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Project title: Automotive Control and Mechatronics Research Center

Instrument: SSA

Thematic Priority: **Sustainable Development - Transport**

PUBLISHABLE FINAL ACTIVITY REPORT

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Project coordinator name: Prof.Dr. Levent Güvenç   **Version: 1.0**

Project coordinator organisation name: İstanbul Technical University

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Executive Summary

Project Description

The automotive area is a vital industry sector with an important economic contribution in Europe. Automotive Control and Mechatronics is becoming essential in today's and tomorrow's road vehicles for improved road transport safety, reduced pollutant emission levels and fuel economy. Road vehicles are, therefore, becoming truly mechatronic devices loaded with sensors and actuators and control code in a large number of electronic control units, connected over a data bus. There is also a trend towards inter-vehicle and vehicle-infrastructure communication for improved safety and comfort. Consequently, Europe's current leading position in the automotive sector relies heavily on its taking part in and leading the anticipated developments in the Automotive Control and Mechatronics area.

The Automotive Controls and Mechatronics Research Center (Acronym: AUTOCOM) of İstanbul Technical University was established with a three year EU FP6 SSA project (INCO project no. 16426) as a Center of Excellence on May 1, 2005. The AUTOCOM project is on contributing to European Research and Technology Development in the Automotive Control and Mechatronics area in order to help achieve safer, cleaner and fuel efficient road vehicles in Europe. The aim of the AUTOCOM project is to make the Automotive Controls Research Group (ACRG) in the Department of Mechanical Engineering at İstanbul Technical University an excellent Automotive Controls and Mechatronics (Acronym: AUTOCOM) Center for Actively Safe, Clean and Efficient Road Vehicles with an increased research and technological development (RTD) capacity and a higher level of participation in EU funded research activities. For this purpose, three thrust areas of research capacity reinforcement were identified as: i) preventive and active safety control systems, ii) powertrain modeling, control and hardware-in-the-loop (HiL) testing and iii) hybrid electric vehicle modeling and control. The project addresses 'integrating' and 'strengthening' the ERA in the eSafety subpriority of the IST thematic priority area and the Transport and Integrated Safety subpriorities of the SustDev thematic priority area of Framework Programme 6.

Project Objectives

The project objectives are:
  i.   To achieve a higher level of contribution to RTD capacity in Turkey and in the EU.
  ii. To improve networking with other research centers in Europe.
  iii. To send Ph.D. students and post-doctoral researchers to other centers for training and experiments.

iv. To organize three workshops on *i) Preventive and Active Safety Systems for Road Vehicles, ii) Powertrain Modeling, Control and HiL Testing and iii) Hybrid Electric Vehicle Modeling and Control*.

v. To visit other centers for cooperative activities and joint RTD proposal preparation – Selected researchers in the center will visit selected European universities and research centers.

vi. To hire two young researchers at the post-doctoral level and three young researchers at the doctoral student or engineer level.

vii. To renew selected S&T equipment in ACRG-İTÜ.

Coordinator Contact Details

The project has only one participant which is also the coordinator. The coordinator is İstanbul Technical University. The contact details are:
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Work Performed and End Results

First Year of the Project

The 1st Workshop of the project on Preventive and Active Safety Systems for Road Vehicles was held in İstanbul during Sept. 19-20, 2005. Training and networking visits to European research groups were realized. One doctoral student level and two engineer level researchers and a project management assistant were hired. Planning and call for papers efforts for the 2nd and 3rd workshops of the project were realized. Selected S&T equipment was renewed. The goal of being a partner in a European project on hybrid electric vehicles was realized earlier than planned. Networking efforts to achieve the goal of being a partner in a European project related to the active safety thrust area took place.

Second Year of the Project

The 2nd Workshop of the project on Powertrain Modeling, Control and HiL Simulation was held in İstanbul during Nov. 17, 2006 as two special sessions within the 2006 International Conference on Automotive Technologies, ICAT 2006. Training and networking visits to European research groups were realized. Two post doctoral researchers were hired. Planning and call for papers efforts for the 2nd and 3rd workshops of the project were realized. Networking efforts to achieve the goal of being a partner in a

European project related to the active safety thrust area resulted in being partners in two EU FP7 ICT area first call proposals. The goal of being a partner in a European project on hybrid electric vehicles was realized in the first year of the project. Continuation of this goal resulted in a partnership in a project proposal in the EU FP7 Transport area in the first call.

<u>Third Year of the Project</u>

The 3rd Workshop of the project on Hybrid Electric Vehicle Modeling and Control was held in İstanbul during June 12, 2007 as a workshop preceding the 2007 IEEE Intelligent Vehicles Symposium. The 2007 IEEE Intelligent Vehicles Symposium, its tutorial and workshops and its demo day were also organized mainly by the AUTOCOM center. Training and networking and EU FP7 project proposal related visits to Europe were realized. Several visits from our European partners took place. EU FP7 project partnership possibilities were discussed during these visits. The visitor also presented a seminar in some of these visits. Networking efforts to achieve the goal of being a partner in a European projects resulted in our being part of the DRIVESAFE and PISA project proposals in the ICT 1st call, and the SAFEHEV project in the Transport 1st call. Project AUTOCAP was also submitted to the REGPOT 1st call, which was re-submitted to the REGPOT 2nd call after major improvement of the proposal. We were also a partner in the GREEN IN-WHEEL project proposal submitted to the Transport 2nd call. The goal of being a partner in a European project on hybrid electric vehicles was already realized in the first year of the project. This Leonardo project with acronym SCEIA ended during the third year of the project. Its follow-up project will soon start.

Dissemination

The project resulted in 13 journal and 45 conference papers including submitted ones and 2 edited volumes and several other publications and presentations. 4 M.S. theses were finished and a Ph.D. dissertation is about to finish. Two press release ceremonies for the FOHEV-I and FOHEV-II (Ford Transit Hybrid Electric Vehicle I, II) projects that the center takes part in was used to publicize and disseminate our work in the many short news articles in newspapers and automotive magazines in Turkey. News about the project appeared in the project newsletters and automotive related magazines. Several presentations on the center and its activities were made. Dissemination was also made through the project web site: http://www.autocom.itu.edu.tr.

1 Project execution

1.1 Summary Description of Project Objectives

The summary description of project objectives are:

i. To achieve a higher level of contribution to RTD capacity in Turkey and in the EU.

ii. To improve networking with other research centers in Europe – In this context, we will cooperate with several European universities and research centers on diesel engine modeling and control, on engine modeling for control applications, on modeling and control of hybrid vehicles, on preventive/active safety systems and intelligent transportation systems and on driveline modeling.

iii. To send Ph.D. students and post-doctoral researchers to other centers for training and experiments.

iv. To organize three workshops on *i) Preventive and Active Safety Systems for Road Vehicles, ii) Powertrain Modeling, Control and HiL Testing and iii) Hybrid Electric Vehicle Modeling and Control.* These workshops will be held in Turkey and will all involve either a visit to the center or a presentation on the center and a separate session devoted to exploring future research and development cooperation possibilities. EU officials in the relevant program will also be invited to the latter session.

v. To visit other centers for cooperative activities and joint RTD proposal preparation – Selected researchers in the center will visit selected European universities and research centers.

vi. To hire two young researchers at the post-doctoral level and three young researchers at the doctoral student or engineer level.

vii. To renew selected S&T equipment.

1.2 Contractors involved

The project has only one participant (contractor) which is also the coordinator, İstanbul Technical University.

1.3 Work performed and end results

The 1st AUTOCOM Workshop on Preventive and Active Safety Systems was successfully organized on 19-20 September, 2005. There was an EU FP projects info session and an EU FP6 ongoing projects session. A meeting of the AUTOCOM center was also held at the end of the workshop. Networking and cooperation activities with European research groups and joint future EU FP proposal possibilities were discussed in the meeting.

Three doctoral student, engineer level researchers and a project management assistant were recruited and hired in the beginning months of the project. Very intensive announcement and recruitment efforts for the post doctoral researcher positions were carried out continuously through the first year of the project. E-mail correspondence was used in recruiting the post doctoral researcher position candidates. It was possible to organize interviews and seminars for two of the candidates. Several offers that were made were rejected as the candidates had already accepted better offers. Finally, two offers were accepted in the first year of the project.

The first workshop allowed a very good opportunity for networking with our scientific partners. Scientific networking efforts continued through conference and automotive control technical committee meeting attendances, a visit by Mr. Ali Boyalı to the University of Salerno in Italy and a visit by Prof. Tankut Acarman to the ProFusion Workshop in Brussels, Belgium of the PREVENT IP project. Both visits were made to explore EU FP project collaboration possibilities.

The *2nd AUTOCOM Workshop on Powertrain Modeling, Control and HiL Simulation* was held during the International Conference on Automotive Technologies (ICAT 2006), in the Hyatt Regency Hotel in İstanbul on the 17th of November, 2006. This was the second of the three annual workshops in automotive control, which is funded by the AUTOCOM Automotive Controls and Mechatronics Research Center. The main aim of the workshop was to gather the leading experts in the Powertrain Modeling, Control and HiL Simulation area to discuss the latest developments in an atmosphere suitable for networking and exchange of ideas. Thus, papers in this field were invited from both industry and academia. The workshop consisted of two successive sessions titled '*Engine and Emissions Control Systems*' and '*Propulsion Powertrain Systems and Control*' in one day. The participants rated the workshop (the two sessions) as being very successful and useful. Two tours of our labs were organized during the workshop day and the day before to dıscuss possibilities of joint EU FP7 projects.

Two post-doctoral researchers were hired and started working in the project. On June 9, 2006 Dr. Ahu Ece Hartavi started working in the two thrust areas of Hybrid Electric Vehicle Modeling and Control, and Powertrain Modeling, Control and Hardware-in-the-Loop (HIL) Testing. On July 14, 2006 Dr. Velupillai Sankarayanan started working in the Preventive and Active Safety Systems thrust area

The second workshop allowed a very good opportunity for continuation of networking with potential EU FP7 project proposal preparation partners. During 13th of May- 12th of June 2006, Mr. Bahadir Akyildiz, one of the engineering researchers of the AUTOCOM Research center, visited the IMRT Laboratory (Measurement and Control Lab.) of ETH Zurich. He focused on the Discrete Modeling and Control of Diesel Engines. Apart from that, he also joined the IMRT staff to conduct experiments on Spark Ignition (SI) engines. He developed and tested a robust idle speed control system. There was a visit by Dr. Ahu Ece Hartavi and Assist.Prof. Tankut Acarman to the University of Salerno in Italy and a visit by Assist.Prof. Tankut Acarman to the ProFusion Workshop in Brussels, Belgium of

the PREVENT IP project. Both visits were made to explore EU FP7 project collaboration possibilities. Prof. Levent Güvenç attended the first proposal preparation meeting of the PISA project proposal group in Brussels Belgium. Ms. Zeynep Kayahan, Assist.Prof. Tankut Acarman and Prof. Levent Güvenç participated in two meetings of the DriveSafe and one meeting of the SAFEHEV project proposal preparation groups, all in İstanbul. There were also some conference attendances to disseminate papers originating from the center. These conference attandances were used for RTD capacity improvement and for identifying future EU FP project partners.

The 3rd AUTOCOM Workshop on Hybrid Electric Vehicle Modeling and Control was the last of the three annual workshops in automotive control being organized by the European Union (EU) Framework Programme 6 (FP6) funded AUTOCOM Automotive Controls and Mechatronics Research Center. The main aim of the workshop was to gather the leading experts in the Hybrid Electric Vehicle and Modeling research area to discuss the latest developments in an atmosphere suitable for networking and exchange of ideas. The workshop took place on the 12th of June, 2007 at İstanbul technical University, Mechanical Engineering Department in Gümüşşuyu campus, İstanbul, Turkey in conjunction with the 2007 IEEE Intelligent Vehicles Symposium. The workshop was organized in a single session format. The workshop mainly concentrated on the third thrust area of Hybrid Electric Vehicle Control, Modeling and HiL Simulation. Papers in this field were invited from both industry and academia. There were a total of 7 contributions in the form of papers. All of the papers were included in the 3rd AUTOCOM Workshop on Hybrid Electric Vehicle Modeling and Control CD and proceedings book. The papers originated mainly from automotive companies, research centers and universities in Turkey and Europe. The third workshop and the 2007 IEEE Intelligent Vehicles Symposium allowed a very good opportunity for networking with potential EU FP7 project proposal preparation partners.

Short term visits to "Advanced Intelligent Mechatronics" conference in Zurich, Switzerland, "Technologies for safer road Traffic" demo meeting of the PREVENT IP project in Versailles, France, "FP7 Transport Info Day" in Brussels, Belgium attendances, and a short visit to Brussels, Belgium for a FP7 Project proposal (SAFEHEV) took place during the third year of the project. Post-doctoral researcher Dr. Vellupillai Sankaranarayanan from the center attended AIM, the IEEE/ASME International Conference on Advanced Intelligent Mechatronics held in Zurich, Switzerland during Sept. 4-7, 2007 to present a paper and to network with researchers in the preventive and active safety systems area. Assist.Prof. Tankut Acarman attended the Technologies for Safer Road Traffic demonstration of the PreVent IP project results in Paris, France during September 18-23 to test the demo vehicles and technologies and to carry out scientific networking. Assoc.Prof. Bilin Aksun Güvenç visited Brussels, Belgium during 5-8 February, 2008 for the EU FP7 Transport Info Day. Four different flyers were prepared, one for each specific call that we wanted to take part in. These flyers were distributed during this meeting. Through Assoc.Prof. Bilin Aksun Güvenç's contacts, we corresponded with a large number of companies and universities for possible EU FP7 project proposal collaboration. Prof. Levent Güvenç visited Brussels, Belgium to

explain the SAFEHEV project to Mr. Frederic Sgarbi of the EC along with the project coordinator during 1-2 May, 2007.

There were several visits to the center associated with work on Intelligent vehicles. Prof. Ümit Özgüner from the CAR-IT center at the Ohio State University visited the center on November 21, 2007 to discuss further joint research work possibilities and possible EU FP7 project partnerships. He also presented the experience of the OSU-ACT team, a semi-finalist in the Darpa Urban Challenge race, in a seminar. Dr. Karen Sommel, leader of the image processing group at the Institute for Measurement and Control and project leader in the special research center Cognitive Automobiles, responsible for the environmental perception, from the University of Karlsruhe in Germany visited the center on February 8, 2008 to exchange ideas on future FP project cooperation possibilities. He also presented a seminar on Team-AnnieWAY which was one of the finalists in the Darpa Urban Challenge autonomous vehicle race. Mr. Sertac Karaman from the Laboratory for Information and Decision Systems of MIT, US visited the center for a week during May 2008 and exchanged ideas on intelligent vehicle technologies for autonomous operation. He also presented a seminar on May 20, 2008 on Talos, the autonomous vehicle of MIT that was a finalist in the Darpa Urban Challenge.

Another scientific networking visit to the center was by Dr. Alexander Schmitt from IPG Automotive in Germany on collaboration on hardware-in-the-loop systems for preventive and active safety systems. A copy of Carmaker HiL (real time capable version) was provided free of charge to our center. Other visits included the visit by Magna Steyr, which was interested in opening a branch in Turkey and a visit by Renault France arranged in the Tubitak Mam research center on future collaboration possibilities on active safety controllers and their hardware-in-the-loop systems. Dr. Umut Genç from AVL UK visited the center. AVL recently opened an AVL Turkey in a nearby technopark. While his visit concentrated more on hybrid electric vehicles, collaboration possibilities in diesel engine control, especially model based, easily calibratable engine control methods and EU FP7 projects were discussed. Mr. Luc Flambard from Sherpa Engineering, France gave a demonstration of the Sherpa engine model and and exchanged ideas on engine control problems during his May 16, 2008 visit of the center. We discussed how the center and Sherpa can collaborate, including EU FP7 projects.

RTD capacity improvement efforts in all three thrust areas of the center were made possible by the three workshops and scientific networking activities mentioned above and the upgrading of the computational hardware, the driving simulators, the instrumentation and vehicle dynamics and engine modeling software of the center. The RTD capacity improvement of the center was reflected in the total of 35 technical publications (journal and conference including submitted ones) originating from the center during the course of the project. The objectives of the project were specified in the form of 42 deliverables which were all completed.

1.4 Current relation to the state of the art

The RTD capacity improvement efforts in the three thrust areas have placed us far beyond the current state of the art in the first thrust area of Preventive and Active Safety Control Systems, past beyond the current state of the art in Hybrid Electric Vehicle Modeling and Control and at the current state of the art in Powertrain Modeling, Control and HiL Testing. The project team was already very good in the Preventive and Active Safety Control Systems area. In this area, research work concentrated on ESP, rollover warning and avoidance, adaptive cruise control, stop and go systems, collision warning and avoidance, steering control and semi active suspensions, ITS and intelligent vehicle technologies and active safety using inter-vehicle communication. We are a leading research team which can easily work in European level research projects in our first thrust area of preventive and active safety. We are the best research team in Turkey in this area. At the end of the third and final year of the project, we are past beyond the state of the art in hybrid electric vehicle modeling and control. We have successfully finished the modeling, controller design and controller testing of three hybrid electric vehicle prototypes and two major projects whose results were highly publicized in Turkey (FOHEV-I and FOHEV-II). These prototypes are at the state of the art in the hybrid electric vehicle area and have been found to be very successful. AUTOCOM center personnel in this thrust area are working on optimization based strategies and local optimization based controllers. The second thrust area of Powertrain Modeling, Control and HiL Testing is where we have reached the current state of the art. We have a home developed real time capable crank angle based diesel engine model and a home built HiL testing system for engine ECU's with a home developed faulty signal generation program along with two commercial real time capable diesel engine models. We are working on advanced, model based and calibratable controls for diesel engines.

1.4 Impact on industry

The project has increased the RTD capacity of our center in the automotive control and mechatronics area. We already had very close ties with the Turkish automotive industry before the project. The abovementioned RTD capacity improvement made it easier for the center to conduct research projects for the automotive industry. There are 19 automotive OEMs in Turkey. Turkey is the number 1 bus manufacturer in Europe and one of the largest commercial vehicle manufacturers in Europe. Our ties with the Turkish automotive industry are closer now.

2 Dissemination and use

2.1 Dissemination of results

Dissemination of results was carried out through the project web site (http://www.autocom.itu.edu.tr) and the scientific and other publications of the project. These publications and presentations in the third year of the project are listed below. A

total of 13 journal and 45 conference papers including submitted ones and 2 edited volumes and several other publications and presentations were the results of the dissemination of the project.

Journal Publications:

1. Aksun Güvenç, B., Güvenç, L., Karaman, S., "Robust MIMO Disturbance Observer Analysis and Design with Application to Active Car Steering," <u>International Journal of Robust and Nonlinear Control</u>, *under review*.
2. Ugur Yildiran and İ. E. Köse., "LMI Representation of the Convex Hulls of Quadratic Basic Semialgebraic Sets," <u>Journal of Convex Analysis</u>, *under review*.
3. Başlamışlı, S.Ç., Köse, İ.E. and Anlaş, G., "Gain Scheduled Integrated Active Steering and Differential Control for Vehicle Handling Improvement," <u>Vehicle System Dynamics</u>, *accepted for publication*.
4. Sankaranarayanan, V., Emekli, M.E., Aksun Güvenç, B., Güvenç, L., Öztürk, E.S., Ersolmaz, Ş.S., Eyol, E., Sinal, M., "Semi-Active Suspension Control of a Light Commercial Vehicle," <u>IEEE/ASME Transactions on Mechatronics</u>, *accepted for publication*.
5. Aksun Güvenç, B., Güvenç, L., Karaman, S., "Robust Yaw Stability Controller Design and Hardware in the Loop Testing for a Road Vehicle," <u>IEEE Transactions on Vehicular Technology</u>, *accepted for publication*.
6. Acarman, T., "Nonlinear Optimal Integrated Vehicle Control Using Individual Braking Torque and Steering Angle with On-line Control Allocation by Using State Dependent Riccati Equation Technique," <u>Vehicle System Dynamics,</u> *accepted for publication*.
7. Sahinkaya, M.N., Hartavi A.E., "Variable Bias Current Control In Magnetic Bearings for Energy Optimization," <u>IEEE Transactions on Magnetics</u>, *accepted for publication*.
8. Scherer, C. W. and Köse, I.E., "Robustness with dynamic IQCs: An exact state-space characterization of nominal stability with applications to robust estimation," <u>Automatica</u>, *accepted for publication*.
9. Sönmez, Ü., Streit, D., Tallon, R., Klinikowski, D., 2008, "Weigh In Motion Studies Using Strip Type Sensors: The Preliminary Results," <u>International Journal of Heavy Vehicle Systems</u>, Vol. 15, No.1, pp. 1- 6
10. Yu, H., Güvenç, L., Özgüner, Ü., 2008, "Heavy Duty Vehicle Rollover Detection and Active Roll Control," <u>Vehicle System Dynamics</u>, DOI: 10.1080/00423110701477529, First Published on: 11 April 2008.
11. Başlamışlı, S.Ç., Köse, I.E. and Anlaş, G., 2007, "Robust Control of an Anti-Lock Brake System," <u>Vehicle System Dynamics</u>, Vol. 45, No. 3, pp. 217-232.
12. Polat, İ, Eşkinat, E. , and Köse, I.E., 2007, "Dynamic Output Feedback Control of Quasi-LPV Mechanical Systems," <u>IET Control Theory & Applications</u>, Vol. 1, No. 4, pp. 1114-1121.
13. Aksun Güvenç, B. and Kural E., 2006, "Adaptive Cruise Control Simulator, a Low-Cost Multiple-Driver-in-the-Loop Simulator," <u>IEEE Control Systems Magazine</u>, Vol. 26, No. 3, pp. 42-55.

Conference Publications:

14. Uygan, İ.M.C., Sezer, V., Hartavi, A.E., Acarman, T., Güvenç, L., Kılıç, V., 2008, "Regenerative Braking Algorithm for Energy Efficiency Enhancement of a Front and Rear Wheel Drive Parallel Hybrid Electric Commercial Van," <u>SAE Commercial Vehicles Conference</u>, Rosemont, Illinois, Oct. 7-9, abstract accepted, full paper under review.
15. Sezer, V., Uygan, İ.M.C., Hartavi, A.E., Acarman, T., Güvenç, L., Kılıç, V., 2008, "Maximum Overall Efficiency Optimization Strategy (MOES) for Power Split Control of a Series-Parallel Hybrid Electric Vehicle," <u>SAE Commercial Vehicles Conference</u>, Rosemont, Illinois, Oct. 7-9, abstract accepted, full paper under review.

16. Özcan, D., Sönmez, Ü., Güvenç, L., Ersolmaz, S., Eyol, E., 2008, "Nonlinear Suspension Spring and Damper Characteristic Optimization for Vehicle Ride and Handling Improvement," <u>SAE Commercial Vehicles Conference,</u> Rosemont, Illinois, Oct. 7-9, abstract accepted, full paper under review.

17. Baslamisli, Ç., Polat, I., Kose, I.E., "Gain Scheduled Integrated Vehicle Control Based on a Parametric Yaw Roll Model", <u>2008 IEEE Intelligent Vehicles Symposium</u>, accepted for publication.

18. Ararat, Ö., Aksun Güvenç, B., 2008 "Development of a Collision Avoidance Algorithm Using Elastic Band Theory," <u>2008 IFAC World Congress</u>, Seoul, S.Korea, July 6-11, accepted for publication.

19. Dinçmen, E., T.Acarman, 2008, "Active Coordination of The Individually Actuated Wheel Braking and Steering to Enhance Vehicle Lateral Stability and Handling," <u>2008 IFAC World Congress</u>, Seoul, S.Korea, July 6-11, accepted for publication.

20. Sankaranarayanan, V., Özcan, D., Öncü, S., Güvenç, L., Öztürk, E.S., Ersolmaz, Ş.S., Eyol, E., Sinal, M., "Vehicle Chassis Control Using Adaptive Semi-Active Suspension," <u>2008 IFAC World Congress</u>, Seoul, S.Korea, July 6-11, accepted for publication.

21. Ünal, K., Güvenç, L., 2008, "Identification And Development of a Parameter Varying Vehicle Dynamics Model For Use in a Rollover Warning System, (in Turkish), <u>4th Automotive Technologies Congress</u> – OTEKON 2008, Bursa, pp. 449-456.

22. Daniş, S., Aytekin, B., Dinçmen, E., Sezer, V., Ararat, Ö., Öncü, S., Aksun Güvenç, B., Acarman, T., Altuğ, E., Güvenç, L., 2008, "A Framework for Development of Driver Adaptive Warning and Assistance System Triggered by a Driver Inattention Monitor," <u>4th Automotive Technologies Congress</u> – OTEKON 2008, Bursa, pp. 107-115.

23. Uygan, İ.M.C., Sezer, V., Hartavi, A.E., Acarman, T., Güvenç, L., 2008, "Propulsion System Design of a Hybrid Electric Vehicle," (in Turkish), <u>4th Automotive Technologies Congress</u> – OTEKON 2008, Bursa, pp. 665-672.

24. Boyali, A., Acarman, T., Güvenç, L., 2007, "Component Sizing in Hybrid Electric Vehicle Design using Optimization and Design," <u>Proceedings of the Workshop on Hybrid Electric Vehicle Modeling and Control</u> (in conjunction with the 2007 IEEE Intelligent Vehicles Symposium), İstanbul, June 12, pp. 13-19.

25. Sezer, V., Uygan, İ.M.C., Hartavi, A.E., Acarman, T., Güvenç, L., 2007, "Propulsion System Design of a Hybrid Electric Vehicle," <u>Proceedings of the Workshop on Hybrid Electric Vehicle Modeling and Control</u> (in conjunction with the 2007 IEEE Intelligent Vehicles Symposium), İstanbul, June 12, pp. 28-34.

26. Hartavi, A.E., Uygan, İ.M.C., Sezer, V., Acarman, T., Güvenç, L., 2007, "Development of Hybrid Braking Algorithm for Hybrid Electric Vehicles," <u>Proceedings of the Workshop on Hybrid Electric Vehicle Modeling and Control</u> (in conjunction with the 2007 IEEE Intelligent Vehicles Symposium), İstanbul, June 12, pp. 35-39.

27. Acarman, T., Özgüner, Ü., Güvenç, L., Yiting L., Daniş, S., 2007, "Test-Bed Formation for Human Driver Model Development and Decision Making," <u>IEEE Intelligent Transportation Systems Conference</u>, Seattle, USA, pp. 934-939.

28. Öncü, S., Güvenç, L., Ersolmaz, Ş.S., Öztürk, E.S., Kılıç, N., Sinal, M., 2007, "Steer-by-Wire Control of a Light Commercial Vehicle Using a Hardware-in-the-Loop Setup," <u>SAE Commercial Vehicles Conference</u>, Advancements in Steering Systems, SAE paper number 2007-01-4198, Chicago, Oct. 30 – Nov. 1

29. Öncü, S., Karaman, S., Güvenç, L., Ersolmaz, Ş.S., Öztürk, E.S., Çetin, A.E., Sinal, M., 2007, "Robust Yaw Stability Controller Design for a Light Commercial Vehicle Using a Hardware in the Loop Steering Test Rig," <u>IEEE Intelligent Vehicles Symposium</u>, June 13-15, pp. 852-859.

30. Sankaranarayanan, V., Emekli, M.E., Aksun Güvenç, B., Güvenç, L., Öztürk, E.S., Ersolmaz, Ş.S., Eyol, E., Sinal, M., 2007, "Transient Active Body Control of a Ford Transit Connect using Semi-active Suspensions," <u>SAE Commercial Vehicles Conference</u>, Chassis and Suspension Systems, SAE paper number 2007-01-4268, Chicago, Oct. 30 – Nov. 1.

31. Sankaranarayanan, V., Emekli, M.E., Aksun Güvenç, B., Güvenç, L., Öztürk, E.S., Ersolmaz, Ş.S., Eyol, E., Sinal, M., 2007, "Observer Based Semi-Active Suspension

Control Applied to a Light Commercial Vehicle," <u>IEEE/ASME International Conference on Advanced Intelligent Mechatronics</u>, Zurich, Sept. 4-7.

32. Kayış, Ö. ve T.Acarman, 2007, "Clustering Formation for Inter-Vehicle Communication," <u>Proc. Intelligent Transportation Systems Conference</u>, Seattle, USA, pp. 636-641.

33. Dinçmen E, Acarman, T., 2007, "Application of Vehicle Dynamics' Active Control to a Realistic Vehicle Model" <u>Proceedings of American Control Conference</u>, NewYork, USA, pp. 200-205.

34. Dinçmen E, Acarman, T., 2007, "Enhancement of Handling and Cornering Capability for Individual Wheel Braking Actuated Vehicle Dynamics", <u>Proc. 2007 IEEE Intelligent Vehicles Symposium</u>, İstanbul, Turkey, pp. 888-893.

35. Sönmez, Ü., 2007, "Compliant MEMS Crash Sensor Designs: The Preliminary Simulation Results", <u>2007 IEEE Intelligent Vehicles Symposium</u>, İstanbul, Turkey. WeE1.7 pp. 303-308

36. Acarman, T., 2007, "Two Methodologies for The Design of Sliding Mode Servomechanism with Uncertain Exosystems," <u>Proc. 46th Conference on Decision and Control</u>, New Orleans, USA, pp. 2035-2040.

37. C.W. Scherer and I.E. Kose, 2007, "n Robust Controller Synthesis with Dynamic D-scalings" <u>Proc. 46th Conference on Decision and Control</u>, New Orleans, USA.

38. C.W. Scherer and I.E., Kose, 2007, "Gain-Scheduling Synthesis with Dynamic D-scalings," <u>Proc. 46th Conference on Decision and Control</u>, New Orleans, USA.

39. I.E. Kose and C.W. Scherer, 2007, "Robust Feedforward Control of Uncertain Systems using Dynamic IQCs," <u>Proc. 46th Conference on Decision and Control</u>, New Orleans, USA.

40. Acarman, T.; Yiting Liu; Ozguner, U.; "Intelligent cruise control stop and go with and without communication", <u>Proceedings of American Control Conference</u>, 2006, pp.1-6.

41. Aksun Güvenç, B., Kural E., Keşli B., Gülbudak K., Güngör S., Kanbolat A., 2006, "Semi Active Suspension Control System Development for a Light Commercial Vehicle," <u>IFAC Symposium on Mechatronics Systems</u>, Heidelberg, Germany, pp. 391-396.

42. Karaman S., Hacıbekir T., Kural E., Öztürk E.S., Demirci M., Aksun Güvenç, B., 2006, "Design and Hardware-in-the-Loop Simulation of an Automatic Headlight Control System," <u>IFAC Symposium on Mechatronics Systems</u>, Heidelberg, Germany, pp. 746-751.

43. Hacıbekir, T., Karaman S., Kural E., Öztürk E.S., Demirci M., Aksun Güvenç, B., 2006, "Adaptive Headlight System Design Using Hardware-in-the-Loop Simulation," <u>IEEE Conference on Control Applications</u>, Munich, Germany, pp. 915-920.

44. Ararat, Ö., Kural E., and Aksun Güvenç, B., 2006, "Development of a Collision Warning System for Adaptive Cruise Control Vehicles Using a Comparison Analysis of Recent Algorithms," <u>IEEE Intelligent Vehicles Symposium</u>, Tokyo, Japan, pp. 194-199.

45. Acarman, T.; 2006, "An Advanced Driver Assistance System by Using State Dependent Riccati Equation Technique", <u>Proceedings of IEEE Intelligent Vehicles Symposium</u>, Tokyo, Japan, pp.114 – 119.

46. Acarman, T.; Ozguner, U.; 2006, "Sliding Mode Servomechanism Design" <u>Proceedings of IEEE International Conference on Control Application</u>, pp.1002-1007.

47. Boyalı, A., Demirci, M., Acarman, T., Güvenç, L., Tür, O., Uçarol, H., Kiray, B., and Özatay, E., 2006, "Modeling and Control of a Four Wheel Drive Parallel Hybrid Electric Vehicle", <u>Proceedings of the Conference on Control Applications</u>, Munich, Germany, 2006, pp.155-162.

48. Boyalı, A., Demirci, M., Acarman, T., Güvenç, L., 2006, "A Simulation Program for a Four Wheel Drive Parallel Hybrid Electric Vehicle and its Use in Rule Based Controller Development and Implementation," <u>Workshop on Hybrid and Solar Vehicles</u>, Salerno, Italy, November 6, pp. 27-33.

49. Güvenç, L., 2006, "Preventive and Active Safety Applications," <u>International Conference on Automotive Technologies</u>, İstanbul, Nov. 26, Invited paper.

50. Karaman, S., Güvenç, L., Ergen, R., Uygun, B., Güraslan, E., 2006, "Robust PI Control of Diesel Engine Idle Speed," (in Turkish), <u>3rd Automotive Technologies Congress</u> – OTEKON 2006, Bursa, June 26-28, 2006.

51. Akyıldız, B., Köse, İ.E., Güvenç, L., 2006, "Robust Idle Speed Control of a Diesel Engine Using H∞ Approach," (in Turkish), <u>3rd Automotive Technologies Congress</u> – OTEKON, Bursa, June 26-28, 2006.

52. Sönmez, Ü., Streit, D., Tallon, R., and Klinikowski, D., 2006, "Weigh In Motion Studies at PTI: The Preliminary Results", <u>9th International Symposium on Heavy Vehicle Weights and Dimensions</u>, June 18 – 22, The Pennsylvania State University.

53. Karaman, S., Güvenç, L., 2005, "A Real-Time Capable Diesel Engine Model Development using Matlab/Simulink," (in Turkish), <u>Conference for Computer-Aided Engineering and System Modeling with Exhibition,</u> İstanbul, Nov. 14-15.

54. Güvenç, L., Aksun Güvenç, B., Sönmez, Ü., Acarman, T., Köse., E., 2005, "The EU FP6 Funded AUTOCOM Automotive Controls and Mechatronics Research Center at Istanbul Technical University and Its Active Safety Thrust Area", <u>Proceedings of the 1st AUTOCOM Workshop on Preventive and Active Safety for Road Vehicles</u> September 19, 2005, Istanbul, Turkey.

55. Ararat, Ö. and Aksun Güvenç, B., 2005, "A Survey of Recent Developments in Collision Avoidance, Collision Warning and Inter-Vehicle Communication Systems," <u>Proceedings of the 1st AUTOCOM Workshop on Preventive and Active Safety for Road Vehicles</u>, Istanbul, Turkey, pp. 238-246.

56. Kural, E., Hacıbekir T., and Aksun Güvenç B., 2005, "State of the Art of Adaptive Cruise Control and Stop and Go Systems," <u>Proceedings of the 1st AUTOCOM Workshop on Preventive and Active Safety for Road Vehicles</u>, Istanbul, Turkey, pp. 229-237.

57. Öztürk, E.S., Güvenç, L., Yiğit, T., Aksun Güvenç, B., 2005, "Application of Combined Steering and Individual Wheel Braking Actuated Yaw Stability Control To a Realistic Vehicle Model," <u>IFAC World Congress</u>, Praque, July 4-8, 2005.

58. Yu, H., Güvenç, L., Özgüner, Ü., 2005, "Heavy Duty Vehicle Rollover Detection and Active Roll Control," <u>IFAC World Congress</u>, Praque, July 4-8, 2005.

Edited Workshop Proceedings Volumes:

59. L. Güvenç (editor), <u>Proceedings of the 1st AUTOCOM Workshop on Preventive and Active Safety for Road Vehicles</u>, Istanbul, Turkey, 2005.

60. Acarman, T., (editor), 2007, <u>Proceedings of the 3rd AUTOCOM Workshop on Hybrid Electric Vehicle Modeling and Control</u>, İstanbul, Turkey.

Other Publications:

61. M. Sinal, L. Güvenç, B. Aksun Güvenç, 2006, "Ford Otosan: Active Chassis Control," <u>dSpace News</u>, May issue 2, pp. 10-12.

62. M. Sinal, L. Güvenç, B. Aksun Güvenç, 2006-2, "Ford Otosan: Aktiv Fahrwerkregelung," (in German), <u>dSpace News,</u> KundenAnwendungen.

63. L. Güvenç, 2005, "Interview: AUTOCOM Center," (in Turkish) <u>TAYSAD (Association of Turkish Automotive Industry Suppliers) magazine</u>, 2005.

Presentations, Demos

64. E.S. Öztürk (presenter), L. Güvenç, "Yaw and Roll Stability Control," *Proceedings of the 1st AUTOCOM Workshop on Preventive and Active Safety for Road Vehicles*, pp. 247-263 (presnetation slides), İstanbul, Turkey, Sept. 20, 2005.

65. L. Güvenç, <u>"The EU Funded Automotive Controls and Mechatronics Research Center (AUTOCOM) at Istanbul Technical University,"</u> in the UK-Turkey R&D Collaboration Day, organized by The UK Research Office (UKRO) and its Turkish counterpart in Brussels, the Turkish Research and Business Organisations (TUR&BO), Research Beehive, Old Library Building, University of Newcastle, United Kingdom, 8 May, 2005.

http://www.ukro.ac.uk/public/events/training_courses_050518_uk_turkey_collaboration_day.htm

66. L. Güvenç, "The EU Funded Automotive Controls and Mechatronics Research Center (AUTOCOM) at Istanbul Technical University – A Success Story," Info Day on EU FP6 Funding Opportunities, The Marmara Hotel, Taksim, İstanbul, June 27, 2005.
67. L. Güvenç, "Controls and Mechatronics Research at Mekar-İTÜ," Koç University Seminar, Koç University, Sarıyer, İstanbul, December 15, 2006.
68. L. Güvenç, "Automotive Control and Mechatronics Research at Mekar-İTÜ," Kolloquium für Humboldt Forschungsstipendiaten und Preisträger, Alexander von Humboldt Foundation, Ceylan Intercontinental Hotel, İstanbul, April 8, 2006.
69. L. Güvenç, "The EU Funded Automotive Controls and Mechatronics Research Center (AUTOCOM) at Istanbul Technical University," invited speech, Ernst and Young EU FP Info Day, 15 May, 2006, Conrad Hotel, İstanbul.
70. L. Güvenç, "The EU Funded Automotive Controls and Mechatronics Research Center (AUTOCOM) at Istanbul Technical University – A Success Story," invited speech, EU FP7 Turkey Forum, organized by Tübitak, TOBB-ETÜ, Ankara, February 12-13, 2007.
71. Güvenç, L., Introduction into Robotics and Mechatronics, Invited Seminar, Yeditepe University, Department of Mechanical Engineering, İstanbul, Dec.25, 2007.
72. Güvenç, L., R&D in Hybrid Electric Vehicle Technology and its Projection into EU-FP7, Workshop on Hybrid Electric Vehicle Modeling and Control held in conjunction with the 2007 IEEE Intelligent Vehicles Symposium, Keynote Speech, İstanbul, June 12, 2007.
73. Güvenç, L., panelist, Panel Discussion on State of Intelligent Vehicle Research/Deployment around the World, IEEE Intelligent Vehicles Symposium, İstanbul, Turkey, June 15, 2007.
74. Paticipation with large screen TV presentations and three research vehicles that the center worked on (semi-autonomous golf cart, Ford Transit Connect with semi-active suspensions, hybrid electric Ford Transit van – FOHEV-I) in the demo day of 2007 IEEE Intelligent Vehicles Symposium on June 16, 2007.

2.2 Exploitable knowledge and its use

Note that the AUTOCOM center project is for RTD capacity improvement and does not involve patents and IPR issues.

Overview table

Exploitable Knowledge (description)	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable for commercial use	Patents or other IPR protection	Owner & Other Partner(s) involved
1. 4WD Hybrid Electric Vehicle Modeling	Program (Simulink model) for hybrid electric vehicles	Automotive	2008	--	--
2. Hybrid Electric Vehicle Control Strategy	Control algorithm	Automotive	2008	--	--

Exploitable Knowledge (description)	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable for commercial use	Patents or other IPR protection	Owner & Other Partner(s) involved
3. Engine ECU HiL system fault injection software	*Program (Simulink code with GUI)*	*Automotive*	*2008*	*--*	*--*