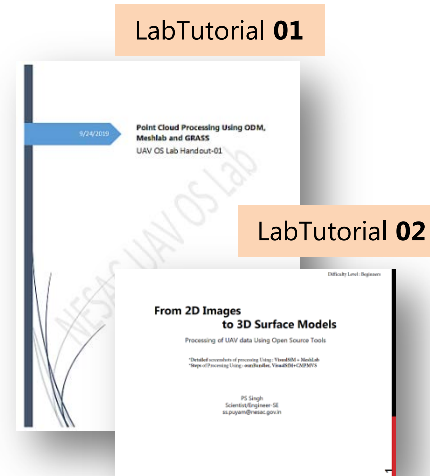
L14 : Computer Vision for 3D Scene Reconstruction

P05 : Open Source 3D Reconstruction Lab



1. **Lab Tutorial Handout 01: Point Cloud Processing Using ODM, Meshlab and GRASS**
   - **a. OpenDroneMap**: Perform Complete Processing Pipeline Using OpenDroneMap
     - i. Generate Orthomosaic, DSM, DTM, 3D Dense Point Cloud, 3D Texture Model
     - **ii. 2D Map Viewer**: Orthomosaic Visualization, Measurement of Area/Perimeter/Volume. Generate Contour Map and Export
     - **iii. 3D Map Viewer** : Visualization of 3D Point Cloud and Measurement Analysis
     - **iv. Export Data** Assets for External Usage.
   - **b. Meshlab**: Use Meshlab for 3D Point Cloud Visualization, Cleaning and Meshing
   - **c. GRASS GIS**: for DEM generation Using 3D Point Cloud
     - i. Use Binning (r.in.lidar) for DEM generation
   - **d. Data** : 42 Drone Images of Mixed Scene / The data provided for Pix4D Lab
2. **Lab Tutorial Handout 02 (Optional): 3D Surface Reconstruction from 2D Images**
   - a. Use **VisualSfM** : Generation of 3D dense Point Cloud
   - b. Use **Meshlab** : For Point Cloud Cleaning, Surface Reconstruction and Texturing
   - **c. Data** : 90 Drone Images of Landslide Scar

Systems : ODM1-13
- ODM : Linux VMs
- Meshlab/VisualSfM/GRASS: Windows OS

Files : Drive/**OS**

Note: All my lectures and Hand-Outs will be made available at **https://github.com/singhpuyam/UAV-OS**

Brief Status of NESAC UAV Activities

The imagery obtained from UAVs can immensely **support in many applications** ranging from large-scale mapping, disaster assessment, infrastructure planning, urban modeling to vegetation structure mapping. Specifically in the **NE region** of our country **with limited connectivity and difficult terrain condition, the local planning and developmental activities can be greatly improved by the UAV survey**.

- UAV Activities at NESAC Started in 2015 as small TDP Project (as PI)
- State-of-the-art UAV lab – Assembly and Building of Muti-Rotor and Fixed Wing UAVs
- So far, NESAC has conducted 100+ UAV surveys till date to assist different line departments and research work in NER.
- Generated ~**1.2 TB** of raw drone images (**2.5 lacs** of High-Res geotagged 4K Images)
- Generated High-Res DEMs and Ortho-mosaics with GSD < 4cm/pixel

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Need to Have an Efficient and Cost Effective 'free' Software to Quickly Process and Analyze large number of UAV derived imagery and generate useful products For various user departments and for Internal R&D Activities

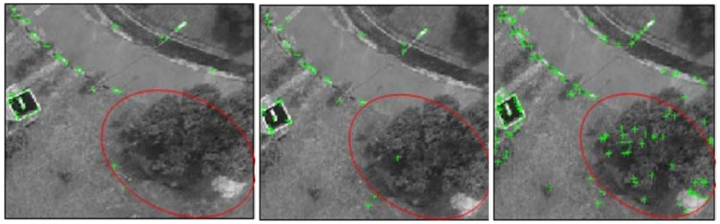



Need for a better and suitable UAV Process Pipeline Solution

Issues with Existing Software/Tools	Propose Solutions
• NER has **uneven terrains, scene with mix** vegetation and built up structures. • **Unable to perform precise feature detection and matching** resulting into inaccurate 3D scene reconstructions	• Need to **devise a platform for intelligent/automatic selection of robust and quality Feature Detection and Descriptors** based on the given 2D images presented. • **Develop new algorithms for feature detections and matching.**
• In-Effective Triangulation and Bundle Adjustment?	• **Efficient and accurate dense 3D Point Cloud** generation with enhanced SfM and MVS approach.
• In-accurate and lossy mesh surface reconstructions	• **Efficient surface reconstruction algorithm** for the large-scale irregular data derived from Photogrammetry approach
• Need for accurate per-pixel classifications	• **Proper algorithms or ML techniques for classification of Point clouds** which is needed for real world modelling, object classification and general scene understanding
• High Computational Cost for processing large number of images	• Optimize Settings for **automatic scene splitting and parallel processing** to reduce computational time.
• No system to adjust intermediate results resulting to incorrect or flawed results / scene outputs	• Options for **intermediate settings which can be adjusted for enhanced output**

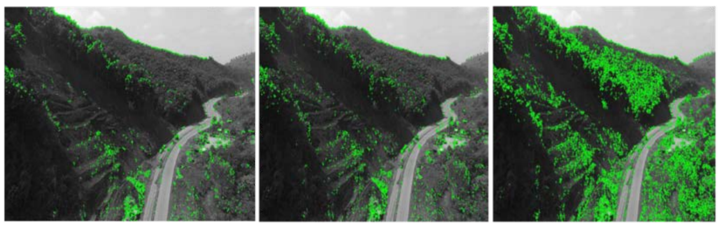
UAV Processing Using Computer Vision Algorithms and FOSS Tools at NESAC

Understanding the suitability of feature detectors for different scene types captured by our UAV



Harris Corner FAST MinEigen

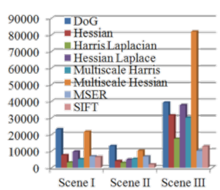
Distribution of KeyPoints



Harris, 1970 FAST, 2784 MinEigen, 22433

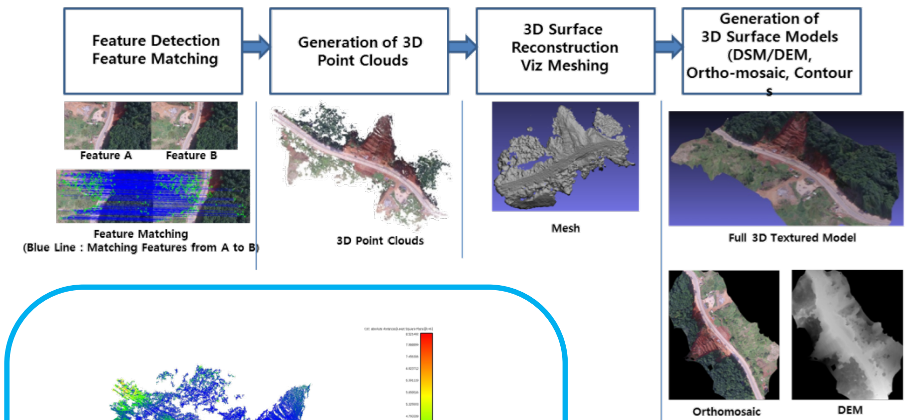
Detection of KeyPoints

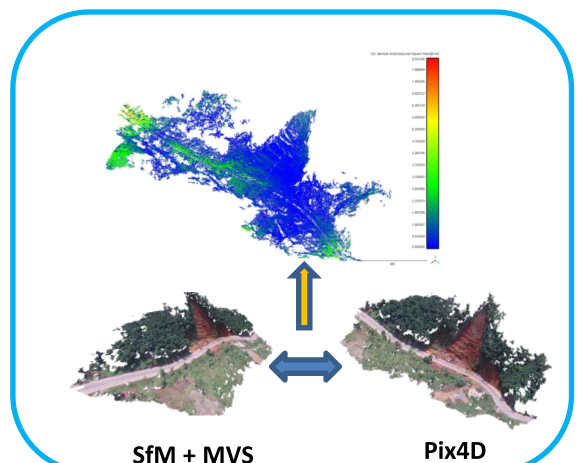
Scene-I Scene-II Scene-III



Describe Feature Descriptors

Match the feature descriptors

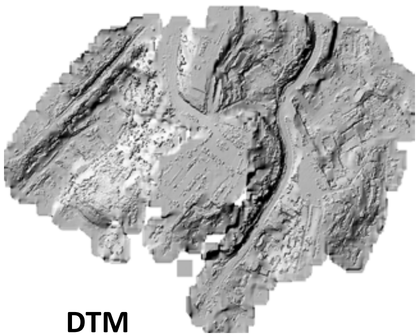




Puyam S Singh et al, 2018. *Towards generation of effective 3D surface models from UAV imagery using open source tools*, Current Science, 2018, Vol. 114 Issue 2, p314-321

UAV Processing Using Computer Vision Algorithms and FOSS Tools at NESAC

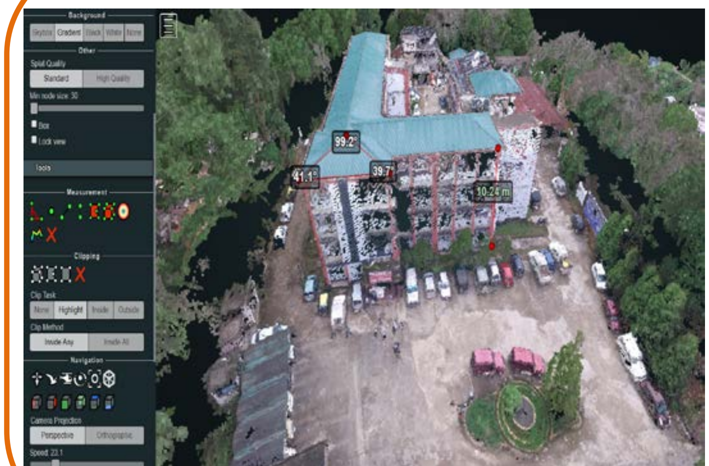
3D Point Cloud Processing : Information Extraction from Point Clouds (Segmentation and Classifications), Visualization and Analysis



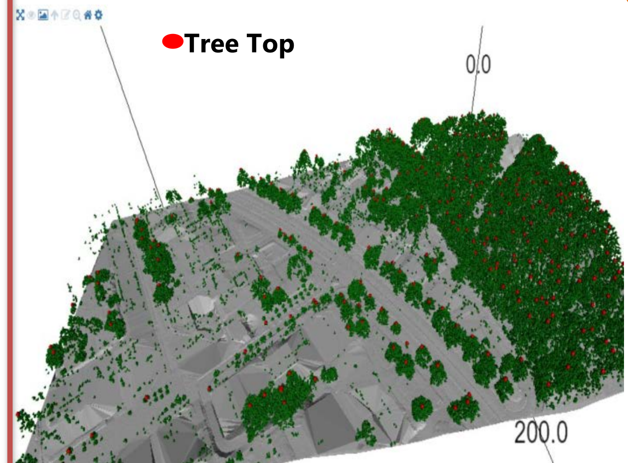
DTM

Point Cloud
Representing 'Ground'

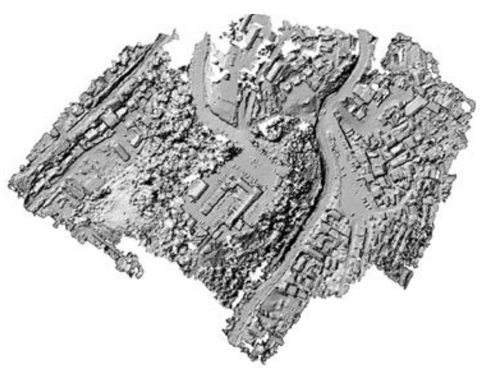
Original Point Cloud



3D Point Cloud Visualization and Analysis



Classification of Trees and Counting



DSM

Activities

- New Approach for Point Cloud Query, Filter, Segment and Classification
- Efficient Techniques for generation of DTM, DSM and OrthoPhotos from 3D Point Clouds
- Visualization and Analysis of 3D point Clouds
- Per-Pixel Semantic Classification of 3D Point Clouds