Information and Communication Technologies

Collaborative Project

"V-Charge"

Autonomous Valet Parking and Charging for e-Mobility

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EXECUTIVE SUMMARY:

The V-Charge Summer School "*Perception and Planning for Autonomous Driving*" was held on July 7-10 at ETH Zurich

The School offered students with high level technical lectures, covering most of the Intelligent Vehicles topics, exercise sessions in lab and also invited talks, taken by some renowned authorities in the ITS community.

The V-Charge Summer School was advertised through the principal robotics mailing list, such as EURON, Robotics-worldwide, as well as the IEEE-ITS mailing list. In addition, each V-Charge partner publicized the School within its organization; in particular academic partners promoted the School by their PhD students, Post-Doc and undergrads.

Registration deadline was on April 22th, 2014. We have got 69 applications mainly from Europe, Asia, Middle East and North America. The great majority were PhD students, in particular:

- 5 already PhD graduates (Post-Doc);
- 42 PhD students;
- 5 MSc graduates, not PhD student;
- 19 BSc graduates, currently MSc student.

In the end only 50 students were accepted. Given the educational vocation of the School and, at the same time, the high technical level of the lectures and invited talks, selection was made following this priority:

1. PhD students
2. Post-Doc
3. MSs graduates
4. Under graduates

Especially for undergrads, the selection also included a deep CV screening, evaluation of the transcripts of exams grades and motivation letter. Also the study field was considered, giving priority to Robotics and Automotive fields. ETH provided basic accommodation for all participants in a remodeled former air-raid shelter in the basement of the Computer Science building. Breakfast and coffee breaks were included as well.

The level of lectures and invited talk were comparable to IEEE conference, with all the academic partner involved in providing their vision on the current state of the most active Intelligent Vehicles research fields.

During the practical sessions students had the chance to experience, hands-on, some of the algorithms and techniques shown during the lectures, often using real V-Charge data, such as images and other sensor data. This allow students to

understand the typical challenges of real world applications, related with noise and real time constrains.

Beside the typical institutional educational activities, during the week were also organized extra activities, more on the leisure side. An out-door barbeque dinner on the first day, World Cup watching sessions were promoted, while the celebration dinner took place on the last day. Socialization and informal discussion about personal research fields and interest were promoted.

On the last day, after the end of all technical sessions, some time was devoted to a ETH Robotics lab tour.

Introduction

The V-Charge project hosted a summer school on fully automated driving. The school was conceived to give a compact introduction to the field of fully automated driving, offer technical sessions that will provide hands-on experience with state-of-the-art techniques, and present invited talks to frame the open research questions in the field. V-Charge activities and preliminary results were discussed as well.

Schedule

The School was organized around four technical session:

Motion planning for on-lane driving – ETH Zurich Autonomous System Lab

This technical session will introduce students to the state-of-the-art in motion planning for fully automated cars. It will provide an overview of basic historical motion planning strategies, trajectory generation for sampling-based methods, cost function design as well as fast collision checking techniques for static and dynamic obstacles. During the exercise, students will implement their own planning algorithm and test it within a vehicle simulation framework.

Image-based localization — ETH Zurich Computer Vision and Geometry Group

Image-based localization is a key component for determining the position and orientation of a camera-equipped vehicle. This technical session will therefore introduce students to state-of-the-art approaches for image-based localization relative to a given 3D model of the scene. The session starts with a brief introduction of the principles of Structure-from-Motion techniques that reconstruct scenes from a set of images. It then explains how a novel query image can be localized relative to such a 3D model by establishing correspondences between 2D image positions and 3D point positions in the model, with a focus on efficient and effective techniques for large scale localization. The last part of the session finally gives an overview over 3D map construction and image-based localization for fully automated vehicles.

During the exercise, students will implement a simple image-based localization method, visualize their results, and extend their implementation to achieve state-of-the-art results.

An introduction to Delay/Disruption Tolerant Networks (DTN) — Automotive Research Centre Niedersachsen, Technische Universität Braunschweig

This technical session is about Delay or Disruption Tolerant Networks (DTNs). The students will learn about the history of this communication architecture and recent research topics such as disruption-tolerant routing. Information on the typical use cases of DTNs inside and outside of the project will be provided during the session.

In the hands-on exercise, the students will set up the IBR-DTN software stack, an open source implementation of DTN, and experience the multi-hop features and disruption tolerance of the DTN by writing their own small application.

Semantic Mapping and Introspection for Classification — University of Oxford

Automated vehicles operating in urban environments can gain a lot of information about how to behave from a higher-level understanding of the objects around it. For instance, the knowledge that there is an upcoming traffic light or pedestrian crossing should be taken into account in the vehicle's current motion plan and speed. Because many of these useful semantic cues are fixed in place, it makes sense to build up reusable semantic maps of the areas in which we want our automated cars to operate. Usually these maps are created manually, which is very time-consuming but offers guarantees that are currently not available when using unsupervised machine learning classifiers.

We are interested in creating semantic maps automatically (in an unsupervised, or semi-supervised manner), but we also need to have some idea of the confidence of a particular map. After all, if the vehicle is not totally sure about what is around it, it should drive more cautiously! There are classification algorithms which offer probabilities (like the Support Vector Machine (SVM) or LogitBoost, or the Gaussian Process (GP)), but can we trust these probabilities?

Introspection is a property of a classification framework to give appropriate probabilistic output. Are all classifiers equal in this regard? We will discuss the various merits of different frameworks, and give some theoretic insights about why all probabilities should not be considered equal.

The Oxford RobotCar: Autonomy on Offer — University of Oxford

The Oxford RobotCar Project aims to provide robust, long-term fully automated driving at a price point suitable for mass-market adoption. At its core, however, lies a philosophy fundamentally different to that fuelling more conventional automated driving research: autonomy when offered, as opposed to on demand. Initially, our vehicles will drive some of the people to some of the places some of the time. The vehicle will decide when it is safe to offer autonomy and for how long. And only over time – as the vehicle experiences the environment – coverage will increase. In this talk we will provide an overview of how this philosophy impacts the technology we develop.

Machine Learning for vehicle and pedestrian detection — University of Parma

Pattern recognition approaches have achieved considerable success in practical applications and the motivations to recognize pedestrians and vehicles in automotive environment are largely known. Embedded devices, that perform these tasks, based on image processing, are now being installed on commercial

vehicles. Even considering the growth of computational power on embedded devices, not all algorithms, at present time, are suitable and ready to be used on devices in the coming years. This technical session aims to illustrate some promising algorithms, such as AdaBoost and SVM, the most common descriptor spaces, such asHaar, ICF and HOG, and give the bases for applying a classifier on an image. During the exercise, students will train several classifiers and apply them on images, understanding in such way potentials and problems behind those kinds of applications.

Agenda

	Monday, July 7	**Tuesday, July 8**	**Wednesday, July 9**	**Thursday, July 10**
8:30--10:00	Welcome and overview	UOX: The Oxford RobotCarSemantic Mapping and Introspection	ETHZ-ASL: On-lane planning I	TUB: An introduction to Delay/Disruption Tolerant Networks I
10:30--12:00	Invited Talks: Steven Shladover	UOX: Training and Evaluation of Classifiers Invited Talk: Cédric Pradalier	ETHZ-ASL: On-lane planning II	TUB: An introduction to Delay/Disruption Tolerant Networks I
LUNCH				
13:30--15:00	Invited Talks: Cyrill Stachniss Alex Stewart Lina Paz	Invited Talks: Falko Dressler	UParma: Machine Learning for vehicle and pedestrian detection I	ETHZ-CVG: Image-based localization I
15:30--17:00	Invited talks: Christof Stiller Michel Parent	Invited Talks: Marc Pollefeys Uwe Franke	UParma: Machine Learning for vehicle and pedestrian detection II	ETHZ-CVG: Image-based localization II
17:00 +	Rooftop Barbecue	FIFA World Cup Football	FIFA World Cup Football	Wrap-up Banquet

Speakers list

- Paul Furgale, ETHZ – ASL
- Christof Stiller, Karlsruhe Institute of Technology
- Michel Parent, INRIA,
- Uwe Franke, Daimler AG
- Falko Dressler, University of Innsbruck
- Steven Shladover, University of California, Berkeley
- Ulrich Schwesinger, ETHZ – ASL
- Marc Pollefeys, ETHZ – CVG
- Torsten Sattler, ETHZ – CVG
- Stefano Cattani, University of Parma
- Julian Timpner, TU Braunschweig
- Lina Paz, University of Oxford
- Hugo Grimmett, University of Oxford
- Alex Stewart, University of Oxford