Karlsruher Institut für Technologie

Fakultät für Informatik
Institut für Anthropomatik und Robotik (IAR)
Lehrstuhl für Intelligente Sensor-Aktor-Systeme (ISAS)
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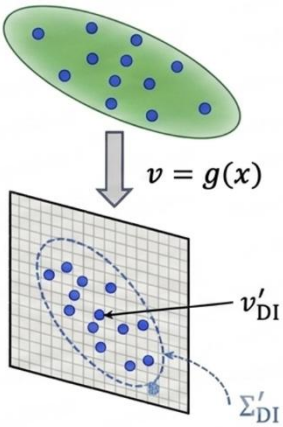
Intelligente ISAS Sensor-Aktor-Systeme

Bachelor/Master Thesis

Advanced 3D Gaussian Splatting with statistical linearization



3D Gaussian Splatting (3DGS) has recently revolutionized the field of novel view synthesis by offering state-of-the-art rendering quality at real-time speeds using only 2D images. By representing 3D scenes as a collection of anisotropic 3D Gaussians, it circumvents the high computational costs of traditional neural radiance fields.

However, the current mathematical formulation has limitations. To project these 3D Gaussians onto a 2D image plane, 3DGS explicitly linearizes the nonlinear perspective projection by applying a first-order Taylor series expansion around the Gaussian mean. This local affine approximation introduces projection errors, especially for highly distorted camera models or at the edges of the field of view.

In this thesis, a novel approach will be developed inspired by the field of nonlinear state estimation. Instead of relying on a first-order Taylor expansion, this project will use statistical linearization to approximate the projection. This should enhance reconstruction quality by reducing projection errors and enable highly distorted camera models. This work will comprise the following tasks:

- Literature research on the mathematical foundations of 3DGS and advanced formulations as well as nonlinear Kalman Filtering techniques
- Familiarize with the existing 3DGS codebase and prior work, utilizing Python and CUDA
- Implement a new 3DGS rendering algorithm utilizing the linear regression approach
- Evaluate the new algorithm and compare with existing state of the art

Requirements:
Students with a background in computer science, mathematics, electrical engineering, mechatronics or other engineering majors. It requires a high level of motivation and the ability to work independently and in a structured manner. Prior knowledge of computer graphics, Python and (CUDA) would be helpful but are not essential.

Emphasis:

Theoretical Study	
Software Implementation	

We offer:

- Excellent support and advice
- Highend-Infrastructure
- Contact to industry and research organizations
- Publication opportunity

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