

**Ph.D. in Information Technology:
Berretta, and Lucchetti Final Dissertations**

DEIB Conference Room

January 13th, 2016

2.00 pm

First Ph.D. presentation and discussion:

Daniele BERRETTA – XXVIII Cycle

“Modeling, design, control and validation of a full hybrid electric bicycle”

Advisor: Prof. **Matteo Corno**

Abstract:

The Thesis deals with the project and design of a full hybrid electric bicycle. The designed novel algorithm manages the main power source (the cyclist) and the secondary power source (the battery pack) with the aims of globally decrease cyclist effort and sustain the charge of the battery pack being independent from the grid. The Thesis is structured into two parts: the first part describes the hybrid electric bike algorithm design and validation while the second part deals with some features that allow the assistance algorithm to work properly and to improve its safety. The modelling and validation of a complete electro-mechanical model of the bike and a control-oriented analysis of the cyclist metabolic efficiency guide the design of the control algorithm. The idea is to recover energy from the cyclist when he is most efficient and then return it during low efficiency pedaling. A lot of simulations support the designing and tuning phases. The proposed system is extensively tested on several users, showing that it can achieve a 25 % improvement in equivalent cycling efficiency, and a reduction in the peak Heart Rate and fatigue during urban cycling. In the second part an innovative road grade Kalman filter estimator and a cyclist on-seat-detection algorithm are developed to improve the charge-sustaining algorithm performances and safety.

Second Ph.D. presentation and discussion:

Alberto LUCCHETTI – XXIX Cycle

“Analysis and Development of Intelligent Systems for Safety Improvement in Vehicles”

Advisor: Prof. **Matteo Corno**

Abstract:

Traditionally, road safety was related to vehicles' dynamics control. With the introduction of advanced driver assistance systems (ADAS's), safety paradigms changes in their definition and are not more only related in the considered vehicles' dynamics control, but new type of interactions have to be considered: (i) vehicle to environment, (ii) vehicle to vehicle and (iii) vehicle to driver.

For the three case studies, was considered a specific problem which belongs to the considered interaction. The main advantages of being linked with the road infrastructure is the notification of unexpected events. Automatic collision notification systems are the first commercialized system which implements a interaction between vehicles and infrastructure (represented by emergency authorities). In two-wheeled vehicles there is a lack of these device. In order to avoid on board hardware installation and to make the procedure as general as possible, a common new generation smartphone was used as measurement and control unit.

The study of interaction between vehicles is the first step in order to develop ADAS's. The main problem of these systems is the definition of the use case. For traditional control systems is more easy to define the working condition and there is no need to define the environment reaction because the actors are only the driver and the vehicle. In ADAS's development, there isn't a clear definition of the control objective and there are many participants to the driving scene because it is needed to taking into consideration also others vehicle behavior. The proposed method is a tool-chain for the extraction of driving scenarios from real long run acquisition.

Lastly, is studied the vehicle to driver interaction. Traditional systems consider the driver only as the input reference generator. With the growth of ADAS's, this interaction becomes bidirectional, thus also the vehicle can infer information from the driver and use it for adapt its behavior. With the possibility of informing the driver, with haptic system or simple indicator, it is also possible to advise the driver of the wrong maneuver and in a implicit way improve users' ability. In this context, by considering an electric pedal assisted bicycle, it is developed a procedure for detecting and penalizing.