Camera Calibration Using Parallel Line Segments

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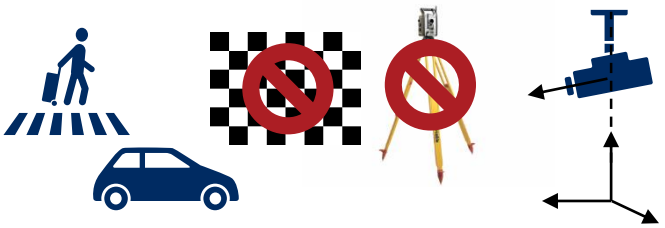
Background

Camera calibration is a necessary preprocess to conduct 3D object analysis from 2D images. For surveillance cameras, the standard methods using a checkerboard or a 3D sensor are not impractical due to traffic restrictions.



Contributions

1. developed a closed-form solution that determines camera parameters as well as 3D position of the lines from $n \geq 2$ line segments.
2. demonstrated that pedestrian joints detected by OpenPose can be available as a calibration object.

Proposed Method

Assumptions of line segments

- Same length
- Parallel
- Perpendicular to the ground

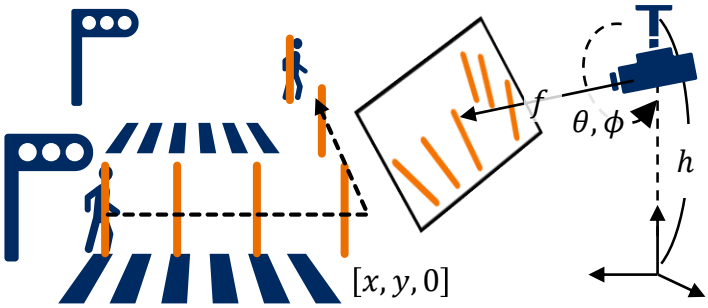
e.g. Traffic lights, Truck box, Pedestrian's height

Num of lines needed to solve

Known variables: $4n$
2D coord. of two endpoints

Unknown variables: $2n + 4$
height h, rotational angles θ, ϕ,
focal length f, (x,y) position of each line

$\rightarrow n \geq 2$



Line segment detection

▼

Linear closed-form solution

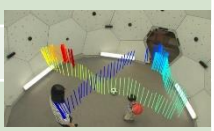
▼

Bundle adjustment with lens distortion

Experimental Results

Noisy lines using human pose

Neck-midhip connections by OpenPose on each frame can be useable for camera calibration.



	Focal length	Lens dist.	θ [deg]	Height [m]
GT	747	-0.356	27.7	2.78
Ours	715	-0.217	28.2	2.73
Rel. Err	4.3%	39%	1.8%	1.8%
GT	1396	-0.286	40.0	3.12
Ours	1386	-0.203	41.7	3.15
Rel. Err	0.7%	29%	4.3%	1.0%

Applications

Social distancing detection

Real-time checking from surveillance cameras that already installed in town.

Planar image rectification

The ratio of four sides are estimated by specifying two lines of a rectangle.