Michael Bekele Maru

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RESEARCH HIGHLIGHTS

- Algorithmic-based structural health monitoring and automatic damage assessment of the existing infrastructures on civil structures using shape information of an object.
- Elevating damage detection and quantification using advanced point cloud-based techniques and machine learning.
- Advancing structural health monitoring and damage assessment through innovative 3D reconstruction techniques and data-driven approaches
- Synergizing digital twin-enabled techniques for advanced structural health monitoring, 3D reconstruction, and damage assessment
- Revolutionizing structural health assessment, non-destructive evaluation, and damage analysis through innovative optical sensor technologies

EDUCATION

Sungkyunkwan University, Suwon, South Korea
Combined M.sc & Ph.D. in Civil, Architectural and Environmental System Engineering. 2018 - 2024
Dissertation title: "Enhancing Lidar Data Processing for Advanced Building Facade Segmentation and 3D Reconstruction."
Advisor: Professor Seunghee Park

Addis Ababa University, Addis Ababa, Ethiopia
B.SC in Civil, Architectural and Environmental System Engineering. 2010 - 2015
Thesis title: "Structural design of 3B+M+G+7 building"
Advisor: Aberham Wolde (Ph.D.)

PROFESSIONAL EXPERIENCES

Site Engineer **Addis Gedle General Contractor**
Oct 2015 - Jul 2016

- Quality Supervision at commercial building construction sites.
- Reviewed plans and specs before construction.
- Monitoring every skilled manpower
- Prepared regular interval progress reports.

Project Engineer **Nasew Construction PLC.**
May 2016 - Jan 2018

- Synchronize all tasks that must be executed on that project.
- Cooperate the office work with the site execution based on the schedule.
- Preparation of scheduling, as built drawing, executed task report and cash flow of the construction.
- Carry out quality assurance tests to discover errors and optimize usability.

RESEARCH EXPERIENCE

Sungkyunkwan University, Smart Construction IT Lab

❖ ***Graduate Researcher to Professor Seunghee Park*** Mar 2018 – Feb 2024

Optical sensor applications in a structural health monitoring

- Visual inspection and damage detection.
  - ✓ Detailed 3D model enables thorough visual inspection.
  - ✓ Identifies structural damage, cracks, and deterioration.
- Novel approach using LiDAR for damage detection.
  - ✓ The application of LiDAR technology for damage detection and shape change analysis in structural elements, including the estimation of deflection through a validated approach involving a robust genetic algorithm and taguchi experiment design.
- Analyzing depth camera sensors performance in computing structural displacement.
  - ✓ Proposing algorithmic-based computation of a structure deflection using depth camera data.
- Conducted comprehensive experimental tests.
  - ✓ Evaluating the effectiveness and performance of the LiDAR and camera sensors on structural health assessment.
- Comparison of the optical sensor performance.
  - ✓ Specifically, a depth camera(DC) and terrestrial laser scanner(TLS), in estimating structural deflection with validation against a linear variable differential transformer sensor.

Computer vision-based damage detection

- Exploration of computer vision and deep learning.
  - ✓ Computer vision and deep learning techniques are investigated for automatic damage detection.
- Rectified intensity images for precise damage detection.
  - ✓ Radiometric information from LiDAR generates rectified intensity images.
  - ✓ Intensity images enhance the precision of damage detection on structural surfaces.
- Leveraging LiDAR's point cloud data.
  - ✓ LiDAR's point cloud data captures both geometric and radiometric characteristics.
  - ✓ Non-destructive detection of damage is enabled by identifying surface alterations and discontinuities.
- Intensity-based image colormaps for deep learning.
  - ✓ Calibrated radiometric information from LiDAR constructs intensity-based image colormaps.
- Method for detecting and quantifying depth of damage.
  - ✓ proposed approach includes a method for detecting and quantifying section loss damage depth in the target structure.
  - ✓ Structural well-being can be comprehended through localized damage detection.
- Validation through experimental verification.
  - ✓ Outcomes are validated through experimental verification to establish reliability and effectiveness.
  - ✓ Demonstrates the potential of LiDAR-based technique for accurate damage detection.

3D vision reconstruction

- Measurement and analysis
  - ✓ Precise measurements aid in comprehensive structural analysis.
  - ✓ Accurate dimensions, angles, and distances are obtained.
  - ✓ Accurate building facade segmentation using LiDAR sensors.
- Development of point cloud intensity correction model
  - ✓ Utilization of an empirical-based intensity correction model for improving the performance of LiDAR point cloud.
- Renovation and design
  - ✓ Supports renovation projects with accurate data for redesign and planning.
  - ✓ Application of deep learning for processing large-scale point cloud data and enhanced component classification.
  - ✓ Experimental validation showcasing the potential of digital twin-enabled segmentation of building

façade for the AEC industry.

- Visualization and Communication
  - ✓ Interactive 3D visualization enhances stakeholder communication.
  - ✓ Integration of the robust segmentation of a point cloud technique into a digital twin for real-time monitoring of a building structure.
- Efficiency and Safety
  - ✓ Faster data collection through LiDAR or photogrammetry enhances efficiency.
  - ✓ Reduces safety risks associated with manual measurements.

❖ ***Postdoctoral Researcher to Professor Seunghee Park*** Mar 2024 – Present

- Digital twin framed techniques for bridge structural health monitoring,
- Synergistic point cloud and image of a bridge local and global damage assessment.
- Automatic 3D model generation of a building facade

Works In Progress

- **Development of robust LiDAR intensity correction model**: enhancement of LiDAR data performance through fusion of empirical and theoretical correction models for improved radiometric information
- **Bridge crack assessment using close-up imaging and 3D point cloud models**: This research focuses on detecting local damage, such as cracks, on bridges using high-resolution close-up images and precisely localizing this damage on a 3D reconstructed model derived from point cloud data. By combining detailed 2D crack detection with comprehensive 3D structural mapping, the study aims to enhance the accuracy and efficiency of bridge inspections and maintenance planning.
- **Semantic-driven digital twin generation for building facades from point cloud segmentation:** This research would contribute to advancing the field of digital twins for building façades by integrating semantic-driven 3D reconstruction with real-time monitoring and analysis. The proposed approach could lead to improved building design, energy efficiency, maintenance, and occupant comfort.

Publications

Google scholar profile: *https://scholar.google.com/citations?user=O3N-bJ8AAAAJ&hl=en*

- **Michael Bekele Maru**, Yusen Wang, Hansun Kim, Hyungchul Yoon and Seunghee Park, 2023. Improved building facade segmentation through digital twin-enabled RandLA-Net with empirical intensity correction model. *Journal of Building Engineering*, 151, pp. 1-14.
- **Michael Bekele Maru**, Donghwan Lee, Kassahun Demissie Tola, Seunghee Park, 2020. Comparison of depth camera and terrestrial laser scanner in monitoring structural deflections. Sensors, 21(1): 10.3390/s21010201.
- **Michael Bekele Maru**, Donghwan Lee, Gichun Cha, Seunghee Park. 2020. Beam deflection monitoring based on a genetic algorithm using lidar data. Sensors, 20(7): 10.3390/s20072144.
- Daniel Asefa Beyene, Dai Quoc Tran, **Michael Bekele Maru**, Huangruia, Seunghee Park., 2023. Unsupervised Domain Adaptation-Based Crack Segmentation Using Transformer Network. *Journal of Building Engineering*. Vol. 80, pp. 1-18
- **Michael Bekele Maru**, Daniel Asefa Beyene, Gichun Cha and Seunghee Park, 2023. Synergistic Fusion of LiDAR and Image Data for Assessing Section Loss Damage in Steel Structural Components. *Measurement* **(Submitted)**
- Shuju Jing, Gichun Cha, **Michael Bekele Maru**, Byoungjoon Yu, and Seunghee Park, 2024. Improved semantic segmentation of building MEP systems in point clouds using a novel multi-class dataset and local-global vector transformer deep learning. *Journal of Building Engineering*.**(Accepted)**

Presentations

- **Michael Bekele Maru**, Donghwan Lee, Soojung Shin, Hau Van Quach, Seunghee Park. 2019. Title: Estimation of Beam Deflection Based on Terrestrial Laser Scanning Data Using Genetic Algorithm. Oral presentation:10th international symposium on a steel structure at Jeju, Korea.
- **Michael Bekele Maru**, Donghwan Lee, Najeebullah Tareen, Junghyun Im, Seunghee Park. 2019. Title: Computation of a Robust Fitness Function of Genetic Algorithm for Finding Deflection. Oral presentation: Korea Institute for Structural Maintenance and Inspection at Pyeongchang, Korea.
- **Michael Bekele Maru**, Kim TaeHeo, Choi Woonggy, Papa Win Aung, Seunghee Park. 2022. Title: Single Image Semantic Segmentation of Damage on Steel Plate Structures using Lidar and Image Data. Oral presentation: The Korean Society of Steel Construction (KSSC) at Jeju, Korea.
- **Michael Bekele Maru**, Ko Dongyoung, Lee Changjun, Seunghee Park. 2024. Title: Enhancing Structural Integrity Assessment through LiDAR-Based Damage Detection. Oral presentation: Korea institute for Structural maintenance and Inspection at Jeju, Korea.

Certifications and licenses

- Python 3 Programming Specialization. Completed Feb15,2021. Coursera.org by university of michigan. *https://www.coursera.org/account/accomplishments/verify/GWZN2PAYMVVV*
- Technical Support Fundamentals. Completed Mar 19,2021 at Coursera.org by Google. *https://www.coursera.org/account/accomplishments/verify/UBL35WV6ULQY*
- BIM Fundamentals for Engineers. Completed Jul 31,2023 at Coursera.org by National Tawan University. *https://www.coursera.org/account/accomplishments/verify/QEG5CZF742TQ*
- Construction Project Management. Completed ,2023 at Coursera.org by Columbia University. *https://coursera.org/share/4d56c5538b3175a907b4e9852c8b5423*
- Dynamo BIM from Zero to Hero. Completed Jul 12, 2024 at udemy.com by Viktor Kuzev https://www.udemy.com/certificate/UC-8fc0865e-e3d1-40b6-8366-fb034f50fc3f/?utm_campaign=email&utm_medium=email&utm_source=sendgrid.com

Skills

- **Programming Languages:** Python, MATLAB
- **FEM software:** CloudCompare, Leica Cyclone, ABAQUS
- **CAD & BIM software:** SketchUp, Autodesk family, Revit
- **Graphics software:** Inkscape, Adobe Illustrator
- **Language:** English (Professional Proficiency), Amharic (Native Proficiency), and Korean(beginner)

Awards and Honors

- Excellent presentation award on 2019 Korea Institute for Structural Maintenance and Inspection at Pyeongchang, Korea (2019. 10. 18): "Computation of a Robust Fitness Function of Genetic Algorithm for Finding Deflection".
- Postgraduate Scholarship for combined MSc. And PhD degree program, Sungkyunkwan University 2018-2023

REFERENCES

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