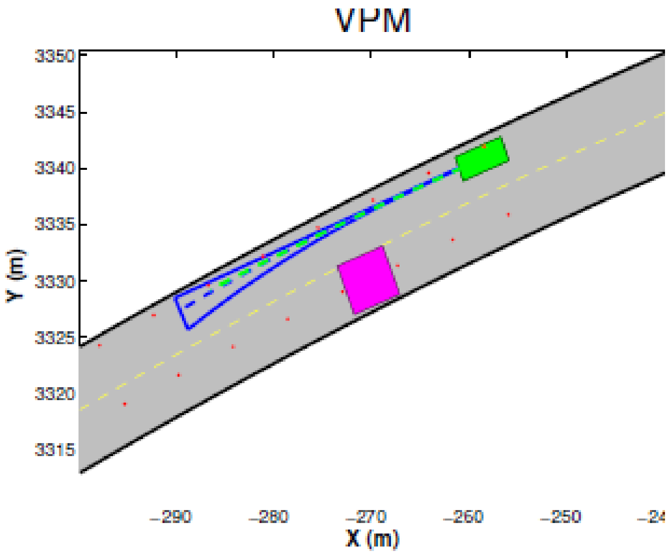
Vehicle model is given

- We assume that we have predictive controller (VPM) for the vehicle and a constraint function that describes the safe part of the environment where the vehicle travels. For that we use vehicle intervention function (VIF).
- The driver is described by state function and the evolution of the driver’s positions of joints
- The semi-autonomous architecture treats the driver’s input as a disturbance ,constructs the Reach set of the vehicle and intervenes whenever the vehicle path intersects with an obstacle. Unfortunately this set is too big and hence we need to constrained it by empirical evidence.

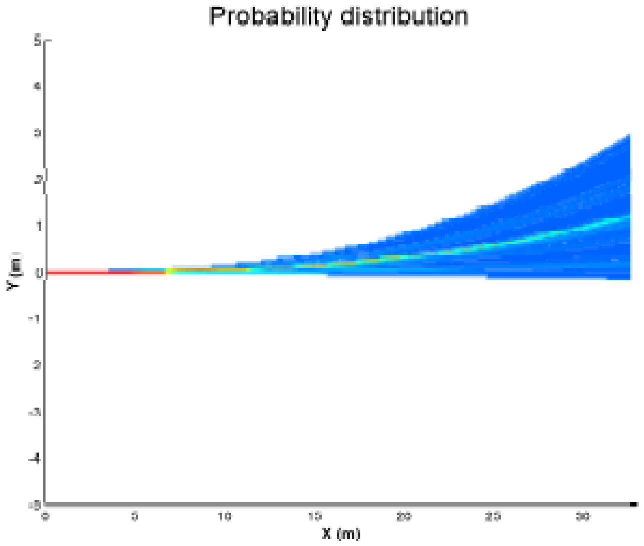
RS=Reach set VPM=predicted safe trajectory



(d) Curved Road and Attentive with Obstacle

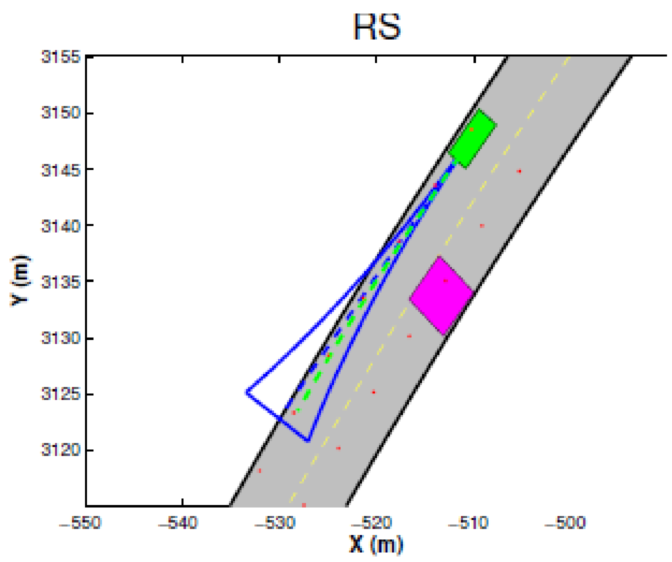


(e) Curved Road and Attentive with Obstacle

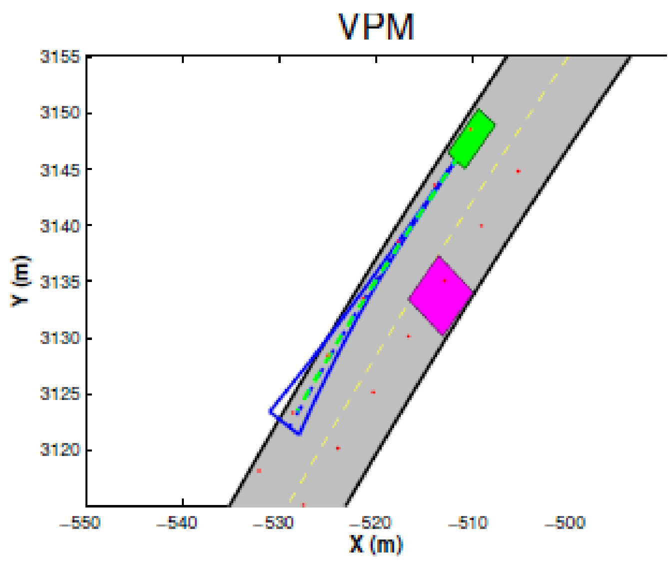


(f) Curved Road and Attentive with Obstacle

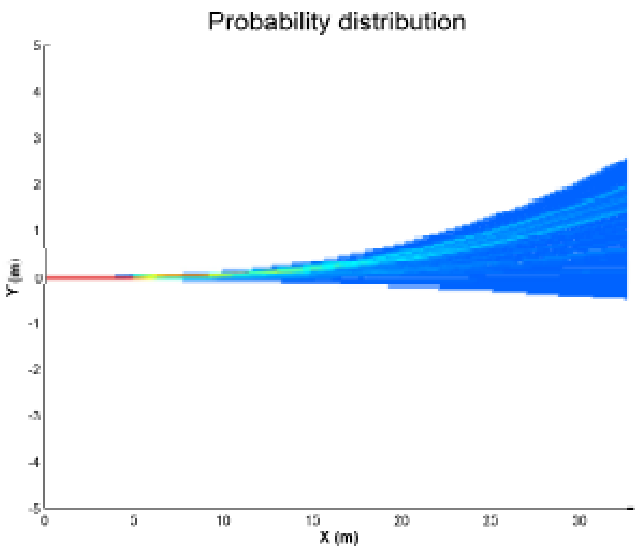
Same as previous figure but with driver distraction



(j) Curved Road and Distracted with Obstacle



(k) Curved Road and Distracted with Obstacle

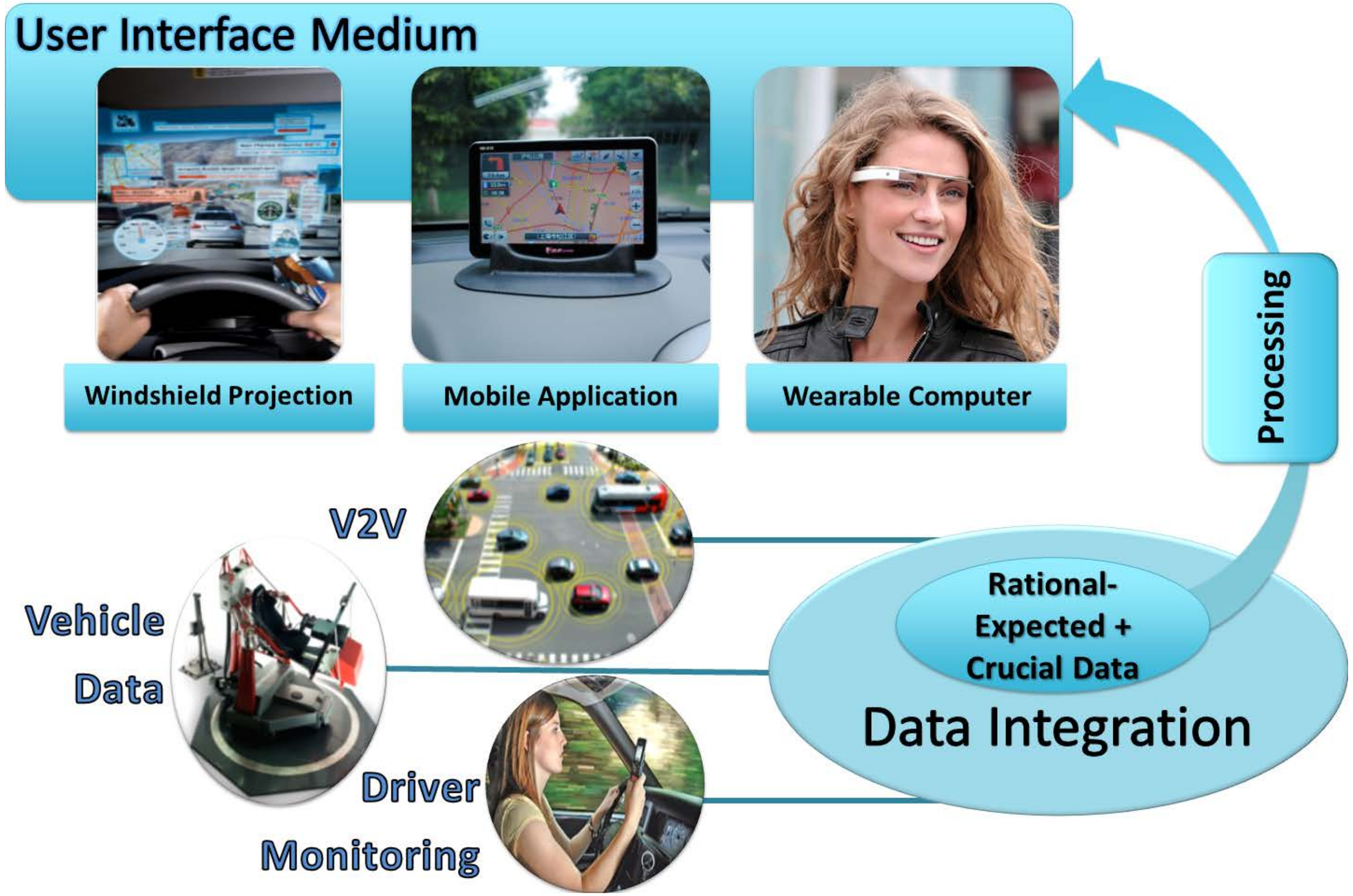


(l) Curved Road and Distracted with Obstacle

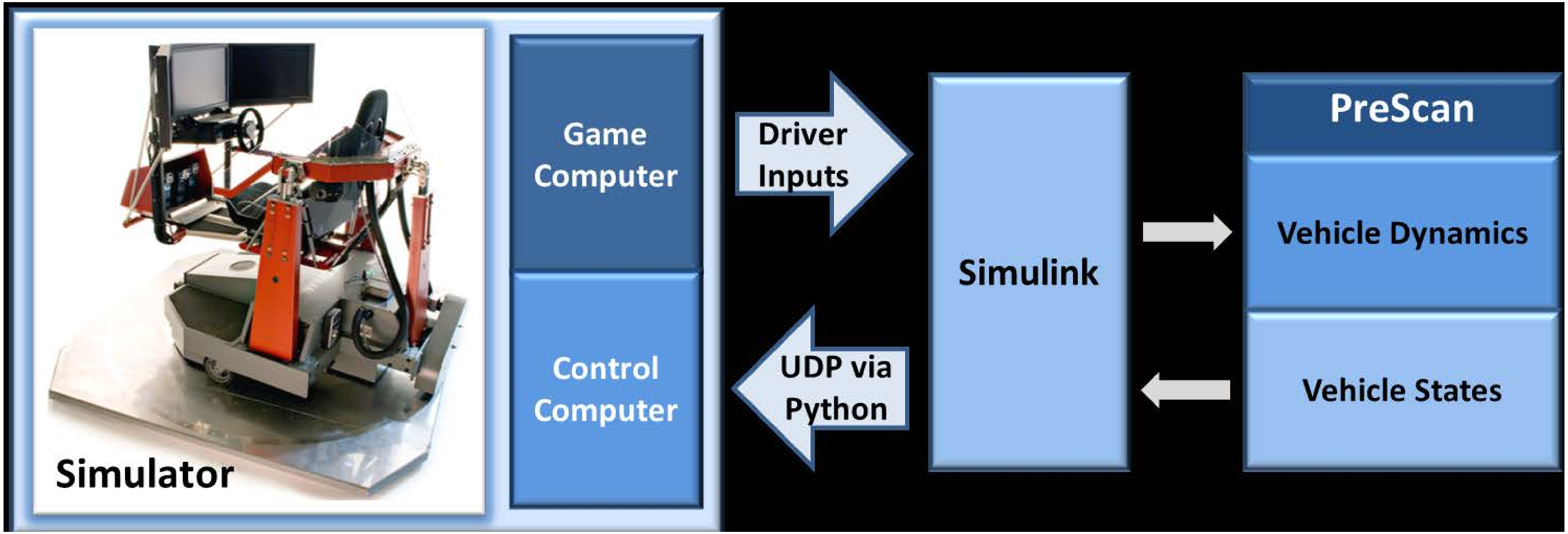
Heterogeneous traffic

- Consider a micro-scale situation of two lanes and the topology of four cars but the cars are mixed mode, that is :
- Car driven by driver only;
- Semi-autonomous car (control of the car is shared between the driver and self driven mode)
- Autonomous car
- The questions are: how to model the interaction amongst these entities, what to communicate and how to assure safety.

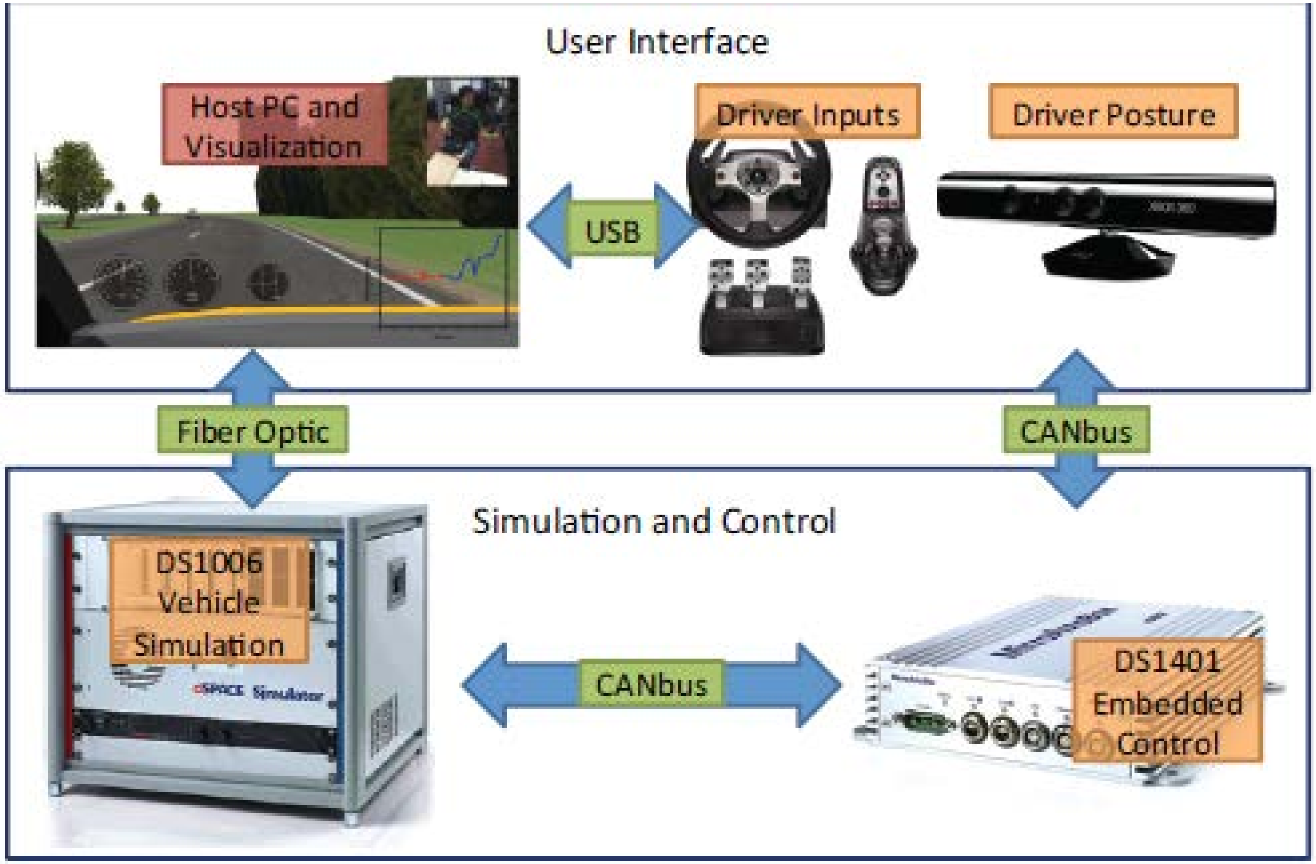
Schematic diagram of our test bed



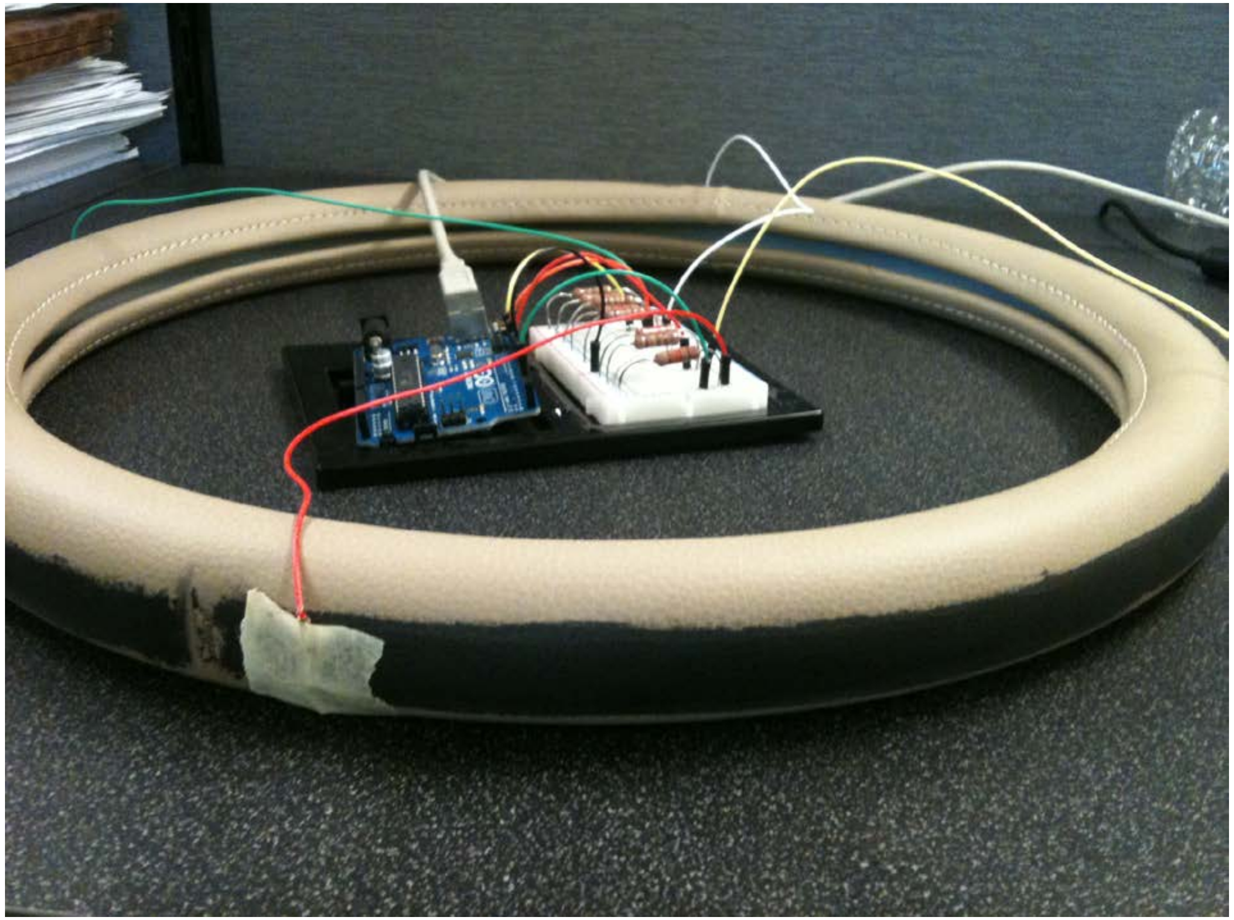
The actual setup



More Details.



Contact sensing on the wheel



Open Problems

- While we believe that the low level controller of the vehicle is a solved problem, the challenge still remains in modeling the driver , and its intent and decision making in complex road situations.
- There are many ways to measure the driver state but the question is what is the necessary measurement and its processing in order to be useful to act in real time (less than a second).
- The road (non-urban)situation and the subsequent actions have been classified , as straight driving and keeping distance from other cars, change lanes ,avoiding obstacles, merging into the traffic, sudden stop.

Open Problems, cont.

- In the case of heterogeneous traffic situations with mixed car modes on the road, the further questions are when and what to communicate between the driver, driven car and the autonomous cars.
- What and when to communicate amongst the autonomous cars only.
- Are there rules and principles that can be used as objective functions
- To guarantee the safety of the overall system.

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