COPIS
Computer Operated Photogrammetric Imaging System

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Photogrammetry

• Photogrammetry is a method of recovering the three dimensional position of points on an object’s surface from 2 or more photographs of the object.
Features identified within an image using Scale Invariant Feature Transformation (SIFT). Scale and orientation indicated by arrows.

Matching keypoints between two pairs of images.
Results of SIFT feature detection, pairwise keypoint matching and Bundle Adjustment using Visual SfM ver 5.26.
Dense Reconstruction

Images & camera positions -> dense point cloud -> mesh -> textured mesh
Alternatives...

- AGIS Photoscan
- 3DSom
- Capturing Reality
- Python Photogrammetry Toolkit
- Theia Vision Library
Photogrammetry

• Pros
  • Accuracy
  • Resolution
  • Color
  • Texture
  • Images can be re-processed as algorithms improve.

• Cons
  • Specimen Staging
  • Camera & Lighting Setup
  • Computationally Intensive
  • Post Processing
Best Practices

• Use high resolution photos
• Avoid blurred, out of focus photos of specimen
• Aperture should be high enough to result in sufficient focal depth
• Avoid specimens with un-textured, shiny, mirrored and/or transparent surfaces
• Avoid moving objects within the scene to be reconstructed
• Avoid any movement of the specimen
Automating Image Acquisition for Photogrammetry

• Design Principles:
  • Fast, high-resolution image capture
    • target of 5 minutes per specimen @ 200 photos
  • Accurate positioning of cameras
  • Scalable
  • Cost effective

Early Prototype/Proof of Concept
Current Status
5 Axis

• Each axis driven by NEMA 17, 76.4 oz-in 1.8 degree/step stepper motors
• X & Y:
  • belt and pinion (.39um positional resolution at 1/16 stepping)
  • GT2 timing belt
  • 18 tooth pulley
  • V-wheels on v-slotted aluminum extrusion
  • 1/8in Aluminum for linear carriage plates
  • paired motors on y-axis
• Z:
  • M8x1.25 threaded rod (6.25um positional resolution at full stepping)
  • V-wheels on v-slotted aluminum extrusion
  • 3D printed top and bottom plates
  • 1/8in Aluminum for linear carriage plates
• Pan & Tilt:
  • 3d printed Pan/Tilt
  • Modified from a design by Josh Sheldon ([http://dcc.umd.edu/portfolio/jsheldon/](http://dcc.umd.edu/portfolio/jsheldon/))
  • 9:44 or 9:110 gear reductions (.023 or .0092 degree positional resolution at 1/16 stepping)
  • 1 inch hollow shaft for cabling to pass through
Pan and Tilt Camera Mount
Electronics

- Designed for ease of production
  - DIY etching, milling or professional fabrication.
- ATMEGA 1284-P Microcontroller
- Allegro A4988 Motor Driver
  - Customizable Microstepping
    - Full, ½, ¼, 1/8, 1/16 via jumpers
- Max 3421E USB Peripheral/Host Controller
Mainboard Firmware

- Written in C++
- Camera Control via:
  - PTP – Picture Transfer Protocol
  - Remote Shutter & Autofocus
  - PC using manufacturer API’s
- X, Y, Z, Pan & Tilt min/max limit switches.
- Multi-board communication via I2C serial bus
- Motion control commands based on a variation of G-Code with extensions for Pan/Tilt and camera control.
Utilizing Point Clouds

PCL features

- Initial point cloud data
- Filtering
- Segmentation
- Surface reconstruction
- Model fitting
copis.tubri.org

Funding provided by: