Reachsak Ly

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Research Interest

Leveraging emerging technologies such as Generative AI, Vision and Large language models, Blockchain and Digital Twins alongside Machine Learning , Construction Robotics and Extended Reality (XR) , to develop innovative solutions for Human building interaction, Smart building, Smart cities and Construction operations.

Education

- **Virginia Polytechnic Institute and State University** *08/22 – Expected 05/25*
  Doctor of Philosophy in Environmental Design and Planning (EDP) Blacksburg, USA
  - Dissertations: Leveraging Artificial Intelligence and Distributed Ledger Technologies Toward Smart and Autonomous Buildings
- **Zhejiang University** *09/17 – 07/21*
  Bachelor of Engineering in Civil Engineering Hangzhou, China
  - Specialization: Structural Engineering

Academic Experience

Graduate Research Assistant *Blacksburg, Virginia, USA*
Department of Building Construction
Myers Lawson School of Construction
Virginia Polytechnic Institute and State University *08/22 – Present*

Graduate Teaching Assistant *Blacksburg, Virginia, USA*
Department of Building Construction
Myers Lawson School of Construction
Virginia Polytechnic Institute and State University *08/22 – Present*

Undergraduate Research Assistant *Hangzhou, China*
College of Civil Engineering and Architecture
Zhejiang University *03/19 – 07/21*

Industrial Experience

Project Engineer *Phnom Penh, Cambodia*
China Railway Construction Corporation (Shangri-La Hotel Project) *06/20 – 06/22*
Roles:

- Coordinate with architects and construction team to ensure compliance with building codes and safety regulations
- Conduct site inspections to monitor the quality and progress of construction
- Provide technical advice and solutions during the construction phase

Honors and Awards

- **Student award recipient for the IIBEC International Convention and Trade Show**. RCI-IIBEC Foundation, 2023
- **Excellent Award in the 1st International Project Competition in Structural Health Monitoring**. The International Project Competition in Structural Health Monitoring, organized by University of Illinois Urbana-Champaign and Harbin Institute of Technology, 2021. **(Result)** **(Award)**
- **Outstanding International Leader**. Zhejiang University, 2020
- **Student travel grants for ASCE competition, (USD 2000)**. Zhejiang University, 2020
- **Fully-funded government scholarship for the undergraduate program** (11/1000+). Zhejiang University, 2016
- **1st Place in Microsoft Hackathon: Window App Studio Challenge**. Microsoft, 2016 **(Award)**

PUBLICATIONS

C=CONFERENCE, J=JOURNAL, S=IN SUBMISSION, P=IN PREPARATION

Refereed Journals

[J.3] Saeed Rokooei, Alireza Shojaei, **Reachsak Ly** (2024). **Faculty development program to enhance teaching quality in construction**. *International Journal of Construction Management* DOI: 10.1080/15623599.2024.2304475

[J.2] Alireza Shojaei, **Reachsak Ly** (2023), Saeed Rokooei, Amirsamman Mahdavian, Ahmed Al-Bayati **Virtual site visits in Construction Management education: A practical alternative to physical site visits**. *Journal of Information Technology in Construction* DOI: 10.36680/j.itcon.2023.036

[J.1] Hossein Naderi, Alireza Shojaei, **Reachsak Ly** (2023). **Autonomous construction safety incentive mechanism using blockchain-enabled tokens and vision-based techniques**. *Automation in Construction*, Vol. 153 DOI: 10.1016/j.autcon.2023.104959

Refereed Journals (Under Review / In progress)

[S.3] **Reachsak Ly**, Alireza Shojaei (2024). **Decentralized autonomous organizations in Built Environments: Applications, Potentials and Limitations**. Manuscript submitted for publication in *Information Systems and e-Business Management Journal*. (Under review)

[S.2] **Reachsak Ly**, Mohammad Hossein Heydari, Hossein Naderi, Josh Iorio, Alireza Shojaei (2024). **Investigation of Gender and Racial Diversity in U.S. Construction Higher Education**. Manuscript submitted for publication in *International Journal of Construction Education and Research*. (In revision for resubmission)

[S.1] MohammadHossein Heydari; Hossein Naderi; **Reachsak Ly**; Alireza Shojaei (2024). **An Industry-Centric Investigation of Educational Practices to Enhance Diversity in the Construction Workforce**. Manuscript submitted for publication in *Journal of Management in Engineering*. (Under review)

[P.4] **Reachsak Ly**; Alireza Shojaei; Xinghua Gao; Philip Agee; Abiola Akanmu (2024). **Decentralized autonomous organization and LLM-based artificial intelligence agents integrated framework for autonomous building cyber-physical system**.(To be submitted to Automation in Construction by 11/30/2024) **(Preprint)**

[P.3] **Reachsak Ly**; Alireza Shojaei (2024). **Blockchain-based IoT and Digital Twin for Decentralized Automation of Building Facilities Operation**. (To be submitted to Automation in Construction by 11/30/2024)

[P.2] **Reachsak Ly**; Alireza Shojaei; Abiola Akanmu; Xinghua Gao; Philip Agee (2024). **Data-driven and distributed governance of building facilities management using decentralized autonomous organization, digital twin, and large language models.** (To be submitted to Automation in Construction by 01/30/2025)

[P.1] **Reachsak Ly**; Alireza Shojaei; Xinghua Gao; Philip Agee; Abiola Akanmu; (2024). **Decentralized autonomous organization and blockchain-based incentivization framework for community-based facilities management.** (To be submitted to Automation in Construction by 01/30/2025)

Refereed Conference Proceedings

[C.5] **Reachsak Ly**, Alireza Shojaei; Hossein Naderi (2024). **DT-DAO: Digital Twin and Blockchain-Based DAO Integration Framework for Smart Building Facility Management**. In *Construction Research Congress 2024*, pp. 796-805. American Society of Civil Engineers. 2024-03-18, Des Moines, Iowa. DOI: 10.1061/9780784485262.081

[C.4] Hossein Naderi, **Reachsak Ly**, Alireza Shojaei(2024). **From Data to Value: Introducing an NFT-Powered Framework for Data Exchange of Digital Twins in the AEC Industry**. In *Construction Research Congress 2024*, pp. 299-308. American Society of Civil Engineers. 2024-03-18, Des Moines, Iowa. DOI: 10.1061/9780784485262.081

[C.3] Hassan Azad, Alireza Shojaei, **Reachsak Ly**, Saleh Naseer, Laurie M. Heller, (2024). **Assessment of annoyance from traffic noise inside a school and a hospital**. In *Inter-Noise 2024 Conference* 2024-08-27,Nantes,France.

[C.2] Jiawei Zhang, Jiangpeng Shu , **Reachsak Ly**, Yiran Ji (2021). **Continual-learning-based framework for structural damage recognition**. In *The 10th International Conference on Structural Health Monitoring of Intelligent Infrastructure*, 2021-06-30-2021-07-02, Porto, Portugal.

[C.1] Jiawei Zhang, **Reachsak Ly**, Weijian Zhao, Yunyi Liu(2020). **Image-Based Structural Damage Recognition using Deep Convolutional Neural Networks**. In *Proceeding of the fib Symposium 2020 Concrete Structure for Resilience Society*, 2020-22-11 2020-24-11, Shanghai, China.

Other publications: Competition/ Research papers / Preprint

Jiawei Zhang, Jun Li, **Reachsak Ly**, Yunyi Liu and Jiangpeng Shu (2024). **Deep Learning-Based Fatigue Cracks Detection in Bridge Girders using Feature Pyramid Networks**. In *The 1st International Project Competition for Structural Health Monitoring*.2020-15-06 - 2020-30-09, Harbin, China **(Paper)**

Jiangpeng Shu, Jiawei Zhang, **Reachsak Ly**, Fangzheng Lin, Yuanfeng Duan . **Structural Damage Recognition using Learning Without Forgetting**. **(arXiv)**

Reachsak Ly, Lou Tao Shen, Yu Yuansheng, Maosi Geng, Yinan Dong, Ce Wang(2019). **Renovation proposal of Santa Clara Street in San Jose**. In *2019 ASCE Mid-Pacific Student Conference, Transportation Challenge*. 2019-14-04-2019-19-04, San Jose, CA **(Paper)**

Research Grants

Contributions to Prior Funded Research

(NSF) SCC-PG Remote Sensing and Prediction of Environmental Noise to Facilitate Addressing the Social and Health Issues of Noise - Pilot Study: Schools and Hospitals
Principal Investigator: Hassan Azad; Co-Principal Investigator: Sanjay Ranka, Laurie Heller, Alireza Shojaei kol kachi
Award Amount: USD 149,437 , Award Number:2125427
Role: Data analysis on noise datasets collected from hospitals and schools. Applied both descriptive and inferential statistical techniques to assess noise levels and identify correlations with times of the day. Performed time series data visualization to illustrate patterns of environmental noise. Co-authored a conference paper.

Diversity and Inclusion Seed Investments fund (Institute for Critical Technology and Applied Science (ICTAS))
Led by Dr.Alireza Shojaei, Myers-Lawson School of Construction, with North Carolina A and T State University
Role: Submitted a journal paper on the topic of Gender and Racial Diversity in U.S. Construction Higher Education (Under review). Conduct data collection for the development of a comprehensive DEI database. Assisted with the design and development of the project website.

Contributions to Submitted Grants

- **Smart and Autonomous Building Cyber-Physical Systems**. (Submitted to **(Cyber-Physical Systems)**(NSF 24-581))
  Principal Investigator: Dr. Alireza Shojaei.
  Role: Co-author, My dissertation research and preliminary data related to Blockchain and LLM in smart building are the basis for this grant proposal. Contributed to the development and writing of the proposal, including the overall research design, project justification, theoretical underpinning, broader impacts, and intellectual merit.
- **Virginia's Nexus Horizon - Synergizing Urban-Rural Resilience for Sustainable Growth**. (Submitted to **Sustainable Regional Systems Research Networks**(NSF 24-533))
  Role: Assisted with the project justification and data management plan.
- **AI and Blockchain-Powered Mentorship and Gamification for Empowering Minority STEM Students: Nurturing a Sense of Belonging** . (Submitted to **Advancing Informal STEM Learning**(NSF 24-601))
  Role: Assisted with the project justification and visaulization.

In preparation for submission

- **AVATAR: AI-assisted Virtual Assistant and Augmented Twin for Advanced Real-time Smart Building Facilities management**.(In preparation, To be submitted to **(NSF ENG-AI)**(NSF 24-039) by 01/15/2025),Principal Investigator: Dr. Alireza Shojaei.
  Role: Co-author, My preliminary works and data on Extended Reality and LLM in smart building are the basis for this grant proposal. Contributed to the development and writing of the proposal, including the overall research design, project justification, theoretical underpinning, broader impacts, and intellectual merit.

Research Project

- **Small language model-based smart home devices for Human-Building Interaction** *07/24 – Present*
  Virginia Polytechnic Institute and State University **(Github)**
  ◦ Deployed small language model (Phi-3 mini) onto Raspberry Pi 5 for human-building interaction application including smart building systems control. (Manuscript in preparation)
- **LLM-based AI agents and (XR) Extended Reality applications for smart building control** *06/24 – Present*
  Virginia Polytechnic Institute and State University **(Github)**
  ◦ Developed LLM-based AI agents and extended reality (XR) applications to enhance smart building control. This project leverages open-sourced vision language model (LLaVA), open-sourced Text-to-speech (TTS) and Speech-to-Text (STT) model, with Unity 3D to develop a simple AI application on Microsoft HoloLens 2 with AI Voice chat and Image understanding. (In progress)
- **Large Language Model for Human-Building Interaction** *06/24 – Present*
  Virginia Polytechnic Institute and State University **(Github)**
  ◦ Designed and implemented a large language model-based chatbot/AI agents to facilitate natural language interactions between building occupants and facility management systems such as smart facilities control. (Manuscript in preparation)
- **Multimodal AI Agent for Emergency Detection and Response in Smart Building** *05/24 – Present*
  Virginia Polytechnic Institute and State University **(Github)**
  ◦ Created an AI agent for emergency response in smart buildings, integrating real-time data analysis and decision-making capabilities to improve response times and safety measures. (In progress)
- **LLM-based Retrieval-Augmented Generation (RAG) Chatbot for Construction Safety** *05/24 – Present*
  Virginia Polytechnic Institute and State University **(Github)**
  ◦ Created a retrieval-augmented generation (RAG) chatbot utilizing LLM to provide real-time safety information and guidance on construction sites to enhance worker's understanding on safety protocols and awareness. (In progress)

- **Vision Language Model for Construction Site Progress and Safety Monitoring** *05/24 – Present*
  Virginia Polytechnic Institute and State University **(Github)**
  ◦ Developed a vision-based language model to monitor construction site progress and safety conditions, integrating computer vision and natural language processing for comprehensive site analysis. (In progress)
- **Blockchain-based IoT and Digital Twin for smart Building Facilities Operation** *01/24 – Present*
  Virginia Polytechnic Institute and State University **(Github)**
  ◦ Developed a blockchain-based IoT framework and digital twin model to automate and optimize building facilities operations, enhancing system efficiency and security of IoT data and building operation. This project uses Hyperledger Fabric, Ethereum blockchain, Digital Twin, and IoT sensors/devices.(Manuscript in preparation)
- **Data-driven and Distributed Governance for Smart Building Facilities Management** *01/24 – Present*
  Virginia Polytechnic Institute and State University **(Github)**
  ◦ Implemented a data-driven governance model using Blockchain technologies, digital twin and large language models with The AI-driven insight and Digital twin visualization.(Manuscript in preparation)
- **Smart and Autonomous Building Cyber-Physical System using LLM and DAO** *01/24 – Present*
  Virginia Polytechnic Institute and State University **(Github)**
  ◦ Developed and evaluated a smart, autonomous cyber-physical system incorporating LLM and decentralized autonomous organization (DAO) technologies to facilitate advanced human-building interaction and management.(Manuscript in preparation)
- **Community-based Facilities Management in Smart Buildings Using Blockchain-based DAO** *01/24 – Present*
  Virginia Polytechnic Institute and State University **(Github)**
  ◦ Implemented a blockchain-based DAO system for community-based management of smart buildings, promoting decentralized governance and stakeholder engagement in facilities management.(Manuscript in preparation)

Teaching Experience

Undergraduate Level

BC 4434 Construction Practice I *(Fall 2022,Spring 2023,Fall 2023)*

This course delves into advanced business and management practices as they relate to vertical construction projects. It covers a wide range of topics, including Work Breakdown Structure (WBS), planning and scheduling, cash flow forecasting and analysis, assemblies estimating, as well as estimating general conditions and overhead costs.Additionally, students will explore site logistics planning, construction contracts and insurance, and the review and management of Building Information Models (BIM). The course also introduces the Design-Build project delivery method.

Duties: Conducted lab sessions and graded students' labs, homework, and exams. Instructed students on key topics such as Work Breakdown Structure (WBS), planning and scheduling, cash flow forecasting and analysis, and assemblies estimating. Supervised and mentored students on these topics, held regular office hours for additional support, and provided personalized guidance to help students understand course material and industry practices.

BC 4444 Construction Practice II (Capstone Project) *(Fall 2022,Spring 2023,Fall 2023)*

This course explores and applies business and construction management practices related to the development and preparation of a response to an RFP to an actual Design-Build capstone project. Topics are reinforced through working on a real-life D/B project. This course is designed to prepare students to understand concepts and principles of the D/B contracting method through working on preparing and delivering responses to an RFP for a real-life D/B project.

Duties: Guided students through the development and execution of their capstone projects, providing supervision on the use of design and project management software, including Revit, MS Project, and RSMeans for cost estimation. Assisted students in preparing responses to project RFPs, offering continuous feedback on design quality and project milestones. Graded student submissions and provided detailed feedback.

BC 4164 Process Planning and Production Design for Construction *(Spring 2024,Fall 2024)*

Course topics include production systems, behavior of construction systems and workers, relationships between subsystems in the construction process, queueing systems, process modeling and simulation. This course gives students an understanding of the production process from both a theoretical and practical perspective. It also equips them with tools and techniques to design analyze and improve construction processes

Duties: Instructed students on the use of Primavera Cloud for project management, including scheduling, process planning, and production analysis. Provided hands-on guidance in utilizing the software to model and improve construction processes. Graded student assignments and projects, offering detailed feedback to enhance their understanding of production systems and process modeling.

Graduate Level

BC 5984 Decision-Making and Risk Management *(Spring 2024,Fall 2024)*

This course explores the theories, methodologies, and tools used in decision making and risk management from a beginner to advanced level. Students will gain insights into the complexities of making decisions in uncertain

environments and learn strategies to manage and mitigate risks effectively. This course is designed to prepare students to think critically and become better decision makers. It will also equip them with risk management knowledge to apply in various contexts.
Duties: Supervised students in performing calculations related to planned and expected values for decision-making in project management. Guided them through the application of risk management strategies and techniques. Facilitated hands-on experience with project simulation using the Monte Carlo method to analyze and manage uncertainties in project outcomes.

Outreach/ Community service

Building Leaders for Advancing Science and Technology (BLAST) program *(July 09, 2024)*
Myers Lawson School of Construction

- Conducted a research demonstration on the integration of LLM-based AI agents and Augmented Reality (AR) for smart building control. Presented the application of AR and LLM technologies, showcasing their potential future impact on the construction industry to high school students participating in the BLAST program of the National Space Grant Foundation.

Virginia 4-H Youth development program *(June 19, 2024)*
Myers Lawson School of Construction

- Organized and conducted a workshop demonstrating the application of quadruped robots in the construction industry. Engaged high school students in hands-on activities and discussions about robotics technology and its potential impact on construction practices.

University service

Research on Diversity, Equity, and Inclusion *(Spring 2024-Present)*

Collaborate with the Diversity, Equity, and Inclusion (DEI) Committee at the Myers-Lawson School of Construction with the aim of fostering an inclusive environment, enhancing representational diversity, and incorporating DEI principles into the academic curriculum.

Duties: Conduct research to investigate the relationship between racial and gender diversity among student graduates and their retention rates within the construction industry. Collaborate with multiple institutions to collect and analyze data on construction student graduates, focusing on diversity metrics. Develop and implement strategies to use research findings for improving DEI initiatives within the academic and professional communities.

Professional Services

Journal Paper Reviewer

- Journal of Construction Engineering and Management
- Journal of Information Technology in Construction

Mentorship Services

Student mentorship *(2022-Present)*

- Conducting one-on-one meetings with students to resolve challenges encountered in the taught courses.

Professional Affiliation/Certification

- Future Professoriate Certificate, *Graduate Certificate Program, Virginia Tech, 2024*
- CIRTL Certificate, *Center for the Integration of Research, Teaching, and Learning, Virginia Tech, 2024*
- Student member, *Center for Human-Computer-Interaction (CHCI), Virginia Tech.*
- Student member, *International Institute of Building Enclosure Consultants (IIBEC).*

Skills

- **Languages:** English, Chinese, Khmer
- **Programming Languages:** Python, CSharp, Javascript, Java, HTML/CSS, Solidity
- **Web Technologies:** React.js, Node.js, Express.js, RESTful APIs, Flask, WebSockets
- **Database Systems:** MySQL, MongoDB, Qdrant, ChromaDB
- **Data Science & Machine Learning:** TensorFlow, PyTorch, Scikit-Learn, Pandas, NumPy, Matplotlib, MLX, Cuda
- **Specialized Area:** Large language models, Blockchain Development, Smart Contracts, Digital Twin Technology, AR/XR Development