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17th ASNEngr Annual Conference

"Bridging the Gap: Engineering, Science, and Technology for Global Progress"

Date: Saturday, August 10, 2024
Venue: Embassy Suites by Hilton, 5400 John Q Hammons Drive NW | Concord, NC 28027

Technical Proceedings

Technical Session I – Information Technology and Artificial Intelligence

Aug 10, 2024 1:15 PM – 2:15 PM EST

Session Chairs:
Ranjan Pokhrel
Sudeep Sapkota

Author(s): Surendra Bajracharya, Lead Software Engineer, Wells Fargo | bajracharya.surendra@gmail.com

Revolutionizing Software Development: The Impact of AI Engineering and GitHub Copilot

Abstract

In the rapidly evolving landscape of software development, artificial intelligence (AI) is emerging as a transformative force, redefining how developers write, debug, and optimize code. This presentation delves into the current state of AI engineering, with a spotlight on OpenAI's advancements and the practical implications of GitHub Copilot. Over the course of 15 minutes, we will explore the following key areas:

The Evolution of AI in Software Development:

A brief history of AI in programming, highlighting major milestones and breakthroughs. The shift from traditional programming paradigms to AI-assisted development.

OpenAI's Contributions:

An overview of OpenAI's mission and its significant contributions to the field of AI. Key technologies developed by OpenAI are influencing current AI engineering practices.

Introduction to GitHub Copilot:

The inception of GitHub Copilot, a collaborative effort between GitHub and OpenAI. How Copilot leverages advanced machine learning models to provide real-time code suggestions and enhance developer productivity.

Practical Applications and Benefits:

Demonstrating how GitHub Copilot integrates seamlessly into the development workflow. Real-world use cases showing Copilot's impact on code quality, speed of development, and innovation. The benefits of Copilot for both novice and experienced developers, including reduced boilerplate coding, improved code accuracy, and faster learning curves.

Challenges and Ethical Considerations:

Addressing potential challenges such as over-reliance on AI, security concerns, and the importance of maintaining human oversight. Discussing ethical considerations in AI-assisted coding, including bias in AI models and ensuring responsible usage.

Future Prospects:

Upcoming features and enhancements for GitHub Copilot and other AI tools in the pipeline. The broader impact of AI on the software industry and potential new roles and skills for developers. By the end of this session, attendees will gain a comprehensive understanding of how AI, exemplified by tools like GitHub Copilot, is revolutionizing software engineering. This presentation will equip developers, team leaders, and tech enthusiasts with the knowledge to harness AI tools effectively, fostering greater innovation and efficiency in their development processes. Join us to explore the cutting-edge intersection of AI and software development and discover how embracing these advancements can propel your projects and teams to new heights of productivity and creativity. Revolutionizing Software Development: The Impact of AI Engineering and GitHub Copilot

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Author(s): Rameshwor Kunwor, Principal Security & Cloud Architect, Condé Nast | rameshwork@hotmail.com

Empowering Engineering Innovation with Generative Artificial Intelligence (AI)

Abstract

Generative Artificial Intelligence (AI) refers to a class of artificial intelligence designed to generate new content that is similar to, but not necessarily in the same way the data they were trained on.

Generative AI is rapidly transforming the landscape of various domains including engineering. It is offering novel solutions to challenges and unlocking opportunities for innovation. This presentation delves into the evolution of Generative AI and its application in various engineering fields. Through case studies and practical examples, it demonstrates the tangible benefits of integrating generative AI into engineering workflows.

AI models augment human creativity rather than replacing it. Additionally, this presentation addresses challenges such as ensuring reliability and safety of AI-generated designs, as well as ethical considerations surrounding their deployment.

Overall, this presentation provides insights into the promising synergy between generative AI and engineering, paving the way for advancements in design, optimization, and problem-solving within various engineering disciplines.

Empowering Engineering Innovation with Generative Artificial Intelligence (AI)

Author(s): Gokarna Sharma, Ph.D., Associate Professor, Department of Computer Science, Kent State University, Kent OH | gsharma2@kent.edu

How can Nepal benefit from innovative practices in ICT

Abstract

This talk will discuss the findings from project "Optimizing ICT Infrastructure for Socio-economic Development and Environmental Sustainability" in the context of Nepal. The speaker has been serving as a research mentor for a fellow who is leading the project through a fellowship program. The fellowship is provided by Daayitwa Abhiyan (DA), a non-profit organization, based in Patan, Lalitpur, Nepal and the research mentorship is provided through DA's collaboration with Nepali Academics in America (NACA) to advance research-based decision making in Nepal. The fellow is working wtih Nepal's Ministry of Communication and Information Technology. The overarching goal of the project is to: (i) Comprehensively assess the current ICT infrastructure, analyzing its socio-economic impacts across sectors and environmental sustainability considerations, (ii) Evaluate emerging technologies and innovative approaches for sustainable, resilient, communal ICT infrastructure systems, (iii) Develop frameworks for public-private collaboration and financing mechanisms for optimizing ICT infrastructure initiatives, and (iv) Review existing policies/regulations and engage stakeholders to identify capacity needs. The findings from this project will inform policy-making as well as engage policy stakeholders and the detailed report will be handed over to Nepal's Ministry of Communication and Information Technology after the completion of the project on September 3, 2024.

The project team thinks that there are opportunities as well as challenges for Nepal to benefit from innovative practices in ICT. The new technologies, such as Blockchain, Generative AI, Machine Learning, and advances in Quantum Computing, are providing ample opportunities for sustainable, resilient, and communal socio-economic growth across sectors if they can be tailored in the context of Nepal. At the same time, there are numerous challenges, namely technology awareness and education particularly in the context of the "right" use of technology, security/privacy aspects, social behavior, trust, mistakes to avoid, ICT infrastructure, internet access, negative impacts on other seeming unrelated sectors with sustainability/conservation efforts on one sector, tailoring ICT ideas/techniques to be usable in the context of Nepal, etc. The speaker will outline some recommendations and considerations on how the majority of the challenges can be overcome for Nepal to truly benefit from innovative practices in ICT.

Technical Session II – Energy and Emerging Technology

Aug 10, 2024 2:15 PM – 3:30 PM EST

Session Chairs:
Dilli Neupane, PE
Ram Chandra Poudel, PhD

Author(s): Manoj Karki, P.E., MBA, Business Development Manager, Duke Energy Corporation, Charlotte NC | karkisir@gmail.com | **Moti KC P.E.**, President & CEO, EquaGen Engineers, Raleigh-Durham, North Carolina | moti.kc@equagen.com

Balancing Scale and Efficiency: Exploring BESS Sustainability Through Size Optimization and Augmentation Strategies

Abstract

The surge in global investment in energy storage technology in recent years has positioned energy storage as a crucial pillar in the power grid system, alongside electricity generation, transmission and distribution, and consumption. Legislative measures like the Inflation Reduction Act of 2022, which allocated $370 billion to climate change and renewable energy initiatives, have significantly bolstered this sector, with 30% of the investment earmarked for energy storage equipment. In the United States, the battery energy storage system (BESS) has emerged as a leading technology, projected to double its capacity in 2024 by adding over 14.3 GW to the existing 15.5 GW. The growth of BESS can be attributed to its versatility in energy arbitrage, voltage control, and ancillary services such as frequency regulation, peak shaving, and black start. BESS generation companies profit from energy arbitrage by leveraging price fluctuations in the power market. However, utility-scale BESS requires significant upfront investment and demands comprehensive techno-economic analysis and price forecasting. Moreover, BESS generation must adhere to contracted power and energy specifications, as well as other technical compliance requirements, necessitating careful plant size selection and battery efficiency maintenance. As batteries age, they typically lose 2%-4% of their energy capacity annually, depending on various factors. To sustain contracted energy levels and revenue streams, BESS owners must plan for either oversized systems or system augmentation over the plant's lifetime. This presentation delves into the sustainability of BESS through size optimization and augmentation strategies, Balancing Scale and Efficiency.

Author(s): Er. Hiva Nasiri, Ph.D., Er. Nistha Shakya, Er. Abinash Kumar Chaudhary, Er. Kishan Kumar Soni, Er. Sudhan Dahal, K&A Engineering Consulting, Charlotte NC | Hiva.Nasiri@kapower.us

Overvoltage Analysis in unbalanced distribution system with multiple DERs

Abstract

As part of the DER System Impact Study (SIS), grid condition before and after the DER interconnection is compared. Traditional load flow analysis assumes that grid voltage worsens as more DERs are connected. However, in circuit scenarios characterized by unbalanced loading and voltage regulators, a nuanced observation surfaces: the most significant overvoltage may result from the disconnection of certain DERs within the system. The occurrence of such violations is contingent upon various factors, including circuit configuration, the functionality of regulating devices, line imbalance percentage, and the power factor operation of DERs, among others.

This paper analyzes the impact of multiple DER interconnection on grid voltage levels in the IEEE 123 node unbalanced test feeder model using CYME DIST software. It highlights the observation that the highest overvoltage does not necessarily occur when all the DERs in the grid are online. Additionally, it advocates the need of automation tools to study and solve such issues, which are inevitable in the future. The findings provide valuable insights to engineers, firms and utilities performing the SIS of DER-integrated power systems to ensure stability, efficiency, and reliability.

Author(s): Jiten Gautam, P.E., CEM, Senior Engineer, Duke Energy Corporation, Charlotte, NC | mejgautam@gmail.com

Smart Microgrid Feasibility Study with multiple constraints using Machine Learning Algorithms for scale up

Abstract

There has been a lot of advancement in many sectors using machine learning and data mining. One of the most critical infrastructures of utility industry, the grid system still relies on conventional data keeping and is in dire need of a future recommendation system for feasible operation of the grid. There are a few studies that have attempted to do some research in this field, mostly for price prediction functionality. Most of this research and studies are more concentrated on specific of either electrical system frequency or smart homes or big data mining strategies. There are several different models studied and proposed that could be utilized for several specific areas but none of the models are recommended for further development. There

is no one such simple solution or study completed on the small scale and proposed to be upscaled. The term “microgrid” means different things to different stakeholders, a customer, solution provider. A microgrid can be utilized as a prototype to complete the physical and virtual experiment of this model and machine learning algorithm. The experiment can then be upscaled to be implemented in the overall grid system. This study is expected to build a system dynamics model for a microgrid system or a regional system, a machine learning algorithm for the model system using historical data, weather, demand and then make a model that can be scaled to much larger grid system. The model construction is trying to solve near real constraints with their relative factors. The completed study is presenting with a reliable model that can be looked at for further analysis and study in this field.

Technical Session III – Civil and Infrastructure

Aug 10, 2024 4:30 PM – 5:30 PM EST

Session Chairs:
Krishna Dhakal PhD, PE
Vinod Mahat PhD, PE

Author(s): Thakur Dhakal, P.E, Engineer IV, Fairfax County Government, Virginia, USA, tdhakal@gmail.com

Opportunities and challenges in preparing planning and policy framework in urban watershed management

Abstract

Urban watersheds are essential parts of the city's environmental infrastructures. Water quality, biodiversity, ecosystems, and the overall environmental health of urban areas will all be impacted if the watersheds are not managed properly. The increase in urban development and population growth requires a robust planning and policy framework to address the unique challenges they present. This presentation discusses on the opportunities and challenges associated with developing such frameworks for urban watershed management.

The first part of the presentation defines urban watersheds and lists the problems that they currently face, such as pollution, urban runoff, and habitat fragmentation. To effectively manage complex landscapes, it highlights the importance of integrated planning and policy frameworks that take into account social, economic, and environmental factors.

Similar to other green infrastructures, urban watershed management is also not without obstacles. The scope and complexity of managing urban watersheds, stakeholder conflicts of interest, and regulatory compliance are some of the main challenges that are identified in this presentation. In addition to those constraints, the availability of limited data, funding, and the need for comprehensive research are also discussed as challenges to effective watershed management.

The presentation demonstrates effective initiatives and best practices from many worldwide contexts through various case studies, showing how distinct regions have overcome particular obstacles through creative policies and community-driven approaches. Discussion on those ideas will help audiences to discuss potential future paths in urban watershed management, such as the incorporation of smart technologies like artificial intelligence and the requirements for adaptation to the impact of climate change.

In the end, the presentation provides recommendations for future planning and policy initiatives and highlights the necessity of increased public participation, interdisciplinary collaboration, and continuing environmental challenges. This will provide environmental experts and urban planners with knowledge and strategies to develop sustainable and resilient urban watersheds.

Author(s): Kshitiz Khanal, Ph.D. Candidate (Corresponding Author), University of North Carolina at Chapel Hill, NC**,** khanal1990@gmail.com **|** **Nikhil Kaza, Ph.D.** Professor, University of North Carolina at Chapel Hill, NC

Comparing flood risk exposure characterization to utility scale solar based on floodplain maps and hurricane induced flooding

Abstract

Increasing frequency and severity of extreme weather events, such as hurricanes, floods, hails, wildfires, etc. threaten performance degradation and even decommissioning of utility scale photovoltaic solar generation assets. Although a proper characterization of climate-related risk to energy infrastructures is vital for planning for resilience, availability of information on risk is often incomprehensive, not publicly available, or outdated, leading to potentially misleading risk characterization.

We characterize and compare exposure to flood risk for utility scale solar in North Carolina using two different datasets: i) 100-year and 500-year floodplain maps created by the Federal Emergency Management Agency (FEMA), and ii) flood footprints from recent Hurricane Events such as Hurricane Matthew (2016) and Hurricane Florence (2018) using geospatial overlay. The flood footprints are a (not yet published) 30 m resolution probability of flood from hurricane events predicted using a random forest model based on National Flood Insurance Program (NFIP) claims dataset created by Garcia et al. (2023). We use utility solar characteristics (mainly geolocation and capacity) from US Energy Information Administration (EIA)'s Preliminary Monthly Electric Generator Inventory EIA-860M dataset. The dataset monitors existing and proposed generation assets with combined rated capacity higher than 1 MW.

Our preliminary analysis reveals that a consequential portion of flooding caused by the hurricane events lies outside the FEMA floodplain maps, especially in the South-Eastern parts of the coast. Apart from a comparison of characterization of risk to utility solar infrastructure in North Carolina, we also discuss the implications for energy infrastructure resilience, resource adequacy, and emergency management. Additionally, the study elucidates the differences in characterization of risk while using information derived from multiple sources. While the FEMA floodplain maps are publicly available, they provide an inadequate representation of risk to energy infrastructure. Combining risk information derived from non-traditional data sources can represent risk more comprehensively to help plan for resilient energy infrastructures

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Author(s): Ujjwal Pokharel, Graduate Research Assistant, Old Dominion University, Norfolk, VA, upokh001@odu.edu

Production of lithium carbonate from geothermal brine by selective extraction of lithium using a novel ion sieve method

Abstract

The proposed idea is to provide a novel approach to extract lithium from a geothermal brine with minimal water loss. This will provide a sustainable alternative to the currently practiced solar evaporation/concentration method which is very slow (takes 24 months) and water intensive. Production of high-capacity lithium-ion (Li-ion) batteries for electric vehicles (EV) is believed to be the way to reduce the use and sale of fossil-fuel based vehicles. Currently, most of the lithium

in the world comes from the mining of lithium or from the evaporative extraction from brine. Mining is not environmentally friendly, and the evaporative process takes long time for the extraction and causes a great loss of water which can lead to a decrease in the water table. To address these issues, we propose to develop a novel method to efficiently extract lithium from the geothermal brine using low-cost, simple, and low water use adsorption technique. We will use H4Mn5-xZrxO12 (where x= 0.1 and 0.5) as an adsorbent material. First a precursor material, doped with Zirconium (Zr) and a composition of Li4Mn5-xZrxO12 will be synthesized. An adsorbent material is then synthesized using ion exchange mechanism by treating the precursor with HCl. This composite material will be used for the adsorption of lithium from the brine and later synthesize lithium carbonate through desorption and purification process. This lithium carbonate can be used in a Li-ion battery. There are several intellectual merits of the proposed system. First, the time required to extract lithium from the geothermal brine will drop from years to a couple of hours and it does not cause any water loss during the adsorption-desorption process. Second, it works as an alternative to lithium mining which produces chemicals that contaminate water resources and affect human health. Third, the domestic production of lithium will increase significantly which will eventually reduce/eliminate the need of lithium import for the electric vehicles. Salton Sea area geothermal brines are recognized as potentially important domestic source of lithium with a lithium concentration as high as 400 mg/L. This process can be implemented in areas with high concentration of lithium to extract lithium economically, sustainably and in shorter span of time.

Abstracts Accepted for Poster Presentation in the Conference

Author(s): Nishan K. Shrestha(Corresponding Author), Beachwood High School, Beachwood, Ohio, USA, nishankshrestha@gmail.com | **Seth H. Frisbie, Ph.D. ,** Norwich University, Northfield, Vermont, USA | **Erika Mitchell, Ph.D.**, Better Life Laboratories, Inc., Calais, Vermont, USA | **Bibudhendra Sark ar, Ph.D. ,** The Hospital for Sick Children, Toronto, Ontario, Canada**, Sushil Dahal,** Tribhuwan University, Kathmandu, Nepal | **Rojina Amatya,** Norwich University, Northfield, Vermont, USA | **Amy Hoeltge, Ph.D.,** Norwich University, Northfield, Vermont, USA

Effectiveness of Strategies to Avoid Microbiological and Chemical Contaminants in Household Drinking Water within the Kathmandu Valley

Abstract

Background: Due to perception of poor quality and infrequent availability of municipal water, people in the Kathmandu Valley store two types of water: drinking water (DW) and non-drinking water (NDW). The purpose of this study was to determine if the deliberate separation of water into

DW and NDW by households results in households having DW with lower microbial and chemical contamination than NDW.

Methods: DW and NDW samples were collected from 50 households across the Kathmandu Valley, selected by stratified random sampling. The samples were compared with respect to the National Drinking Water Quality Standards (NDWQS) of Nepal.

Results: Overall, 17 of the 100 water samples met the standard for all essential parameters of NDWQS. DW samples failed fewer parameters than NDW samples (mean 1.08 vs. 1.96, difference 0.88, 95% C.I. 0.53-1.23, p-value<0.001), but a similar association was not found for non-microbiological parameters (OR 1.65, 95% C.I. 0.74-3.71, p-value 0.22). Among DW samples, proportions safe for different intervention strategies were: filtering (95%), boiling (75%), purchasing jar water (<50%), and consuming raw water (0%).

Conclusions: DW samples were microbiologically safer than NDW samples, thereby validating the practice of keeping separate DW and NDW supplies. Boiling and filtering appeared to be effective methods of obtaining microbiologically safe water, while purchasing jar water and consuming raw water did not

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Author(s): Nita Khanal (Corresponding Author), Ph. D Student, Department of Civil Engineering, University of North Carolina at Charlotte, Charlotte NC | **Md Ariful Islam Juel**, Department of Civil Engineering, University of North Carolina at Charlotte, Charlotte NC | **Cynthia Gibas,** Department of Bioinformatics and Genomics, University of North Carolina at Charlotte, Charlotte NC | **Jessica Schlueter ,** Department of Bioinformatics and Genomics, University of North Carolina at Charlotte, Charlotte NC | **Mariya Munir,** Department of Civil Engineering, University of North Carolina at Charlotte, Charlotte NC

Evaluating Extraction Principles for Increased Viral RNA Output

Abstract

Detecting SARS-CoV-2 in wastewater provides a cost-effective alternative to expensive methods like random group testing and individual clinical tests, potentially identifying asymptomatic cases. Electronegative Membrane Filtration (EMF) is a widely used, cost-effective tool for large-volume wastewater virus concentration. However, there's limited research on efficient RNA extraction methods. This study aimed to achieve efficient RNA extraction kits for wastewater surveillance by integrating them with the EMF method of virus concentration. Raw wastewater samples from three treatment plants were collected in Mecklenburg County. Two RNA extraction protocols, the 'QIAamp Viral RNA Mini Kit' and the 'Zymo Quick RNA Viral Kit,' utilizing lysis buffer principles, were modified to enhance RNA yield by adjusting buffer ratios and removing inhibitions. These optimized methods were compared with two different extraction methods, the 'RNeasy Power Water Kits' and the 'AllPrep Power Viral DNA/RNA Kit,' utilizing bead-beating principles. The Zymo Quick RNA Viral Kit outperformed the other three kits significantly in Cq value (29-31), copies per reaction, and copies per liter (100,000 to 350,000, P<0.01). It also

exhibited a better recovery of 10% of the surrogate Bovine Coronavirus (BCoV). Moreover, the 'Zymo kit' was found to be cost-effective at $159.5 for 50 preps compared to other extraction methods. This suggests that the 'Zymo Quick RNA Viral Kit' is more efficient at extracting and purifying viral RNA, enabling accurate virus quantification. It informs public health decisions and supports the development of sensitive diagnostic tests, crucial for early virus detection and control.

Author(s): Biswas Gautam, MS student, Department of Mechanical Engineering, University of North Carolina at Charlotte, Charlotte NC, biswashgautam30@gmail.com

Performance Analysis of a Propeller Turbine

Abstract

Most of the turbines used in Nepal are medium or high head turbines. These types of turbines are efficient but limited for rivers and streams in the mountain and hilly region which have considerably high head. Low head turbines should be used in the plain region if energy is to be extracted from the water sources there. This helps in the rural electrification and decentralized units in community, reducing the cost of construction of national grid and to its dependency, in already aggravated crisis. There are good turbine designs for medium to high heads but traditional designs for heads under about 5m are slow running, requiring substantial speed increase to drive an AC generator.

Propeller turbines have a higher running speed, but the airfoil blades are normally too complicated for micro hydro installations. Therefore, the open volute propeller turbine with non-uniform thickness blades was ventured as possible solution. Such type of propeller turbine is designed to operate at low inlet head and high suction head. This enables the exclusion of closed spiral casing. This leads to considerable reduction in manufacturing cost and complexity. A 245 W prototype was designed and fabricated and. The runner consisted of four blades of 3mm thickness with camber and twist. The runaway speed of 600 rpm was attained at design flow rate of 25 l/s. The expected efficiency of the prototype was estimated to be about 84%.

The aim of this paper is to analyze the efficiency with the number of blade and pressure pulsation on the turbine of low head Propeller turbines.

Author(s):Manish Niraula, Power Conversion Controls Engineer, Electrification Department, Canoo Technologies Inc., Torrance, CA, USA, mniraula8@gmail.com

Grid Integration of Electric Vehicles and Renewable Energy: Opportunities and Challenges

Abstract

Several research and surveys have been performed to understand the effect of EV integration into the grid, such as peak overloading of the grid causes voltage imbalance issues, line overloading and transformer overloading issues, especially in rural areas and countries with weak grid infrastructure [1]. Electric Vehicles (EVs) introduce variable electrical loads that are highly dependent on the customer's behaviour [2]. NREL's study [3] shows that in 2050 EVs could contribute to a 33% increase in energy use during peak electrical demand, for heavy-duty vehicles, the loading impact is more prominent. Electrified truck fleets will hit the road soon, creating megawatts of localized demand during extreme fast charging operation. The important concern at this moment is battery powered electric vehicle grow in market share without any evolution in vehicle charging coordination strategy.

This work presents how EV can be used as an energy storage for the grid and renewable energy, reactive power compensation tool for the grid and how integration of EV helps to enhance the integration of the distributed renewable energy sources (such as solar, wind etc.) into the electrical grid. Some of the negative impacts of the integration of Electric vehicles to grid are increase in peak demand, voltage instability and phase imbalance, harmonic distortion and few positive impacts can be listed as: frequency regulation support, voltage regulation and reactive power compensation support, backup power supply and other ancillary services [4]. Integration of renewable energy into the grid poses multiple challenges such as grid instability issues, reliability, location specific energy generation, and these challenges can be solved by operating EVs as energy storage system, decentralized micro or mini grid systems based on the wind, solar or other renewable energy systems in islanded mode, implementation of virtual power plant (VPP) concept to help manage and control the distributed energy resources (DERs).

Author(s): Sachin Tripathi (Ph.D. candidate)**,** Department of Civil & Environmental Engineering, University of Connecticut, Storrs | **Rahul Anand** (M.S. Student), Department of Civil & Environmental Engineering, University of Connecticut, Storrs | **Celso Cruz De Oliveira** (Ph.D. Candidate), Department of Civil & Environmental Engineering, University of Connecticut, Storrs | **Ramesh B. Malla, Ph.D., F. ASCE, F. EMI, A.F. AIAA, F. ASNEngr,** Professor (Corresponding Author), Department of Civil & Environmental Engineering, University of Connecticut, Storrs, mallar@engr.uconn.edu

Finite Element Model Updating for Old Railroad Bridges using Field Experiment Data and Optimization Algorithms

Abstract

Most of the railroad bridges currently in service in the United States were built over a century ago, including many on Amtrak's Northeast Corridor (NEC), the busiest rail network in the country. As the bridges continue to deteriorate, it is essential to evaluate their structural performance and safety to ensure continued serviceability. Finite Element (FE) models are extensively used to predict structural responses in engineering. However, these models, typically developed using original drawings, may not accurately represent real conditions due to factors like wear and tear. Accurate prediction of structural responses is crucial for ensuring the safety and reliability of civil infrastructures, making FE model updating essential.

This study presents an effective, efficient, and practical methodology for updating FE models. The methodology consists of (1) development of initial FE model of the bridge structure based on the original drawings, (2) performing sensitivity analyses to identify the most influential and critical parameters requiring adjustment for accurate structural response prediction, (3) conducting limited field tests to determine modal properties, such as natural frequencies, and dynamic responses like displacements under operational train loads, (4) development of an objective function based on the experimental and computational modal parameters, and (5) determination of optimized parameter values using the Genetic Algorithm. The methodology was verified on the more than 120 year-old Cos Cob railroad bridge located in Connecticut which lies in the NEC line (Figure 1).

The displacement results of the refined FE model were compared against the field experimental data.

Before updating the model, there was larger discrepancy in the displacement results. However, with the updated FE model, the displacement results were much closer to the field data, demonstrating the effectiveness of the proposed methodology.