by M.E. El-Hawary

Announcing SMCS Award Winners

The 2016 Andrew P. Sage Best Transactions Paper Award has been granted to Ziho Kang and Steven J. Landry for their paper, "An Eye Movement Analysis Algorithm for a Multielement Target Tracking Task" and to Ignacio Javier Pérez, Francisco Javier Cabrerizo, Sergio Alonso, and Enrique Herrera-Viedma for their paper, "A New Consensus Model for Group Decision-Making Problems with Non-Homogeneous Experts." This award recognizes the authors of the best paper published annually in *IEEE Transactions on Systems, Man, and Cybernetics*.

Judging is based on originality; technical merit; potential impact to the IEEE Systems, Man, and Cybernetics Society (SMCS) fields of interest; and presentation quality. The award was established in 1998 and is funded by the SMCS through an endowment administered by the IEEE Foundation. The prize is US$500 for each author, up to a maximum of US$2,500 for multiple authors, as well as a plaque for each author.

The Andrew P. Sage Best Transactions Paper Award

An Eye Movement Analysis Algorithm for a Multielement Target Tracking Task: Maximum Transition-Based Agglomerative Hierarchical Clustering

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Eye-movement analysis can be utilized to better understand humans' cognitive processes and to analyze individual and group performances in human-integrated systems. Eye-movement analysis not only considers eye fixation numbers and durations on the targets of interest but also visual scanpaths defined as time-ordered eye fixations and saccades. Although many promising algorithms have been developed to analyze and compare complex visual scanpaths, it is difficult to apply those algorithms when the targets of interests are moving on a display, especially when there are no starting or end points when performing a task and large deviations exist among the long visual scanpaths.

Furthermore, there are cases when we are more interested in investigating which pairs or groups of targets were interrogated together, meaning that the eye fixation order within those pairs or groups of targets may not necessarily matter. For example, in air traffic control, air traffic control operators (ATCOs) need to visually identify which aircraft pairs or groups may have conflicts (i.e., collisions) in the near future when observing a radar screen. The ATCOs would keep looking back and forth between the possible conflict pairs or groups, and it wouldn't necessarily matter which ones within the pair or group were observed first.

To address the issues, an algorithm was developed to characterize, compare, and analyze the eye movement sequences that occur during visual tracking of multiple moving targets. In detail, the concept of visual groupings (VGs), the groupings of the targets that have higher eye-movement transitions compared to other targets, was devised. The developed algorithm characterizes the visual scanpaths by 1) creating an unordered transition matrix from the frequencies of eye fixation transitions among the targets and 2) hierarchically clustering the targets from the unordered transition matrix to obtain multilevel VGs. The multilevel VGs can be used to compare and analyze human performances among individuals and groups.

The proposed algorithm was applied in an air traffic control task (i.e., conflicts detection task) composed of easy, moderate, and difficult scenarios. The algorithm supported identifying different eye movement characteristics between experts and novices for all types of scenarios. Visual scans of the experts created multilevel VGs around the conflict pairs, whereas those of the novices included multiple aircraft not in conflict.

In addition, the novices sometimes did not create multilevel VGs around the conflict pairs. Based on the findings, we were able to deduce why the novices' performances were low. In conclusion, the results showed promise in using the compact representation of eye movements for human performance analysis.

About the Authors

Ziho Kang (zihokang@ou.edu) earned his Ph.D. degree from the School of Industrial Engineering at Purdue University, West Lafayette, Indiana, in 2012. He is currently an assistant professor in the School of Industrial and Systems Engineering at the University of Oklahoma. His research areas are in human factors, cognitive engineering, and human-integrated systems engineering.

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A New Consensus Model for Group Decision-Making Problems with Non-Homogeneous Experts

Group decision making (GDM) consists of multiple individuals interacting to reach a decision. Usually, two processes are necessary to solve GDM problems: a consensus process and a selection process. The consensus process is used to reach a final solution with a certain level of agreement among the experts. It is a dynamic and iterative process, composed of several rounds where the experts express, discuss, and modify their preferences. On the other hand, the selection process uses all individual preferences to obtain a collective solution.

To achieve a high consensus level among the experts, it is useful to provide the whole group of experts with some advice (feedback information) on how far the group is from consensus, what the most controversial issues (alternatives) are, which preferences are in the highest disagreement with the rest of the group, how their change would influence the consensus degree, and so on. In the literature, we find that the consensus models proposed for GDM problems are guided by consensus degrees, similarity measures, and/or consistency measures.

> Judging is based on originality; technical merit; potential impact to the IEEE Systems, Man, and Cybernetics Society fields of interest; and presentation quality.

When we work in heterogeneous GDM frameworks, we have importance degrees associated with the experts by expressing their different knowledge levels on the problem. Usually, the importance degrees are applied in the weighted aggregation operators developed to solve the decision situations.

In our paper, we study another application possibility, i.e., the use of heterogeneity existing among experts to guide the consensus model. Thus, the main goal of the paper is to present a new consensus model for heterogeneous GDM problems guided also by the heterogeneity criterion. It is also based on consensus degrees and similarity measures, but it presents a new feedback mechanism that adjusts the amount of advice required by each expert depending on his or her own relevance or importance level.

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The 2016 IEEE SMC Franklin V. Taylor Memorial Award

The IEEE SMC Franklin V. Taylor Memorial Award is presented annually to recognize the best effective oral presentation and paper at the previous calendar year's SMCS conference. Judging is based on quality and technical merit. The prize consists of US$500 and a plaque funded by the SMCS. The winners for 2016 are George Bucsan, Michael Balchanos, Dimitri N. Mavris, Jae Seung Lee, Masanori Ishigaki, and Atsushi Iwai. A portion of their winning paper is presented next.

Management of Technologies for Electric Vehicle Efficiency Toward Optimizing Range (MOTEVETOR)

Heating, ventilation, and air-conditioning (HVAC) systems control is a primary concern during the conceptual design of hybrid-electric, plug-in hybrid electric vehicle, or electric vehicles (EVs). Due to limitations of battery storage and the lack of a heat source, other than the internal combustion engine, certain challenges arise in controlling the temperature of the passenger cabin. Several technologies are available for allowing additional energy sources, but design complexity can rapidly increase, thus resulting in unfavorable production, operation, and maintenance costs.

The Toyota Technical Center (TEMA-TTC) in Ann Arbor, Michigan, has partnered with the Aerospace Systems Design Laboratory (ASDL) at the Georgia Institute of Technology to address the issue of efficient energy management through HVAC systems control technology integration. As part of this partnership, the MOTEVETOR project was initiated. The objective for this research study was to investigate the conditions for which energy flow through the electrical/thermal networks can be optimized.

A spiral approach has been established for the identification of technologies, architectures, and control methods that can increase the range and efficiency of EVs. A transient baseline vehicle model was developed, and additional architectures and technologies were explored. These steps led to the development of a visualization-based, integrated, parametric analysis and design exploration environment, which allows for testing and evaluation of either drivetrain or control algorithm options, subject to prescribed scenarios. These scenarios have been defined as combinations of driver profiles and varying environmental conditions, or they include modeling of critical event occurrences. Their impact was observed and compared through visuals also included in the MOTEVETOR dashboard, and successful solutions were identified.

After a 3.5-month period of performance, the graduate student team working under this academic research initiative presented its work at the 2015 ASDL External Advisory Board Meeting.

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Extended Abstract

Demand and supply for EVs is rapidly growing around the world, driven by a multitude of factors such as environmental awareness, gas price volatility, monetary incentives, government regulations, and technological advances. Impressive performance figures and styling have made some EVs the stars of the premium segment in terms of both demand and sales increase.

Still, there are reasons for consumers not to orient themselves toward EVs, the most frequently cited being limited driving range, high charging time, and the limited availability of charging infrastructure. Elon Musk, chief executive officer of Tesla, the most popular premium EV company on the market, is quoted as saying: "200 miles is the minimum […] for an electric car. We need 200+ miles in the real world. Not 200 miles in 'AC off, driving on flat road' mode." Only three EVs on the market are currently above that psychological threshold and under ideal conditions. The limited range issue is accentuated when driving conditions are not ideal. Ambient temperature can have a great impact on EVs by affecting the battery pack performance and by making imperative the use of the HVAC system. A National Renewable Energy Laboratory study showed up to 40% higher energy consumption and up to 50% less range in more extreme temperatures.

As the technology of EVs is still in its infancy, consecrated solutions to tackle these issues have yet to appear, and the demand for innovation is very high. Given the large number of possible approaches and solutions presented in specialty literature, a methodology is needed for identifying the most promising ideas and technologies worth extensive investigation. The objective for this research study has therefore been to outline a method for identifying technologies and means of increasing the range and efficiency of electric vehicles, with a particular focus on the HVAC system, the powertrain, and their interaction.

The proposed methodology starts with identifying sets of novel technologies that impact EV figures of merit, estimating their effects, and down-selecting the most promising ones using auto-industry expertise. In parallel, current EV technologies and architectures have to be evaluated to establish a vehicle baseline. The selected baseline vehicle and additional technologies must then be modeled, validated, and integrated into one vehicle model. Following the modeling, experiment designs must be created and used to drive simulations that together comprise the design space exploration. The explored design options must be graded based on multiple criteria such as performance, maturity, and cost. Finally, to make the best use of available data, it is imperative to create an interactive multicriteria decision support tool for vehicle designers.

The proposed methodology was followed and demonstrated by the Georgia Tech student team, supported by research engineers and advised by the industry side (Toyota TTC). After the novel technology investigation, the most promising idea that emerged refers to a thermal management system architecture, built around a heat pump with integrated fluid loops that make use of waste heat from the battery, motor, and power electronics.

For the powertrain area of interest, the most promising ideas found are ways of storing more energy through novel battery chemistries, such as lithium-sulfur, and ways of generating more energy such as using regenerative braking aggressively and almost exclusively.

For the baseline system, a configuration similar to the most popular mainstream EV on the market was chosen and modeled. The powertrain chosen is composed of a permanent magnet synchronous motor powered by a Li-ion battery through an insulated-gate bipolar transistor (the most conventional power switching technology on the market) power converter unit. The drivetrain uses a single-gear transmission to power the front wheels. On the thermal management side, the architecture uses liquid cooling for the powertrain, air cooling for the battery, and a heat pump and electrical heater for the cabin (HVAC). The software chosen for modeling the system in this case study is DYMOLA (Modelica language) due to the array of available libraries with parametrized models. The modeling effort resulted in a new Modelica library for electromechanical and thermal simulation of EVs. The top-level models of the library, the Vehicle System (mechanical/electrical aspects) and the Thermal Management System, were integrated externally into a co-simulation by using a MATLAB fixed-point iteration scheme to reduce simulation time. This solution was automated through scripting and was used to run a three-level full factorial design of experiments.

Using the data obtained from the simulations, a low-level performance-only overview was first conducted through sensitivity analysis. Relationships between the selected inputs and outputs are shown in a table of charts. This simultaneous visualization of all interactions aids in searching for errors by observing erroneous trends and helps reduce the dimensionality of the problem by identifying inputs with little impact on results. For a higher-level overview, a technique for multicriteria decision making, TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), was used. This technique allows the user to select the relative importance of objectives and chooses the solution closest to the ideal and farthest from the worst possibility. The algorithm was coded into an Excel-driven interface for effectiveness and portability.

> **What is an engineer? What do engineers really do? How do they affect the world as we know it? "Every day is a new learning experience for them."**

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