Dr. Matthew McQuaigue

PhD · Computer Graphics · AR/VR · Interactive Web Tech · Visualization
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Technical Expertise

Rendering & Visualization: WebGL, OpenGL, GLSL, Vulkan, D3, Unity
Programming Languages: C++, Python, Javascript
Web Technologies: React, Flask, MongoDB, PostgreSQL, AWS, Apigee, Terraform

Professional Experience

Analytics Software Engineer, *Ally Finacial* Feb 2024 – Present

- Maintained business-critical tag management system with **Adobe Launch**, integrating complex **Javascript** tracking rules and Shell script integration systems. System deployed pixels and event-based architecture, tracked site interactions, and facilitated surveys, providing crucial analytics data.
- Developed full-stack engineering portal using **React**, **DynamoDB**, and **AWS** for codebase interaction and tagging specs.
- Created AI-driven auto-documentation tool using **Esprima.js**, enhancing codebase visibility and reducing manual effort and documentation time by 90%.
- Developed team's robust **CI/CD** pipeline, reducing tag deployment time by **40%** and increasing system reliability for production publishes.

Researcher and Lead Engineer, *The Ribarsky Center for Visual Analytics, UNCC* 2017 – 2024

- Developed advanced **AR/VR** perception software and studies using **C++**, integrating eye-tracking, motion capture, **GI**, and **PBR** rendering.
- Implemented custom pipeline for capturing environment information (Lighting, Geometry) using **MRTK** and **OpenCL**.
- Designed and executed user studies to evaluate depth perception accuracy in virtual environments.
- **Lead** the development of the algorithm visualization software called **BRIDGES** used by over **2000** students across many universities.

Key Projects

Egocentric AR/VR Perceptual Matching Rendering Experiment Framework

- Designing and implementing a framework for manipulating depth cues and rendering techniques in AR/VR environments using Unity and C#
- Implementing Image-Based Lighting (IBL) techniques to enhance realism in Augmented Reality environments
- Integration of real-world lighting information into AR renderings through Hololens Depth Camera and RGB camera Information in C++ and Python OpenCL.
- Auto performance analysis of subjects on depth estimation performance using ANOVA (Analysis of Variance) statistical analysis in Python

BRIDGES 3D/2D Engine:

- Fully designed a **WebGL**-based 3D rendering **API** for undergraduate CS education.
- Implemented **scene graph** management, shader programs, and texture handling.
- Developed a **custom serialization format** for efficient **SocketIO ExpresJS** client-server communication.
- Worked closely with instructors and curriculum developers to ensure the engine aligned with learning objectives.

BRIDGES Visualization Infrastructure and SDK: *Visualization toolkit used by over 20 universities*

- Maintained **C++, Java, and Python** codebase for data structure visualization SDK.
- Performed Server expansion for new visualization renderings using **MongoDB**, **SocketIO**, and **ExpressJS**.
- Optimized and Designed **D3.js/SVG** visualizations for rendering complex data structures.
- Developed **RESTful** API endpoints for seamless integration with backend services.

CS-Materials Webtool: *CS Curriculum auditing web tool*

- **Fully developed** front-end architecture and data pipeline for complex visualizations using **REACT**.
- Designed scientific visualizations using **D3** with customized layouts and **binary matrix clustering**.
- Designed and implemented **RESTful** API for efficient data retrieval and manipulation.
- Optimized application performance through **lazy loading**, **virtualized lists**, **caching**, and backend rendering based on data size.
- Maintained backend storage and retrieval using **Flask Python API**.

GLSL Path Tracing:

- Implemented **unidirectional** path tracing algorithm in **GLSL** compute shaders.
- Developed **physically-based shading** models for realistic material rendering.
- Optimized rendering pipeline using **importance sampling** and **BVH** acceleration structures.
- Implemented **denoising techniques** for improved image quality at lower sample counts.

Education

Ph.D. in Computer Science 2023
University of North Carolina at Charlotte
Dissertation: Understanding Egocentric Depth Perception in VR/AR using Depth Cue and Rendering Manipulations

Publications

1. **McQuaigue, M.**, Subramanian, K., Goolkasian, P., & Wartell, Z. (2024). Impact of Background, Foreground, and Manipulated Object Rendering on Egocentric Depth Perception in Virtual and Augmented Indoor Environments. *IEEE Transactions on Visualization and Computer Graphics*. https://doi.org/10.1109/TVCG.2024.3382616

2. **McQuaigue, M.**, Larson, M., Smith, P., Melech, S., Subramanian, K., & Saule, E. (2024). Engaging CS1 Students with Audio Themed Assignments. *Journal of Computing Sciences in Colleges*, 39(8), 158–172.

3. Burlinson, D.,**McQuaigue, M.**, Goncharow, A., et al. (2023). BRIDGES: Real world data, assignments and visualizations to engage and motivate CS majors. *Education and Information Technologies*. https://doi.org/10.1007/s10639-023-11958-4

4. **McQuaigue, M.**, Saule, E., Subramanian, K., & Payton, J. (2023). Data-Driven Discovery of Anchor Points for PDC Content. In *Proceedings of the SC '23 Workshops of The International Conference on High Performance Computing, Network, Storage, and Analysis (SC-W '23)* (pp. 335–342). Association for Computing Machinery. https://doi.org/10.1145/3624062.3624099

5. Subramanian, K., Saule, E., Payton, J., & **McQuaigue, M.** (2022). Improving the Structure and Content of Early CS Courses with Well Aligned, Engaging Materials. In *Proceedings of the 53rd ACM Technical Symposium on Computer Science Education* (pp. 1202-1202). https://doi.org/10.1145/3478432.3499153

6. Goncharow, A., **McQuaigue, M.**, Saule, E., Subramanian, K., Goolkasian, P., & Payton, J. (2021). CS-Materials: A system for classifying and analyzing pedagogical materials to improve adoption of parallel and distributed computing topics in early CS courses. *Journal of Parallel and Distributed Computing*, 157, 316–330. https://doi.org/10.1016/j.jpdc.2021.05.014

7. Goncharow, A., **McQuaigue, M.**, Saule, E., Subramanian, K., Payton, J., & Goolkasian, P. (2021). Mapping Materials to Curriculum Standards for Design, Alignment, Audit, and Search. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education* (pp. 295–301). Association for Computing Machinery. https://doi.org/10.1145/3408877.3432388

8. Subramanian, K., Payton, J., & **McQuaigue, M.** (2021). Real-World Data, Interactive Games and Data Structure Visualizations in Early CS Courses Using BRIDGES. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education* (p. 1351). Association for Computing Machinery. https://doi.org/10.1145/3408877.3432489

9. Beckman, A., **McQuaigue, M.**, Goncharow, A., Burlinson, D., Subramanian, K., Saule, E., & Payton, J. (2020). Engaging early programming students with modern assignments using BRIDGES. *Journal of Computing Sciences in Colleges*, 35(6), 74–83.

10. Strahler, J., **McQuaigue, M.**, Goncharow, A., Burlinson, D., Subramanian, K., Saule, E., & Payton, J. (2020). Real-world assignments at scale to reinforce the importance of algorithms and complexity. *Journal of Computing Sciences in Colleges*, 35(8), 166–175.

11. **McQuaigue, M.**, Beckman, A., Burlinson, D., Sloop, L., Goncharow, A., Saule, E., Subramanian, K., & Payton, J. (2020). An Engaging CS1 Curriculum Using BRIDGES. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education (SIGCSE '20)* (p. 1317). Association for Computing Machinery. https://doi.org/10.1145/3328778.3372609

12. Goncharow, A., Boekelheide, A., **McQuaigue, M.**, Burlinson, D., Saule, E., Subramanian, K., & Payton, J. (2019). Classifying Pedagogical Material to Improve Adoption of Parallel and Distributed Computing Topics. In *9th NSF/TCPP Workshop on Parallel and Distributed Computing Education (EduPar-19)*, Rio de Janeiro, Brazil.

13. **McQuaigue, M.**, Burlinson, D., Subramanian, K., Saule, E., & Payton, J. (2018). Integrating visualization, assessment and analytics in data structures learning modules. In *Proceedings of the 49th ACM Technical Symposium on Computer Science Education (SIGCSE '18)*.