

Construction Research Congress 2026

Automation and Robotics, Computer Applications, Information Modeling, and Simulation in Construction

Selected Papers from the Construction Research Congress
2026

San Antonio, Texas, USA
18-21 March 2026

Volume 1 of 2

Editors:

**Chuma Nnaji
Jiannan Cai
Ibukun Gabriel Awolusi
Kaushik Bhattacharjee**

ISBN: 979-8-3313-4003-2

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2026) by American Society of Civil Engineers
All rights reserved.

Printed with permission by Curran Associates, Inc. (2026)

For permission requests, please contact American Society of Civil Engineers
at the address below.

American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, VA 20191
USA

Phone: (800) 548-2723
Fax: (703) 295-6333

www.asce.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

Contents

Automation of Interior Design for Accessibility in Science, Technology, Engineering, and Mathematics (STEM) Laboratories	1
Jingyi Lai, Jiansong Zhang, Hazar Nicholas Dib, Bradley Duerstock, and Nan Kong	
Integrated Mixed Reality Teleoperation Framework for Humanoid Robots in Construction: Real-Time Perception and Control with Safety-Aware Simulation	12
Yuming Zhang and Houtan Jebelli	
Assistive Autonomy and Safety Overlays for Mixed-Reality Guided Humanoid Teleoperation in Construction	23
Yuming Zhang and Houtan Jebelli	
Benchmarking Humanoid Robot Controllers for Contact-Rich Construction Tasks	34
Tianyu Ren, Yuming Zhang, Yizhi Liu, and Houtan Jebelli	
ConstrucSim: A Reproducible Platform for Dexterous Humanoid Robot Perception, Planning, and Contact in Construction	45
Tianyu Ren, Iftekhar Hasan, Xiayu Zhao, Yizhi Liu, and Houtan Jebelli	
Humanoid Robot Learning of Contact-Rich Manipulation Skills through Retargeted Construction Demonstrations.....	56
Tianyu Ren and Houtan Jebelli	
Advances in Robotic Perception for Construction Automation: A Systematic Literature Review	67
Yanxi Liu, Dorna Jokar, Dong Zheng, Mahmoud Habibnezhad, and Yizhi Liu	
In Situ Resource Utilization (ISRU) for Autonomous Remote Construction: Trends and Applications	78
Kambiz Kia, Yusna Ayer, Kereshmeh Afsari, and Tanyel Bulbul	
AI-Assisted Autonomous Quadruped Mobile Robotic System Integrated with Thermal and Environmental Sensing for Real-Time Fire Hazard Detection and Mitigation in Construction and Facility Safety Management.....	90
Oscar Poudel, Rayan H. Assaad, and Mohamad Awada	
BIM Augmented VR Teleoperation for Precise Robotic Arm Manipulation with Human-in-the-Loop in Low Level Construction Tasks	100
Oscar Poudel, Ghadi Charbel, Rayan H. Assaad, and Mohamad Awada	

LiDAR-Driven Framework for Safety Monitoring of Construction Sites	110
Chao He and Da Hu	
Exploring Construction Tasks That Can Be Performed by Robots.....	120
Fangxiao Li and Robert M. Leicht	
Design of a Sensory-Enhanced Workstation Prototype with a Multimodal Interface for Teleoperated Demolition.....	130
Zihao Wang, Patrick B. Rodrigues, Yiyang Fang, Lucio Soibelman, Burcin Becerik-Gerber, Gale M. Lucas, and Shawn C. Roll	
Safety-Aware Motion Planning Method for Autonomous Cranes Using Adaptive Safety Margin.....	141
Samiha Tasnim, Inbae Jeong, and Youjin Jang	
BIM Semantics-Enhanced Pose Initialization for Indoor Mobile Construction Robots	152
Chuan Yang and Yujie Lu	
Integrating Physiological Monitoring Systems and Artificial Intelligence for Human-Robot Interaction in Construction—A Systematic Literature Review	163
Didong Xu, Nana Kwabena Asamoah Antwi, and Gilles Albeaino	
Automated Floor Flatness and Levelness Measurement Framework Using a LiDAR-Equipped Mobile Robot	175
Jiheon Kim, Mingeon Kim, Taewan Kim, and Seulbi Lee	
Sensory-Augmented Teleoperation for Humanoid Robots in Construction: A Risk-Aware Multimodal Approach	185
Yuming Zhang, Tianyu Ren, Yizhi Liu, and Houtan Jebelli	
Tactile-Aware Soft Hexapod UAV Gripper for Multi-Modal Aerial Manipulation in Construction	196
Xiaoyu Zhao, Yizhi Liu, Katherine Driggs-Campbell, and Houtan Jebelli	
Robotic Inspection and Maintenance of Energy Infrastructure: A Review	207
Xin Wang, Naveen Kumar Muthumanickam, Shanti Pless, and David Mascarenas	
UGV-Based Spatiotemporal Monitoring of Indoor Environmental Quality Using an Integrated BIM-IoT Framework with Autonomous Navigation.....	217
Fahad Iqbal and Shayan Mirzabeigi	

Open-Vocabulary, Context-Aware Robot Navigation on Construction Sites: Integrating LLM-Driven Value Map Composition with Hierarchical Scene Graphs	227
Xiaoyu Zhao and Houtan Jebelli	
4D BIM Integrated Rule-Based Safety Checking System for Identifying Safety Hazards in Construction Robot Operations	238
Hafiz Oyediran, Kyungki Kim, Pei-Chi Huang, Terry Stentz, and Kelli Kopocis	
Reinforcement Learning-Based Motion Planning for Mobile Crane Operation in Precast Concrete Bridge Installation.....	249
Mohsen Navazani, Ao Du, Shuai Li, and Jiannan Cai	
Human Factors in Teleoperation for Construction: An Ergonomic Perspective	260
Usman Rasheed, Xiaoyun Liang, Yuqing Hu, Scarlett Miller, Shuai Li, and Jiannan Cai	
A Hybrid Approach to Cutting-In Painting: Human Skills Meet Robotic Precision.....	270
Sage Schaefer, Jia Xu, and Xi Wang	
Digitizing Homebuilding: A Case Study of Technology Integration in a Residential Construction Firm	281
Feroz Ahmed and Fan Zhang	
Learning Contact-Rich Construction Skills from Human Demonstrations: A Comparative Analysis of Data Collection Methods	291
Jia Xu and Xi Wang	
A Framework for VR-Based Safety Simulation of Multi-Robot Human–Robot Work Collaboration in Construction.....	303
Saratu N. Terreno, Pedram Ghannad, Pooja Podduturi, Naila Mahaveen, and Sai Phanindra Siddam	
Automating Spatial Reasoning and Component Localization for Sustainable Demolition Using Hierarchical BIM Scene Graphs and Multimodal AI	314
Wei-Yu Hsu and Yuqing Hu	
Deep Learning-Enabled Robotics across Construction Project Lifecycles	325
Somin Park and Hongrui Yu	
Automated BIM-to-Reality Alignment in Indoor AR Using Instance Segmentation and Reinforcement Learning	336
Srijeet Halder, Aritra Pal, Deepika Adalarasu, and Sanjeev Adhikari	

Large Multimodal Model-Based Framework for Contextual-Conditioned Task-Based Autonomous Positioning of Mobile Construction Robots	346
Seongju Jang, Francis Baek, and SangHyun Lee	
Privacy-Preserving Stress-Aware Physiological Model for Adaptive Worker-Drone Interaction.....	357
Wei Zhou, Woei-Chyi Chang, and Sogand Hasanzadeh	
Automated Inspection of Concrete Column Verticality Using Laser-Scanned 3D Point Clouds	368
Abdullah Alsuhaibani	
Error Taxonomy and Failure Analysis of Large Language Models for BIM Scripting.....	376
Zaid Alwashah, Bo Xiao, Hexu Liu, Shane Mueller, and Xiaoyun Shao	
Exploring Student Trust in a Virtual Learning Environment for Ergonomic Risk Identification and Exoskeleton Training in Construction	386
Joshua Nsiah Addo Ofori, Colin Logan, Yuhui Zhao, Omobolanle Ogunseiju, Thad Starner, and Mariam Tomori	
Vision-Based Pipeline for Gesture-Driven Robot Control during Tool Handling and Glove Use	397
Francis Baek, Seongju Jang, Leyang Wen, and SangHyun Lee	
Graph-Driven Analysis of Construction Process for Digitalization and Robot Integration.....	408
Nozomi James Hirata, Yuqing Hu, and John Messner	
Bridging 4D BIM and Robot Task Planning Systems for Autonomous Construction Operations.....	418
Hafiz Oyediran, Kyungki Kim, Pei-Chi Huang, Terry Stentz, and Kelli Kopocis	
Application of Neural Networks in BIM and 3D Reconstruction: A Systematic and Scientometric Review	428
Anto Ovid, Alex Albert, S. M. Jamil Uddin, Abdullah Alsharef, and Gongfan Chen	
Enhancing Construction Project Efficiency: An Integrative AI-Enabled Framework for Automated 4D Scheduling	439
Ali Mohammadjafari, Mohammadamin Havaei, Saurav Ghimire, and Mahmoud Habibnezhad	
Vision-Guided Real-Time Monitoring and Adaptive Control for Defect Mitigation in Concrete 3D Printing	450
Seyedali Mirmotalebi, Hyosoo Moon, Raymond Teshiero, and Sadia Jahan Noor	

Impact of Multimodal Cues on Flood Risk Perception and Evacuation Decisions in Virtual Reality	461
Hardik Chauhan, Youjin Jang, Jisoo Park, and Inbae Jeong	
Automated Elevation Clash Detection in Building Information Models (BIM): Application to Clearance Distances for Mechanical, Electrical, and Plumbing (MEP) Systems	471
Ghiwa Assaf, Rayan H. Assaad, Sara Fayek, and Mohamad Awada	
Creating Realistic Virtual Disaster Environments for First Responder Training	482
Sultan Al Shafian and Da Hu	
AI-Driven Disaster Response System through Social Media Intelligence and Autonomous Drone Deployment	492
Chao He and Da Hu	
Pavement Deterioration Prediction by Integrating Agent-Based Simulation and Transformer-Based Machine Learning Models for Smart Infrastructure Asset Management	502
Ghadi Charbel, Oscar Poudel, Mohamad Assaf, Rayan H. Assaad, and Mohamad Awada	
Comparative Analysis of Machine Learning Models for Predicting Bridge Condition Ratings: A Massachusetts Case Study	513
Sara Asgari, Farzane Asgari, Tyrone Hua, and Sadegh Asgari	
Development of a Virtual Testbed for Automated Rebar Inspection in Infrastructure Projects	524
Kumar Adarsh, Nikhil Bugalia, and Aritra Pal	
A Preliminary Study on the Quantitative Effects of Visual Interfaces on Excavator Teleoperation Performance	534
ChungBae Yoon and SangUk Han	
Generative Design of Interim Housing Sites for Homeless Communities	544
Hisham Said and Joanne Price	
Numerical Modeling of Argon Concentration in Insulating Glass Units Using Ultrasonic Wave Propagation through Finite Element Method	554
Parisa Salehi, Hamed Khaleghi, Didem Ozevin, and Aslihan Karatas	
Aligning Project Schedules and BIM Models for 4D BIM: An ISO 19650-Based Project Controls Perspective	565
Jaehyun Park	

Influence of Modular Unit Stacking Method on Differential Settlement of Raft Foundations: A Numerical Study	576
Mahya Nazarisharabian and Jin Ouk Choi	
High-Rise Morphological Design in Dense Urban Contexts: A Parametric Modeling and Evolutionary Optimization Approach.....	586
Ali Jezzini, Yasser Jezzini, Mohsen Mohammadi, and Philippe Marin	
Prototype Design of Digital Twins and Visual Indicators of Human-Centered Interface for Teleoperated Robot Control in Lunar Construction.....	595
Miran Seo, Samraat Gupta, and Youngjib Ham	
Tracing the Footprint of Urbanization on River Water Quality across the US.....	605
Daniela Correa-Caselles and Gabriel Castelblanco	
A Conceptual Framework of Building Digital Twins for Autonomous Robot Control: A Facility Management Use Case	615
Ping Xu and Xinghua Gao	
Deep Learning-Based Concrete Bughole Detection and Area Estimation for Quality Assurance and Control	625
Tianru Zhao, Sandra Anto Vazhappilly, Jinwoong Lee, and Kyubyung Kang	
Exploring the Role of Digital Tools in Reverse Logistics: A Stakeholder Perspective	634
Paula Lopez Alvarez de Neyra and Amelia Celoza	
Enhancing Communication among AEC Project Partners through the Use of Emerging Technologies.....	645
Emma Trisch, Mamdouh Mohamed, and Mackenzie Murtha	
Scalable Carbon Assessment for Sustainable Urban Futures through Automated Systematic Tools: Lessons from New York.....	655
Siavash Ghorbany, Ming Hu, Siyuan Yao, Matthew Sisk, and Chaoli Wang	
Automating Plywood Optimization: A Simulated Annealing Approach for Smarter Construction Sites	665
Ayman M. Sherif, Mohamed S. Eid, and Mohamed Elsayad	
Collective Intelligence for Architectural Programming in Mega Transportation Projects: Multi-Agent Simulation and Optimization	675
Yuan Deng and Shitao Jin	

Building Cohesive Digital Ecosystems: Proposing a Conceptual Framework for Integrating Digital Twins, Digital Threads, Ontologies, and Data Architecture	686
Amin Khoshkenar and Hala Nassereddine	
Interoperability in Smart Cities: A Systematic Review of Unified Digital Twin Models.....	697
Amin Khoshkenar and Hala Nassereddine	
Scan2floorplan: Generating As-Built Floor Plans for Aging Buildings via Sequential 2D Analysis	707
Tao Zhong, Yujie Lu, and Bo Peng	
Digital Twin Adoption in Facilities Management: Critical Success Factors for Mission-Critical Buildings.....	717
Mahdi Anbari Moghadam, Deniz Besiktepe, and Rodolfo Valdes-Vasquez	
Challenges at the Design–Construction Interface in Building Projects and the Emerging Role of the Digital Twin	729
Muhammad Kamran, Amr Ashmawi, and Phuong H. D. Nguyen	
Multimodal Retrieval Augmented Generation for Information-Enriched Digital Twins: Automating Information Extraction and Mapping in a University Central Utility Plant.....	740
Chan Young Park, Rafay Ali, H. David Jeong, Ashrant Aryal, and Ghang Lee	
Point Cloud-Based Debris Volume Estimation for Urban Demolition: A Case Study at Tumwata Village, Oregon City, Oregon	748
Chonnapat Opanasopit, Joseph Louis, Erzhuo Che, and David Abiola	
Advanced Uncertainty Quantification in Bridge Load Rating Using Probabilistic and Machine Learning Models Informed by BWIM and LRFR Frameworks	758
Haiyan S. Xie and Mangolika Bhattacharya	
Towards Integrated Product-Process Modeling of Crane Operations in Modular Construction Using Smart Objects	769
Samira Mirhasani, Joseph Louis, and Hisham Said	
Diffusion-Based Generation of Multi-Layered Building Layouts for Accessibility Design and Checking in BIM	780
Haolan Zhang and Ruichuan Zhang	
Leveraging Construction Site Data for Business Intelligence Using Enterprise Digital Twins: Insights from UK Contractor Organisations	790
Abdulmalik Badamasi, Xiang Xie, and Mohamad Kassem	

Leveraging Multimodal Artificial Intelligence Models for Information Acquisition in Building Materials and Components Salvage Assessment.....	801
Zheng Lu, Utkarsh Vikram Singh, and Yuqing Hu	
Understanding Value Creation of Project Digital Delivery in Transportation Projects: A Literature Review	812
Helen S. Ghali and Roy Sturgill	
A Review of Artificial Intelligence Applications in Structural Health Monitoring of Bridges Using Digital Twins	823
Mahdi Ghafoori, Mirsalar Kamari, Mojtaba Parsaee, and Afshin Hatami	
Obstacle-Aware Crane Operation Planning for PPVC Projects via Environment Mapping and Digital Simulation.....	833
Chhatrapal Pal and Aritra Pal	
Leveraging Historical Data in a GIS-Based Digital Twin: A Scalable Framework for Facility Maintenance Resource Allocation	843
Kaitelyn J. Haynes and Daniel J. Weeks	
Testing the Effects of Virtual Reality Training on the Familiarization of New Heavy Equipment Operators.....	854
Brian J. Fink and Daniel J. Weeks	
Data-Driven Decision-Making Modeling for Construction Organizations: Optimizing Complex Challenges in Resource Allocation.....	865
Kyudong Kim, Arkajyoti Roy, and Kasey M. Faust	
4D-5D Additive Construction: Integrating 4D and 5D Simulations into 3D Concrete Printing Construction.....	874
Jorge Rojas and Sogand Hasanzadeh	
As-Built Digital Twins: AI-Enhanced, Semantic-Rich Building Models for Energy Simulation and Retrofit Analysis.....	885
Ahmad Gholizadeh Lonbar and Kaiwen Chen	
Reducing Operator Variability in Real-World Simulation of Post-Building Collapse Rescue Operations	896
Maral Nazemi, Ahmad Alshami, Juyeong Choi, and Qian Zhang	
A Data-Driven Approach for Multi-Scale GIS-Based Building Energy Modeling Supporting Retrofitting Analysis and Decision Making	907
Narjes Faghieh, Kaiwen Chen, and Yunyang Ye	
Automated MEP Drawing Analysis Using Computer Vision Preprocessing and Vision Language Models.....	919
Rafay Hayat Ali, Chan Young Park, Ashrant Aryal, and H. David Jeong	

Towards Trustworthy Highway Infrastructure Digital Twins: A Regional Graph-Based Method for Section-Level Pavement Data Quality Assessment	929
Linjun Lu, Yuandong Pan, Ya Wen, and Ioannis Brilakis	
Understanding Barriers and Opportunities for Technology-Enhanced Weatherization: A Community-Engaged Study for the Design of an AI-Assisted Digital Twin Platform	940
Kaiwen Chen, Ahmad Gholizadeh Lonbar, Sophia Arthur, and Yining Wen	
Quantifying the Economic Viability of Adoption of Exoskeleton Technology in Construction via Agent-Based Simulation	950
Maryam Soleymani, Mahdi Bonyani, and Chao Wang	
Extended Reality and Digital Twins in Construction: A Bibliometric Study	961
Ina Sthapit and Svetlana Olbina	
Advancing Graph-Based Hybrid Modularization for Integrated Decisions on Volumetric Modules and Panelized Walls	972
Sebastian Valencia Zapata, Heung Jin Oh, and Soowon Chang	
Enhancing Construction Site Inspection with a Portable LiDAR-Inertial Odometry-Based Mapping System for Cost-Effective Point-Cloud Integration with BIM and Digital Designs	983
Pedro Dulanto and Ivan Mutis	
Smartphone LiDAR-Based Workflow for Fast On-Site Inspection of Placed Reinforced Bars with BIM	993
Hojeong Jeong, Jisoo Park, Hyeonggi Lee, Heejun Yang, Mohamed Abdelsalam, and Sungjin Kim	
Effects of Drone Approaching Distance on Workers' Attention Allocation: Cognitive Tunneling under Time Pressure	1001
Yibo Qiang, Sebastien Helie, Jeffrey M. Haddad, Sogand Hasanzadeh, and Behzad Esmaeili	
Feasibility Assessment of 360-Degree Virtual Reality Storytelling for Safety Communication among Small Construction Employers	1012
Faraz Khojasteh Far, Jingyuan Shen, and Jing Wen	
Structuring Unstructured Construction Logs: A No-Code ChatGPT Workflow for Entity Extraction	1022
Tianjiao Zhao, Ri Na, and Xi Wang	