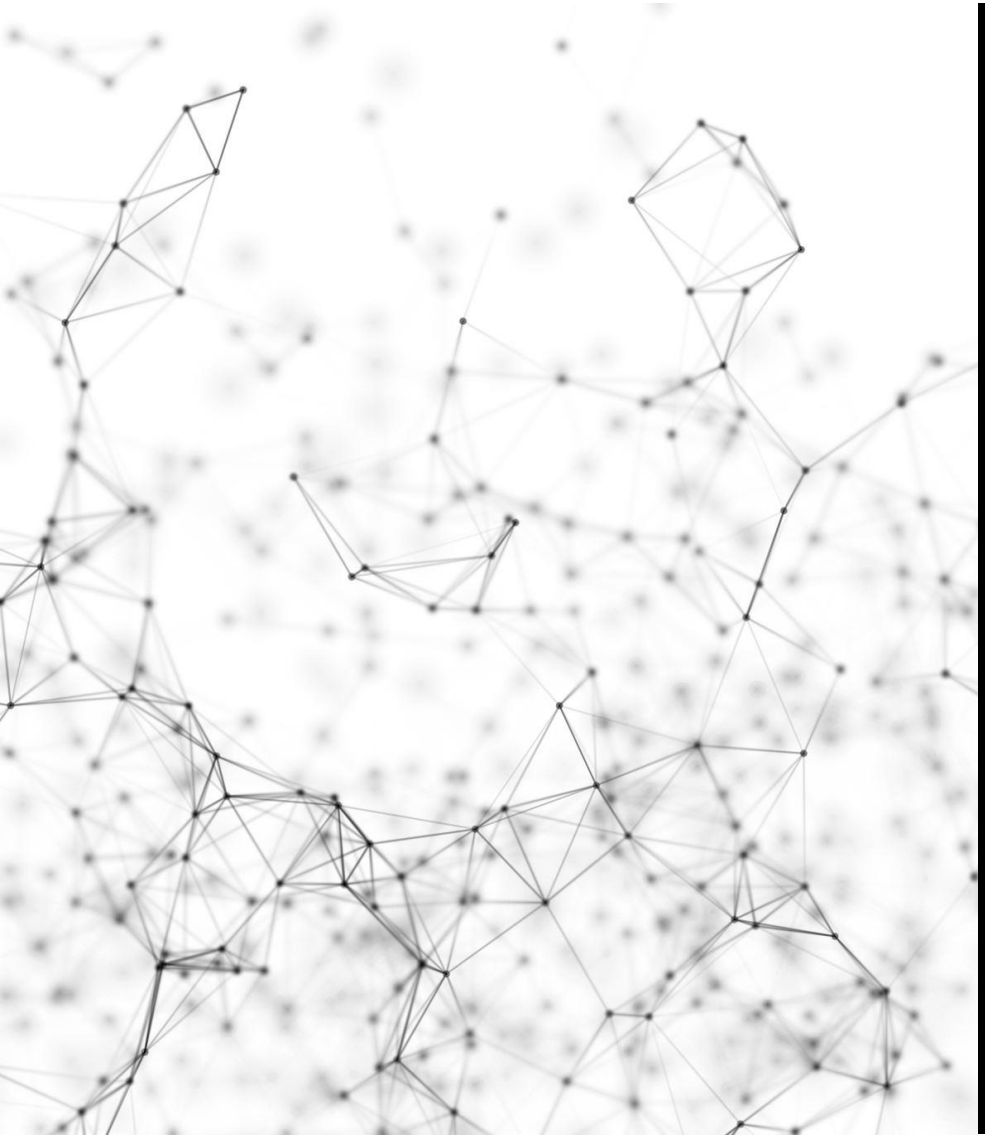


3D POINT CLOUD RECONSTRUCTION

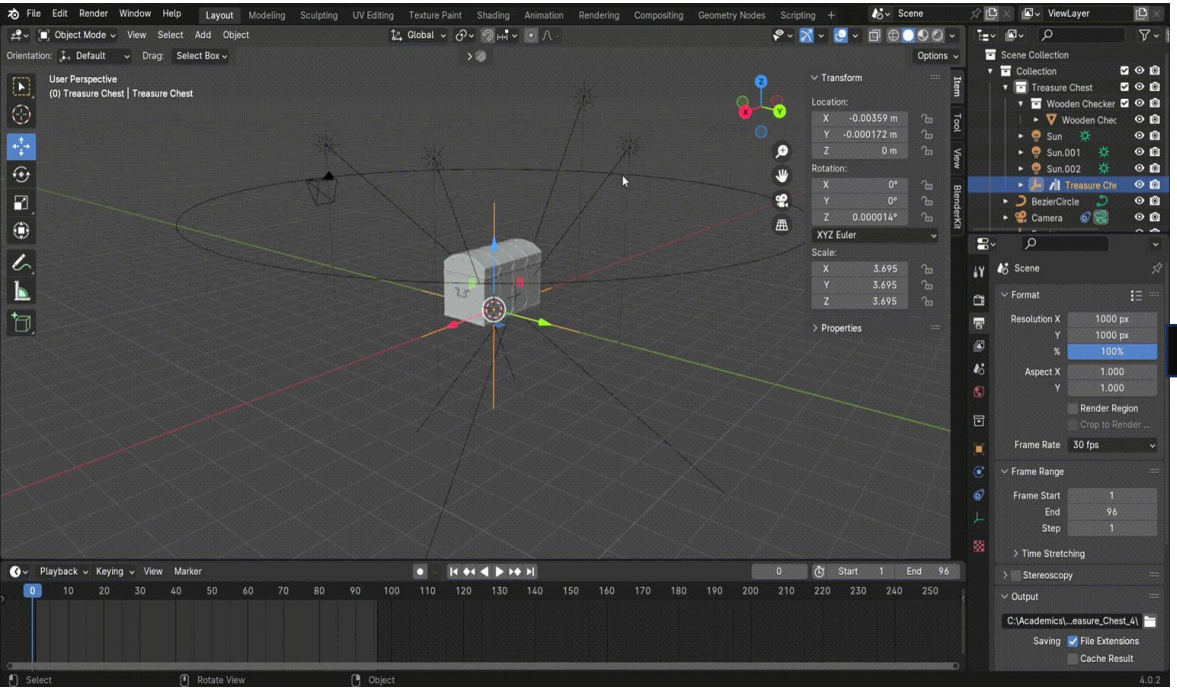
-Kevin Vaishnav
-Naveen Alampally
-Malhar Patel

ABSTRACT

Three-dimensional (3D) reconstruction from multiple images is a fundamental task in computer vision with applications spanning robotics, augmented reality, and cultural heritage preservation. In this project, we present an approach to reconstructing 3D point clouds from a series of 2D images. Our method uses feature detection and matching techniques, camera calibration, and triangulation to generate accurate and detailed 3D representations of objects or scenes. We detail the step-by-step process, including image capturing, feature extraction, camera matrix refinement, and point cloud generation. Using a combination of open-source libraries and optimization techniques, we demonstrate the effectiveness of our approach on a artificially generated dataset.

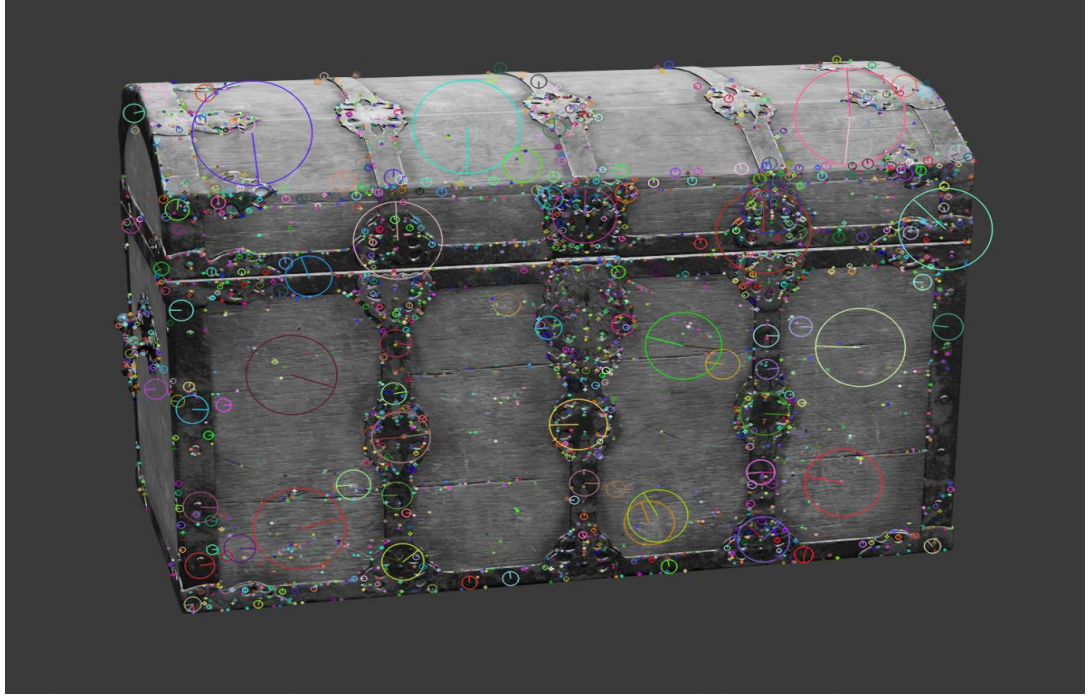
DATASET

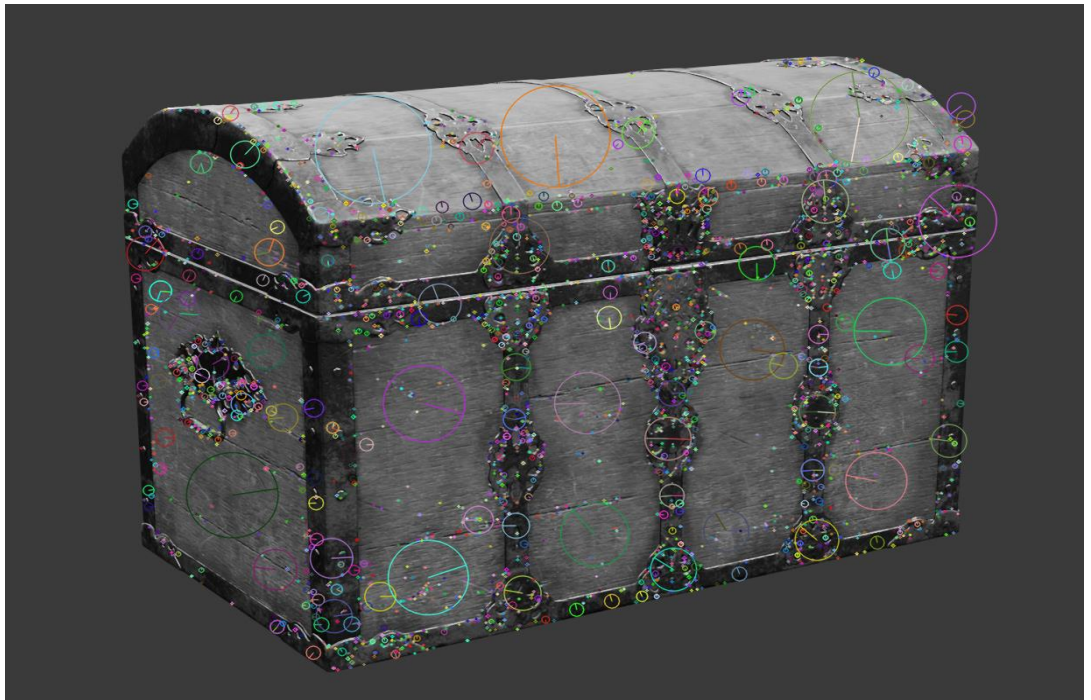
- IMAGE RESOLUTION: 1920 X 1080
- FOCAL LENGTH: 50MM
- SENSOR WIDTH: 36MM

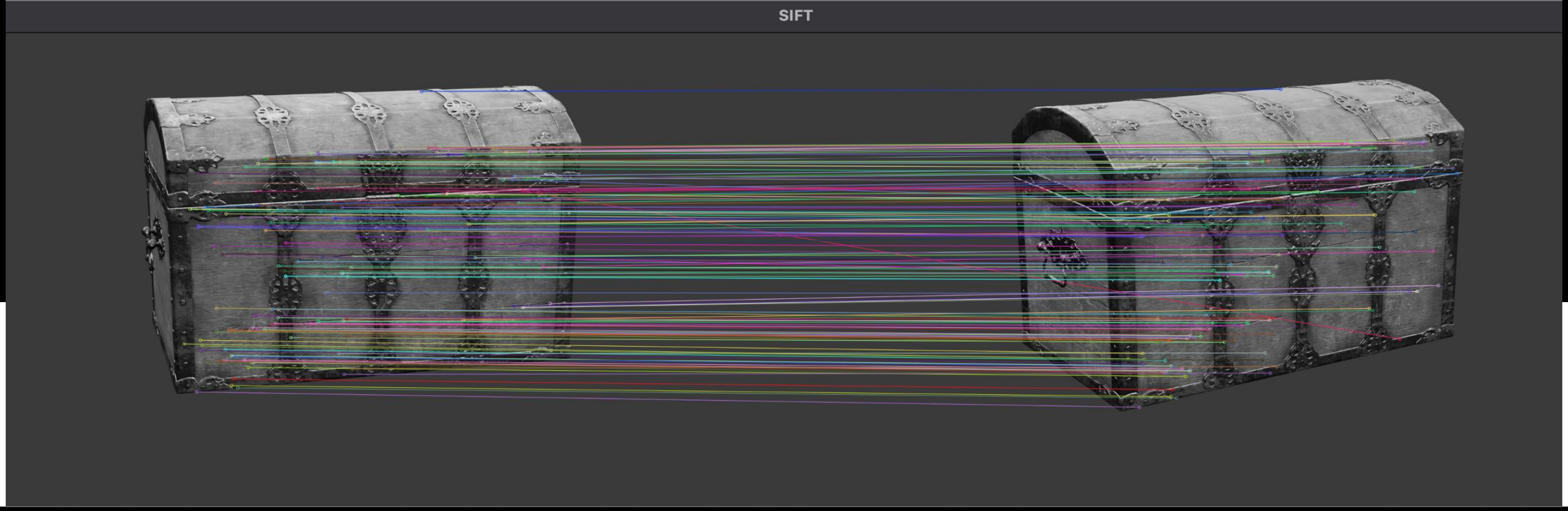


METHODOLOGY

- Detecting and matching key points across multiple images with varying viewpoints and lighting conditions.

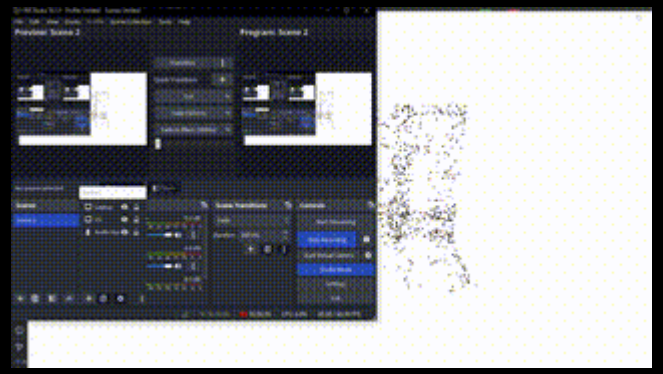






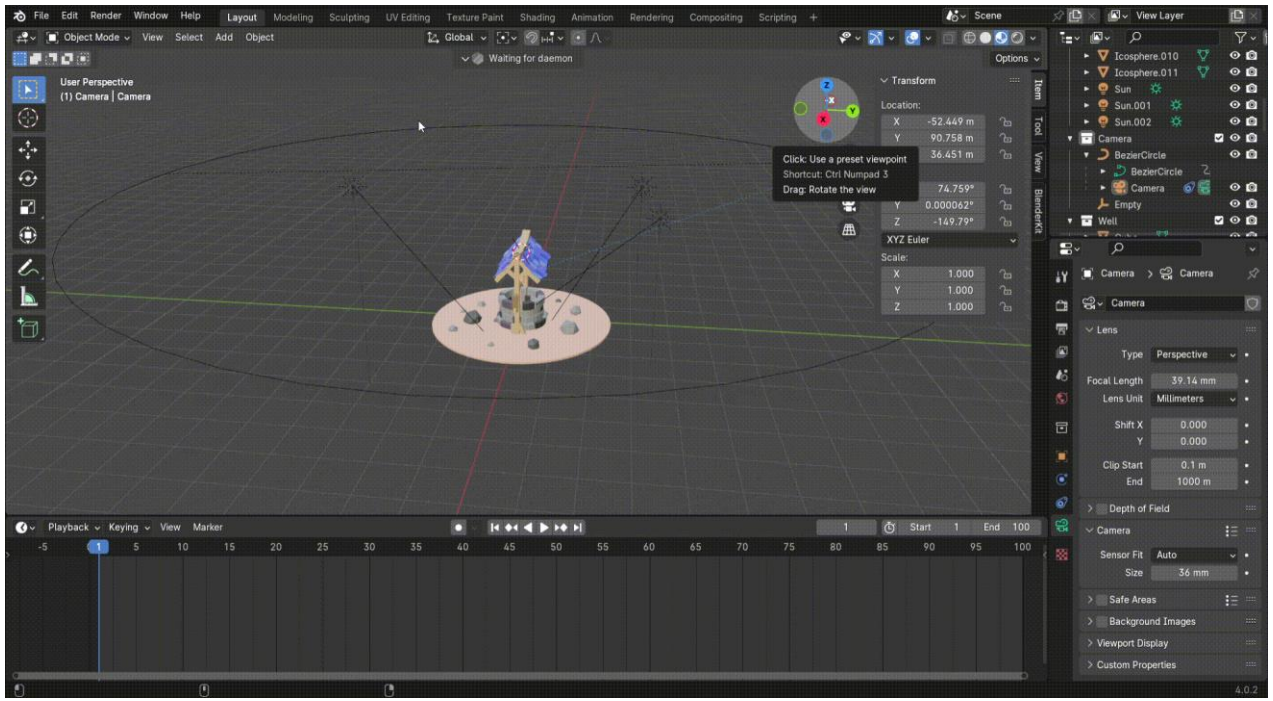
- The k-nearest neighbors (kNN) algorithm matched descriptors obtained from the Scale-Invariant Feature Transform (SIFT) algorithm across image pairs.
- Image pairs with feature matches below a designated threshold were filtered out to ensure better 3D reconstruction.
- Triangulating 3D points from matched key points and estimating the relative pose between image pairs.

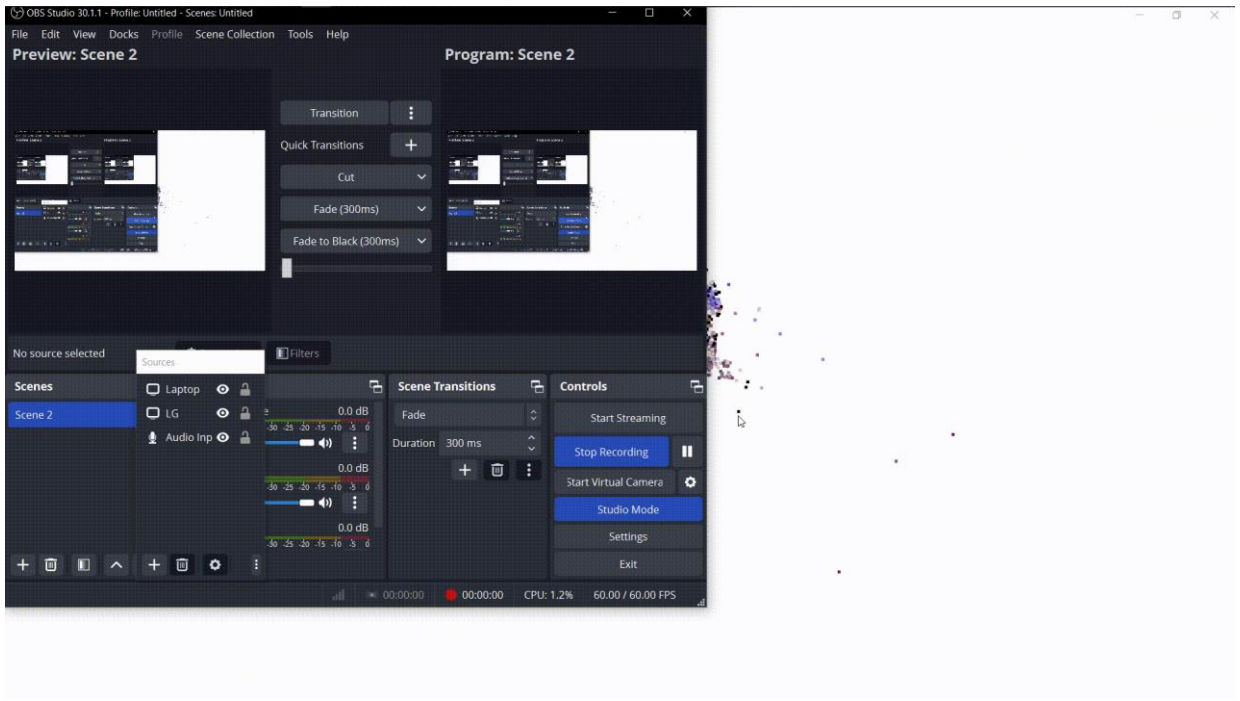
RESULTS



- RANSAC was used to estimate the essential matrix from matched features, utilizing the refined calibrated camera matrices. This enabled accurate recovery of relative poses for effective 3D point cloud reconstruction.
- Handling noise, outliers, and varying point densities in the reconstructed point clouds.
- Manually combining partial 3D reconstructions into a globally consistent point cloud.

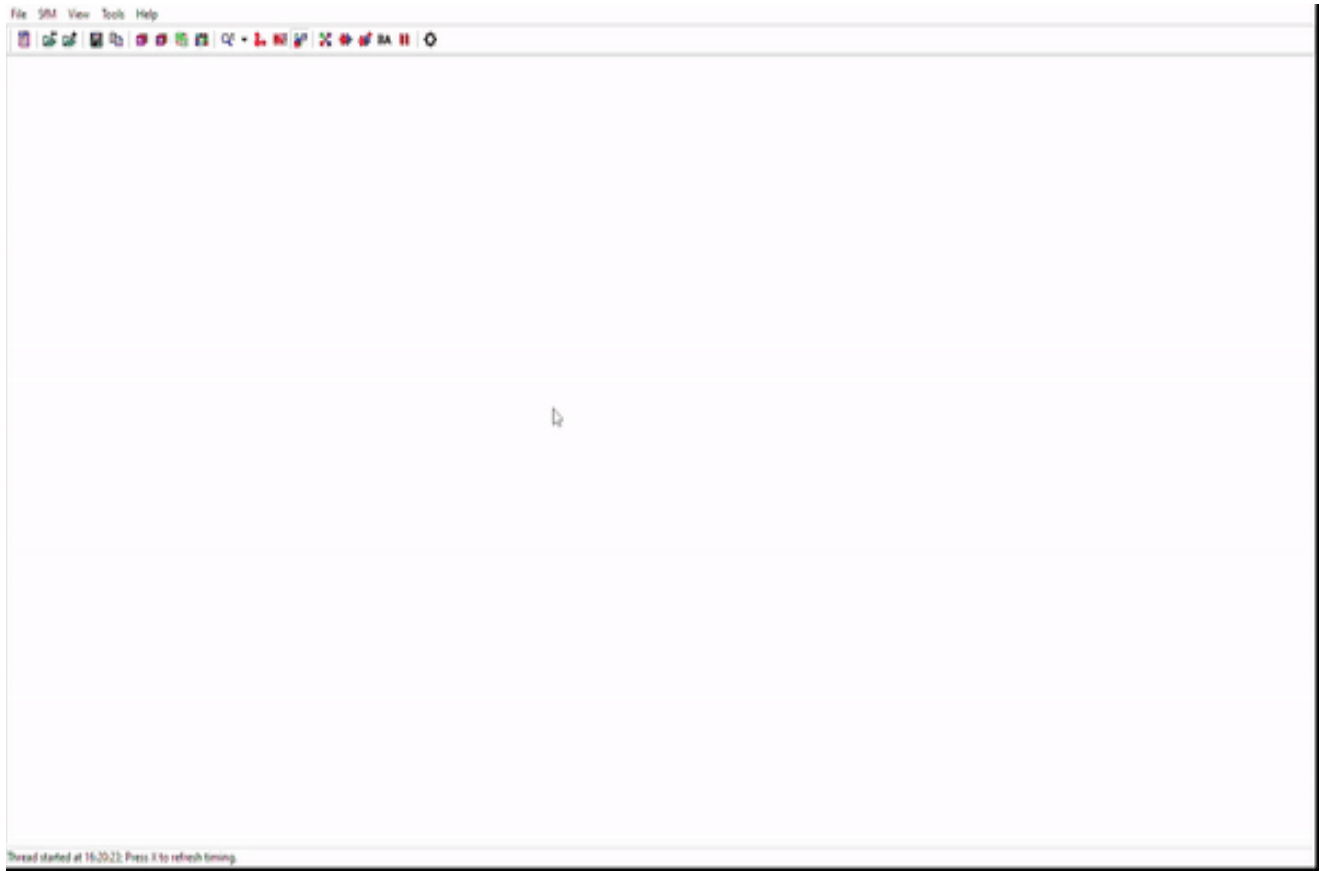
RESULTS

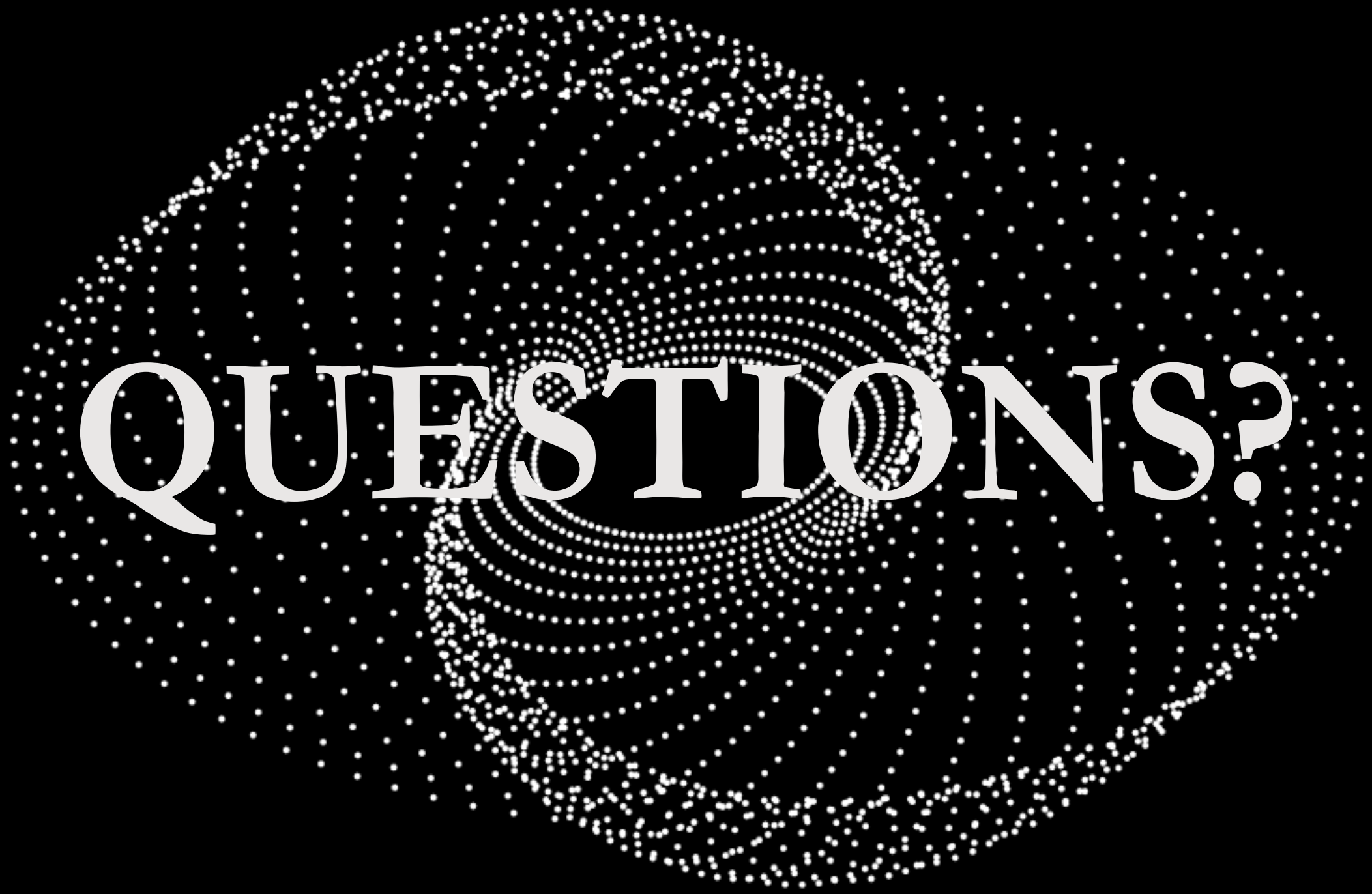

File Edit Render Window Help
Layout Modeling Sculpting UV Editing Texture Paint Shading Animation Rendering Compositing Scripting
Object Mode View Select Add Object
Global
Waiting for daemon
Options
User Perspective
(1) Camera | Camera
Click: Use a preset viewpoint
Shortcut: Ctrl Numpad 3
Drag: Rotate the view
Transform
Location:
X -52.449 m
Y 90.758 m
36.451 m
74.759°
0.000062°
-149.79°
XYZ Euler
Scale:
X 1.000
Y 1.000
Z 1.000
Scene
View Layer
Icosphere.010
Icosphere.011
Sun
Sun.001
Sun.002
Camera
BezierCircle
BezierCircle
Camera
Empty
Well
Camera
Lens
Type Perspective
Focal Length 39.14 mm
Lens Unit Millimeters
Shift X 0.000
Y 0.000
Clip Start 0.1 m
End 1000 m
Depth of Field
Camera
Sensor Fit Auto
Size 36 mm
Safe Areas
Background Images
Viewport Display
Custom Properties
Playback Keying View Marker
Start 1 End 100
4.0.2


OBS Studio 30.1.1 - Profile: Untitled - Scenes: Untitled
File Edit View Docks Profile Scene Collection Tools Help
Preview: Scene 2
Program: Scene 2
Transition
Quick Transitions
Cut
Fade (300ms)
Fade to Black (300ms)
No source selected
Sources
Filters
Scenes
Scene 2
Laptop
LG
Audio Inp
0.0 dB
0.0 dB
0.0 dB
Scene Transitions
Fade
Duration 300 ms
Controls
Start Streaming
Stop Recording
Start Virtual Camera
Studio Mode
Settings
Exit
00:00:00
00:00:00
CPU: 1.2%
60.00 / 60.00 FPS

FUTURE WORK

- Stitching individual point clouds from different viewpoints using bundle adjustment techniques and visualizing the combined 3D reconstruction is planned as future work.




QUESTIONS?