Cristina Olaverri Monreal, Editor

Transportation Network Modeling and ITS Research Group

EDITOR'S NOTE

Please send your proposal on profiling research activities of your or other ITS research groups & labs in the ITS Research Lab Column to Cristina Olaverri Monreal via olaverri@technikum-wien.at

QUICK FACTS

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Established: 2004

Research Focus: Dynamic Network Modeling & Optimization, Traffic Flow Modeling & Control, Transportation Network Planning & Design, ITS, Road Safety, Rail Traffic Management

Director: Prof. Dr. Hilmi Berk Celikoglu

Hilmi Berk Celikoglu is a full Professor specialized in Traffic Flow Theories and Transportation Network Modeling at the Istanbul Technical University (İTÜ) Department of Civil Engineering and the coordinator of the Working Group on Transportation at İTÜ since 2014. He received B.Sc. (2000), M.Sc. (2002), and Ph.D. (2006) degrees from ITU, where he has been with since 2002. He has been on the editorial board of the Transportation Research Part C: Emerging Technologies and the IEEE ITS Podcast and is an Associate Editor for the IEEE Transactions on Intelligent Transportation Systems and IEEE ITS Magazine. He has contributed as a Guest Editor to special issues at journals IEEE ITS Magazine, Transportation Research Part C: Emerging Technologies, and Accident Analysis & Prevention.

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Mission

Istanbul Technical University (ITU), established in 1773, is one of the world's pioneering technical universities known for its historical, scientific, technological, arts, and sports achievements. Offering 99 undergraduate programs at 13 faculties—with 23 engineering programs accredited by ABET-, 109 graduate and 64 doctoral programs at 6 institutes on five different campuses ITU has around 38400 full-time students, 40% of which is enrolled in graduate programs. As a state university with around 2450 full-time faculties, ITU ranked 79th in Asia by the Times Higher Education World University Rankings in 2016–2017 ([1]) and was placed 242nd by the QS World University Rankings of the same year in the field of Engineering and Technology ([2]).

In addition to around 360 laboratories available at schools and 13 research centers, ITU's Research & Development (R&D) base techno-park, ITU ARI Teknokent, is settled in an area of around 2000 K m^2. With the objective of strengthening Turkey's R&D and innovation based infrastructure, ITU ARI Teknokent aims to support, develop, and direct to the correct channels the synergy created by the collaboration of the academic know-how and R&D companies,

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FIG 1 Istanbul Technical University Ayazaga Campus.

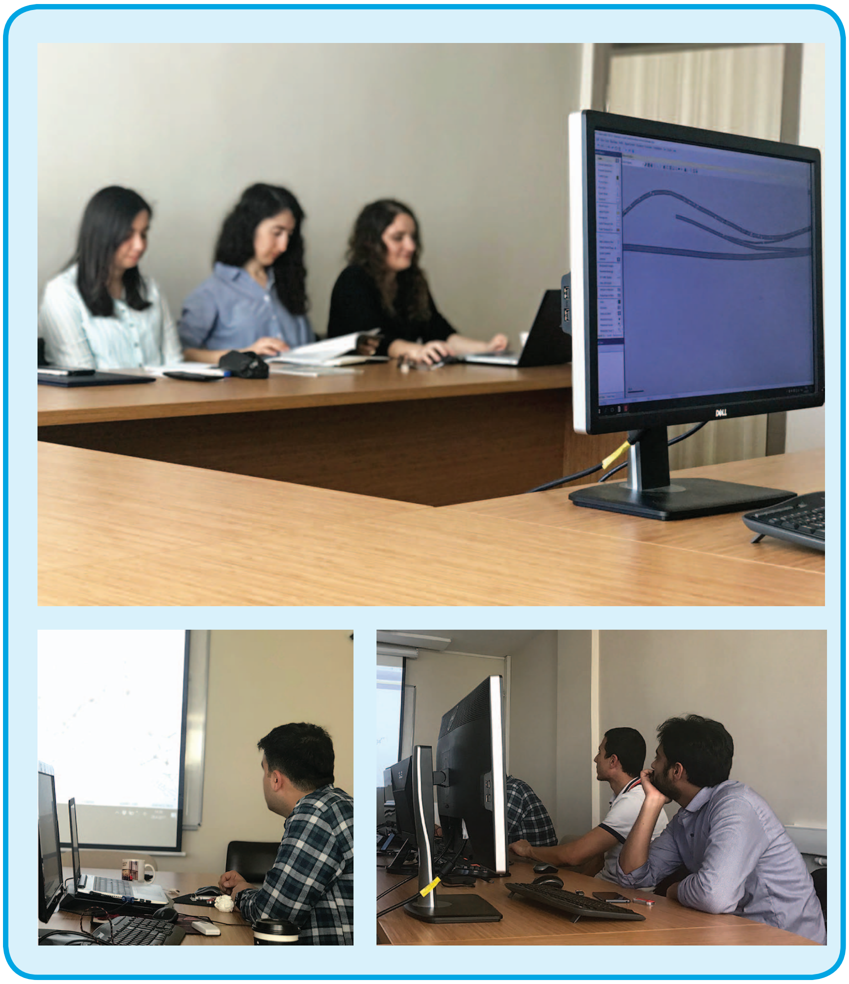


FIG 2 ITU Transportation Network Modeling and ITS Research Group.

where its ecosystem is composed of ITU NOVA Technology Transfer Office, ITU CEKIRDEK Incubation Center, ITU MAGNET Entrepreneurship Center, and ITU GATE International Venture Acceleration ([3]).

The Transportation Network Modeling and ITS Research Group at ITU Faculty of Civil Engineering is dominantly composed of professors from Transportation Division and graduate students from Transportation Engineering Programme at ITU Institute of Science & Technology. With the ultimate motivation of shaping the future mobility considering environmental and economical sustainability, safety and efficiency the Transportation Network Modeling and ITS Research Group focuses on innovative research and development network-wide transportation problems, including dynamic network modeling and optimization, real-time traffic flow modeling and control, transportation network planning and design, road safety, and rail traffic management. Two main project types that the research group have sought fund for up to now are the pure scientific research projects and the R&D projects in collaboration with the industry, supported by the Scientific & Technological Research Council of Turkey (TUBITAK), Consiglio Nazionale delle Ricerche (CNR) Italy, the European Union (EU) Cooperation in Science and Technology (COST), and/or ITU. Tools and equipment, including hardware and software, owned by our research group have been improved in time thanks to funds provided by above mentioned bodies.

International Cooperation

Either with bilateral agreements or within COST Actions, international cooperation has been an important criterion for the ITU Transportation Network Modeling and ITS Research Group in high quality research.

The “Mesoscopic Simulation of Within-Day Dynamics: A Dynamic Network Loading Model” and the “Sustainable Transport: A Dynamic Network Loading

Model for Evaluation & Control of Traffic Pollution" were the projects that were jointly funded by the TUBITAK, Turkey and CNR, Italy and have been our first two international cooperation, within which we've studied: the implementation of a dynamic meso-simulation model of within-day fluctuations of traffic flow introducing a novel flow propagation model that takes into account the acceleration and deceleration of vehicles ([4], [5]); and further adopted this model for the accurate evaluation of traffic pollution, as a function of speed and acceleration of vehicles, with proper interventions to model structure in order to control and reduce emissions to the threshold values recommended by the World Health Organization ([6]).

In 2011 our research group got involved in the EU COST Action TU00903, titled "MULTITUDE—Methods and tools for supporting the Use calibration and validaTIon of Traffic simUlation models", where the participants were from more than 20 research institutions in 17 European countries, the European Commission Joint Research Centre, and market dominating traffic software production companies. A milestone reference, Traffic Simulation: Case for Guidelines ([7]), on: structuring a simulation project/calibration activity; handling the model warm up and run durations, as well the number of runs to be performed; sensitivity analysis and the ways to perform it; and the definitions, methodologies, and indicators of calibration and validation, as well the need of data for these processes has been produced as one of the proceedings of this action.

Aiming to model traffic flow propagation at network level and enabling the appropriate model as a tool to be utilized in real-time systems in conjunction with the specific objectives of EU COST Action TU00903, i.e., on reviewing methods for data collection/reduction, model estimation, calibration, and validation, developing estimation/filtering techniques for traffic data, and defining methodologies for the calibration and validation of models, our research group has finalized a project, titled "Analysis of network flow propagation: model development and utilization of simulation models in calibration process" and funded by the TUBITAK, in which we've developed a traffic flow propagation model, specified a calibration method, and analyzed and validated the performance of the flow propagation model within simulation approach with the incorporation of simulation software. We've formulated the network wide flow propagation problem as a dynamic network loading problem and sought the solution within a dynamic assignment frame sourcing traffic data on: flow measures collected by remote microwave sensors existing on Istanbul road network; traveling times; and other flow relevant measures collected by global positioning system devices. Calibration and validation trials of the overall dynamic assignment process

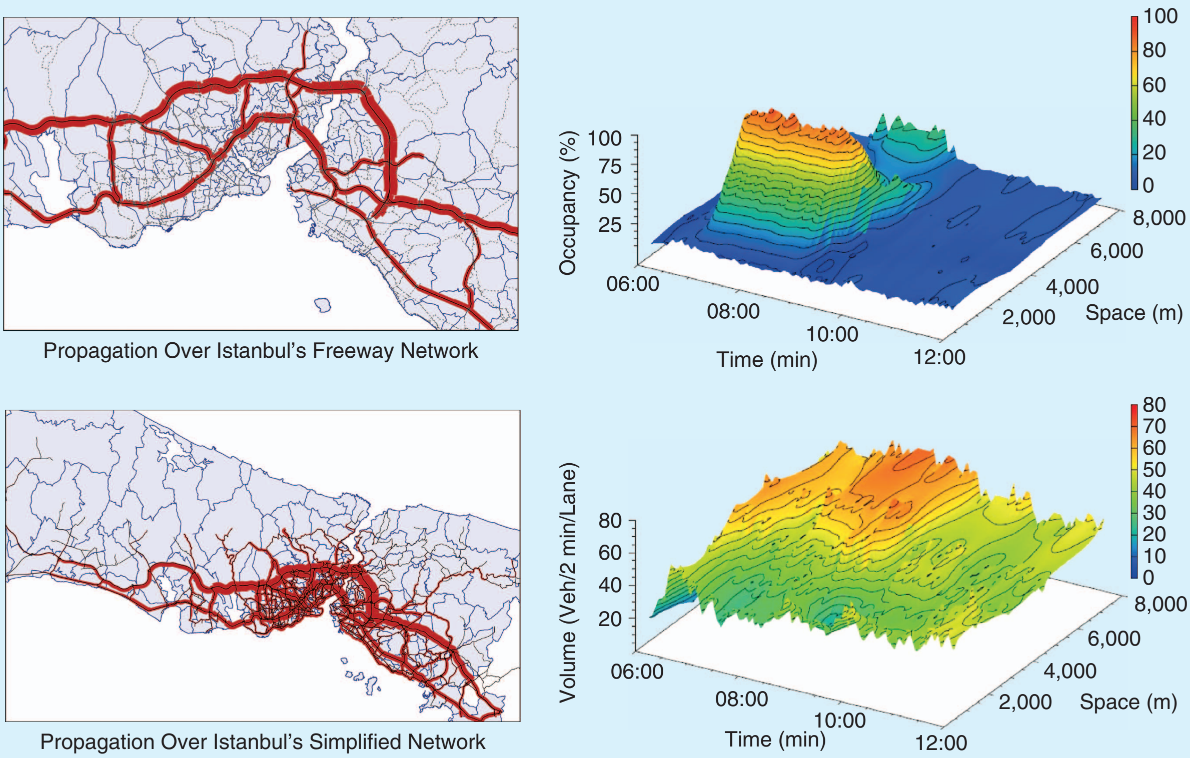


FIG 3 Analysis of Network Flow & Congestion Propagation in Istanbul.

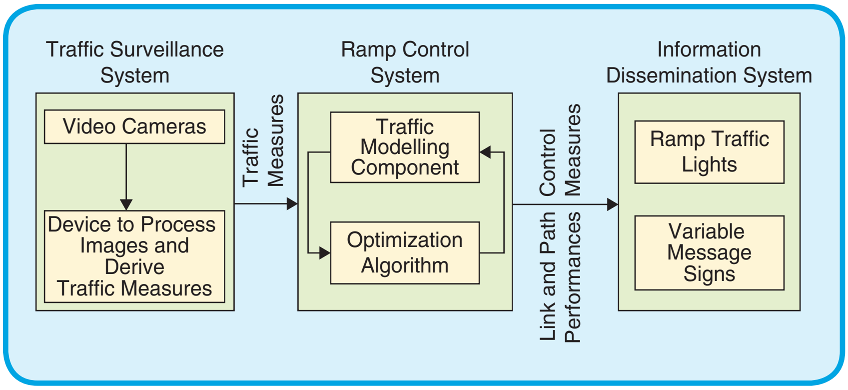


FIG 4 Ramp Control System Architecture.

are sought considering the inputs and outputs of the ultimate Istanbul transportation master plan.

The success of the network flow propagation model in representing actual traffic dynamics ([8], [9]) and the model's adaptive structure to real-time applications to cope with congestion in terms of time consumption and environmental impacts were the main contributions of this study that benefited from the of EU COST Action TU00903.

Currently, our research group has contributed to the WISEmob (W (Well-being & Walkable), S (Sustainability & Safety), E (Environment, Energy & Economy) mobility) COST Action nominee, where the aim of the action is to create a network of professionals that lead the way into WISE perspective of future mobility and establish a cooperative framework for training and capacity-building, as a tool to harmonize all EU Smart Mobility applications.

Cooperation with Industry

ITU Transportation Network Modeling and ITS Research Group has contributions in theory to practice R&D solutions by close collaboration with industry, specifically with Small & Medium-Sized Enterprises as Integrated Systems & Systems Design (ISSD) company that focuses on digital signal processing, software development and electronic design and provides solutions for ITSs such as active traffic management, dynamic junction management, automated number plate recognition, and etc.

In addition to consultancy work collaborations, such as traffic impact studies, the Dynamic Junction Control System—CHAOS™-that is in use at more than 700 intersections in Turkey, India, Georgia, and Kazakstan- ([10]), and etc., our research group cooperated with ISSD in developing an integrated control system, which adopts a series of sequential processes comprising surveillance, modelling, optimization and dissemination, has been developed throughout the industrial R&D project, titled "Design & Development of Ramp Control Systems", funded by TUBITAK.

In the purpose of increasing efficiency and safety at freeway networks by the real-time control of ramp sections at both isolated and coordinated level, an integrated ramp control system is designed.

The equipment composed of video camera recorders and a device used to process image data to map traffic flow measures serves as the surveillance component of the system. Time-varying performance of existing ramp control algorithms were evaluated in comparison to novel propositions, where optimization of link performance measures were sought following the validation with empirical flow features. Proposed algorithms were coded to be integrated to the overall process of the proposed system. Outputs of the system has been input for information on prevailing traffic conditions as well as lights for on-ramps.

Throughout this innovative R&D project ITU Transportation Network Modeling and ITS Research Group had been responsible for the theoretical background of ramp control scheme and algorithms, and the validation of proposed methods with real data, where ISSD had been responsible for developing the ramp metering system that is composed of: devices to surveil traffic and collect and count data, the VIERO™ ([10]); device to process data incorporating proposed methods for ramp control,

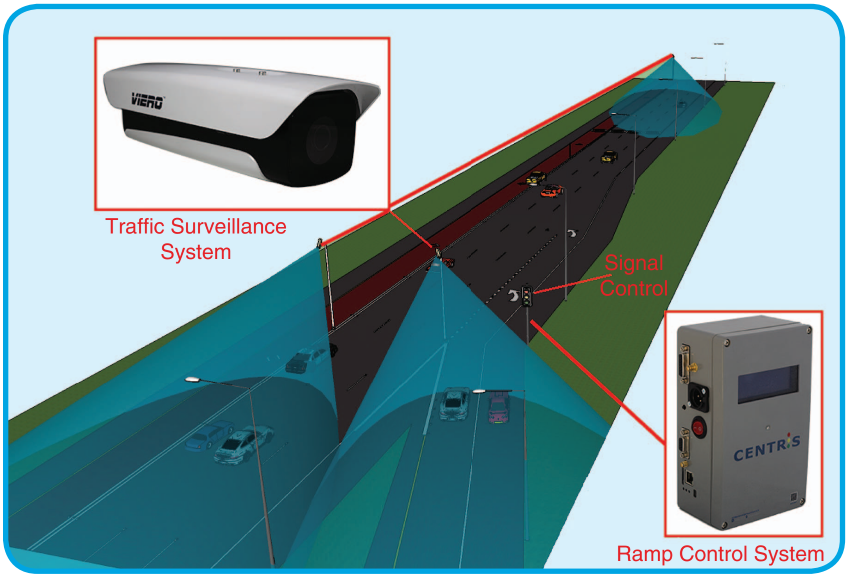
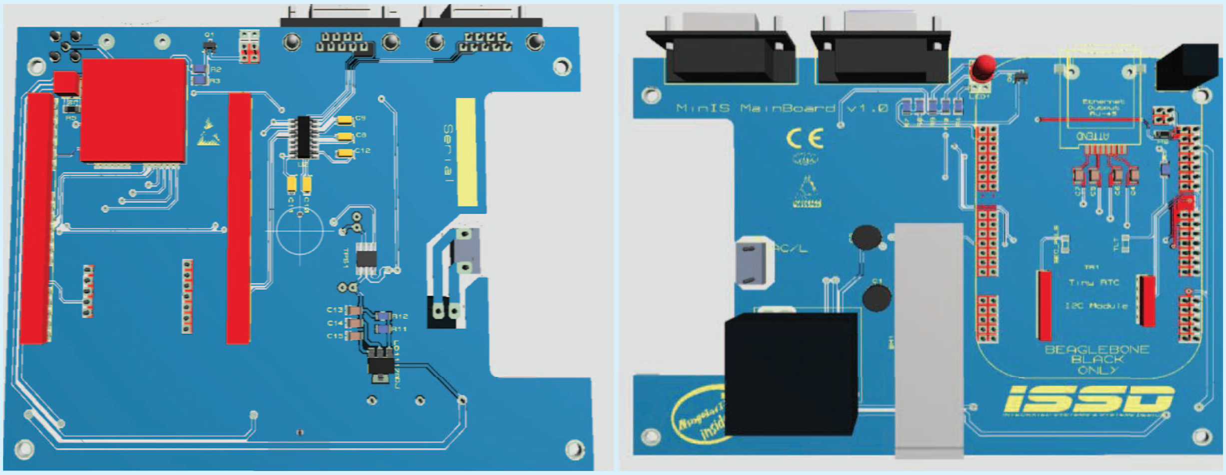


FIG 5 Ramp Control System Components.



Two Sides of Processor in CENTRIS

FIG 6 Hardware Design of Ramp Control System.

the CENTRIS ([10]); and devices to disseminate outputs resulting from control computations.

Currently, we have a number newly initiated ongoing projects on the effect of cooperative vehicle dynamics to traffic flow including connected and automated vehicles, eco-routing of school bus fleet at ITU, and development and HPC implementation of meso-scale models for multi-level dynamic transport network optimization.

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