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ANNEX 3

Real Uniform Resolution of SVAVISCA Sensor - Experimental Validation

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Abstract

We investigate experimentally how uniform is the resolution of a real uniform-resolution OMNIVIEWS sensor and compare it with simulations. The experiments were carried out with a real SVAVISCA sensor with log-polar pixel distributions. The reference points with known 3D coordinates were captured in distances $10cm$, $20cm$, $30cm$, and $200cm$ from the camera-mirror axis. Experiments show that the uniformity decreases with increasing y-coordinates. Comparison of the achieved results with the theoretical solution shows that the maximal deviation from the linearity of uniformity is 20%. It is 10 % higher than what was expected from the theory of the design.

1 Introduction

In this report we study the limits of the use of SVAVISCA panoramic images, especially the constancy of mapping of a real world to the imager along the y coordinate.

The aim is to determine how many pixels can be used in the y-coordinate of the panoramic image. Due to the numeric solution of the mirror cross section function, a systematic error exists [1]. We cannot also forget non-linearity (e.g. radial distortion) of the optics (e.g. lens). The mapping between the world and image dimensions are therefore only approximately linear. The parameters of the mirror were designed for distance $d = 200cm$, however we provided also measurements for other distances.

2 Experiment

We want to show the uniformity of the mapping of an interval of a constant length from a scene to an imager as a function of its position in a scene.

SVAVISCA sensor with log-polar pixel distributions was used. All parameters (focal length, distances) were set like in [1]. For image acquisition the Giotto software was used.

The mirror is designed such that after correct setting of a mirror and the SVAVISCA camera the uniform pixel distribution in the image is obtained. It means that an interval of a fixed distance in the scene should be projected into an interval of a fixed distance in the image. It must hold true for any vertical interval in a constant distance from the camera-mirror axis independently from its height in the scene.

We moved the reference target along a sequence of positions in the vertical direction in a constant distance d from the camera-mirror axis. We carried out the experiment for distances $d = 10cm$, $d = 20cm$, $d = 30cm$, and $d = 200cm$. Table 1 includes measured data. Figure 1 depicts these experiment. We obtained sets of images as shown in Figure 3. Figure 2 shows the orientation of axes in images.

Let us explain how they were further processed. We took y-coordinates from the first and the second image, subtracted them and obtained

$$\Delta\rho_i = y_{i+1} - y_i,\ i = 1 \ldots 5. \tag{1}$$

We determined the minimal and the maximal angle of view [1]. We calculated the angle $\Delta\phi$ corresponding to one pixel in the image. By that, angle ϕ is determined as $y.\Delta\phi$, where y is the height in pixels of the target in the image. For better understanding see Figure 1. Figure 4(a) shows $\Delta\rho$ as a function of ϕ. We calculated also relative errors

$$rel.error_i = \frac{\Delta\rho_i - \Delta\rho_1}{\Delta\rho_1} 100 \; [\%] \tag{2}$$

for each step. Then, we repeated it for the second and the third point and so on. See Figure 4(b).

It is difficult to make experiments for distances farther than $d = 200cm$ because we need to put the reference target higher than $350cm$.

3 Conclusions

The experiments show that the length of the image of a fixed interval in the scene is decreasing as y-coordinate is increasing in the panoramic image. In [1] the maximal deviation from linearity was estimated to be 10% between the point at the middle of mirror and the point at the border of the mirror independently to the distance d from the camera-mirror axis. The real experiments show that the maximal deviation from linearity was to 20% for all distances which were measured.

References

[1] Stefan Gächter. Mirror design for an omnidirectional camera with a uniform cylindrical projection when using the SVAVISCA sensor. Research Report CTU–CMP–2001–03, Center for Machine Perception, K333 FEE, Czech Technical University, Prague, Czech Republic, March 2001.

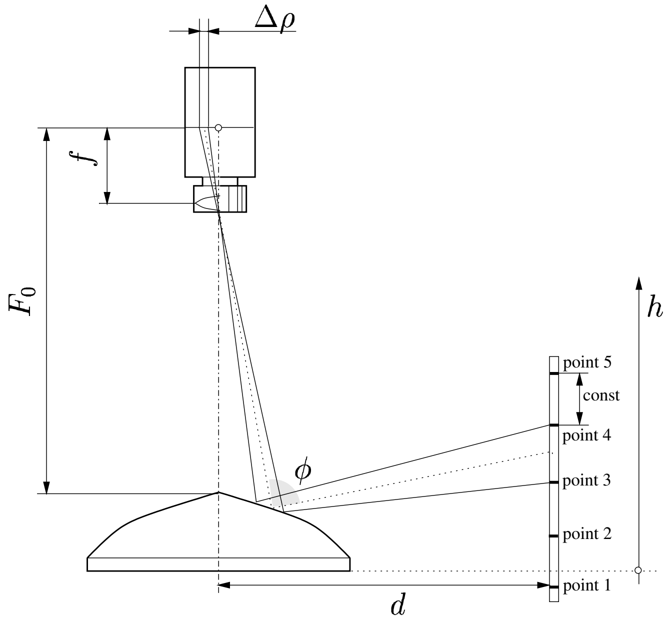
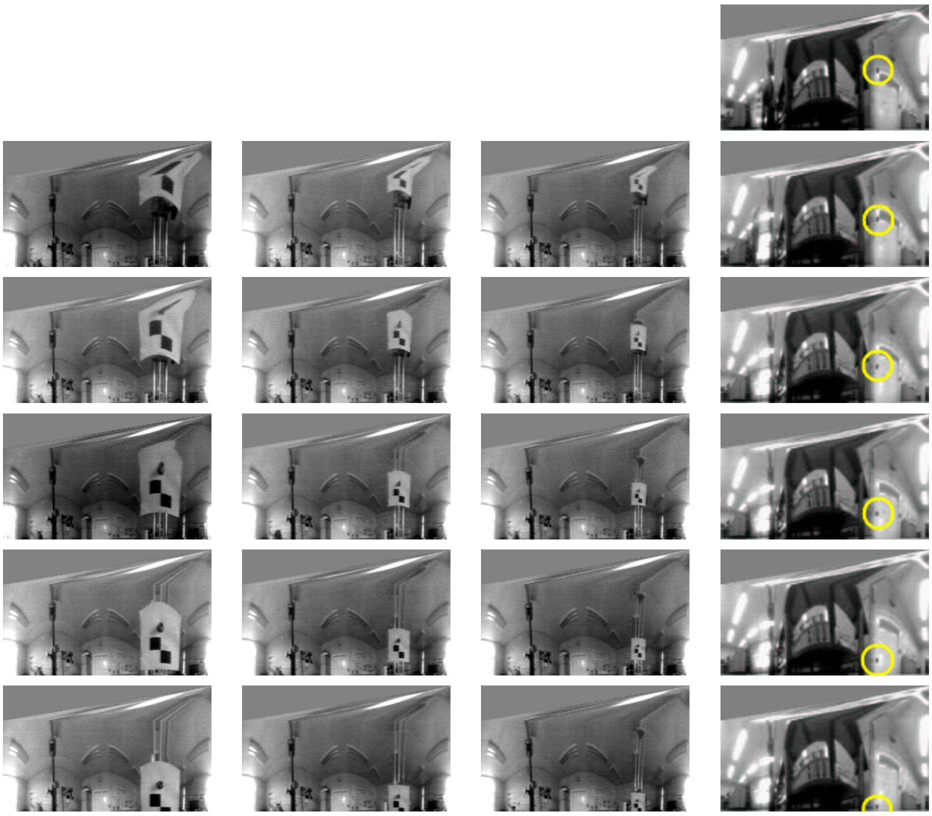


Figure 1: Schematic diagram of the experiment.

Figure 2: Axes orientation in panoramic images.

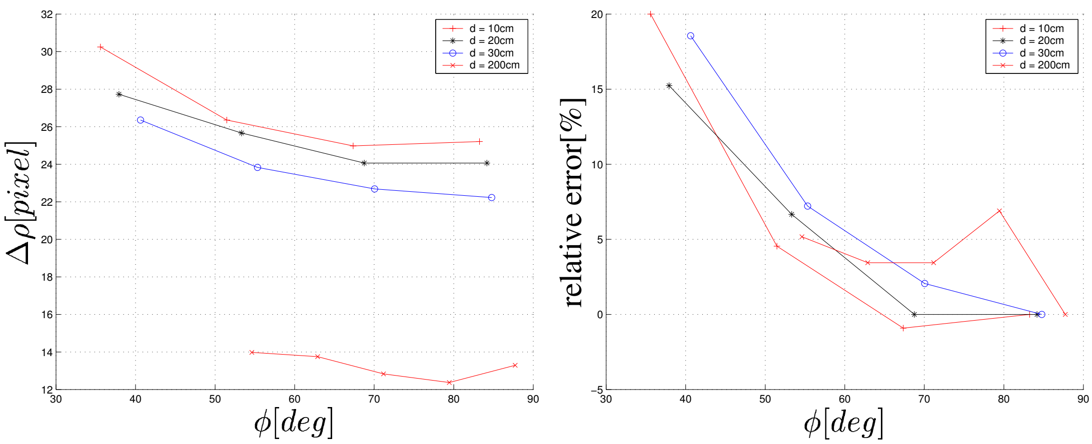
$d[cm]$	$h_1[cm]$	h_2	h_3	h_4	h_5	h_6
10	0.8	5.8	10.8	15.8	20.8	–
20	0.8	10.3	19.8	29.3	38.8	–
30	0.8	14.3	27.8	41.3	54.8	–
200	-5.5	44.5	94.5	144.5	194.5	244.5

Table 1: Real positions of targets. d is distance from the camera-mirror axis, h_i is vertical distance from the bottom of the mirror.



(a) (b) (c) (d)

Figure 3: Panoramic images. The targets for distances (a) 10cm, (b) 20cm, (c) 30cm, (d) 200cm.



(a) (b)

Figure 4: (a) Distances between images of each two consecutive targets as a function of angle ϕ (b) and relative error of the deviation from linearity for distances $d = 10cm$, $20cm$, $30cm$ and $200cm$ from the camera-mirror axis respectively.