Stereoscopy

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March 23, 2019

Version	Date	Change
.1	21 febraury 2019	added par. Process & par. Calibration
.2	11 march 2019	added par. determination
.3	22 march 2019	added par. stereoscopy -> introduction
.4	22 march 2019	added par. calibration -> calibration parameters & added par. calibration -> canidate

1 Stereoscopy

1.1 introduction

Stereoscopy uses 2 images of the same object taken from different angles to give the impression of depth. The best example would be our eyes. The both look at the same scene, but from different angles. Cover 1 up and you suddenly can't estimate depth anymore.

1.2 Process

The aim of this project is to measure the length of an infant in an artificial incubator. This will be done by taking 2 images of the infant simultaneously and marking interest points. These interest points can be used in a triangulation function to determine the length of the infant. The body is divided in 4 key dimensions:

1. tip of the heel - knee
2. knee - center of the genitals
3. center of the genitals - base of the neck
4. base of the neck - tip of the head

These are then summed up to get the length of the infant [1, p.2-3]. There are 2 phases to the stereoscopic processing:

1. **calibration**: Getting the reference points/dimensions.
2. **determination**: Determining the spatial position for each point to make a depth map.

1.3 Calibration

1.3.1 canidate

To determine the spatial dimension between the interest points there must be a reference object/dimension. Something with a fixed dimension which can be used to calibrate the camera. A possible canidate for the reference object/dimenson is the red knobs within incubator as seen in figure 1.

Figure 1: picture of the incubator

The knobs are found on every incubator and the distance between them is fixed.

Another option is a checkerboard, the opencv library for python has a calibration method that uses a checkerboard to calibrate.

1.3.2 calibration parameters

The calibration phase gives us the intrinsic and extrinsic parameters for the used cameras. The intrinsic parameters don't depend on the scene viewed. As long as the focal length doesn't change (e.g. a camera with auto-focusing lens), then these values don't change [2]. The intrinsic parameters are usually given in matrix form, also know as the **camera matrix**.

$$cam_i = \begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix}$$

With $f_{x,y}$ being the focal point of the lens.

And $c_{x,y}$ being the principal point on the image plane (usually the center of the image).

No lens is perfect, every lens comes with some distortion. Radial distortion, which is caused by the shape of the lens. And tangential distortion caused by the assembly process [2][3]. Radial distortion comes in 2 forms, positive & negative distortion. Positive radial distortion is also know as barrel distortion, see figure 2. The opposite of this is negative radial distortion, also know as pincushion distortion, see figure **??**.

Figure 2: example image from https://en.wikipedia.org/wiki/Distortion_(optics)

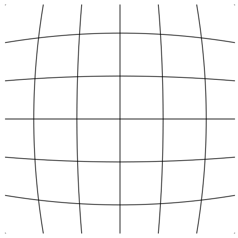
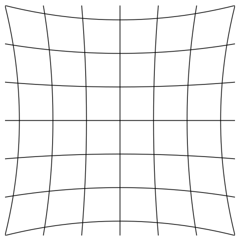


Figure 3: example image from https://en.wikipedia.org/wiki/Distortion_(optics)

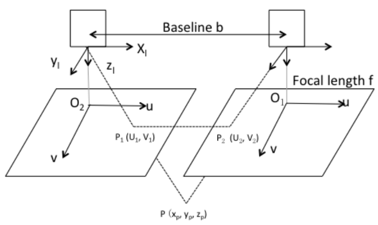


2 determination

In this image the point P appears on the two image planes. The V value (y coordinate) for both P1 & P2 are the same. The baseline B is the distance between the cameras. The distance between the points on the image planes is called disparity. The focal length of the camera is F. The x, y & z coordinates can be calculated as followed:

$$x_p = \frac{B*u_1}{D}$$
$$y_p = \frac{B*v_1}{D}$$
$$z_p = \frac{B*F}{D}$$

Figure 4: example image from https://en.wikipedia.org/wiki/3D_reconstruction#/media/File:Stereoscopic_schematic.png



When this has been done for every image, the acquired information is used to make a depth map.

References

[1] N. Sokolover, et al. 'A novel technique for infant length measurement based on stereoscopic vision'. referenced on: 21 febraury 2019.

[2] opencv dev team, 'Camera Calibration and 3D Reconstruction', [online], https://docs.opencv.org/2.4/modules/calib3d/doc/camera_calibration_and_3d_reconstruction.html, refrenced on: 22 march 2019.

[3] F. Uhrweiler, S. Vujasinovic. 'Stereo-Vision', [online], https://github.com/LearnTechWithUs/Stereo-Vision/blob/master/Stereo%20Vision%20-%20Explanation%20-%20German.pdf, [German], refrenced on: 22 febraury 2019.