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Module 7 part 2

Object size Estimation Using Uncalibrated Stereo

In uncalibrated stereo, the camera parameters such as focal length f and baseline B are unknown. Therefore, we cannot directly compute depth using the usual calibrated formula $Z = fB/d$. However, the relationship between disparity and depth still holds, namely

$$Z \propto \frac{1}{d},$$

where

$d = x_L - x_R$ is the disparity between corresponding left and right image points.

1. Using stereo to Ensure Same Depth

for the object to be measured and a reference object of known size, we compute their disparities:

$$d_{obj} = x_L^{obj} - x_R^{obj}, \quad d_{ref} = x_L^{ref} - x_R^{ref}.$$

If

$d_{obj} \approx d_{ref}$,

then both objects lie at approximately the same depth Z.

This is important, because once depth is the same, their image sizes scale in a simple, proportional way.

This step is the only role of uncalibrated stereo in the procedure.

2. Image Size Vs. Real Size at fixed Depth

for a pinhole camera, points at the same depth satisfy the relation

$$\omega = \lambda(z) W,$$

where

- W = real width of object,
- ω = image width (in pixels),
- $\lambda(z) = f_{eff}/z$ is an unknown constant depending on depth and the camera.

for two objects at the same depth, the same $\lambda(z)$ applies.

So we write:

$$\omega_{obj} = \lambda(z) W_{obj},$$

$$\omega_{ref} = \lambda(z) W_{ref},$$

3. Eliminating Unknown Camera Parameters

Divide the two Equations:

$$\frac{\omega_{obj}}{\omega_{ref}} = \frac{W_{obj}}{W_{ref}}$$

Solving for the unknown real ~~depth~~ width of the object:

$$W_{obj} = W_{ref} \cdot \frac{\omega_{obj}}{\omega_{ref}}$$

This formula no longer contains any unknown camera parameters. All we need to measure are:

- image width of reference object ω_{ref},
- image width of the object ω_{obj},
- real ~~pg~~ physical width of reference object W_{ref}.

4. final Procedure

(i) Identify the object and reference object in both left and right images.

(ii) Compute disparities d_{obj} and d_{ref}.

(iii) If $d_{obj} \approx d_{ref}$, both lie at same depth

(iv) Measure pixel widths ω_{obj} and ω_{ref} in one image

(v) Use

$$W_{obj} = W_{ref} \cdot \frac{\omega_{obj}}{\omega_{ref}}.$$

This gives the real size of the object using uncalibrated stereo.