AEROSPACE ENGINEERING
TEXAS A&M UNIVERSITY

LASR
Land Air and Space Robotics

Progress Report # 1
VR Robotics

Texas A&M University - ASTRO/LASR Lab

NASA JSC - Virtual Reality Lab

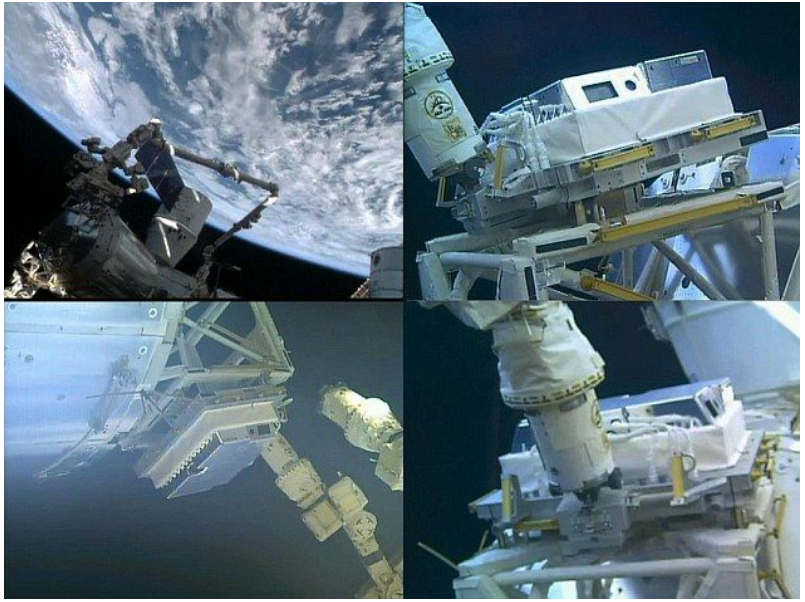
July 28, 2016

Overview

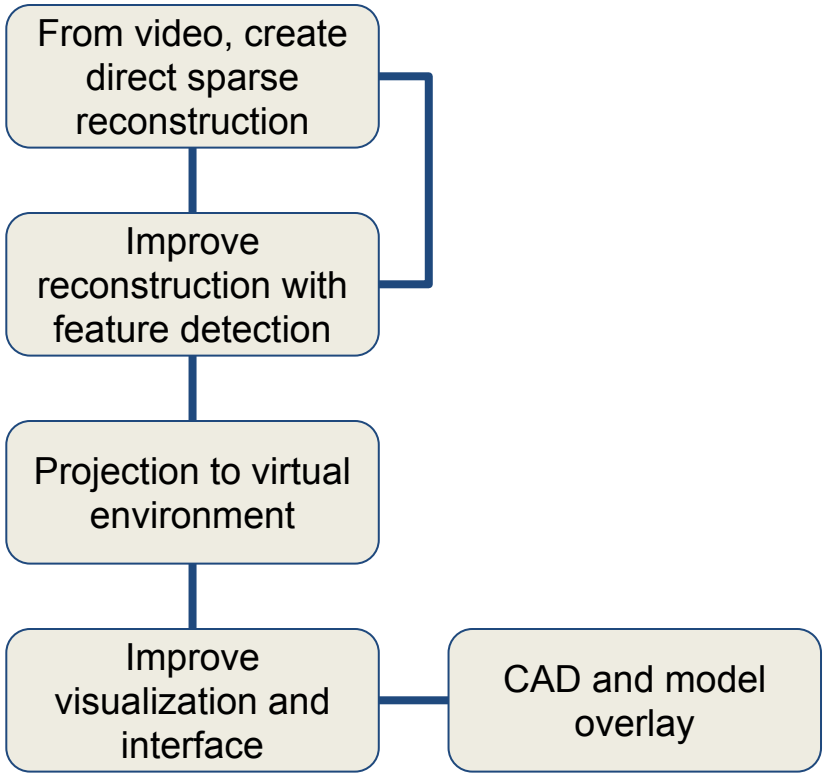
- Introduction
- Roadmap
  - Diagram and complete explanation
- Progress and preliminary results (pics)
- Current results (pics/video)
- Future work
  - Tentative: data request

Introduction

- Proposed to apply SLAM concepts to multi-view stereo, taking image and odometry data, and generates live 3D renderings
- Second part of the project comprises the CAD and reconstructed model overlay



Summarized Roadmap



Roadmap

- Generate sparse reconstruction (point cloud) based on technique presented on the paper:
  - LSD-SLAM: Large-Scale Direct Monocular SLAM (J. Engel, T. Schöps, D. Cremers), In European Conference on Computer Vision (ECCV), 2014.
  - http://vision.in.tum.de/research/vslam/lsdslam
- Pros: real-time, runs on CPU of an average laptop
- Cons: to be adapted to dynamic environments

Roadmap

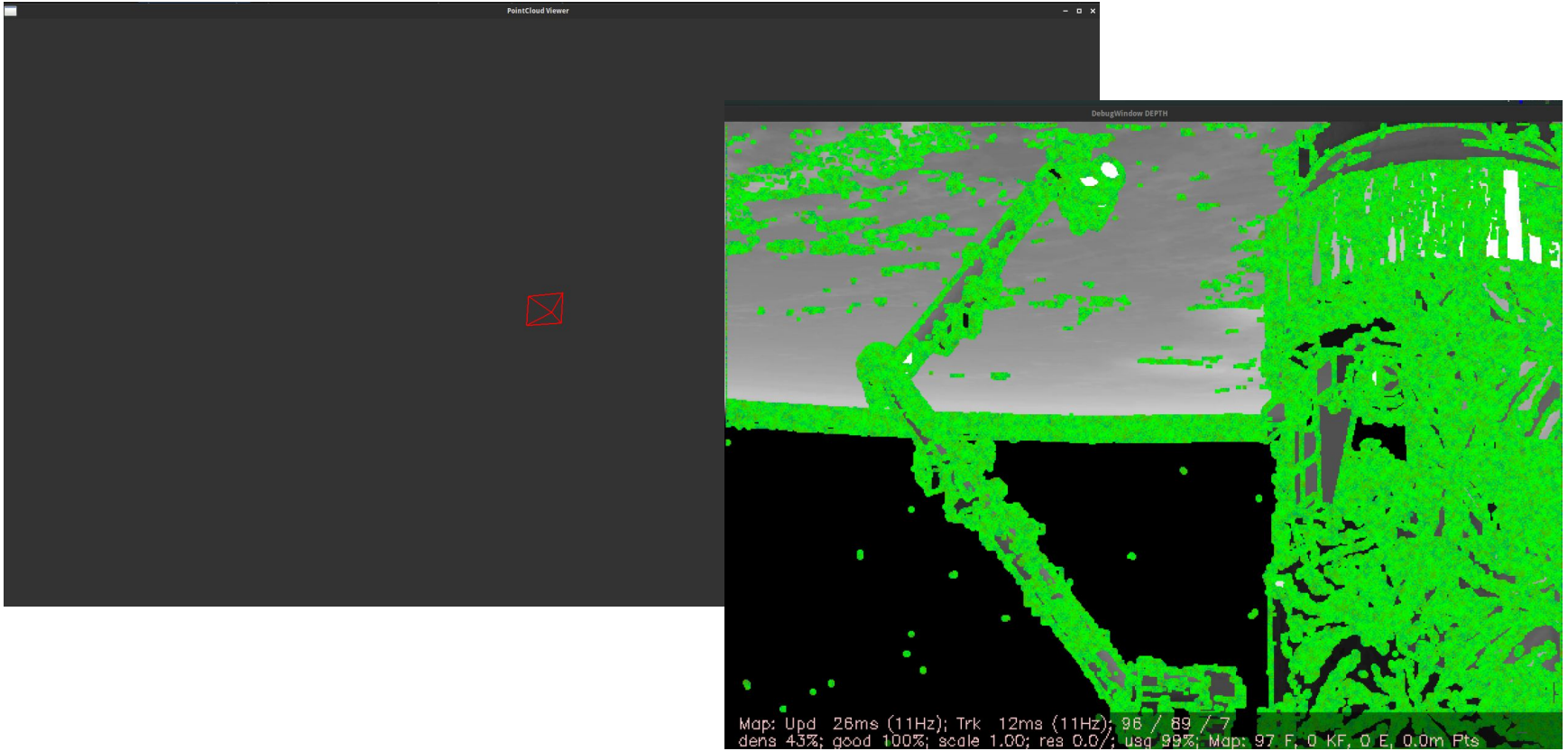
- Improve point cloud computing extrinsic parameters for the moving cameras using ORB and FLANN techniques
- Project point cloud to VR environment and develop intuitive command interface
- Mesh point cloud and improve visualization
- CAD and model overlay will be developed after finished reconstruction and software optimization

Progress

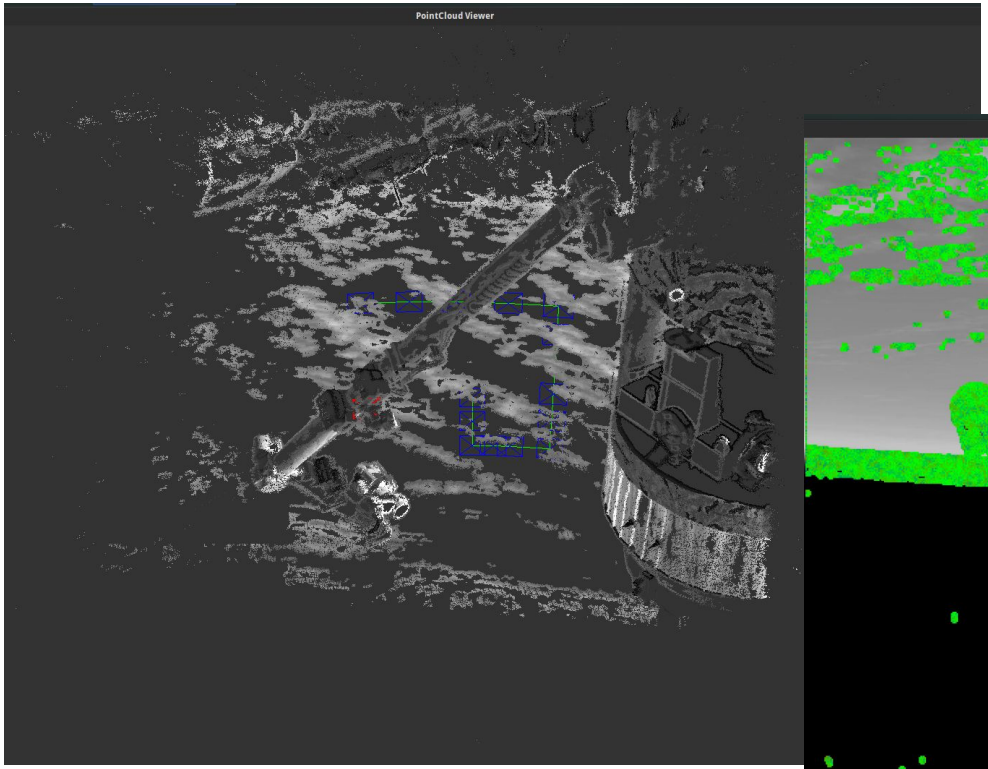
Initial Attempts:

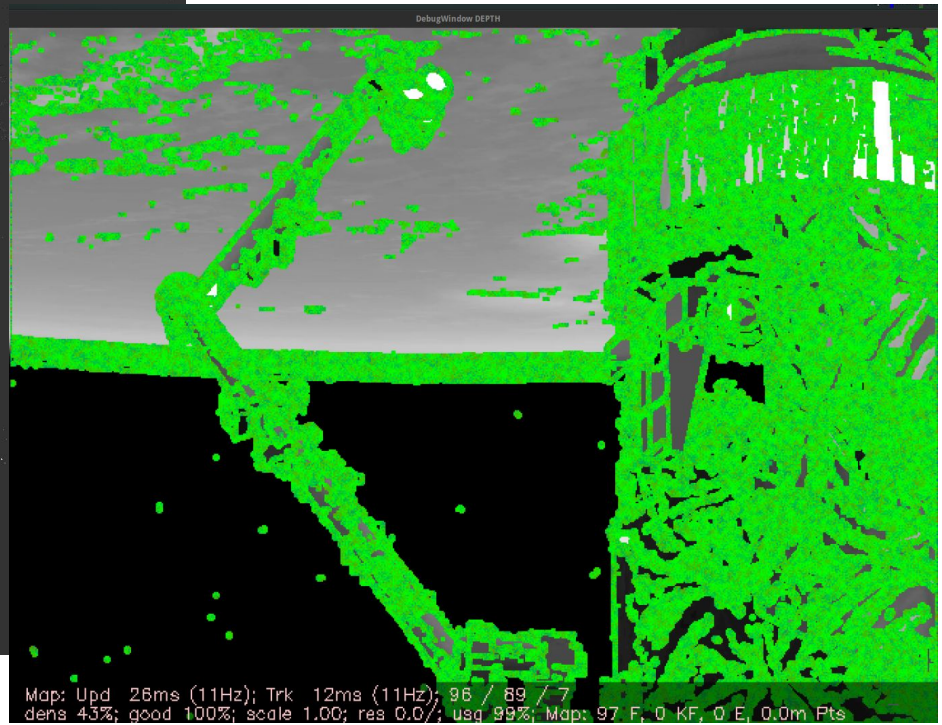
- Generating a point cloud from a static camera looking at the robotic arm (1), from a static camera applying pan/tilt motion (2). Tested on both cloudy and black background.
- Results: point cloud generated, unsatisfactory depth recovery
- Video source: EDGE Software

(1) Static camera, no motion, cloudy

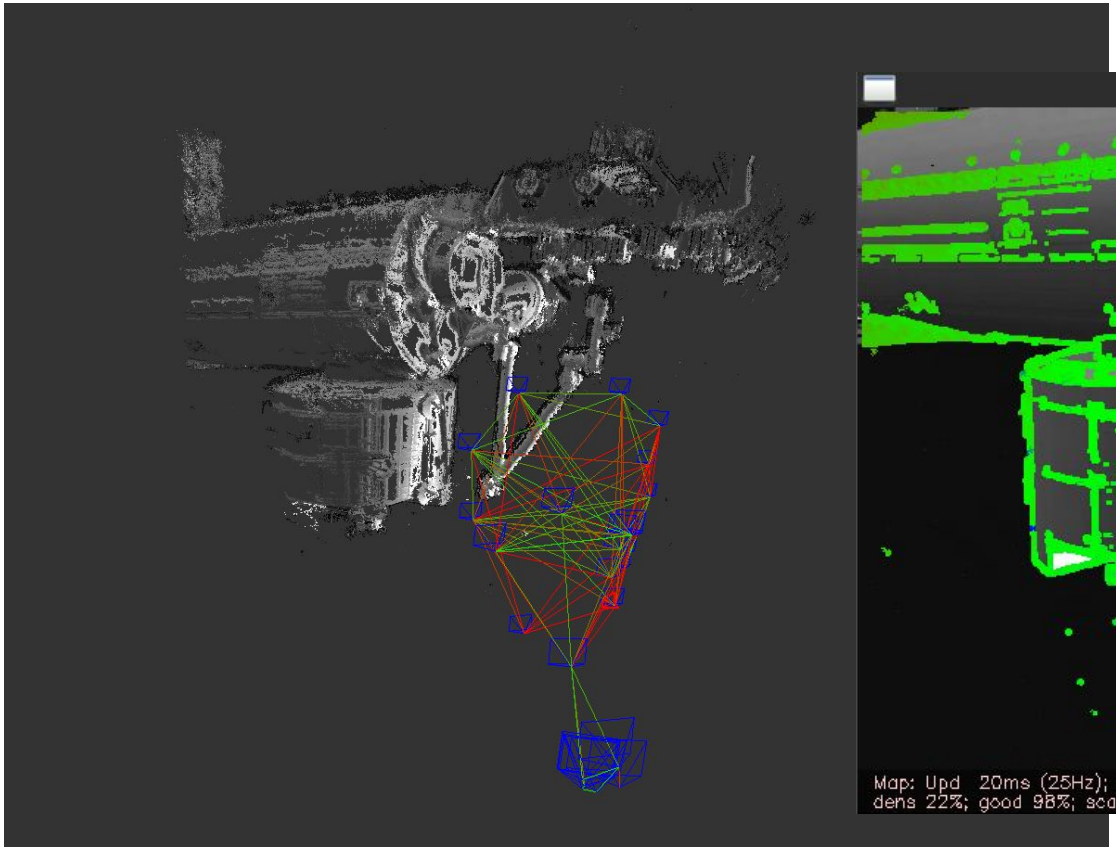


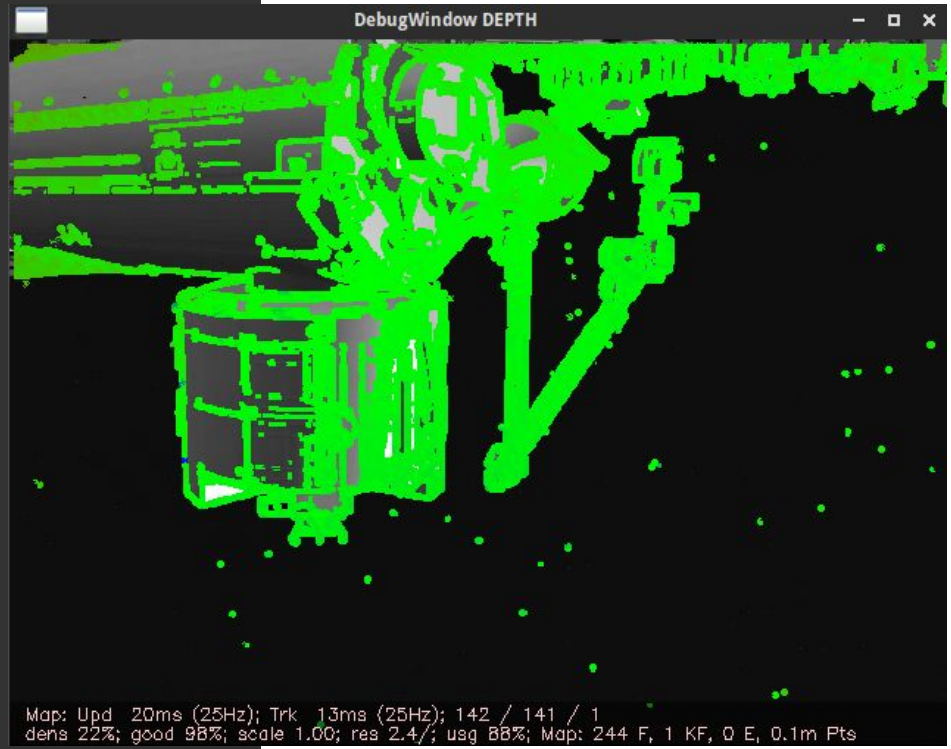
(2) Static camera, motion, cloudy





(2) Static camera, motion, not cloudy





Progress

Discussion on initial attempts:

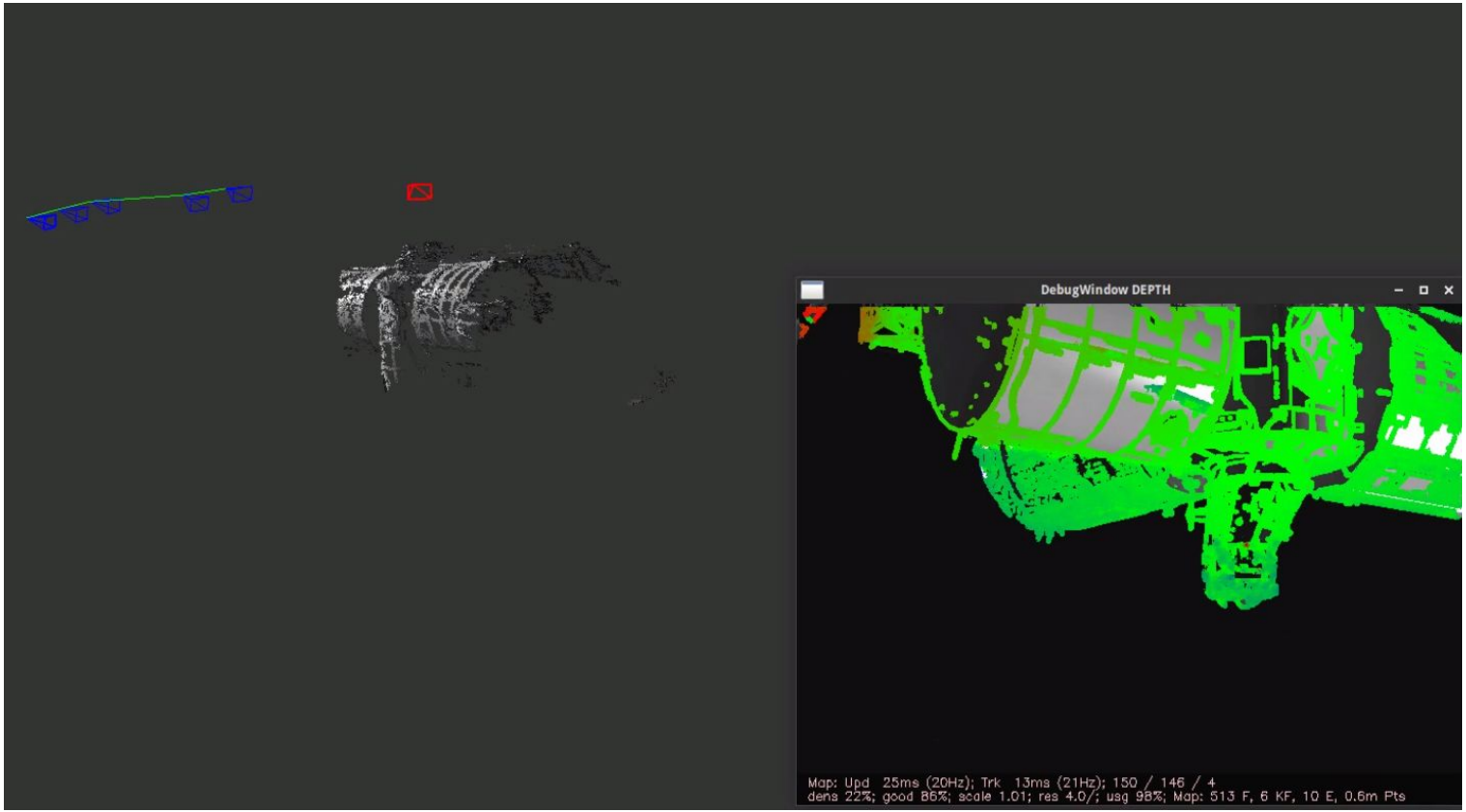
- Good point cloud recovery, but not difference on depth (colors on the right screen represents difference on depth)
- Cloudy background “pollutes” reconstruction, but it can corrected using background extraction techniques

Progress

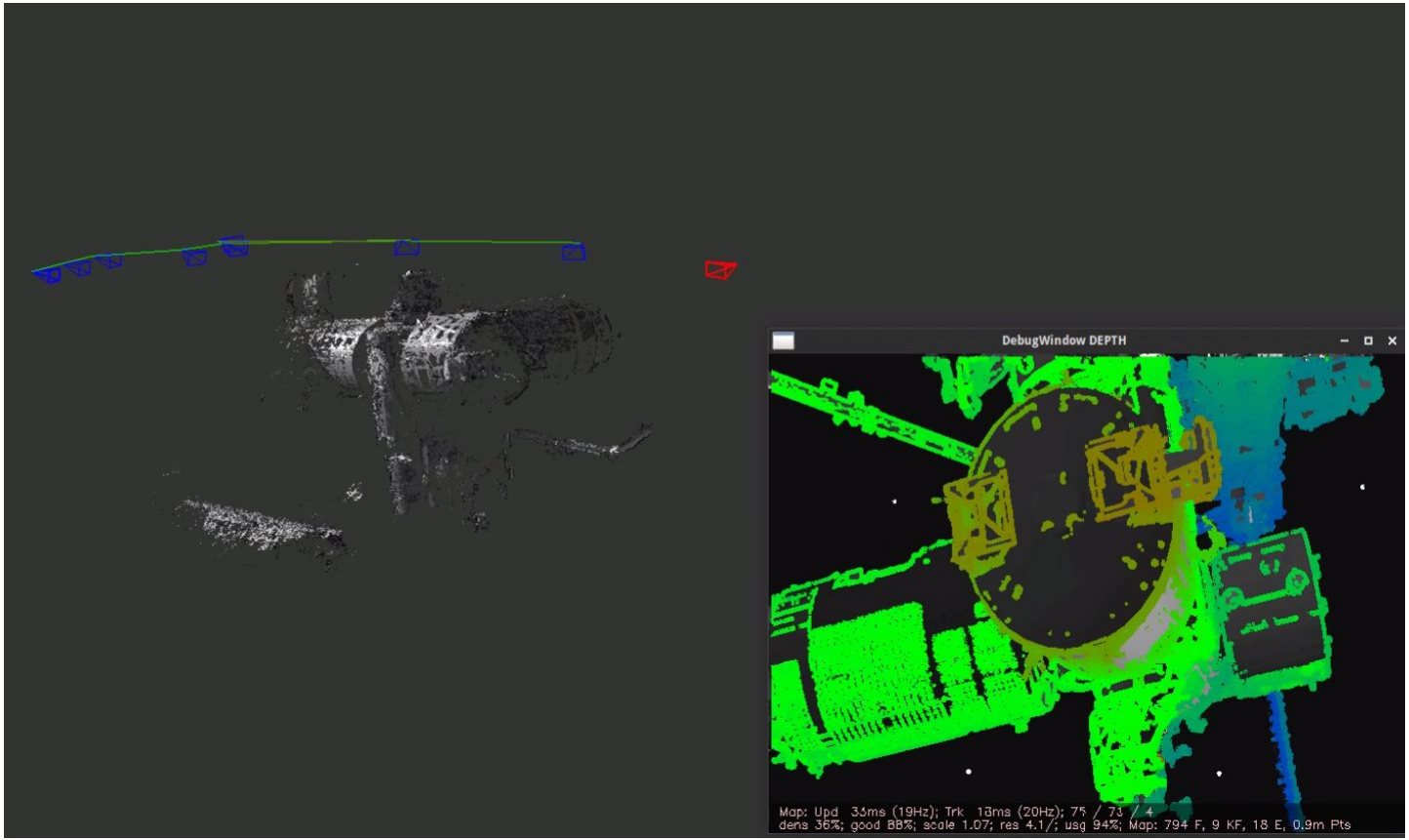
Current status:

- Generating a point cloud from a moving camera, like the ones fixed on the robotic arm
- Results: point cloud generated, satisfactory depth recovery
- Video source: EDGE Software
- Video of results: https://vimeo.com/176204666

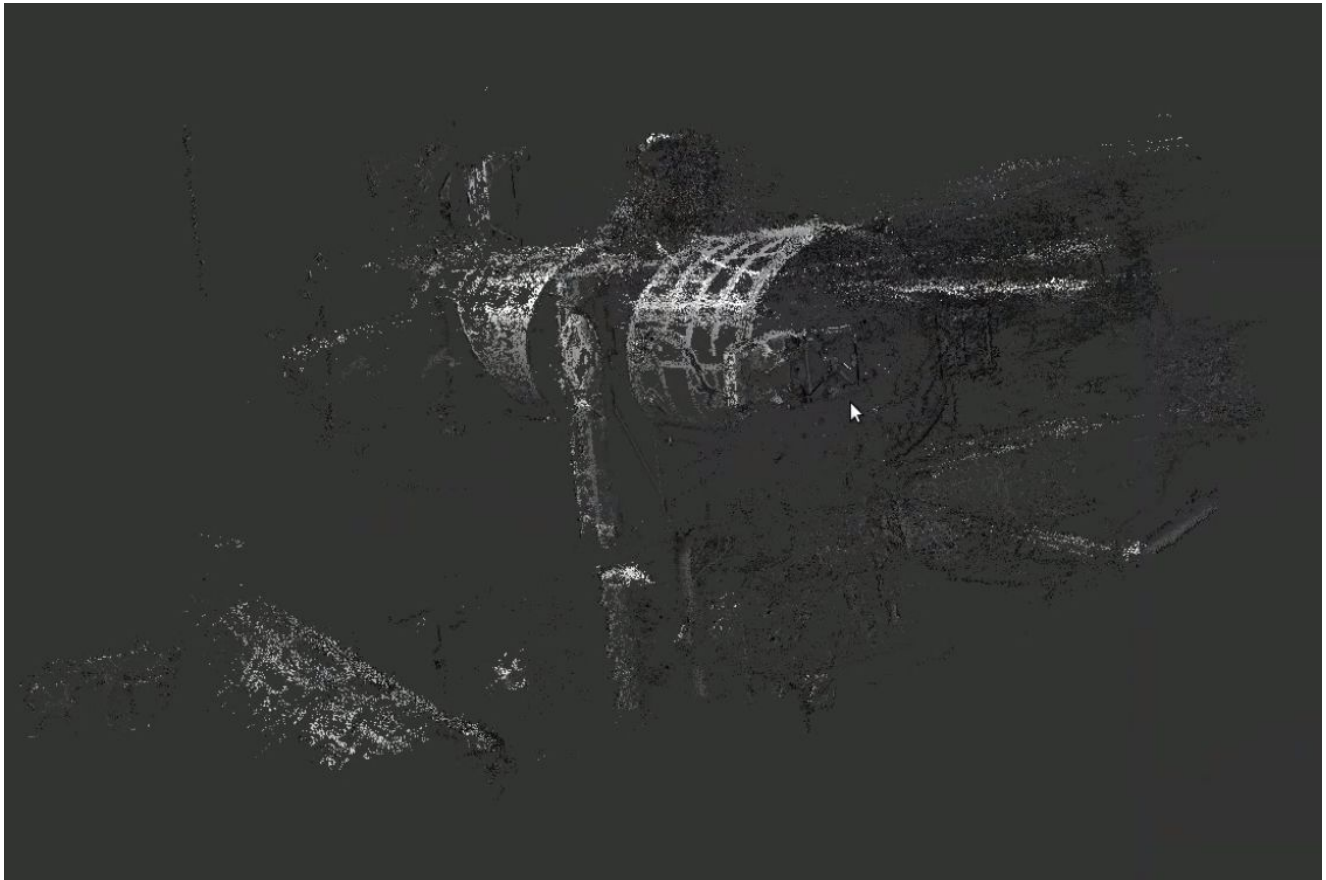
Sample pics of current results



Sample pics of current results



Sample pics of current results



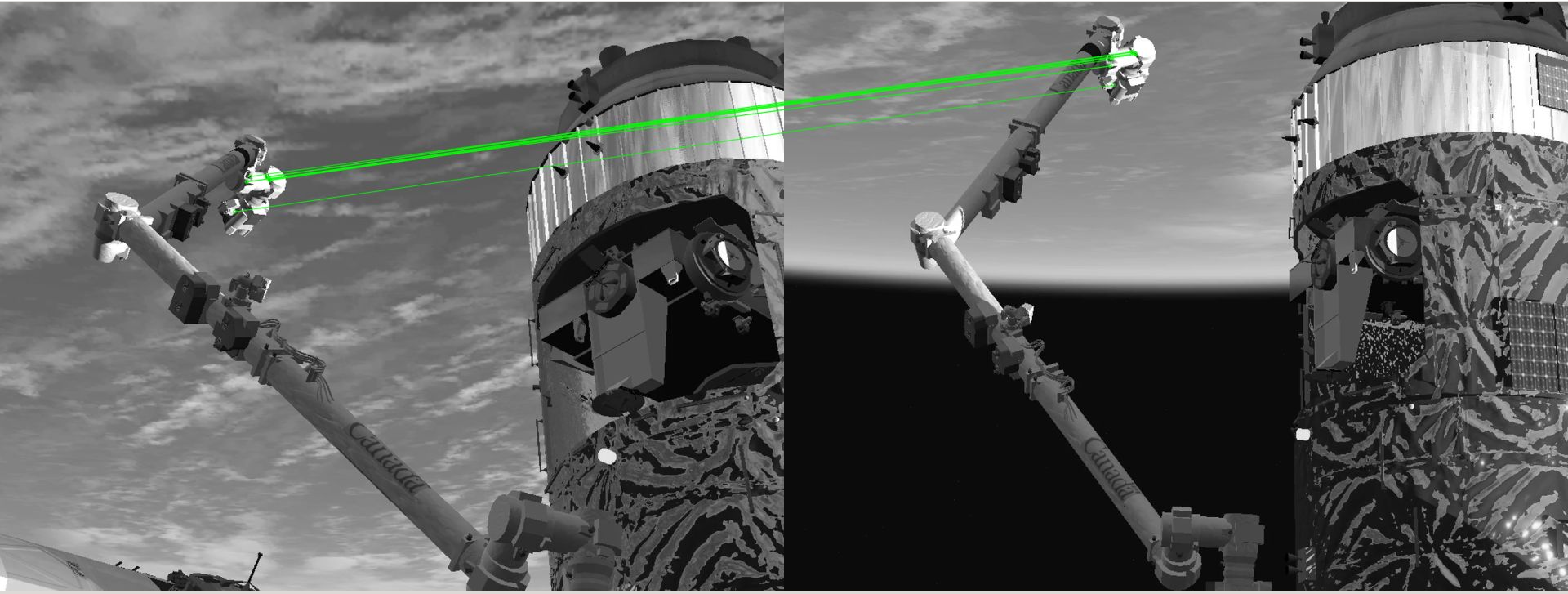
Progress

- Notes:
  - System running in real-time on CPU (no GPU acceleration required), allowing implementation on any laptop current onboard of the ISS
  - Satisfactory point cloud generated after only a single flyby maneuver
  - Multiple point clouds can be generated from different cameras at the same time and joined together
  - Final wild spin not intentional

Future Work

- Improve tracking of camera pose computing features between frames
  - Method to be applied: ORB for feature description and FLANN for matching
  - Available on OpenCV
  - Technique currently implemented to calculate extrinsic parameters between cameras, but not to correct their pose (next picture):

Recover extrinsic parameters



Future Work

- Apply same techniques on real data from ISS
  - Since LSD-SLAM is a direct method (does not rely on feature detection, but on pixel intensity), we believe that we might obtain different results on real and synthetic data
  - Validate current results on real data
- Overlay point cloud over DOUG/CAD data

Data Request

- Sample video data (~30sec) of two static cameras (synchronized feed)
- Sample video data (~30sec) of one moving camera (e.g. attached to the robotic arm)
- Datasheet of actual cameras, if possible, with calibration data