EIT Digital – Industrial PhD position proposal

PhD thesis information

PhD Thesis – Title	Information fusion of video analysis in ADAS system
PhD Thesis – Short summary	The safety problem of autonomous driving is still challenging. Technologies based on LIDAR remain expensive and unlikely to result in affordable cars for the mass market (although the first solid state technology LIDAR has been announced in June 2018 in China by Alibaba). Alternative solutions based on AI would be more affordable but despite the considerable advances in machine vision propelled by the advent of deep networks they are not providing absolute safety. A single deep algorithm cannot be trusted as it can misinterpret potential dangers and cause accidents. The strength of fusing different information sources, rules, constraints, and physical models should be studied to overcome this issue. Information fusion also requires efficient anomaly detection for detecting unmodeled situations. A key issue in advanced AI solutions and combination of the deep networks is the possibility of explaining the decision making process, when observations can be narrative via spatio-temporal segmentation, i.e., an episodic description and the spatio-temporal context, i.e., preceding, concurrent and predicted episodes. Hence any solution shall also include ways of monitoring.
Rationale/challenge – *describe the problem and why it is relevant*	Accidents have occurred with Tesla's self-driving car showing that minor aspects of the visual information may change and spoil the observations. Handling unusual, unexpected situations is one of the most difficult tasks. One major issue is facing false positive (like a sign over the road that is seen as touching the road due to the incline of the road) that result in undesired counter measures (unnecessary use of breaks) or in delayed decisions. Some works at the Neural Information Processing Group on Cognition (arXiv 2016, Cognitive Systems Research 2017), spatio-temporal correlations (ICCV MCCB, 2017, EuCog 2017) using deep learning and on human-AI interaction (submitted) and 2D-to-3D mapping (in progress) describe the problem and offer a solution that also includes anomaly or salience detection in a joined deep learning and traditional AI architecture capable of self-training. Such issues are relevant for Bosch Hungary. The underlying innovation and economical impact is in the joining of episodic (concurrent and temporal) and semantic (context based) information, consistence seeking based on experiences and physical laws, and the detection of anomalies as soon as possible in such a way that erroneous data are to be collected to serve further training. This way the known degradation of AI solutions can be avoided.
Innovation – *describe what is the intended solution and the advance w.r.t. the state-of-the-art*	There are many object recognition algorithms giving rise to superhuman performances in various fields that can be included into the visual system of self-driving cars. Dangerous situations can be evaluated, including the intention of passengers and bicyclists.

	The innovation is beyond the mainstream of present day developments. In short, the goal is to develop, implement and use a number of deep learning tools that (i) can be trained independently, (ii) can work parallel, (iii) can resolve inconsistencies, (iv) can train each other and thus (v) can improve their joint performances including adaptations to novel situation. The project is concerned with the development and the adjustment of the model of the environment and the representation/interpretation of the situation at each time instant.
Research focus/topics – *describe* ***how*** *you are going to solve the problem*	Use database for improved representation of situations: use 2D-to-3D mapping, use temporal prediction, re-evaluate past representations given novel observations, maintain a single and consistent interpretation, predict and learn from prediction. These are “in progress” Adapt anomaly detection using both learned models, unresolved interpretations, and outliers in the predictions. Exploit state of the art deep-learning methods, such as object detection, semantic segmentation, pose estimation, monocular depth estimation, optical flow, boundary flow, structure from motion, saliency objectness, vanishing point detection. Use databases, such as KITTI, Cityscapes, Mapillary, MS COCO plus databases that will be released in the near feature. We note that there is a doctoral activity with Mapillary that can create data for this proposed one, and synergies are evident.
Deadlines/milestones (Gantt chart)	The industrial relevance is the predictive model that can infer insufficient or inconsistent information and detect anomalies in order to avoid accidents. Known accidents where detection problems without any exception that can save lives. The main task is 2D-to-3D mapping from monocular views, e.g., for the case if one lense of the stereo camera is obstructed/broken. This task includes subtasks, such as distance estimation, speed estimation, motion prediction and detection of unknown objects. Read the literature, collect state-of-the-art, make plans
	Implement 2D-to-3D deep learning estimation methods, evaluate them on the KITTI and in the context of Bosch application
	Combine the deep methods by considering them as individual “experts”. Develop a consistence seeking deep method that combines and corrects the different outputs of the “experts”. Evaluate the results and transfer them to Bosch Hungary
	Summarize the results and complete the PhD thesis.
Expected outcome – *describe the expected results of the PhD*	The expected results of the PhD is a self-improving model that uses state of the art algorithms and gives rise to complex and reliable description of the environment in space and time and has value for self-driving cars. Detailed analysis of the used algorithms Prototype of the new model for the designers and engineers for thorough testing and hardware development that will be acquired by Bosch.

	Published papers in high-quality academic conferences and journals Consulting with Bosch through out the doctoral work on the embedding of the methods into self-driving cars under observational and computational time constraints ensures the alignment with the industrial constraints and ease final technology transfer.

Relevance for the Action Line (section to be filled out by the Action Line Leader)

Action Line	Smart City
Alignment with Action Line – *statement from the Action Line Leader indicating the relevance for the AL from his perspective*	
Relevant IA – *List any relevant Innovation Activity (if applicable)*	

Partnership/financial information

Action Line Leader	
Industrial partner	Bosch, Hungary and/or ELTE-Soft
Industry advisor – *name and short bio*	László Anka, Engineering Section Manager at Robert Bosch Hungary
Academic/research partner	ELTE
Academic/research supervisor – *name and short bio*	András Lőrincz, ELTE András Lőrincz's research interest lies at the interface of artificial general intelligence (AGI, or Strong AI), cognition, and neuroscience, with principal areas of focus including intelligent systems, human-computer interaction and collaboration, social cognition, modeling, and applications, i.e., anthropomorphic AGI.
HEI granting the title	ELTE
DTC location	Budapest
Geographical mobility plan	
No. of PhD positions	1
PhD duration	4 years
Co-funding percentages: - Industry - Academia - EIT Digital	20% 30% 50%