Generation of Coastal Area DEMs Using Oblique Stereo Imagery from Non-Metric Cameras with SfM Techniques

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Introduction

- Development of Digital Elevation Model for forecasting coastal inundation
- Utilizing Oblique stereo imagery in conjunction with nonmetric cameras [1]
- Implementing efficient 3D reconstruction using Structure From Motion(SfM) approach [2]
- Evaluating the influence of different inclination of camera angle during image capturing on the precession and accuracy of created DEM

Intellectual merits:
- Economical generation of DEMs utilizing non-metric cameras
- Enhanced temporal resolution to better capture the dynamic of environmental systems

Methodology

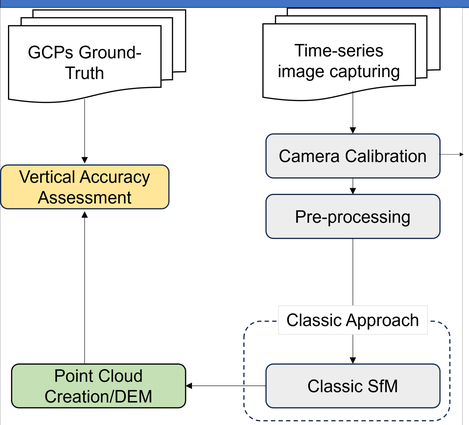


Image capturing at 3 different angle:
- High oblique~ 65 degree
- Standard oblique ~45 degree
- Low oblique ~35 degree

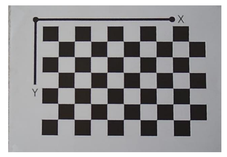
Camera Calibration:
- Using checkboard and MATLAB software

Image preprocessing including:
- Rectification
- Geo-referencing
- Wavelet transformation

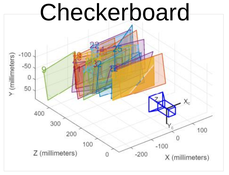
Classic two-view SfM:
- Creating Point cloud

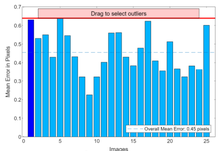
DEM generation:
- ArcGIS Pro

Vertical accuracy assessment:
- Based on 10ftx10ft surveyed grid

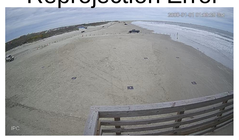


Checkerboard


Extrinsic Camera View



Reprojection Error


Distorted Images


Undistorted Images

Study Areas & Cameras

- Study area is Horace Caldwell Pier located in Port Aransas, Texas, USA.
- Two Amcrest UltraHD 4k(8MP) nonmetric cameras have been mounted in the corners of an elevated building located on the beach.

Figure 1. Study Area: Horace Caldwell Pier, port Aransas, TX, USA

Conclusion & Future work

- The project's main challenge was the use of oblique imagery for DEM generation, as most software prefer vertical images. Our findings show that less oblique angles enhance DEM accuracy.
- Images with 35-degree from Nadir provide greater accuracy for DEM compared to 65-degree angle but lead to a smaller area observed due to the view angle.
- SfM is capable of generating DEMs with reasonable accuracy from oblique imagery.
- High-resolution cameras at higher elevations above the beach and reduced angles enhance feature extraction for SfM in feature-deficient areas like beaches.

Future work:
- Developing a Deep learning model and automating DEM generation process based on SFM approach
- The deep learning model will be trained on a vast dataset of stereo images, enabling it to understand and predict 3D structures from 2D data with high precision

References

[1] Erik Vest Sørensen, Asger Ken Pedersen, David Garc´ıa- Sell´es, and Max Nykjær Strunck, "Point clouds from oblique stereo-imagery: Two outcrop case studies across scales and accessibility," European Journal of Remote Sensing, vol. 48, no. 1, pp. 593–614, 2015.
[2] Shimon Ullman, "The interpretation of structure from motion," Proceedings of the Royal Society of London. Series B. Biological Sciences, vol. 203, no. 1153, pp. 405–426, 1979.

Acknowledgments

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Results & Discussion

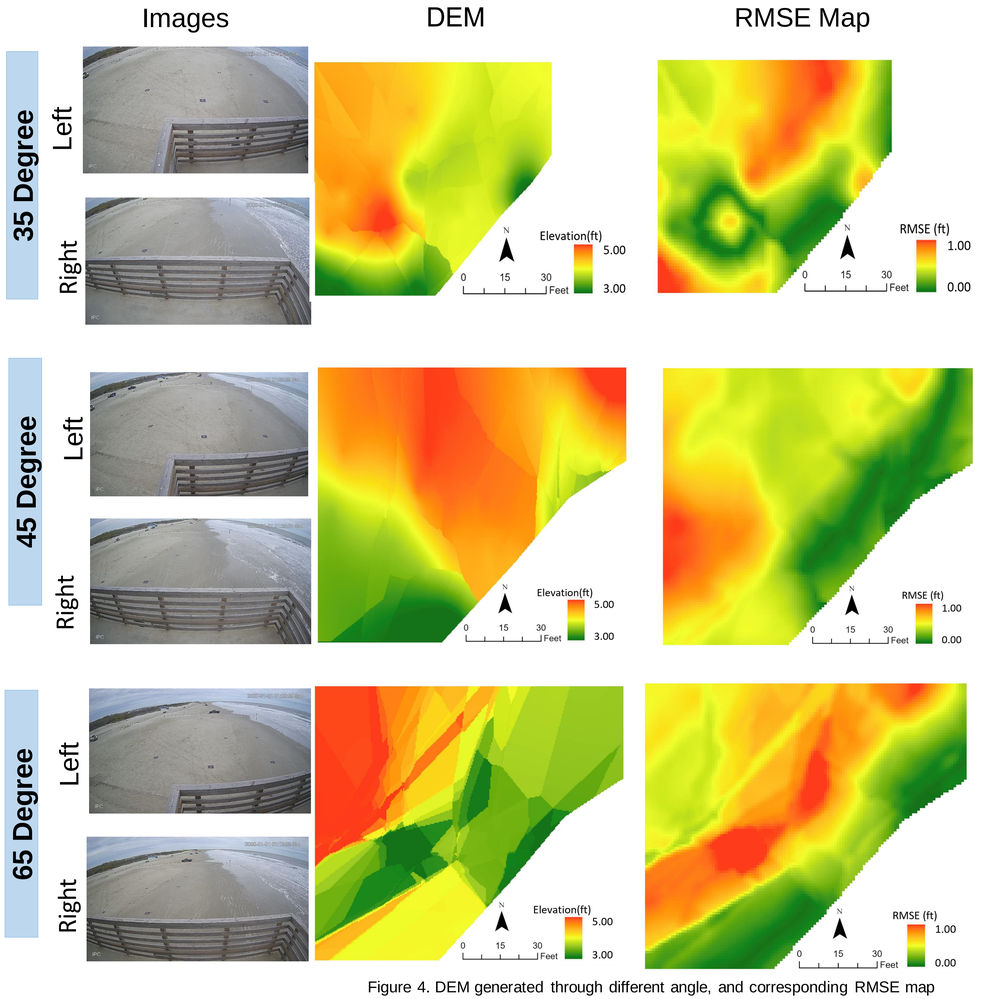

Figure 4. DEM generated through different angle, and corresponding RMSE map

- Camera angle without Horizon presents a better results with less area coverage.
- Image rectification is the key step for area coverage.
- Camera with angles of 35, 45 and 65 from Nadir present vertical accuracies of 0.53, 0.61 and 0.73 ft.