KOSTAS
Kostas Research Institute
at Northeastern University, LLC

Kostas Research Institute for Homeland Security (KRI)

141 South Bedford Street,

Burlington, MA. 01803.

Walk-Through Rendering from Images of Varying Altitude: WRIVA

The Kostas Research Institute for Homeland Security (KRI), a research institute formed by Northeastern University, currently employs research personnel who are experts in developing geospatial AI algorithms and knowledge prototypes to enable tactical scale planning and operations over varied environments (dense urban to tropical landscapes to subarctic and Arctic cold regions, and with varying soil moisture). Specifically, enhanced geospatial processing algorithms utilize high-volume, high-dimensional 1-, 2-, 3- and 4D data to provision accurate terrain analytics, enabling geolocation, and to appraise value of information. KRI's geospatial team builds the engine that turns these data into products, with a current focus on multimodal ML/AI fusion, SfM and SLAM. One modality of data is rarely effective in all situations, so we visualize the same space through several modalities and domains to provide more dimensions of discovery for multimodal, multidomain synthesis.

A prototype developed is a first-generation, collaborative, multi-modal Data-driven Defeat System for Small objects (DS2; nonprovisional application filed with the U.S. Patent and Trademark Office on March 30, 2022). By leveraging multiple sensor sources in an orchestrated fashion, we have adapted open-source AI algorithms to improve synergistic information sharing in our neural nets (NN) that improve model performance. This NN algorithm development was explicitly achievable through collection of in-house, generic data that leverage KRI's outdoor drone cage facilities. We selected to use the cage for experimental advantage through in tandem data collection and analysis and efficient ML/AI implementation. Our experimental approach allowed us to determine if the correct task is being solved before expanding the size of our dataset or knowing what the next collection needs to look like. The result, an algorithm that enables continuous monitoring of very small moving objects under irregular environmental and day/night conditions. DS2 is currently being refined to incorporate tracking functionality and spatial trajectories. An example is real-time SfM products that utilize sparsely available coordinate information to create higher level information.

Software developed can utilize numerous high resolution 2D images from a variety of different sensors, whose intrinsic and extrinsic camera properties are unknown, to create accurate and reliable 3D geo-registered data sets. Software combines open source SfM methods to create 3D point clouds in an arbitrary frame of reference. When converting this arbitrary point cloud to real world coordinates, coordinates are used for a few points in any one of our reference images, to derive an accurate transformation between the frames of reference. Where geospatial coordinates are not available, we employ an orthorectification procedure and feature extraction to match with available/known georeferenced images, e.g., WorldView, KOMPSAT, Sentinel etc. Using the RANSAC algorithm, we accurately geo-reference our base images. Our algorithms operate on GPU architecture in a high-performance network environment, to provide near-real time results.

For the Walk-through Rendering from Images of Varying Altitude Program, we aim to contribute some - or all – of the following tasks:

i. Leverage our multimodal DS2 algorithm fusion network and integrate with SfM for spatial trajectories.
ii. Refine, optimize, and merge our SfM and 3D point cloud geo-registration algorithms for seamless operation over a variety of scales and domains.
iii. Integrate precise elevation metrics from LiDAR sources, Digital Elevation Maps and/or Digital Surface Maps to scale the SfM generated 3D point cloud.
iv. Develop an efficient pipeline that combines the above to operate both in near real time and on large scale areas.