

# **ON GEOMETRIC PROCESSING OF MULTI-TEMPORAL IMAGE DATA COLLECTED BY LIGHT UAV SYSTEMS**

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# Introduction

- Our general objective: development of rigorous methods for local area remote sensing and photogrammetry
  - Geometric processing
  - Radiometric processing
- Geometric processing
  - Sensor calibration
  - Image orientation
  - Point cloud generation
- Data collection in highly variable weather and illumination conditions around the year will be necessary in many applications of UAV imaging systems
- Research question: Performance of state-of-art methods in geometric processing of multi-temporal image data and point cloud generation



# Test set-up

14.9.2011

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# UAV



- Microdrone md4-200 & md4-1000
- Navigation & automatic flight mode
- Dynamic control
- Payload ~250g & ~1000g
- Operation time: 10min & 15min
- Wind limitation: imaging < 4 m/s



# Flight methods



✓ Pre programmed flight with continuous shoot



✓ Visual navigation

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# Cameras



- Panasonic GF1 20mm lens
- Ricoh GR III & II
- Nikon D5000 20mm af lens



# Image materials

- Agricultural area, built area and residential area



- Sjökulla
- 5 campings
- 4 seasons



- Masala built environment
- 4 campings
- 3 seasons



- Masala residential area
- 1 camping
- Winter

# 2 Separate work flows

## Photosynth

- A freeware service by Microsoft
- Inner and outer orientations
- Point cloud in local coordinate system
- Similarity transform with well-identifiable objects

## Bae Systems Socet Set 5.5

- Commercial photogrammetric software
- Approximate outer orientation with interactive measurements
- Automatic tie point matching
- Self-calibrating bundle block adjustment
- Point clouds by NGATE



# Results

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# Results: Image quality

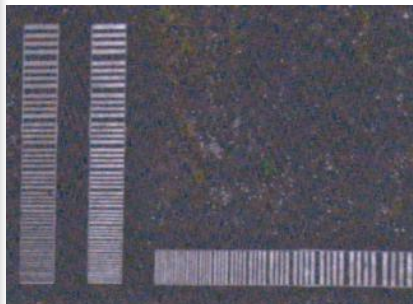
Ricoh



✓ Sunny

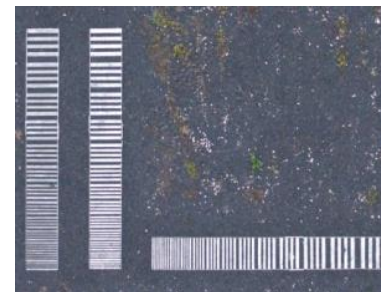


✓ Cloudy



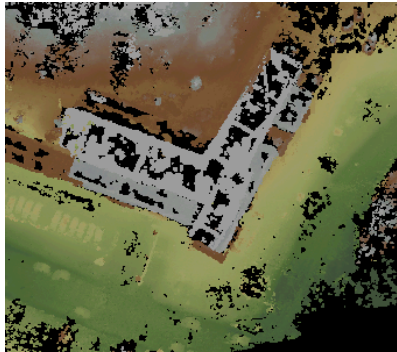
✓ Cloudy

GF 1

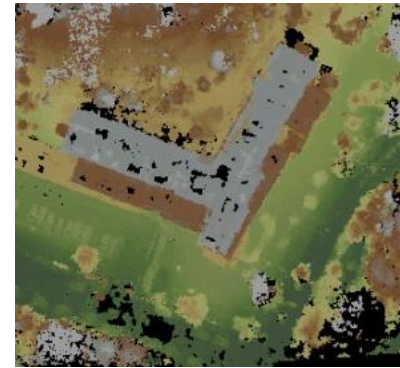


✓ Cloudy

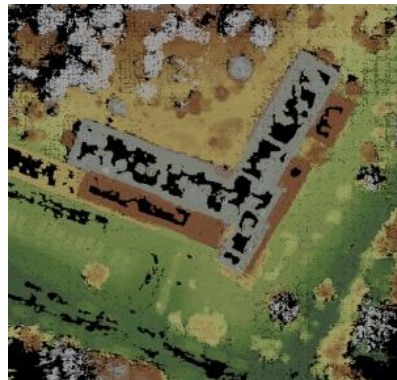
# Results: Masala Point Clouds by NGATE



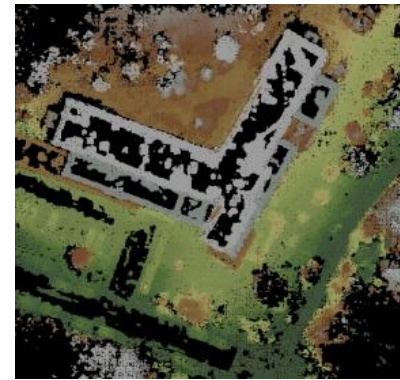
✓ Sunny



✓ Sunny



✓ Cloudy

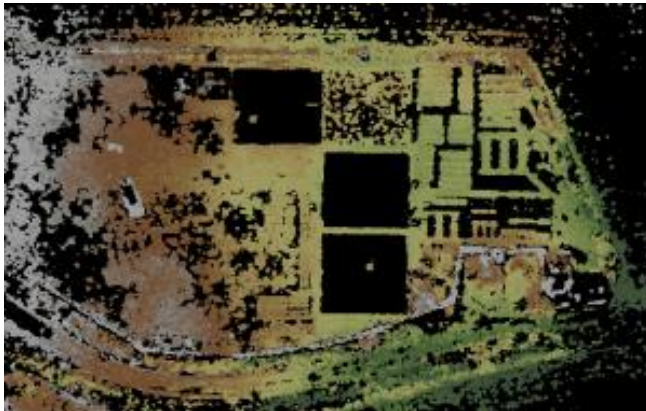


✓ Cloudy

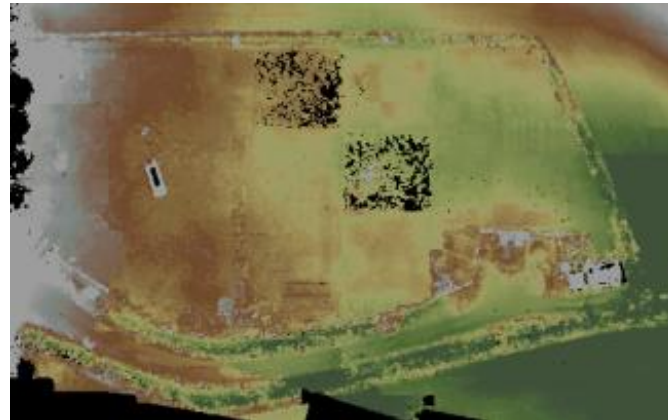
- ✓ Season or weather didn't effect on block accuracy
- ✓ Homogenous areas give better results in sunny weather than in clouded weather
- ✓ Shadowed regions work better in cloudy conditions
- ✓ Leaf of season -influences appeared in desious trees and bushes
- ✓ Further seasonal effects could not be detected

# Point Clouds Sjökulla by NGATE

✓ Ricoh GR 3



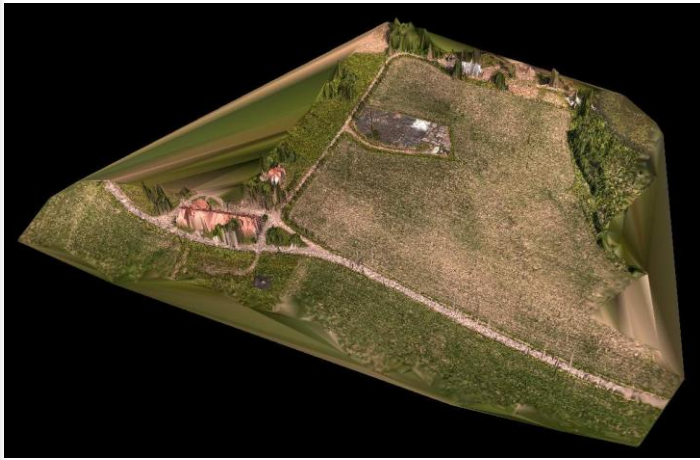
✓ GF1



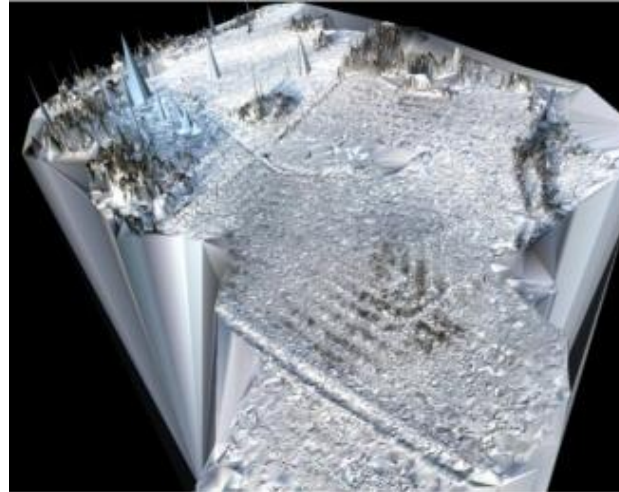
- GF1 semi DSLR clearly outperforms Ricoh GR III pocket camera

# Results: Photosynth models

✓ Sjökulla middle summer



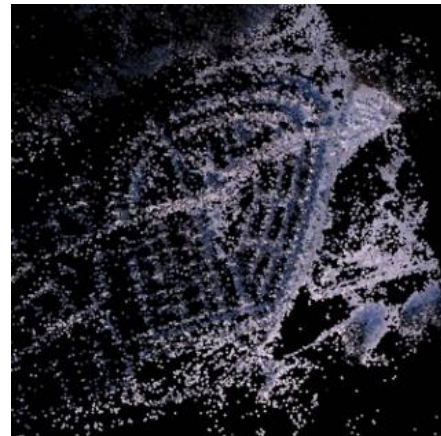
✓ Sjökulla middle winter



✓ Masala  
late summer



✓ Masala  
residential area  
middle winter

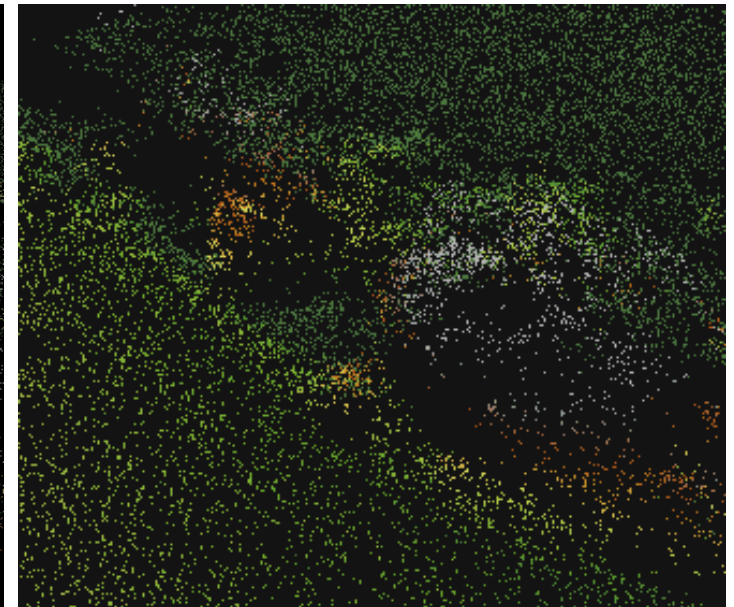
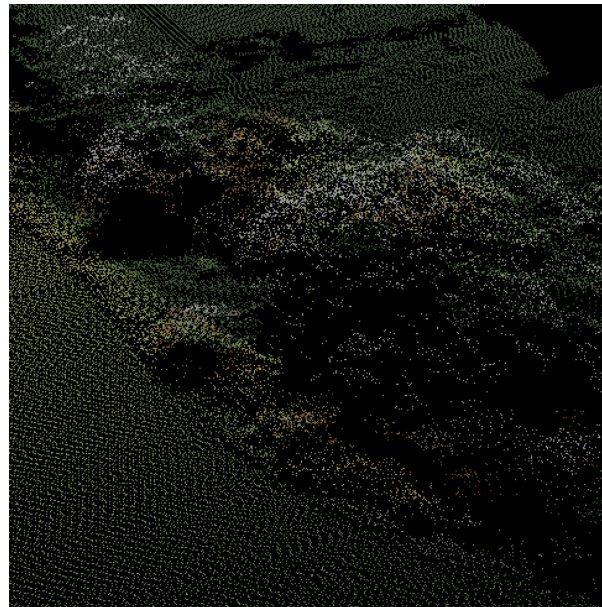


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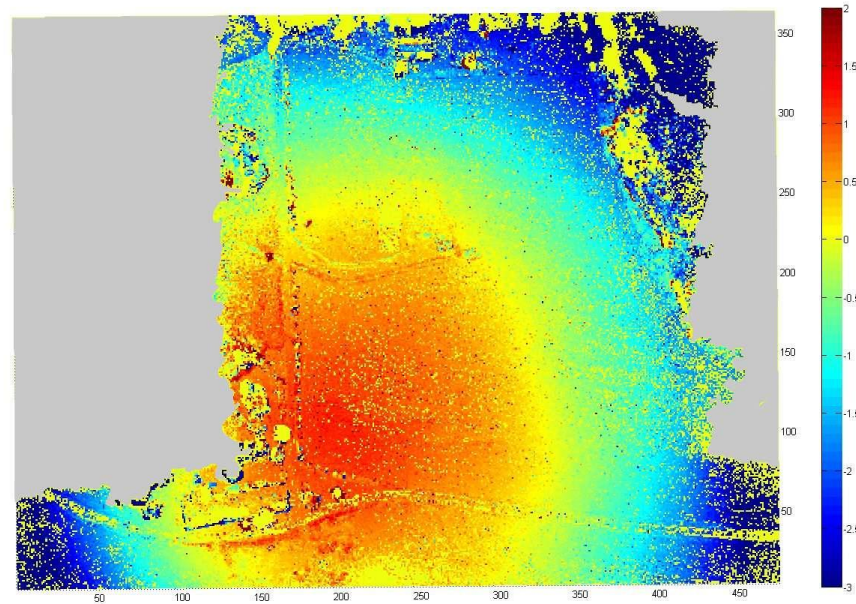
# Details

## ■ Socet Set

## ■ Photosynth

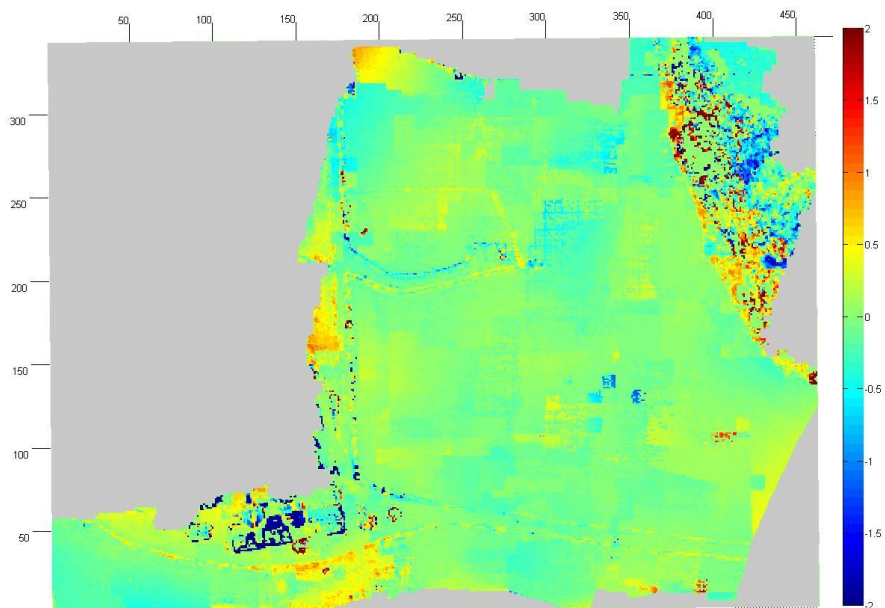


# Difference to reference, Sjökulla summer



- Photosynth
  - Curved systematic height error surface, RMSE: 1.5 m
  - 2-3 points/m<sup>2</sup>
  - Failures in uniform surfaces
  - High noise (0.3 m) in flat surfaces

# Difference to reference, Sjökulla summer



- **SOCET SET + NGATE**
  - Less systematic errors, RMSE 0.15 m
    - Followed all theoretical expectations
  - Point density adjustable, for example 100/m<sup>2</sup>
  - Problems in 3D-objects
  - Low noise (<0.1) in flat surfaces

# Conclusions

- Season, solar elevation, weather condition and sensor influenced to the quality of point clouds
- Cloudy weather may be more suitable for pocket cameras
- Signal to noise ratio of the sensor has a great effect on accurate point cloud generation
- In general, methods are operational in point cloud matching in all seasons, but we still have room for improvements