Sandia National Laboratories

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Pipeline Development for 2-D Scene Reconstruction toward an Immersive Virtual Reality Experience

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ABSTRACT

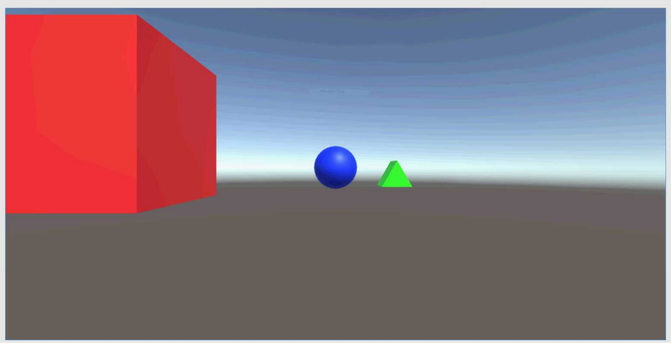
The goal of this project is to develop a pipeline for conversion of 2D images of a scene into an immersive Virtual Reality recreation with emphasis in position, rotation, and scale.

https://www.cgtrader.com/3d-models/interior/living-room/interior-scene-8c73dabd-41bd-4915-8f9a-bc07e2c7ab2b

New Oculus Rift Now Available for Developers by BagoGames, CC BY 2.0

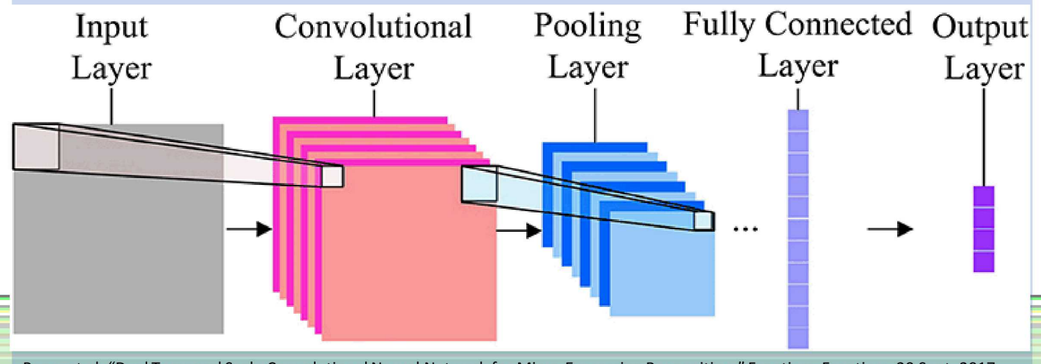
OBJECTIVE

Develop a pipeline to enhance developer productivity utilizing a basic exemplar scene with fundamental geometric shapes.



MILESTONES

1) Research methods for 3D reconstruction and mesh separation with Photogrammetry and Machine Learning
2) Build model 3D reconstruction pipeline: photos -> point cloud -> mesh
3) Postprocessing: Separate one basic object from mesh for individual processing by Unity
4) Postprocessing: Isolate multiple 3-D objects from each other
5) Provide interaction with objects in VR using SteamVR



Peng, et al. "Dual Temporal Scale Convolutional Neural Network for Micro-Expression Recognition." Frontiers, Frontiers, 20 Sept. 2017, www.frontiersin.org/articles/10.3389/fpsyg.2017.01745/full.

PROGRESS MADE:

STRUCTURE FROM MOTION

Keypoints (features with high contrast) are found by similar pixel groupings, grouped by the similarity of scale-space (varied detail) and partial derivative.

An **epipolar** graph is generated by matching the keypoints and associated features to each camera. Only prominent keypoints are used in order to maximize efficiency $O(n^2)$ to $O(kn)$. Increased scale-space generally creates more matches in the graph

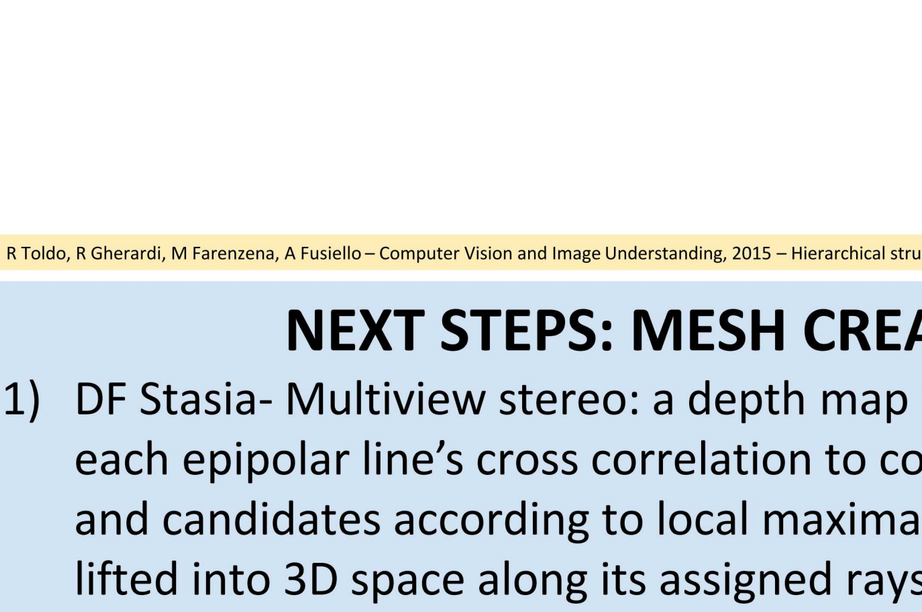
Clustering occurs by measuring the overlap distance between all points on the epipolar graph and clustering by similarity

Final structure from motion is generated by recursively:
1) building a stereo model from two images (camera positions and triangulation), 2) singularly resecting (attaching external feature relations) and triangulating into an existing stereo model, or 3) merging two stereo models by recognizing scale and adjusting position and rotation of features.

R Toldo, R Gherardi, M Farenzena, A Fusiello – Computer Vision and Image Understanding, 2015 – Hierarchical structure-and-motion recovery from uncalibrated images

NEXT STEPS: MESH CREATION

1) DF Stasia- Multiview stereo: a depth map is generated by using each epipolar line's cross correlation to compute depth scores and candidates according to local maxima. Next, each point is lifted into 3D space along its assigned rays. The Poisson algorithm is used fit planes to every group of close neighbors.
2) 3DF Sasha (**proprietary algorithm**): Details are considered to be a key aspect of this process. Sharp edges on the generated mesh are able to be maintained.
3) 3DF Texturing (**proprietary algorithm**): With an emphasis on variable camera parameters and lighting, a textured model can be generated with accuracy.



Model: https://github.com/alicevision

U.S. DEPARTMENT OF ENERGY
National Nuclear Security Administration

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IDEAS productivity

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