Research Log

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June 5, 2016

March 30, 2016	Established research log after 3 hours of learning new LaTeX

April 2, 2016	Added some additional comments to the **Process**

April 3, 2016 — Have been reading [ImageBasedRendering] [1].

Question for Kamangar: regarding [ImageBasedRendering] [1] about difference between:
- **Camera Plane** : Cooridinates u,v
- **Focal Plane** : Cooridinates s,t

April 11, 2016 — Reviewing blog articles located at:
- `https://erget.wordpress.com/2014/02/01/calibrating-a-stereo-camera-with-opencv/`
- `https://erget.wordpress.com/2014/02/28/calibrating-a-stereo-pair-with-python/`
- `https://erget.wordpress.com/2014/03/13/building-an-interactive-gui-with-opencv/`
- `https://erget.wordpress.com/2014/04/27/producing-3d-point-clouds-with-a-stereo-camera-in-opencv/`

for process to get webcam up and running. Previous issues related to fine-tuning *block matching* parameters. Need to review sources at list at bottom of `http://docs.opencv.org/2.4/modules/calib3d/doc/camera_calibration_and_3d_reconstruction.html` to understand.

April 19, 2016 — Made adjustments to python for image acquisition scripts (from blogs mentioned on April 11, 2016.)

NOTE: Consider creating rig with glue to keep stereo camera placement / direction constant.

April 19, 2016 — **UPDATE:** Error with `calibrate_cameras` python code causing linux machine to crash. If can't be resolved switch over to MacBook.

NOTE: Package should be setup by calling `$ python setup.py install`.

April 19, 2016 — **UPDATE:** Crash due to recursive shell call and was fixed. OpenCV not detecting all chessboard corners. Will try a new board.

April 20, 2016 — Did small amount of work on **Change of Reference** section in the paper. Added a section to the intro containing a map of commonly used symbols and notation.

April 29, 2016	Read following sections of [Chen1993] [2]: • Abstract • Introduction • Visibility Morphing **SUMMARY:** Explicit Geometry is ignored (i.e. surface mesh and 3d-points). Geometry is kept in 2-d. Whereas Image Morphing interpolates between *pixel intensity values in fixed locations* the method in this article interpolates between *pixel locations with (relatively) fixed intensity values*. **Question:** Sections read mention that pixel positions are stored in 3d (3-tuple) data structure. I'm not sure I understand this correctly, since 1. This would effectively make this structure a point cloud (but no mention of it in the paper). 2. There is no mention of special "depth-based" hardware or cameras (Far as I know this is supposed to be a regular image).

April 30, 2016	Checked understanding of *epipolar constraint* through reading of [Hartley2004] [3] and its derivation of $$'\mathbf{x}^T \cdot \mathbf{E} \cdot \mathbf{x} = '\mathbf{x}^T \cdot [\mathbf{t}]_\times \cdot \mathbf{R} \cdot \mathbf{x}$$ $$= '\mathbf{x}^T \cdot 'l$$ and creation of MatLab code verifying this. I may have been mistaken about relation of **Fundamental Matrix** and **Essential Matrix**. My current understanding is the *Fundamental Matrix* describes point/epipolar line correspondance for images under **scale invariant** conditions (i.e. point correspondance and Fundamental matrix does not change when one image (or both images) are scaled (uniformly or omni-directionally). *Essential Matrix* describes point/epipolar line correspondance for images under **normalized** conditions (i.e. unit-length is set equal to focal-length, and projection center is set at $(0, 0, 1)$.

May 2, 2016	Additional wording to Stereo-vision section. I am unsure of best order to present ideas related to *multi-view* geometry.

May 18, 2016	Reviewed [Chen1993] [2] Section 2. Consider reviewing follow relevant articles: • Disparity [Gosh89] • Optical Flow [Nage86] • Look-up tables [Wolb89] • 3d scenes [Pogg91] Working on MatLab code to pick correspondig points in stereo-images, and calculate pixel offset vectors.

May 19, 2016	Read Section 2.3 of [Chen1993] [2]. View interpolation is limited by: • **Penumbra**: pixels visible in one source image *but not both* • **Umbra**, pixels visible in neither source image, and *invisible* in destination image. • **Holes**, pixels visible in neither source image, but *visible* in destination image. Calculatred formula for *pre-displaced* quad-pixel calculation using a bi-linear interpolation as: $$\mathbf{P}(u,v) = \mathbf{P}(0,0) \cdot (1-u) \cdot (1-v) + \mathbf{P}(1,0) \cdot u \cdot (1-v) + \mathbf{P}(0,1) \cdot (1-u) \cdot v + \mathbf{P}(1,1) \cdot u \cdot v$$

May 20, 2016	Derived formula for *uv* calculation using *geometry matrix*, *blending matrix* and *basis vectors* of $\mathbf{u} = [u\ 1]^T$ and $\mathbf{v} = [v\ 1]^T$

$$x_{uv} = \begin{bmatrix} u & 1 \end{bmatrix} \begin{bmatrix} -1 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_{00} & x_{01} \\ x_{10} & x_{11} \end{bmatrix} \begin{bmatrix} -1 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} v \\ 1 \end{bmatrix}$$

$$y_{uv} = \begin{bmatrix} u & 1 \end{bmatrix} \begin{bmatrix} -1 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} y_{00} & y_{01} \\ y_{10} & y_{11} \end{bmatrix} \begin{bmatrix} -1 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} v \\ 1 \end{bmatrix}$$

Question for Kamangar: Is there a way given x and y to solve for u and v?

May 22, 2016	Added more to thesis document.

Worked on singular-value of previous blending equation. where:

$$\begin{bmatrix} x_{uv} & 0 \\ 0 & y_{uv} \end{bmatrix} = \begin{bmatrix} \mathbf{u} & \mathbf{0} \\ \mathbf{0} & \mathbf{u} \end{bmatrix}^T \begin{bmatrix} \mathbf{M} & \mathbf{0} \\ \mathbf{0} & \mathbf{M} \end{bmatrix}^T \begin{bmatrix} \mathbf{X} & \mathbf{0} \\ \mathbf{0} & \mathbf{Y} \end{bmatrix} \begin{bmatrix} \mathbf{M} & \mathbf{0} \\ \mathbf{0} & \mathbf{M} \end{bmatrix} \begin{bmatrix} \mathbf{v} & \mathbf{0} \\ \mathbf{0} & \mathbf{v} \end{bmatrix}$$

where

$$\mathbf{u} = \begin{bmatrix} u \\ 1 \end{bmatrix}, \mathbf{v} = \begin{bmatrix} v \\ 1 \end{bmatrix}, \mathbf{X} = \begin{bmatrix} x_{00} & x_{01} \\ x_{10} & x_{11} \end{bmatrix}, \mathbf{Y} = \begin{bmatrix} y_{00} & y_{01} \\ y_{10} & y_{11} \end{bmatrix}, \text{ and } \mathbf{M} = \begin{bmatrix} -1 & 1 \\ 1 & 0 \end{bmatrix}$$

May 23, 2016	Read [Chen1993] [2] section 2.4 on *Block Compression*.

SUMMARY: Blocks are established established by *threshold* where each block contains pixels that are *offset by no more than the threshold*, allowing all pixels to be offset at once.

Question for Kamangar: Doesn't this assume that all pixels in the block have a uniform offset?

Working on MatLab program to perform pixel offsets of corresponding points (i.e. assign corresponding points to pixels in MatLab by non automatic methods)

May 24, 2016	Read following sections from [Chen1993] [2]:

- Implementations (3)
  - Preprocessing (3.1)
  - Interactive Interpolation (3.2)
  - Examples (3.3)
- Applications (4)
  - Virtual Reality (4.1)
  - Motion Blur (4.2)

Question for Kamangar: With regards to Section 3.1 and Section 1, why is a graph structure needed? Why is it a lattice?

Question for Kamangar: With regards to Section 4.1, I don't understand the concepts of *temporal anti-aliasing* and *super-sampling*?

Made additional changes / added material to thesis document.

May 25, 2016	Was using figures from `http://www.robots.ox.ac.uk/~vgg/hzbook/hzbook2/HZfigures.html` as test images, which may not be best source as there white borders, appear to be up-sampled, and do not contain (extrinsic) calibration info. Consider using images located at `http://vision.middlebury.edu/stereo/data/scenes2014/` that contain meta-info including (intrinsic) calibration info.

May 29, 2016	Finished [Chen1993] [2]. Not sure if remaining article is of consequence.
	Finished MatLab program for *animating / hand-drawing* (See wording in [Chen1993] [2]) offset vectors. Program performs offsets in 2-dimensional space. Conisder adding automatic *feature correspondance* and *z-buffer* information from depth map images avaiable on MiddleBury database.
May 30, 2016	Point-correspondances do not follow even pattern as indicated in [Chen1993] [2]: *Bi-linear coordinates* and *quad partitionions*; May be better to use *Barycentric coordinates triangle partitions*.
	Read on MatLab `tform`, `maketform`, and `Delaunay` triangles for purpose of image partitions.
June 1, 2016	Read and finished [Park2003] [4].
	SUMMARY: Multiple sections including *point correspondance* and *interpolation*. **Point correspondance**: Breaks images into rectangular partitions. Gets maximum horizontal and vertical pixel gradients using *Sobel operator* in each partition. The maximum gradient in each partition is thresholded to disregard homogeneous and textured regions. **Interpolation**: The images are partitioned with *Delaunay triangulation* using the point correspondances as triangle vertices.
	Question for Kamangar: Article published seems to be vastly different depending on source (See `Park2003` folder). ScienceDirect version has more math and detail (maybe too much since it details what a *Sobel filter* is). Why would critical information, including algorithm steps and details, be ommited?
June 2, 2016	Reviewing PDF at `https://staff.fnwi.uva.nl/l.dorst/hz/chap11_13.pdf` for information on *tri-focal tensor*. Don't understand *practical* calculation of *fundamental matrix* from *Singular Value Decomposition* and *Linear Least Squares* (i.e. don't understand LLS calculation from SVD).
June 3, 2016	Working on implementing *triangle patch transform* in MatLap (using previously mentioned `delaunay`, `tform`, and `maketform` functions) needed for [Chen1993] [2] and [Park2003] [4].
June 4, 2016	Continuting work on getting triangular patches transformed in MatLab. Will use `affine2d` and `imwarp` instead of `maketform` and `imtransform`.
	Spent several hours on a false start trying to implement line drawing on pixel data, in order to implment polygon seperation. Finally found MatLab's `roipoly` function which does what I need.
June 5, 2016	Almost done with MatLab triangle interpolation program. Hoping to have something to show Kamangar in the next few days.
	Was reading up on image-segmentation as a way to improve feature detection through masking. Came accross references to **spectral clustering** which I still don't understand after data mining class. Was reading tutorial at `http://classes.engr.oregonstate.edu/eecs/spring2012/cs534/notes/Spectral.pdf` for starters.

References

[1] Sing Bing Kang Heung-Yeung Shum, Shing-Chow Chan. *Image Based Rendering*. Springer Publishing, 1 edition, 2007. Available online at: `http://link.springer.com/content/pdf/10.1007%2F978-0-387-32668-9.pdf` Pages cited are **Book Page** Numbers. Formula for **PDF Page** Number is (**PDF Page Number = Book Page Number + 17**).

[2] Shenchang Eric Chen and Lance Williams. View interpolation for image synthesis. In *Proceedings of the 20th Annual Conference on Computer Graphics and Interactive Techniques*, SIGGRAPH '93, pages 279–288, New York, NY, USA, 1993. ACM.

[3] R. I. Hartley and A. Zisserman. *Multiple View Geometry in Computer Vision*. Cambridge University Press, ISBN: 0521540518, second edition, 2004.

[4] Joon Hong Park and HyunWook Park. Fast view interpolation of stereo images using image gradient and disparity triangulation. In *Image Processing, 2003. ICIP 2003. Proceedings. 2003 International Conference on*, volume 1, pages I–381–4 vol.1, Sept 2003.