Robot Aided Stereo Panorama

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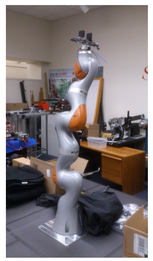
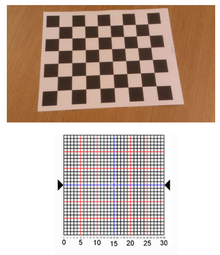
Objective: The objective of this project is to generate stereo panoramic images from data acquired by a single camera rotating around an axis. Such a panorama can be displayed on virtual reality hardware like the oculus rift and allows for an immersive user experience.

Data Acquisition / Preprocessing

Robot arm acquires video → Camera calibration → Frame extraction → Distortion removal and image alignment

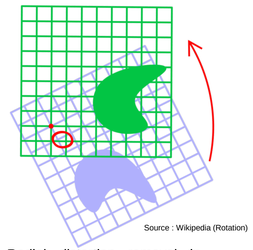


Data acquired at 30fps. Rotation rate of 2-3 degrees per second at varying arm lengths (radius of rotation).



Camera calibration done in MATLAB using a checkerboard pattern. Camera horizontal and vertical field of view calculated manually.

Frames extracted using third party software (Free Studio), angle of rotation and video fps means we get 1800 - 2700 frames for every 180 degrees of rotation.



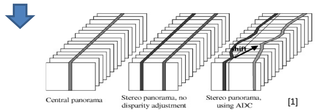
Source : Wikipedia (Rotation)

Radial distortion removal in MATLAB.

All images are aligned to account for slight errors in camera alignment on the robotic arm.

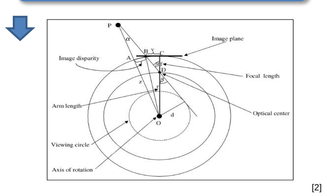
Processing Pipeline

Data collection and preprocessing



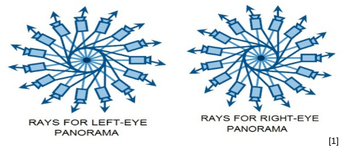
[1]

Strip gap calculation for column extraction



[2]

Stereo Panorama Generation

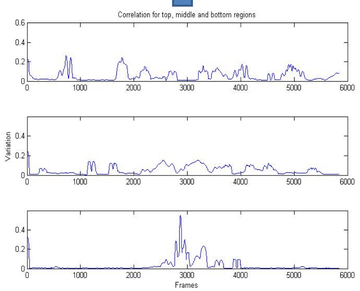


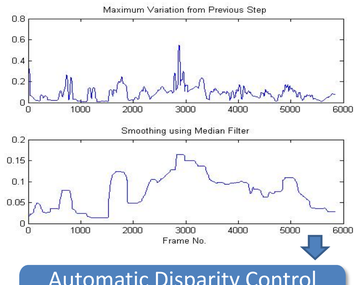
[1]

Panorama alignment with focus at infinity.

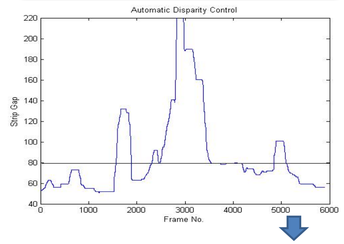
Correlation Calculation between panoramas – Sliding Window

Maximum variation & Filtering to smoothen disparity variation.





Automatic Disparity Control Application (Increase strip gap for Higher Disparity and vice-versa)



Regeneration of panoramas using new strip gaps.

Future Work

- Incorporating translational head motion into the panorama display.
- Accounting for camera shaking to enable manual capture of images.
- Extending our cylindrical panorama to be a fully immersive sphere.
- Broadening the scope to 360° video generation.

References

[1] Richardt, C.; Pritch, Y.; Zimmer, H.; Sorkine-Hornung, A., "Megastereo: Constructing High-Resolution Stereo Panoramas," Computer Vision and Pattern Recognition (CVPR), 2013 IEEE Conference on

[2] Peleg, S.; Ben-Ezra, M.; Pritch, Y., "Omnistereo: panoramic stereo imaging," Pattern Analysis and Machine Intelligence, IEEE Transactions on ,

[3] Peleg, S.; Ben-Ezra, M., "Stereo panorama with a single camera," Computer Vision and Pattern Recognition, 1999. IEEE Computer Society Conference on.

Final Results

Source : Samsung

Can be viewed on the Samsung Gear VR or as an Anaglyph.