World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:19, No:09, 2025

Enhanced Visualization Of Minimal Surfaces Through Fast Marching Method

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Abstract : This research develops a framework for visualizing minimal surfaces using the fast marching method (FMM), a numerical technique for efficiently solving boundary problems. By integrating FMM into geodesic computation, this framework allows for accurate and interactive visualization of shortest paths on minimal surfaces. it built the system for real-time interaction, allowing users to quickly change parameters, input their equations, and see how the surface geometry changes. The platform includes a 3D rendering engine based on JavaScript libraries and an intuitive graphical user interface. These features enable users to easily adjust surface types, resolutions, and visualization settings. We describe a proposed interface for making up documents with mathematical concepts in detail. Preliminary testing with educators and students demonstrates its potential to enhance the understanding of mathematical concepts and stimulate interest in studying minimal surfaces. The MathBox library and its supporting visualization tools have been developed to enhance the process of creating interactive and dynamic mathematical visualization. Performance evaluations were conducted to certify that the average frame rate (FPS) is >30 and the average computation speed is 1.158 seconds. The developed platform successfully visualizes various minimal surfaces with high precision and interactive controls. The platform's user-friendly interface allows explicit exploration, making it a valuable tool for educational and research purposes.

Keywords : minimal surfaces, fast marching method, geodesic, mathematical visualization
Conference Title : ICMLDA 2025 : International Conference on Machine Learning and Data Analysis
Conference Location : Tokyo, Japan
Conference Dates : September 09-10, 2025

Open Science Index, Computer and Information Engineering Vol:19, No:09, 2025 publications.waset.org/abstracts/198118.pdf