Computer Science Project Proposal

Constructing 3D models from image sequences

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Introduction and Description of the Work

The aim of this project is to extract a 3D model of a small object from a sequence of plain images and then to export the model into a 3D geometry format such as PLY. The resulting file can then be rendered and processed by MeshLab (or similar).
The main focus of the project is to obtain a wireframe model, leaving shading and texture mapping as a possible extension.
The inputted set of pictures must be obtained using the following technique [add an image to represent this]: *Define an "origin" on a perfectly horizontal table and place the camera there facing a white background. Place an object of max height X at a distance Y from the origin. Take the first picture. Rotate the object 30 degrees (counter clockwise as seen from camera) and take the second picture ... until 12 pictures are taken. Some other details to work out such as focal distance. Update pictures in the order in which they were taken. Assume well-lit room and no major light differences between pictures in the same set.*
Extension: implement self-calibration such that in theory the project will work on any set of pictures as long as large overlap.

Starting Point

Some experience with C/C++. IB maths and graphics.

Resources Required

Camera(add detailed description), my own computer + backup plans

Work to be done

For core bits (strictly sufficient to satisfy the success criterion):

- detect edges in the 12 pictures
- computing a dense set of correspondences between neighbouring images *s*tereo rectification, stereo matching, dense depth map
- reconstructing the 3D object shape *o*verlying a 2D triangular mesh on top of one of the images to bild corresponding 3D mesh by wrapping vertives of the trianglesin 3D space by using depth maps OR volumetric depth map integration, Kalman filter

Extensions:

- self-calibration: computing the geometric relation between neighbouring images, estimating the motion and calibration of the camera
- *s*earch for texture mapping techniques

Success Criterion

A system that can successfully construct the wireframe of a fairly regular object of maximum height X [more specific?] from pictures taken as described in introduction.
Might be helpful (but daunting) to compare results to those generated by ARC3D.

Possible Extensions

- add shadowing to model
- add texture to model
- self-calibration

[unbelievably unrealistic] Timetable

Planned starting date is 09/10/2014.

1. **Slot 0: 9^{th} Oct - 24^{th} Oct**
   - Read relevant literature and plan the project.

   Milestone: Submit proposal
2. **Slot 1: 25^{th} Oct - 14^{th} Nov**
   - Gain deeper understanding of the techniques
   - Plan

   Milestone:
3. **Slot 2: 15^{th} Nov - 5^{th} Dec**
   - Start implementation

   Milestone: finish implementing edge-detector
4. **Slot 3: 6^{th} Dec - 26^{th} Dec**
   - Implement dense set stuff

   Milestone: finish implementing dense set stuff
5. **Slot 4: 27^{th} Dec - 16^{th} Jan**
   - Implement mesh stuff

   Milestone: Finish implementation
6. **Slot 5: 17^{th} Jan - 30^{th} Jan**
   - Buffer time: catch up or start doing the extensions
   - Write progress report

   Milestone: Submit progress report
7. **Slot 6: 31^{st} Jan - 20 th Feb**
   - Debug and test

   Milestone: write and pass tests
8. **Slot 7: 21^{st} Feb - 13^{th} Mar**

- Catch-up time or extensions

Milestone:

9. **Slot 8: 14^{th} Mar - 3^{rd} Apr**
    - Analysis

    Milestone:
10. **Slot 9: 4^{th} Apr - 17^{th} Apr**
    - Start writing dissertation

    Milestone:
11. **Slot 10: 18^{th} Apr - 8^{th} May**
    - Finish writing dissertation

    Milestone:
12. **Slot 11: 9^{th}May - 15^{th}May**
    - Safety slot

    Milestone: Submit dissertation