EX2: Reprojector

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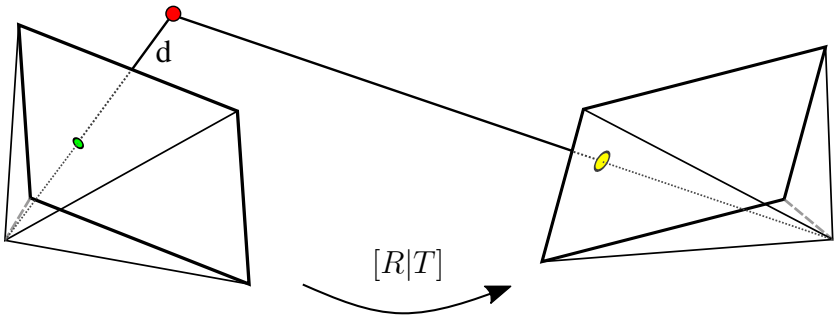

Problem description

In this task, your objective is to reproject a point from one image onto another (yellow). You are provided with the projections of points in the first image (green), as well as the distannce to that points, rotation (R), translation (T), and camera calibration for two images.

The program will take as input

- camera model for the first camera (pinhole/fov)
- camera model for the next camera (pinhole/fov)
- rotation and translation represented in a single 3x4 matrix $[R|T]$ (a transformation from first camera's coordiante system to the second camera's coordinate system)
- the rest of the input are the points' projections on the first image with corresponding distances

pinhole camera is given to you as:

```
pinhole <width> <height> <focal x> <focal y> <center x> <center y>
```

and fov as:

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fov <width> <height> <focal x> <focal y> <center x> <center y> <w>
```

Your task is to output, in a given order, the corresponding point locations on the other image.
If a point lies outside of the image, the output should be "OB".

FOV model

A general image formation model for radially distorted cameras is generic projection followed by a non-linear transformation of the radius for each image point. The distorted coordinates of a generically projected point $\tilde{\mathbf{X}}$ are given by

$$\pi_d(\tilde{\mathbf{X}}) = g\left(\|\pi(\tilde{\mathbf{X}})\|\right) \cdot \pi(\tilde{\mathbf{X}}) \in \mathbb{R}^2 \,.$$

$g : \mathbb{R}^+ \to \mathbb{R}^+$ is the function that radially distorts the coordinates of $\pi(\tilde{\mathbf{X}})$. It is typically approximated by some parametric function. The pixel coordinates of the distorted camera are

$$\begin{pmatrix} u_d \\ v_d \\ 1 \end{pmatrix} = K \begin{pmatrix} \pi_d(\tilde{\mathbf{X}}) \\ 1 \end{pmatrix} = K \begin{pmatrix} g\left(\|\pi(\tilde{\mathbf{X}})\|\right) \cdot \pi(\tilde{\mathbf{X}}) \\ 1 \end{pmatrix} \,.$$

The so-called FOV model, first suggested by Devernay and Faugeras in 2001, and used e.g. in the open source implementation of PTAM (Parallel Tracking and Mapping), is given by

$$g_{\text{ATAN}}(r) = \frac{1}{\omega r} \arctan\left(2r \tan\left(\frac{\omega}{2}\right)\right) \,.$$