Creating and Using Neural Radiance Field-Based Maps for Urban Autonomous Vehicle Navigation

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CAREER: High Integrity Positioning for Autonomous Vehicles
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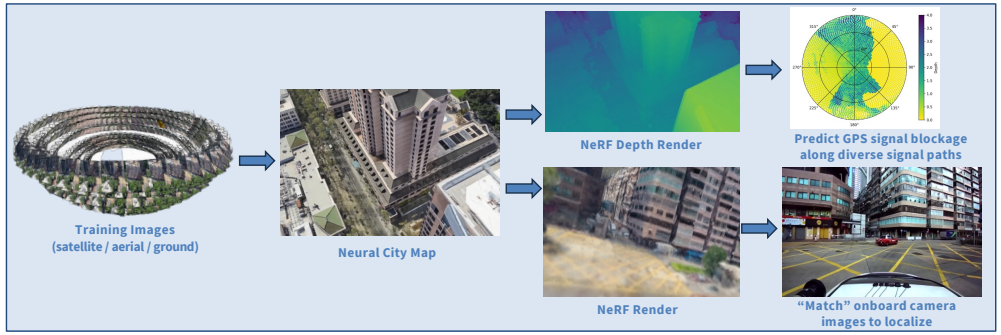
Goal: Explore Neural City Maps with Neural Radiance Fields (NeRFs) for **cost-effective**, **memory-efficient**, and **detailed** urban representations for autonomous driving.



Advantages of Neural City Maps: detailed; agnostic to object geometry or number; readily and conveniently generable from a few camera images; can query from any origin and direction; compact.

Challenges: While NeRFs have shown impressive results in synthesizing novel views of complex 3D scenes, their suitability as a map representation for urban environments has not yet been systematically explored.

Solution: Designed a system for creating, querying, and maintaining Neural City Maps; evaluated the ability of NeRFs to disambiguate between distinct locations using real-world urban driving camera images; designed a framework to use Neural City Maps to predict GPS signal blockage and propagation in urban environments.

Scientific Impact: This work can be generalized to other CPS research, where we model the physical environment using a deep neural network and use it to infer how the physical environment interact with the cyber signals.

Broader impact on society:

Integrated this research into active industry engagement: obtained driving data from the Google Android Localization Team for this research.

Broader impact on education and outreach:

Integrated this research into a graduate course: "AA275 Advanced Autonomous Navigation."

Participated in "Stanford Science Bus" for outreach to K-12 students.

Broader impact on women and minorities:

More than half of the PI's research group are women or minority students.

Engaged women/URM undergrads from Stanford and a community college.