THE RECAR PROGRAM - RESEARCH CENTER FOR AUTONOMOUS ROAD VEHICLES

Dr. SZALAY, Zsolt

Car of the Future - Conference

19.05.2016

BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS
FACULTY OF TRANSPORTATION ENGINEERING AND VEHICLE ENGINEERING

Research history

Participation in several Autonomous Vehicle related projects funded by the EU and/or Hungarian Government:

- 2000-2003 Chauffeur II (EUR 10.0 M, DaimlerChrysler)
- 2001-2004 PEIT (EUR 3.6 M, DaimlerChrysler)
- 2004-2007 SPARC FP6 (EUR 12.6 M, DaimlerChrysler)
- 2004-2008 EJJT (EUR 6.2 M, Knorr-Bremse)
- 2008-2011 HAVEit FP7 (EUR 27.5 M, Continental Automotive)
- 2008-2011 TruckDAS (EUR 1.13 M, Knorr-Bremse)
- 2014-2016 ERNYO-13 (EUR 0.4 M, Bosch)
- 2015-2019 PROSPECT (EUR 6,9 M, IDIADA)

Research history

Name	PEIT: Powertrain Equipped with Intelligent Technologies
Dates	2001 to 2004
Total cost	EUR 3.6 million
EU contribution	55%
Funding scheme	EU-FP5
Academic partner(s)	Budapest University of Technology and Economics (Hungary), Universität Stuttgart (Germany), Universität Karlsruhe (Germany), Technical University of Braunschweig Carolo Wilhelmina (Germany)
Industrial partner(s)	DaimlerChrysler AG (Germany), Knorr Bremse Fékrendszerek Kft (Hungary), TÜV NORD STRASSENVERKHEHR GMBH (Germany), RWTÜV Fahrzeug GmbH (Germany), TÜV Automotive GmbH Unternehmensgruppe TÜV Süddeutschland (Germany), Kraftfahrt–Bundesamt (Germany)
Results	To achieve an overall improvement in safety an intelligent powertrain was developed which provides an interface to serve as a base for all accident prevention and driver assistant functions of the vehicle.

Research history

Name	Highly Automated Vehicles for Intelligent Transport
Dates	From 2008-02-01 to 2011-07-31
Total cost	EUR 27.5 million
EU contribution	62%
Funding scheme	FP7-ICT collaborative project
Academic partner(s)	Universität Stuttgart, Deutsches Zentrum Luft- und Raumfahrt e.V.
Industrial partner(s)	Continental Automotive GmbH (Germany), Volvo Technology Corporation AB, Volkswagen AG
Results	The path-breaking HAVE-it proposal aims at the long-term vision of highly automated driving. Within this proposal important intermediate steps will be developed, validated and demonstrated. These intermediate results on the one hand offer high potential for exploitation within road vehicle series production.

Research history

Name	TRUCKDAS
Dates	From 2015-05-01 to 2018-11-01
Total cost	EUR 1.13 million
EU contribution	0%
Funding scheme	Research and Technology Innovation Fund of National Office for Research and Technology
Academic partner(s)	MTA SZTAKI (Hungary)
Industrial partner(s)	Knorr-Bremse Fékrendszerek Kft. (Hungary), Trigon Elektronika Kft. (Hungary)
Results	Intelligent vehicle applications and the sensors and actuators necessary for their expressed functions, which systems can reduce the most significant safety risks – shown in international statistics as well – of commercial vehicles. The applied project management is presented. The system prototypes and technologies that have been created, as well as the necessary test benches, measurement and simulation environments used for their development are shown.

Research history

Name	PROSPECT: Proactive Safety for Pedestrians and Cyclists
Dates	From 2009-09-01 to 2011-12-31
Total cost	EUR 6.938 million
EU contribution	100%
Funding scheme	Horizon 2020 MG.3.4-2014
Academic partner(s)	Budapest University of Technology and Economics (BME), Chalmers University of Technology, IFSTTAR , TNO, University of Amsterdam, University of Nottingham, Swedish National Road and Transport Research Institute (VTI), Volvo Car Corporation (VCC)
Industrial partner(s)	AUDI AG , Bundesanstalt für Straßenwesen (BASt), BMW Group (BMW), Robert Bosch GmbH (Bosch), Continental (CONTI), Daimler AG (Daimler), 4a Engineering GmbH (4aE), Toyota Motor Europe (TME)
Results	Significant progress on active pedestrian safety, as a result of advances in video and radar technology. This has culminated in the market introduction of first-gen active pedestrian safety systems, which perform autonomous emergency braking (AEB-PED) in case of critical traffic situations. PROSPECT will significantly improve the effectiveness of active VRU safety systems compared to those currently on the market.

Research partners

- Industrial partners
  - OEM:
    - Daimler
    - Volkswagen
    - Volvo
    - Audi Hungária Motor
  - TIER 1
    - Bosch
    - Knorr-Bremse
    - Haldex
    - Continental
    - Thyssen Krupp
- Academic Field
  - Institutes:
    - MTA SZTAKI
    - Institut National de Recherche en Informatique et en Automatique
    - Deutsches Zentrum für Luft- und Raumfahrt (DLR)
  - Universities
    - Universität Stuttgart
    - Universität Karlsruhe

RECAR Program

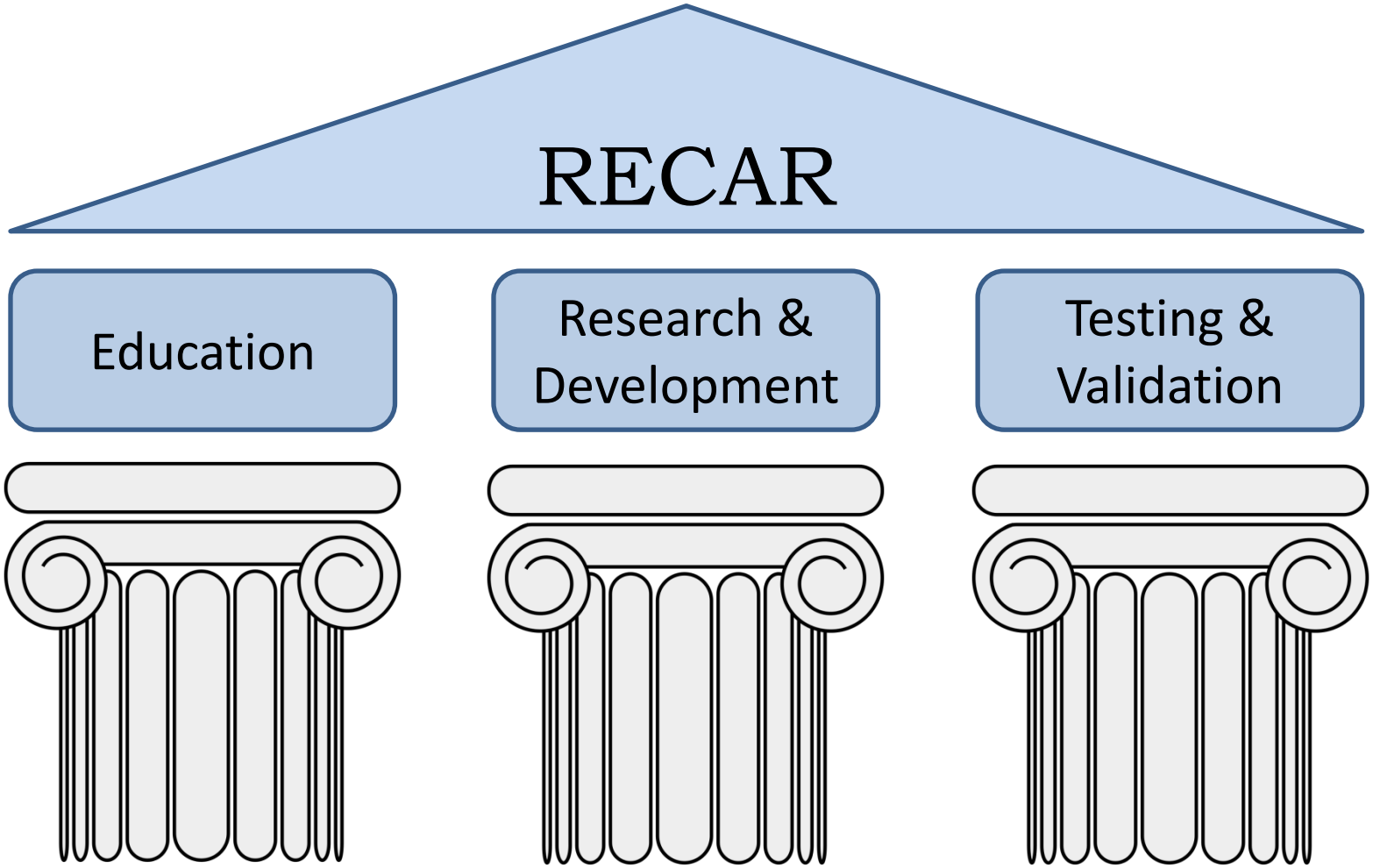
- **RE**search **C**enter for **A**utonomous **R**oad vehicles (RECAR)

- Unique Cooperation
  - Industrial partners (Bosch and Knorr-Bremse)
  - Academic sphere (BME, ELTE, MTA SZTAKI)
- Market Demand
  - Global trends and timing in automotive development
  - 4 OEMs and 15 TIER1s are in Hungary
  - Continuous need for qualified engineers
- Strong Governmental Support
  - Beyond manufacturing, provide higher added value
  - ROI calculation on a national economic level

BME KJK

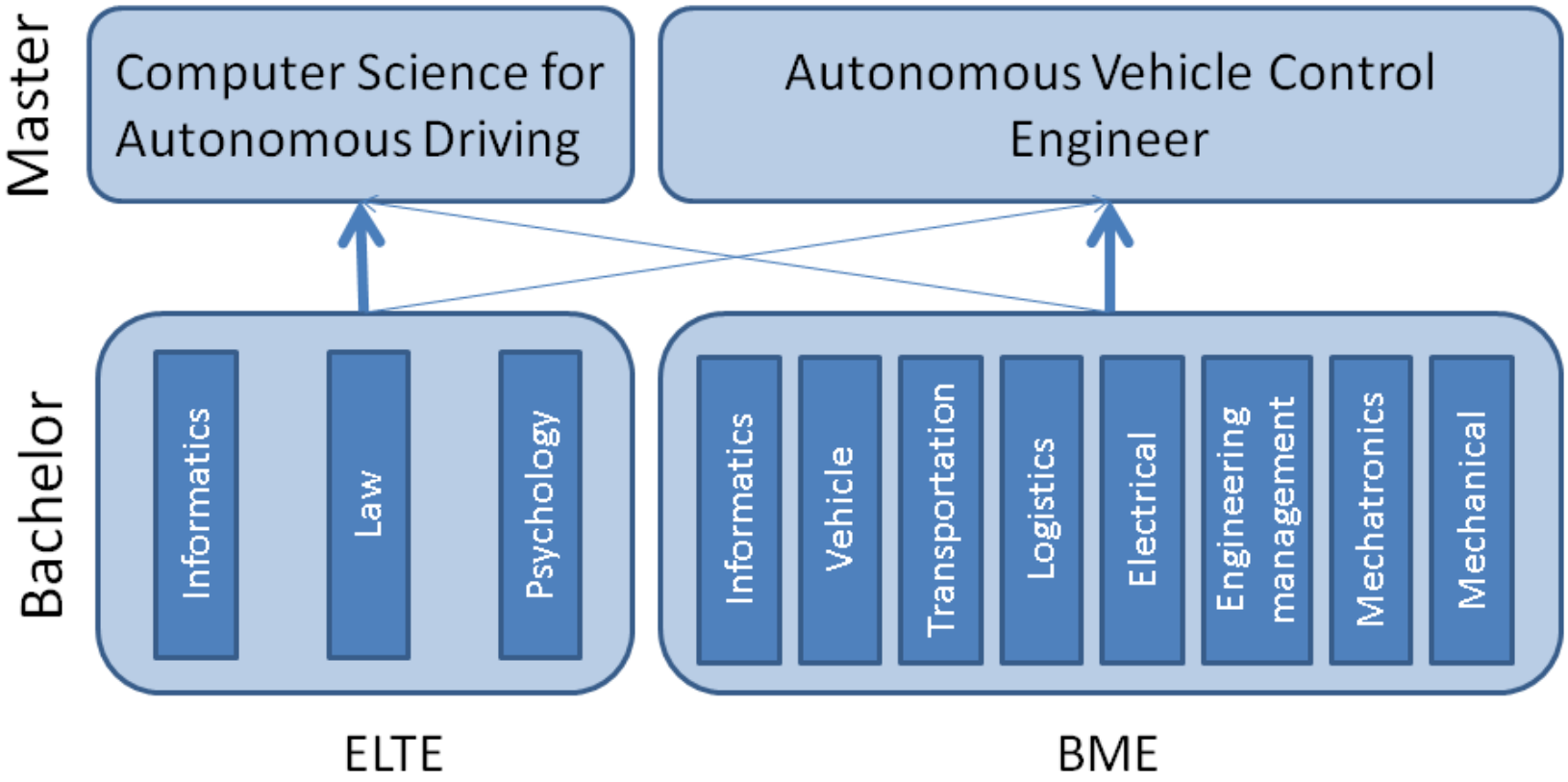
MTA SZTAKI

3 Pillars of the RECAR program



RECAR Education

- Autonomous Vehicle Control Engineer M.Sc. (BME)
- Computer Science for Autonomous Driving M.Sc. (ELTE)



Autonomous vehicle control engineer MSc

1	2	3	4
Numerical mathematics ELTE 2 0 1 f 4 TT IK	**Industrial image processing** Vajta László BME 3 1 0 v 4 TT VIK	**Automotive R&D processes and quality systems** Wahl István BME 3 0 0 f 4 GH GJT	Diploma thesis 0 30 0 f 30 ÖP
Control theory and system dynamics Bokor József-Gáspár Péter BME 2 0 2 v 4 TT KJIT	**High performance microcontrollers and interface** Tevesz Gábor BME 2 1 0 f 4 TT VIK	**Project management** BME 2 0 0 f 2 GH GTK	
Intelligent systems Dobrowiecki Tadeusz BME 3 0 0 f 4 TT VIK	**Human factors in traffic environment** ELTE 2 0 0 f 2 GH IK	**Machine vision** Szirányi Tamás BME 2 0 2 v 4 SZT ALRT	
Compensation block v f 6 0 6 f 12 SZV BME	**Legal framework of autonomous vehicles** ELTE 2 0 0 f 2 GH IK	**Safety and security in vehicle industry** Sághi Balázs BME 2 0 0 f 3 SZT KJIT	
	Localization and mapping Barsi Árpád BME 2 0 2 f 4 SZT EMK	**Design and integration of embedded systems** Majzik István BME 2 1 0 v 3 SZT VIK	
	Autonomous robots and vehicles Kiss Bálint BME 2 1 0 v 4 SZT VIK	**Traffic modelling, simulation and control** Varga István BME 2 0 2 f 4 SZT KJIT	
	Automotive environment sensors Bécsi Tamás BME 2 0 2 v 5 SZI KJIT	**Automotive network and comm. systems** Szalay Zsolt BME 2 0 2 v 4 SZI GJT	
Vehicle dynamics Németh Huba BME 2 0 1 v 3 SZI GJT	**Automated driving systems** Szalay Zsolt BME 2 0 2 v 5 SZI GJT	**Automated vehicle design project** Gáspár Péter BME 1 0 2 3 SZI KJIT Németh Huba BME 1 0 2 v 3 SZI GJT	
Vehicle testing and validation Szabó Bálint BME 0 0 3 f 3 SZI GJT			

Autonomous vehicle control engineer MSc

- Compensation blocks for equalizing knowledge level
  - for Vehicle engineers
  - for Mechanical/Mechatronical engineers
  - for Electrical engineers
  - for Informatics

For vehicle engineer BSc

Signal processing fundamentals						BME
2	0	2	f	4	SZV	VIK
Programming in C- and Matlab Bécsi Tamás						BME
2	0	2	f	4	SZV	KJK
Software Development Methods and Paradigms Lengyel László						BME
2	1	0	v	4	SZV	VIK

For mechanical/mechatronics engineer BSc

Signal processing fundamentals						BME
2	0	2	f	4	SZV	VIK
Software Development Methods and Paradigms Lengyel László						BME
2	1	0	v	4	SZV	VIK
Automotive vehicle systems Szabó Bálint						BME
2	0	2	f	4	SZV	GJT

For electrical engineer BSc

Vehicle operation						BME
2	0	2	v	4	SZV	GJT
Automotive vehicle systems Szabó Bálint						BME
2	0	2	f	4	SZV	GJT
Vehicle mechanics fundamentals Szabó Bálint						BME
2	0	2	v	4	SZV	GJT

For informatics BSc

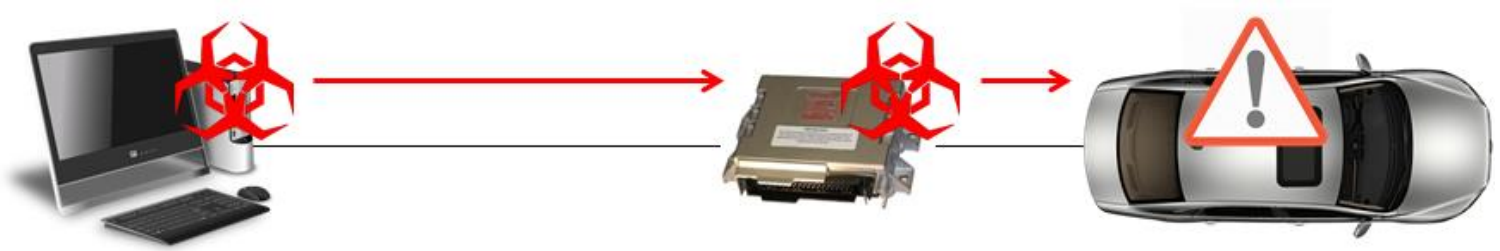
Embedded Operating Systems and Client Applicatio Tevesz Gábor						BME
3	1	0	f	4	SZV	VIK
Automotive vehicle systems Szabó Bálint						BME
2	0	2	f	4	SZV	GJT
Vehicle mechanics fundamentals Szabó Bálint						BME
2	0	2	v	4	SZV	GJT

BME KJK

MTA SZTAKI

RECAR Research & Development

- Challenges addressed in RECAR
  - **Liability** – how to program responsibility and liability into vehicles?
  - **Transparency** – of data handling and data access modes
  - **Privacy** – how to guarantee protection of personal data?
  - **Cyber Security** – how to prevent misuse of intelligent functions?



https://hacktivity.com/en/hacktivity-2015/presentations/hacking-cars-in-the-style-of-stuxnet1/

- Knowledge gained is transferred into education

- Audi TT based vehicle simulator
  - https://www.youtube.com/watch?v=Wa7vpGFDLYQ&noredirect=1

RECAR Research & Development

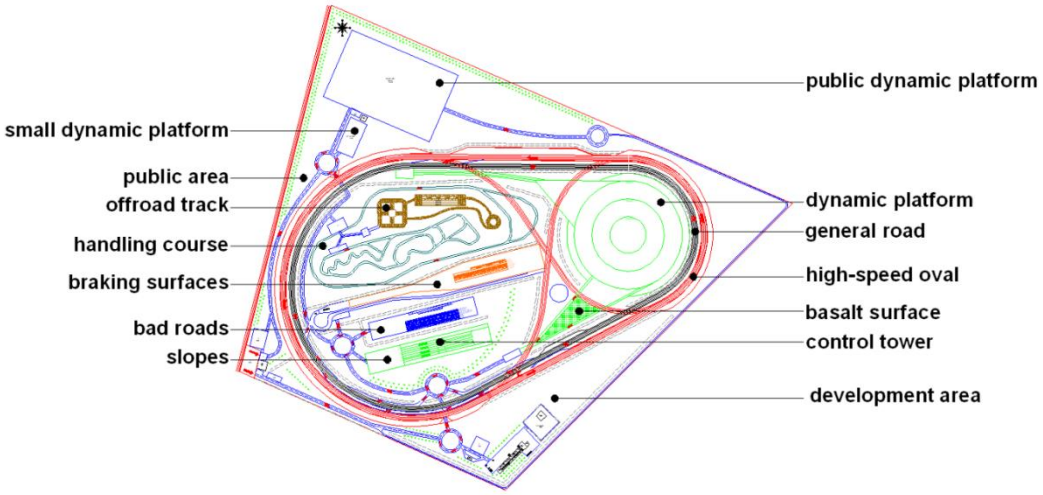
RECAR Testing & Validation

- University laboratories
  - Technology research lab
  - Component analysis lab
  - System integration lab
  - Vehicle-in-the-loop lab

- Automotive Proving Ground project
  - Standard vehicle endurance testing functions
  - Autonomous Vehicle specific testing functions
  - Urban city crossings, suburban traffic, Highway+
  - „Smart City” features
    - intelligent lighting
    - traffic control, etc.
  - Moving obstacles, C2X communication

RECAR Testing & Validation

- Autonomous Vehicle Proving Ground
  - Industrial partners:
    - Knorr-Bremse
    - Bosch
    - Continental
    - AVL
    - Thyssen Krupp
    - TÜV Rheinland KTI
  - Academic partners:
    - BME (Academic Coordinator)
    - Széchenyi István University
    - Pannon University
    - Óbuda University
    - Kecskemét College
    - University of Szeged



Example: Mcity, MI

BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS

Dr. SZALAY, Zsolt

email: zsolt.szalay@gjt.bme.hu