THE ATHENS INSTITUTE FOR EDUCATION AND RESEARCH

Abstract Book

7th Annual International Conference on Industrial, Systems and Design Engineering 24-27 June 2019, Athens, Greece

Edited by
Gregory T. Papanikos

2019

Abstracts
7th Annual International Conference on Industrial, Systems and Design Engineering
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(In Alphabetical Order by Author's Family name)

Preface

This book includes the abstracts of all the papers presented at the *7th Annual International Conference on Industrial, Systems and Design Engineering (24-27 June 2019)*, organized by the Athens Institute for Education and Research (ATINER).

In total 20 papers were submitted by 20 presenters, coming from 13 different countries (Canada, Chile, China, Germany, Italy, Japan, Jordan, Romania, South Africa, Taiwan, UAE, UK, and USA). The conference was organized into 8 sessions that included a variety of topic areas such as Manufacturing, Machine Learning, Optimization, Environmental Issues and Sustainability, Recent Issues in Transportation, Ergonomics, and more. A full conference program can be found before the relevant abstracts. In accordance with ATINER's Publication Policy, the papers presented during this conference will be considered for inclusion in one of ATINER's many publications.

The purpose of this abstract book is to provide members of ATINER and other academics around the world with a resource through which to discover colleagues and additional research relevant to their own work. This purpose is in congruence with the overall mission of the association. ATINER was established in 1995 as an independent academic organization with the mission to become a forum where academics and researchers from all over the world could meet to exchange ideas on their research and consider the future developments of their fields of study.

It is our hope that through ATINER's conferences and publications, Athens will become a place where academics and researchers from all over the world regularly meet to discuss the developments of their discipline and present their work. Since 1995, ATINER has organized more than 400 international conferences and has published nearly 200 books. Academically, the institute is organized into 6 divisions and 37 units. Each unit organizes at least one annual conference and undertakes various small and large research projects.

For each of these events, the involvement of multiple parties is crucial. I would like to thank all the participants, the members of the organizing and academic committees, and most importantly the administration staff of ATINER for putting this conference and its subsequent publications together. Specific individuals are listed on the following page.

Gregory T. Papanikos
President

7th Annual International Conference on Industrial, Systems and Design Engineering
24-27 June 2019, Athens, Greece

Scientific Committee

All ATINER's conferences are organized by the Academic Council. This conference has been organized with the assistance of the following academics, who contributed by a) setting up the program b) chairing the conference sessions, and/or c) reviewing the submitted abstracts and papers:

1. Gregory T. Papanikos, President, ATINER & Honorary Professor, University of Stirling, UK.
2. Theodore Trafalis, Director, Engineering & Architecture Division, ATINER, Professor of Industrial & Systems Engineering and Director, Optimization & Intelligent Systems Laboratory, The University of Oklahoma, USA.
3. Timothy Young, Director, Center for Business & Manufacturing Excellence (CBME), ATINER & Professor and Graduate Director, Center for Renewable Carbon, The University of Tennessee, USA.
4. Dimitrios Goulias, Head, Civil Engineering Unit, ATINER and Associate Professor & Director of Undergraduate Studies Civil & Environmental Engineering Department, University of Maryland, USA.
5. Yew-Chaye Loo, Professor Emeritus, Griffith University, Australia.
6. Fouad Mohammad, Academic Member, ATINER & Senior Lecturer, Nottingham Trent University, UK.
7. Sanaul Chowdhury, Senior Lecturer, Griffith University, Australia.
8. Olga Gkounta, Researcher, ATINER.

FINAL CONFERENCE PROGRAM
7th Annual International Conference on Industrial, Systems and Design Engineering, 24-27 June 2019, Athens, Greece

Monday 24 June 2019

Conference Venue: Titania Hotel, 52 Panepistimiou Avenue, Athens, Greece (close to metro station *Panepistimio*)

07:50-08:20 Registration and Refreshments

08:30-09:00 (Room A - 10th Floor): Welcome and Opening Address by Gregory T. Papanikos, President, ATINER.

09:00-10:30 Session I (Room C - 10th Floor): Manufacturing

Chair: Olga Gkounta, Researcher, ATINER.

1. Timothy Young, Professor, University of Tennessee, USA. Quantifying Interactions in Manufacturing using Regression Tree Models – A Useful Inductive Step for Planning a Designed Experiment.
2. Glen Bright, Professor, University of KwaZulu-Natal, South Africa, Ganiyat Soliu, PhD Student, University of KwaZulu-Natal, South Africa & Chiemela Onunka, Mangosuthu University of Technology, South Africa. Performance Optimization on Waiting time using Queuing Theory in an Advanced Manufacturing Environment: Robotics to Enhance Productivity.

10:30-12:00 Session II (Room C - 10th Floor): Special Topics in Engineering

Chair: Theodore Trafalis, Director, Engineering & Architecture Division, ATINER, Professor of Industrial & Systems Engineering and Director, Optimization & Intelligent Systems Laboratory, The University of Oklahoma, USA.

1. Tsutomu Yoshida, Professor, Takushoku University, Japan. Measurement of Time-Varying Stress by Natural Frequency of Impact Sound.
2. Nader Zamani, Professor, University of Windsor, Canada. Two Case Studies Involving Connection Properties for FEA in Catia v5.

12:00-13:30 Session III (Room B - 10th Floor): Recent Issues in Transportation

Chair: Sanaul Chowdhury, Senior Lecturer, Griffith University, Australia.

1. Akmal Abdelfatah, Professor, American University of Sharjah, UAE & Osama El-Sahly, Graduate Student, American University of Sharjah, UAE. Influence of Autonomous Vehicles on Freeway Traffic Performance for Undersaturated Traffic Conditions.
2. Kuo-Liang Lin, Professor and Department Head, I-Shou University, Taiwan. A Vision-Based Method for Determining Degradation Level of a Road Marking.
3. Marian Goellner, Research Fellow, PhD Student, Ostfalia University of Applied Sciences, Germany. Fusion Structure for Environment Perception and Model-Predictive Navigation of Autonomous Vehicles.
4. Sarvani Sonduru Pantangi, Graduate Research Assistant, University at Buffalo, The State University of New York, USA, Md Tawfiq Sarwar, Assistant Professor, East West University, Bangladesh, Abhishek Bhargava, Data Scientist, Advisory Services, USA, Grigorios Fountas, Lecturer, Edinburgh Napier University, UK, Satish Mohan, Associate Professor, University at Buffalo, The State University of New York, USA & Panagiotis Ch. Anastasopoulos, Associate Professor, University at Buffalo, The State

University of New York, USA. Public-Private Partnerships for Roadway Construction and Preservation, and Traffic Safety: An Exploratory Empirical Analysis of Crash Frequencies.

13:30-14:30 Lunch

14:30-16:00 Session IV (Room B - 10th Floor): Environmental Engineering

Chair: Timothy Young, Professor, University of Tennessee, USA.

1. Guojian He, Associate Professor, Tsinghua University, China, Hongwei Fang, Professor, Tsinghua University, China, Xu Han, PhD Student, Tsinghua University, China & Lei Huang, Assistant Research Fellow, Tsinghua University, China. The Impacts Analysis of Plant Shape and Spatial Distribution on the Flow Properties.
2. Lei Huang, Assistant Research Fellow, Tsinghua University, China & Hongwei Fang, Professor, Tsinghua University, China. Characteristics of Bacterial Community in the Surface Sediment of Three Gorges Reservoir.
3. Camilo Souto, PhD Candidate, Universidad de Concepción, Chile, Octavio Lagos, Associate Professor, Universidad de Concepción, Chile, Eduardo Holzapfel, Professor, Universidad de Concepción, Chile & Daniele Zaccaria, Specialist, University of California, Davis, USA. A Modified Surface Energy Balance to Soil Evaporation on Partially Wetted Orchards with Drip Irrigation Systems.
4. Marwan Batiha, Professor, Al-Hussein Bin Talal University, Jordan. Synthesis, Characterization and Properties of Bottom Ash Based Geopolymer from Medical Wastes Incineration.
5. Ziad Al-Ghazawi, Associate Professor, Jordan University of Science and Technology, Jordan, Khaldoon Bani-Hani, Professor, Jordan University of Science and Technology, Jordan & Rami Alawneh, Professor, Jordan University of Science and Technology, Jordan. Testing and Evaluation of the Use of Digital Image Analysis and Artificial Neural Networks in Monitoring Wastewater Quality.

21:00-23:00 Greek Night and Dinner

Tuesday 25 June 2019

08:30-12:00 Session V: An Educational Urban Walk in Modern and Ancient Athens

Group Discussion on Ancient and Modern Athens.
Visit to the Most Important Historical and Cultural Monuments of the City (be prepared to walk and talk as in the ancient peripatetic school of Aristotle)

Conference Venue: University of Athens (Kapodistriako), 48 Akadimias Street, Athens, Greece (map, close to metro station *Panepistimio*)

12:30-14:00 Session VI (Room B): Sustainability, Resilience and Other Issues

Chair: Fouad Mohammad, Senior Lecturer, Nottingham Trent University, UK.

1. John Sansalone, Professor, University of Florida, USA. Permeable Pavement as Green and Low Impact Development Urban Infrastructure.
2. Norma Jean Mattei, Professor, University of New Orleans, USA. Barriers to Sustainable and Resilient Inland Waterway Infrastructure in the United States.
3. Onur Kuzgunkaya, Associate Professor, Concordia University, Canada, Navneet Vidyarthi, Associate Professor, Concordia University, Canada & Masoud Amel Monirian, PhD Student, Concordia University, Canada. Mixed-Integer Second-Order Cone Programming: An Application in the Design of Preventive Healthcare Facility

Network.
4. Anna Mazzi, Assistant Professor, University of Padova, Italy & Beatrice Gatto, Master Student, University of Padova, Italy. Circular Economy Concept in Sustainable Building Design.

14:00-15:00 Lunch

15:00-16:00 Session VII (Room B): Special Topics: Design, Construction and Machine Learning

Chair: Yew-Chaye Loo, Professor Emeritus, Griffith University, Australia.

1. Hector Estrada, Professor, University of the Pacific, USA. Performance Based Design (PBD): A Renovating Seismic Design in Building Codes.
2. Fouad Mohammad, Senior Lecturer, Nottingham Trent University, UK & Michael Wright, Principal Structural Engineer, Arc Partnership, UK. Optimum Design of Cold-Formed Steel Mono-Pitch Portal Frames According to BS 5950.
3. Andreea Mihailescu, Research Scientist / Development Engineer, Lasers Department, National Institute for Lasers, Plasma and Radiation Physics / Politehnica University of Bucharest, Romania. Machine Learning for Intelligent Wireless Sensors Networks, Wearables and Autonomous Unmanned Systems.

20:30- 22:00 Dinner

Wednesday 26 June 2019
Mycenae and Island of Poros Visit
Educational Island Tour

Thursday 27 June 2019
Delphi Visit

Friday 28 June 2019
Ancient Corinth and Cape Sounion

Akmal Abdelfatah
Professor, American University of Sharjah, UAE
&
Osama El-Sahly
Graduate Student, American University of Sharjah, UAE

Influence of Autonomous Vehicles on Freeway Traffic Performance for Undersaturated Traffic Conditions

Autonomous vehicles (AVs) are smart driving technology that are expected to alter the perception of transportation and become the next generation of vehicles. One of the major challenges that are expected to happen is the interaction between AVs and regular vehicles (RVs) in the traffic fleet, using the same roads, as the mode share for AVs (percentage of AVs) would not be 100% in the early stages of adoption. The purpose of this study is to evaluate the impacts of AVs on freeway traffic performance at different mode share values of AVs ranging from 0% to 100% and at two different undersaturated traffic volume levels (for demand to capacity ratio of 0.6 and 0.8). The study considered a section of a major freeway in Dubai, UAE as the test corridor for the study. VISSIM 10 was used to develop a microsimulation model to evaluate different scenarios that represent different mode share of AVs and different demand to capacity ratios. The results showed that increasing AVs mode share from 5% to 100% yields the following:

- The average speed at 0.6 demand to capacity ration improved by about 5% (at 5% AVs) to about 10% (at 100% AVs). While at 0.8 demand to capacity ratio the improvement ranges from about 5 % (at 5% AVs) to about 15% (at 100% AVs).
- At 0.6 demand to capacity ratio the travel time decreased by less than 1% (at 5% AVs) to about 8% (at 100% AVs). While the reduction at 0.8 demand to capacity ratio is about 4 % (at 5% AVs) and about 12% (at 100% AVs).
- A reduction in delay at 0.6 demand to capacity ratio that ranges from about 18% (at 5% AVs) to about 97% (at 100% AVs). While the reduction at 0.8 demand to capacity ratio that ranges from about 11% (at 5% AVs) to about 94% (at 100% AVs).

The improvement in traffic performance when AVs mode share increases from 0% to 100% is because RVs are replaced by AVs that can travel with higher constant speed and with a smaller time headway.

T-test was carried out to examine the difference between scenarios' average speeds and between the average speed of both AVs and RVs. The test showed that there is a significant difference between the AVs and RVs

performance at demand to capacity ratio of 0.6 and 0.8, for all AVs mode shares because the low congestion at this demand to capacity ratios, so AVs can travel freely with speeds significantly higher than RVs.

Ziad Al-Ghazawi
Associate Professor, Jordan University of Science and Technology, Jordan
Khaldoon Bani-Hani
Professor, Jordan University of Science and Technology, Jordan
&
Rami Alawneh
Professor, Jordan University of Science and Technology, Jordan

Testing and Evaluation of the Use of Digital Image Analysis and Artificial Neural Networks in Monitoring Wastewater Quality

Monitoring wastewater treatment plants in Jordan has mostly focused on a few effluent parameters to meet the regulations of Water Authority of Jordan (WAJ) and other ministries. Image-based monitoring of wastewater quality parameters provides an easy tool to improve plant efficiency and accurate process control. This study used the digital image analysis (DIA) and artificial neural networks (ANN) techniques to develop an economical method for monitoring wastewater quality in terms of BOD_5, SS and Turbidity. The study used two types of wastewater samples including real wastewater samples, which were collected from Jordan University of Science and Technology's wastewater treatment plant (WWTP) and Wadi Arab WWTP, in addition to synthetic wastewater samples which were prepared by dilution of real wastewater with de-ionized distilled water. Two ANN models were developed to classify wastewater digital images and to predict wastewater quality parameters. The first ANN model was developed for predicting BOD_5 concentration in wastewater, the second ANN model was developed for predicting SS concentration and Turbidity content in wastewater. The color indices associated with each wastewater image pixels were used as the only inputs for each ANN model. The results showed good correlations between observed and predicted values of BOD_5, SS and turbidity. Finally, ANN models were able to classify wastewater digital images and to predict BOD_5, SS and turbidity in wastewater from digital images color indices.

Marwan Batiha
Professor, Al-Hussein Bin Talal University, Jordan

Synthesis, Characterization and Properties of Bottom Ash Based Geopolymer from Medical Wastes Incineration

Jordan has witnessed a rapid development in private and public medical care establishment. This results in a significant increase in the generation of clinical waste. An investigation of the handling, storage, transport and disposal practices at Jordanian hospitals, medical laboratories and pharmaceutical plants was conducted to ensure a safe disposal and avoid risk to public health. The disposal process is to convert this hazardous waste to ash by using an incineration process.

The ash was characterized in terms of particle size distribution, chemical and mineralogical composition in order to convert it into geopolymer. The major elements found in the medical waste ash were Ca, Si, Al, Na, Cl, Fe, Ti, S, Mg, Ba and K, while the main mineral phases found in the ash were calcite, halite, sylvite, hematite, hydrochlorborite, cristobalite, melanterite and chlormayenite.

During polymerization process, Silicon and aluminum ratio, solid and water ratio, the fineness of obtained ash, the concentration of alkali, curing temperature and curing time were studied.

A geopolymer was prepared by mixing a ground ash (different particle size) with different NaOH concentrations with a ratio of 1.25 ash to NaOH. The obtained mixtures were pre-cured at different temperatures and time. The product along with the ash were characterized using XRF and XRD. It was found that higher concentration of sodium hydroxide solution and long curing time results in higher compressive strength of bottom ash based geopolymer.

Glen Bright
Professor, University of KwaZulu-Natal, South Africa
Ganiyat Soliu
PhD Student, University of KwaZulu-Natal, South Africa
&
Chiemela Onunka
Mangosuthu University of Technology, South Africa

Performance Optimization on Waiting time using Queuing Theory in an Advanced Manufacturing Environment: Robotics to Enhance Productivity

Performance optimization plays a key role in controlling the waiting time during manufacturing in an advanced manufacturing environment to improve productivity. Queuing mathematical modeling theory was used to examine the performance of multi-stage production line. Robotics as a disruptive technology was implemented into a virtual manufacturing scenario during packaging process to study the effect of waiting time on productivity. The queuing mathematical model was used to determine the optimum service rate required by robots during packaging stage of manufacturing to yield an optimum production cost. Different rates of production were assumed in a virtual manufacturing environment, cost of packaging was estimated with optimum production cost. An equation was generated using queuing mathematical modeling theory and the theorem adopted for analysis of the scenario is the Newton Raphson theorem. Queuing theory presented here provides adequate analysis of the number of robots required to regulate waiting time in order to increase the number of output. Arrival rate of the product was fast which shows that queuing mathematical model was effective in minimizing service cost and the waiting time during manufacturing. At a reduced waiting time, there was an improvement in the number of products obtained per hour. The overall productivity was improved based on the assumptions used in the queuing modeling theory implemented in the virtual manufacturing scenario.

Marian Goellner
Research Fellow, PhD Student, Ostfalia University of Applied Sciences, Germany

Fusion Structure for Environment Perception and Model-Predictive Navigation of Autonomous Vehicles

A research focus of the Research group for Control Engineering and Vehicle Mechatronics at Ostfalia University is on autonomous driving using existing function carriers and research vehicles. An important part of autonomous driving is the recognition and classification of other road users as well as the detection of obstacles. Together with roadway detection and global position data, a trajectory is to be generated which can be followed by an autonomous vehicle with the aid of predictive control technology.

The paper describes the entire process from the acquisition of measurement data to the fusion of the data to an environment map, the generation of trajectories on this map and the subsequent model-predictive trajectory control.

First, the preparation and pre-processing of the sensory input to ensure error-free and exact detection is to be demonstrated. It is not only important to collect static and dynamic information about the contour of the surrounding terrain and the objects moving in it, but also to classify these objects. Classification can be used to make model-based statements about future movements of the object. It is possible, for example, that a stationary car is detected as an immobile object, but the classification can be used to calculate preventive scenarios that predict the car's future movement. The data obtained are then used for autonomous driving of a machine and are therefore safety-critical. As described in the full paper, the usable measuring principles of the sensors suitable for environmental detection can be deceived by various external influences. One way to compensate for the individual disadvantages of environmental sensors is to merge, assign and validate the measured data with a data fusion process.

The fusion results are detailed objects in the environment, which can be fully described by classification and localization. These objects can now be drawn together with static obstacles such as road markings or walls in a time-varying environment map.

By projecting the global target vector, a local trajectory can now be superimposed in this map.

By optimization methods a trajectory optimal in time and energy is represented in form of a sequence of waypoints to be traveled, which are passed to a subordinate control as set points. If simple linear controllers are used to follow these points, the trajectory is traversed with the

appropriate control quality, but reacts to the changes in the target coordinates as well as to a set point step. Better results thus provide control strategies which take into account the next expected set point.

A valid approach to the tracking is a model predictive control algorithm which allows the prediction of future driving conditions and thus allows the direct integration of following waypoints. On the basis of an extended state space model of the model plant, the future course of the state variables of the system can be predicted. Since the underlying model description usually does not completely correspond to the real system, the principle of the "Receding horizon control" is to be applied here.

Hector Estrada
Professor, University of the Pacific, USA

Performance Based Design (PBD): A Renovating Seismic Design in Building Codes

There are a number of shortcomings in most current building code specifications; in particular, they only address the life-safety function of buildings in the event of a rare natural disaster that causes a sudden drastic increase in load – an extreme event. Performance Based Design (PBD) provides a more specific set of requirements for different levels of intensity and occurrence intervals of a natural disaster, allowing engineers to focus on the serviceability of buildings. A serviceable building must perform all original functions for which it was intended, including life-safety. Allowing a building to be serviceable after going through a rare natural disaster decreases the total building cost, and reduces its carbon footprint, over its lifespan. This paper focuses on the current shortcomings of seismic design in building codes and provides an overview of seismic performance based structural design in the context of sustainability. It also covers the recent developments in PBD introduced in the 2010 edition of the American Society of Civil Engineers (ASCE), Minimum Design Loads for Buildings and Other Structures better known as ASCE/SEI 7. We also discuss PBD for existing buildings; particularly the difference between life-safety and collapse prevention.

Guojian He
Associate Professor, Tsinghua University, China
Hongwei Fang
Professor, Tsinghua University, China
Xu Han
PhD Student, Tsinghua University, China
&
Lei Huang
Assistant Research Fellow, Tsinghua University, China

The Impacts Analysis of Plant Shape and Spatial Distribution on the Flow Properties

Vegetation in shallow water systems, such as rivers and wetlands, plays an important role in altering flow resistance and turbulence. Submerged or emergent vegetation reacts to the drag of water by either remaining erect, oscillation in response to turbulent fluctuations, or bending. There are extensive research focused on the plant-flow interactions. However, given the variety for plants and their temporal and spatial variability, in addition to the wide rand of flow and morphological conditions in nature, significant knowledge gaps still exist. To get the details of the velocity distribution around the plants in three-dimensional direction, Large Eddy Simulation is used in this study. Three plant shapes with different configurations are formed with Immersion Boundary Method. The river bed is formed by five layer packed particles so that both permeability and roughness can be considered. Based on the LES model, three dimensional velocity is simulated. The relationship between the turbulent events and eddy and the plants shapes are analyzed. Moreover, using the double average method, the form-induced normal and shear stresses are calculated for different plant shapes and different spatial distribution. It can be seen the significantly influence under and over-canopy flow behaviour, as well as the interfering wakes among the stems. Element scale (stem scale) turbulence is generated within the canopy. These phenomena will affect the sediment transport and the mass diffusion. Then, the drag and the drag coefficient distribution are calculated in different cases. The results show that not only the additional drag exerted by plants can reduces the mean flow velocity, but also the plant form and the spatial distribution can have a significant effect on the mean flow field. These results are applied to the ecological restoration of the Yongding River in Beijing. The plant types and density are suggested for the engineering design and the evaluation of the flood risk and the sediment transport.

Lei Huang
Assistant Research Fellow, Tsinghua University, China
&
Hongwei Fang
Professor, Tsinghua University, China

Characteristics of Bacterial Community in the Surface Sediment of Three Gorges Reservoir

Bacteria are ubiquitous in aqueous environment and crucial for the biogeochemical processes. The characteristics and distribution of bacterial community will be an important reflection of human activities. In this study, surface sediment samples were collected from the Three Gorges Reservoir (TGR) in June, 2015 to characterize the bacterial communities using 16S rRNA gene sequencing, including sediment samples from the dam area, mainstream, urban area, and tributaries. The responses of bacterial communities to environmental variables are then statistically analyzed using the Redundancy analysis (RDA) and heatmap. Results show that *Proteobacteria*, *Acidobacteria*, *Chloroflexi*, *Bacteroidetes*, *Firmicutes*, *Nitrospirae* are the dominant phyla of the bacterial communities, accounting for over 80% of the total abundance. There is a greater abundance of *Proteobacteria* and *Nitrospirae* in the mainstream sites, while more *Acidobacteria*, *Chloroflexi*, and *Bacteroidetes* in the urban area sites, and more *Firmicutes* in the tributary sites. The bacterial communities are affected by environmental variables such as the sediment size D_{50}, water depth, dissolved oxygen *DO*, and potential ecological risk index R_I. For example, *Firmicutes* is negatively correlated with the *DO* concentration, i.e. preferring an anaerobic condition. *Cyanobacteria* is positively correlated with the water depth, probably due to the eutrophication of the reservoir. *Aminicenantes*, *Armatimonadetes*, *Actinobacteria*, and *Caldiserica* are all positively correlated with the R_I index, implying a potential effect of heavy metal distribution on the bacterial communities. The reservoir operation results in sediment sorting and increasing water depth along the mainstream, as well as heavy metal accumulation in the surface sediment, thus exerting effects on the characteristics of bacterial community and accordingly affecting the biogeochemical processes. Overall, there is no significant difference of the community richness and diversity among these sediment samples. This study will provide a better understand of the effects of impoundment on bacterial community and the resultant ecological implications.

Onur Kuzgunkaya
Associate Professor, Concordia University, Canada
Navneet Vidyarthi
Associate Professor, Concordia University, Canada
&
Masoud Amel Monirian
PhD Student, Concordia University, Canada

Mixed-Integer Second-Order Cone Programming: An Application in the Design of Preventive Healthcare Facility Network

Preventive healthcare (PH) programs and services aim at reducing the likelihood and severity of potentially life-threatening illness by early detection and prevention. The effectiveness of these programs depends on the participation level and the accessibility of the users to the facilities providing the services. Factors that impact the accessibility include the number, type, and location of the facilities as well as the assignment of the clients to these facilities. In this paper, we study the impact of system-optimal (i.e., directed) choice on the design of the preventive healthcare facility network under congestion. We present a model that simultaneously determines the location and the size of the facilities as well as the allocation of clients to these facilities so as to minimize the weighted sum of the total travel time and the congestion associated with waiting and service delay at the facilities. The problem is set up as a network of spatially distributed M/G/1 queues and formulated as a nonlinear mixed integer program. We use Mixed-Integer Second-Order Cone Programs (MISOCPs) as an efficient procedure for non-linear models. Ten different MISOCPs reformulations, containing strong valid inequalities, are developed and compared. We also compare MISOCP reformulations against a piecewise linear approximation and cutting plane algorithm exact solution approach (ε-optimal) to show the quality of the solutions generated by the MISOCPs. The results show that the MISOCPs can perform better in many cases where the piecewise approximation is inefficient. Moreover, the results show that the optimal PH facility network design can reduce the total time spent by clients which can be determined within a reasonable CPU time by MISOCPs.

Kuo-Liang Lin
Professor and Department Head, I-Shou University, Taiwan

A Vision-Based Method for Determining Degradation Level of a Road Marking

Road marking provides informative guidance for vehicle drivers and is a critical aid in maintaining road safety. Quality of road marking plays an important role in providing satisfactory functional condition of a road pavement. Pavement marking degrades as traffic goes, so quality inspection must be made regularly to ensure its serviceability. This paper proposes a quality inspection method for determining the level of degradation of a road marking utilizing machine vision technologies. The method is executed by a determination unit including a processor, a database of reference image, and an image- capturing device having a plurality of shutter speeds. An analytical algorithm is incorporated with the system so that the method can adapt to different illumination situations. After receiving examined road marking image, the analytical algorithm generates an image according to the selected shutter speed by assessing surrounding illumination level, then retrieves one of the reference data from the database that has the same shutter speed as the examined road marking, and next performs a difference determination procedure between the retrieved reference data and the examined data. Finally, the processor outputs a normalized result of the level of degradation of the examined road marking. As such, accurate determination on the level of degradation of the examined road marking can be achieved. The proposed method is demonstrated through several real cases to show how it works. In the end, a test comparing the inspection results between the proposed method and expert inspection is conducted to prove the accountability of the proposed method.

Norma Jean Mattei
Professor, University of New Orleans, USA

Barriers to Sustainable and Resilient Inland Waterway Infrastructure in the United States

The Mississippi River basin drains 41% of the continental United States. Locks, dams and other infrastructure such as the Mississippi River and Tributaries Project (MR&T) were constructed on the river and its tributaries, beginning in the 1930's, that allowed for the expansion of the nation and played a substantial part in building the US' economic might. Currently there are four "revolutions" that are impacting the greater Mississippi River watershed. The first is an explosive growth in agricultural productivity of the nation's breadbasket, increasing the demand for water, rail and overland transportation demands. Energy production, "revolution"2, has increased with the advent of economic fracking. This also puts stress on the transportation system as frack sand and energy products must be moved to refining facilities and then to market. Thirdly, manufacturing is returning to the Mississippi valley, spurred by cheap fuel costs and the advantage of the inland waterway transportation system. The last "revolution is the impacts of climate change and the focus on the creation of resilient infrastructure. With increased stress placed on the United State's inland waterways, investment and recapitalization is needed in creating a more resilient waterway system. A brief history of the inland waterway system will first be discussed. The four "revolutions will be explained in detail. Barriers to creating a more resilient system will be presented, ending with some proposed solutions.

Anna Mazzi
Assistant Professor, University of Padova, Italy
&
Beatrice Gatto
Master Student, University of Padova, Italy

Circular Economy Concept in Sustainable Building Design

In the last decades, in industrialized Countries, the environmental problems of waste production are enormously increased. One of the most responsible sectors of this phenomenon is building construction and demolition. In order to reduce waste quantities and improve the possibilities of reuse and recovery of everything that may still have a possibility of use, European Union has recently adopted Circular Economy. Coherently with this approach, the EU framework directive on waste commits EU Members to achieve the 70% reduction in the weight of construction waste, by adoption of reuse, recycling and recovery, avoiding landfill as much as possible.

Selective demolition is a realistic alternative to avoid the environmental impacts related the demolition building: it allows an effective recovery of materials derived from a building demolition, as direct reuse (without any treatment) or recycling (with ad-hoc treatment activities), and it minimizes the amount of waste that must be sent to incineration or landfill (according to their dangerousness).

However, selective demolition is still a rare practice today, as demonstrated by the literature review of recent scientific papers. The most frequently methods of processing waste materials on construction and demolition do not have any waste selection system, because a selective demolition is too expansive, and when a building is demolished nobody is willing to pay additional costs for waste selection.

Therefore, selective demolition is a viable solution for sustainable management of construction waste only if it is a constructive specification from the building design. Indeed, the selective demolition in design phase of building allows giving an added economic value to justify the subsequent recovery activities of materials coming from demolition.

To confirm this point of view, we summarize the results related an Italian case study, concerning the environmental impact assessment of demolition activities of a single house. The case study shows the environmental convenience of selective demolition compared to traditional non-selective demolition, especially if in design selective demolition is defined.

Hence, the next challenge for sustainable construction includes sustainable demolition criteria in building design.

Andreea Mihailescu
Research Scientist / Development Engineer, Lasers Department, National Institute for Lasers, Plasma and Radiation Physics / Politehnica University of Bucharest, Romania

Machine Learning for Intelligent Wireless Sensors Networks, Wearables and Autonomous Unmanned Systems

With an estimated of over 26 billion connected devices by 2020, the Internet of Things (IoT) is increasingly becoming more than a growing technological trend, namely a vital part of many solutions to problems of global concern. Industry 4.0, smart farming, smart cities and personalized intelligent healthcare services comprise most of the IoT applications today. At the same time, the wide availability of broadband internet along with the decreasing costs of connection as well as of smartphones or tablets create the perfect environment for either new or IoT transformed solutions.

While connectivity problems are less likely to pose major issues, the real challenge for IoT is to offer devices an intelligent functionality and to make them reliable at all times and in any conditions. This basically means to have robust machine learning (ML) running on your device. However, since the common trend is to use low-cost and low-power electronics, incorporating machine learning or deep learning algorithms that run with data collected from sensors can be extremely demanding for such electronics and the limited onboard memory. Hence, most of the existing smart IoT solutions are based on cloud communication, namely on sending acquired data to a cloud running ML algorithms. On the other hand, Industrial IoT (IIoT) is starting to rely more and more on edge computing.

This presentation is meant to offer an overview of self-designed and implemented machine learning solutions for intelligent wireless gas sensors networks, wearables and autonomous unmanned water surface biovehicles for offshore plastic waste degradation. The intelligent wireless gas sensors network was developed in our laboratory and is currently undergoing heavy testing. Its main purpose is to serve detecting common greenhouse gases related to industrial activities, to issue level and toxicity alerts and to subsequently predict the nature of the fault and equipment malfunction. Two intelligent wearables were designed for smart farming and for personalized remote healthcare respectively. They were part of two distinct projects submitted this year to the Google AI Impact Challenge, the main highlight of the wearables being the ML algorithms adapted to run on device. The last item showcased is the hybrid ML solution on board of an intelligent autonomous unmanned water surface vehicle that detects, collects and degrades plastic waste offshore in an

environmentally friendly manner, while using the by-products of the degradation process to create energy for self-power and nutrients for marine life. This vehicle is this year's second-runner of a national tech challenge competition.

Concluding remarks address general guidelines on how to design and add a suitable AI functionality to an IoT solution in accordance to its designation, to the electronics budget and to limitations imposed by connectivity and power consumption. A discussion on the deployment of digital twins for design and test purposes will also be provided.

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Optimum Design of Cold-Formed Steel Mono-Pitch Portal Frames According to BS 5950

Steel portal frames are usually common in construction industry, particularly for single-storey structures where the requirement for wide spans is a priority. Typical examples are warehouses, hangars, agricultural buildings and sports venues. The use of cold-formed steel (CFS) portal frames has several advantages such as ease of transport and handling, high strength-to-weight ratio, flexibility of cross-sections, non-combustibility, durability and recyclability. This implies that CFS portal frames provide sustainable construction which require less material to carry the same load compared to other materials and reduces the amount of waste material on site.

This research deals with the optimum design in terms of minimum weight of CFS mono-pitch portal frames. The columns and rafters of the frame were chosen to be compound I-sections, made up of back to back lipped channels. The CFS sections were formed from sheet metal with thicknesses starting at 2mm increasing to 3.2mm. The frame spans investigated were 7.5m to 12.5m with frame spacing of 3m to 6m. The minimum weight of the CFS portal frame was ascertained through optimisation process, using the Generalised Reduced Gradient (GRG) method. Implementation of GRG was accomplished using Microsoft Excel Solver. The design constraints were set in accordance to limit state principles of BS 5950. Linear elastic analysis was employed for finding the internal forces at the critical sections of the frame. The results and analysis confirm the effectiveness of optimisation as a major structural engineering tool. The findings also demonstrated that minimum weight CFS portal frames have structural capability of performing at spans up to 10.5m dependant on the frame spacing. The results of this investigation were compiled into practical design charts for initial sizing of CFS portal frame members.

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Permeable Pavement as Green and Low Impact Development Urban Infrastructure

The constructed environs and anthropogenic activities can alter the restorative capacity of the ecological and water balance of the pre-constructed environs. Given the potential impacts of the constructed environs and activities there have been recent controls and regulatory guidance. While there are valid arguments as to the accuracy of the term "Low Impact Development" (LID), the term has been utilized for decades to describe methods and procedures to reduce or lower the impact of constructed environs and activities utilizing components of permeable infrastructure to mitigate impacts of built environs on the urban hydrologic cycle. Permeable pavement with partial exfiltration can allow variable quantities of particulate matter (PM) filtration and hydrologic restoration in the urban rainfall-runoff cycle. Physical and computational fluid dynamics (CFD) of unsteady PM filtration were coupled to model a partial exfiltration system (PES). An unsteady CFD model was validated with monitoring of hydrologic phenomena as well as influent and effluent particle size distributions (PSDs).

This study has applied computational fluid dynamic (CFD) model to simulate the filtration performance of permeable pavement as part of a partial exfiltration system (PES) subject to event-based physical validation and continuous simulation. A user-defined discrete phase model (DPM) was applied in the CFD model for unsteady particle tracking during a storm event. Four storm events collected at an urban site, Cincinnati, Ohio, were used to validate and evaluate the simulation of a PES system (a partial exfiltration reactor with oxide-coated media) performance in CFD model. RMSEs between modeled and measured effluent PSDs are all less than 10% for four studied events, indicating that CFD model is suitable for the simulation of PES and CPP performance under unsteady flow conditions with application of user-defined DPM. The performance of PES and CPP was also examined by the CFD model as a function of different flow rates. A decrease trend of removal efficiency on particles was reported with increasing flow rate. Results indicate a high removal efficiency of particles (>90%) for the PES under any possible flow rate condition. Beyond that, the performance of PES was investigated on an annual basis. Without considering the bypass flow, removal efficiency of influent particles by the PES is 97% over the representative year of 2005, and 68% for the entire runoff volume as considering bypass effect. Overall, the application of CFD model is a feasible and viable tool to simulate and predict the performance of LID systems (PES in this study), as green

infrastructure and for sustainable urban drainage systems in lieu of more traditional best management practices.

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Public-Private Partnerships for Roadway Construction and Preservation, and Traffic Safety: An Exploratory Empirical Analysis of Crash Frequencies

Public-Private Partnerships (PPP) in transportation infrastructure projects constitute a promising alternative to the traditional approaches where the project is either done in-house or is done by hiring contractors to accomplish specific tasks, depending on the availability of transportation agency's resources. PPP contracts ensure greater private sector participation and responsibility in project delivery. Various contracting approaches have been used over the past couple of decades. This paper seeks to provide new insights into the effectiveness of six different PPP contracting approaches, namely Traditional, Performance-Based-Contracting (PBC), Warranties, Incentives/Disincentives (I/D), Cost-Plus-Time (A+B), Design-Build and its derivatives (DBOM), and Lane rentals from a transportation safety perspective. To that end, the frequency of crashes that occurred during the contract execution period, as well as their influential factors are investigated and compared among the six PPP types. Through this comparison, their safety performance can be assessed and possible safety challenges can be identified. Using data from 645 PPP contracts that were executed across multiple states in the US between 1996 and 2011, statistical models of crash frequency were developed. For model estimation, the correlated random parameters negative binomial and Poisson with heterogeneity in means modeling approach has been employed. Correlated random parameters and heterogeneity in means can account for the effect of unobserved characteristics (i.e., unobserved heterogeneity) on crash frequencies at

multiple levels of statistical estimation. Specifically, the model parameters are allowed to vary across the observations according to pre-specified distributions, whereas the means of the latter distributions are also allowed to vary as a function of exogenous variables. The results show that several contract characteristics (contract cost, duration, size in lane-mile), pavement condition, road geometry (shoulder width, median, intersection), traffic characteristics (AADT, truck percentage), and contract work activities affect the frequency of crashes during the contract execution. Contracts associated with higher cost, shorter duration, fewer lane-miles, more asset work activities, as well as contracts executed at sites with good pavement and drainage conditions and sites with more lanes, curves, and junctions, were all found to result in lower crash frequencies. Overall, Cost-Plus-Time (A+B) and Incentives/Disincentives (I/D) were found to exhibit higher safety performance relative to the other PPP types considered in this study.

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A Modified Surface Energy Balance to Soil Evaporation on Partially Wetted Orchards with Drip Irrigation Systems

A surface energy balance model based on previous multiple-layer model approaches was extended to estimate the crop transpiration and soil evaporation for orchards that are normally partially wetted by drip irrigation systems. Previously, Lagos et al., (2009; 2012) modified and extended the Choudhury and Monteith model (Choudhury and Monteith, (1988)) for partially vegetated surfaces to include the partition of evapotranspiration (ET) into soil/residue evaporation and plan transpiration. However, in this approach, soil evaporation (E) has still not yet been able to discriminate areas that are irrigated and areas that are not wetted by normally used micro-irrigation systems. A previous attempt to include partially wetted soil areas in ET, using the method known as dual crop coefficient and reference ET, was made (Allen et al., (2005)), but to our knowledge, there are no other approaches with which an surface energy balance (SEB) model can discriminate irrigated and non-irrigated areas. Therefore, this research proposes to develop and extend a multiple-layer surface energy balance model, which may be suitable for partially wetted surfaces (SEB-PW), accounting for the effects of soil evaporation on the total ET. The aim of this work is to describe the development of the model and provide a sensitivity analysis of the model parameters and variables. In addition, to preliminarily assess the model performance, simulated ET, E and crop transpiration, the components are compared with measurements of two surface renewal systems and micro-lysimeters at two vineyards sites. The proposed surface energy balance (SEB-PW) model estimates the latent, sensible and soil heat fluxes and has an advantage over conventional methods, as this approach separates the total evapotranspiration into dry and wet soil evaporation and crop transpiration. The model describes the energy balance and flux resistances for the evaporation from dry and wet soil areas below the canopy, evaporation from dry and wet soil areas between rows, crop transpiration and total crop ET. The model development, sensitivity analysis and a preliminary model evaluation are presented. The evaluation shows that

simulated hourly amounts of ET have a good correlation with the surface renewal method and micro-lysimeters measurements from an irrigated vineyard for a range of crop canopy covers. Hourly ET estimations were evaluated, with a root mean square error (RMSE), mean absolute error (MAE), a Nash-Sutcliffe coefficient (C_{NS}) and an index of agreement (d_a) of 58.6 W m^{-2}, 35.6 W m^{-2}, 0.85 and 0.94, respectively. Daily E estimations were evaluated, with an RMSE, MAE, C_{NS} and d_a of 0.27 mm d^{-1}, 0.21 mm d^{-1}, 0.87 and 0.94, respectively. The daily E estimation has a coefficient of determination (r^2) of 0.85, when compared with the micro-lysimeter measurements, and E can reach values from 28 to 46% of the total ET, after an irrigation event. The proposed SEB-PW model may be used to estimate the effect and importance of dry and wet soil evaporation areas in connection with the total ET and may help in water balances studies and the optimization of irrigation management.

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Measurement of Time-Varying Stress by Natural Frequency of Impact Sound

Machines and structures are subjected to a static stress or a time-varying stress. Non-destructive methods to measure these stresses with ease and high reliability are useful for the safety of machines and structures. A tensile stress in a guitar string determines a tune of the string. An axial stress in a bar also determines the natural frequency of the bar. And if the stress varied, the natural frequency of the bar would vary. The variation of natural frequency tells us how the stress in the bar is changing with time. We tried to evaluate a time-varying axial stress in a specimen by a natural frequency.

An experiment was conducted. We used a round bar with 8 mm diameter and 290 mm span length as the specimen which was fixed at both ends. We applied a sinusoidal axial stress to the specimen, which is one-sided amplitude stress in tension. The applied stress is defined by three parameters of a mean stress, an amplitude stress and an oscillation cycle. In the experiment, we can arbitrarily alter a magnitude of a mean stress and an amplitude stress. We gave not only sinusoidal but also irregular time-varying stresses to the specimen.

We investigated the relation between the natural frequency and the static axial stress of the specimen experimentally employing a fast Fourier transform method. The relation enables us to transform the natural frequency to the axial stress. To measure the natural frequency of the specimen, we used a sound produced by the free vibration of the specimen when it was impacted. A free vibration fades and the time-varying stress changes the natural frequency of the specimen. To follow the variation of the natural frequency of the sound, we made a device. The device gives small impacts periodically to the specimen to bring about free vibrations. The series of the natural frequency at impacts tells us the variation of the stress in the specimen.

Employing a short-time Fourier transform method, we followed the variation of the 1st mode natural frequency of the sound. We obtained relations among the time, the frequency and the spectrum of the sound by the analysis. The fast Fourier transform method gives us a definite value of a natural frequency. But the short-time Fourier transform gives us the natural frequency with a tapered widening. Taking into consideration the width, we compared the stress evaluated by the analysis with one measured by strain gauges attached to the specimen.

For lower cycle than 10 Hz, the stress measured by strain gauges is well estimated by the analyses for sinusoidal and irregular time-varying

stresses. For higher cycle than 20 Hz, outlines of time-varying stresses could be estimated, but their definite values were not obtained.

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Quantifying Interactions in Manufacturing using Regression Tree Models – A Useful Inductive Step for Planning a Designed Experiment

The ability to detect special-cause variation of incoming feedstocks from advanced sensor technology is invaluable to manufacturers. Many on-line sensors produce data signatures that require further off-line statistical processing for interpretation by operational personnel. However, early detection of changes in variation in incoming feedstocks may be imperative to promote 'early-stage' preventive measures. A method is proposed in this applied study for developing 'control bands' to quantify the variation of 'data signatures' in the context of statistical process control (SPC). Control bands based on pointwise prediction intervals constructed from the 'Bonferroni Inequality' and two-dimensional smoothing splines were developed. Simulations of k = 100, k = 1000, and k = 10000 curves indicated that the 'Bonferroni Inequality' method for detecting special-cause variation for data signatures was closer aligned with the Shewhart detection method for univariate data relative to the two-dimensional smoothing spline method. Examples from data signatures derived from near infrared (NIR) spectroscopy scans of industrial fibers of Switchgrass (*Panicum virgatum*) and Loblolly Pine (*Pinus taeda*) were used to illustrate the usefulness of the control bands for practitioners.

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Two Case Studies Involving Connection Properties for FEA in Catia v5

The commercial CAD software CatiaTM v5 is widely used in industry and academia for engineering applications. Embedded in this software, is the limited version of the "Elfini" finite element program. It is primarily intended for the designers, practicing engineers, and university students. The limitation is due to the small strain and displacement, together with material linearity assumption. Subject to the above restrictions, there are basic contact capabilities within the code. Needless to say that contact arises in "Assemblies" where different parts interact with each other. This requires the need for defining the "Analysis Connection" between different parts, followed by specifying the "Connection Properties". There are several options for such properties. To name a few, we mention, Slider,Contact, Fastened, Rigid, and Smooth. These "Connection Properties" are often used improperly due to the fact that they are not thoroughly documented in the software "Help". Frequently, average users in industry and academia apply these connections without knowing their roles and limitations.

Many years ago, the commercial FEA/CAE software supplied a "Verification Manual" as a part of their online help but this practice is no longer a priority. Therefore, the users have no recourse to develop a better ideaof many features in the software they are using. The actual online "Help" manual is written in a brief and coded format which does not reveal much information.

The purpose of this expository paper is to shed light on the differences between the "Connections Properties" within CatiaTM v5through two case studies. The keypoint is the simplicity of the cases in order to avoid convoluting the results and conclusions. It becomes clear that although different properties allow the user to employ the tools and produce results, the quality and validity of such information depends on the nature of the property used.