Format of param.cal file

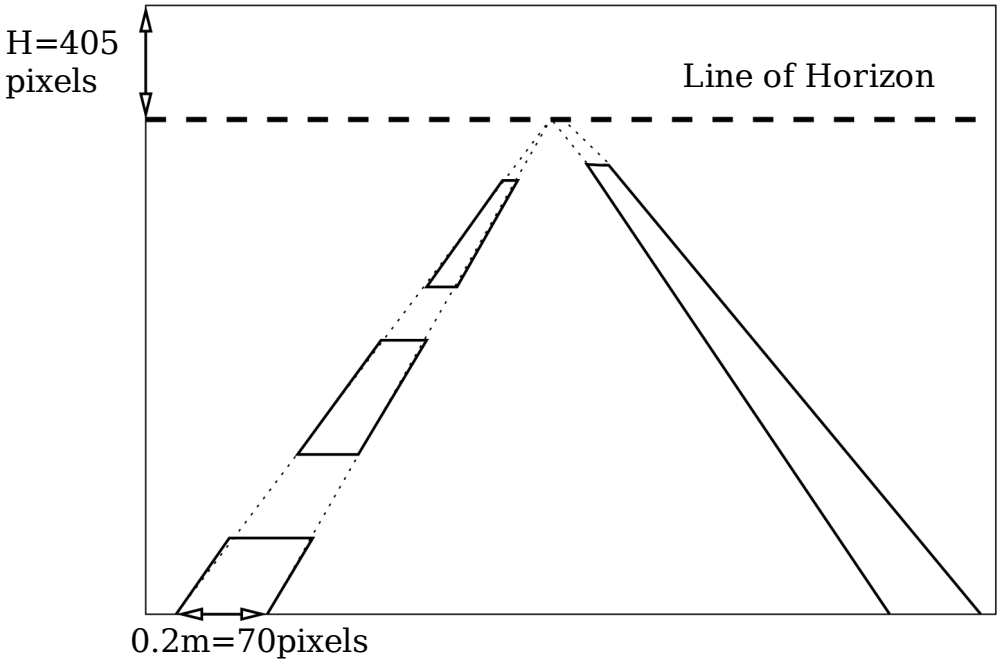
This file contains the necessary information for marking extraction algorithms that do not use any inverse perspective mapping of the image.

Example of param.cal file:

```
405
0.05 17
0.20 70
0.45 156
0.90 314
```

The first line of the file is the height H of horizon line in pixels (the origin is the top-left corner of the image), see Figure. Then, the two column array gives the correspondence between width measurements on the ground plane and on the image plane. More specifically:

- In the first column appears several distances in meter (0.05m, 0.2m, 0.45m and 0.9m). These distances are taken on the road plane along, perpendicularly to the main road axis.
- In the second column, the corresponding distances in pixels along the last line of the image are given.



Format of file param.cam

1) Pinhole camera model with radial distortions

The camera model consists in 4 transformations a), b), c) and d).

a) Transformation from the scene to the camera:

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} r_1 & r_2 & r_3 \\ r_4 & r_5 & r_6 \\ r_7 & r_8 & r_9 \end{pmatrix} \begin{pmatrix} U \\ V \\ W \end{pmatrix} + \begin{pmatrix} t_x \\ t_y \\ t_z \end{pmatrix} \qquad (1)$$

where (U,V,W) are the coordinates of a point in the scene reference system, and (X,Y,Z) the corresponding coordinates in the camera reference system. Parameters r_i are related with calibration parameters (R_x,R_y,R_z) by:

$r_1 = \cos(R_y) * \cos(R_z)$
$r_2 = \cos(R_z) * \sin(R_x) * \sin(R_y) - \cos(R_x) * \sin(R_z)$
$r_3 = \sin(R_x) * \sin(R_z) + \cos(R_x) * \cos(R_z) * \sin(R_y)$
$r_4 = \cos(R_y) * \sin(R_z)$
$r_5 = \sin(R_x) * \sin(R_y) * \sin(R_z) + \cos(R_x) * \cos(R_z)$
$r_6 = \cos(R_x) * \sin(R_y) * \sin(R_z) - \cos(R_z) * \sin(R_x)$
$r_7 = -\sin(R_y)$
$r_8 = \cos(R_y) * \sin(R_x)$
$r_9 = \cos(R_x) * \cos(R_y)$

b) Perspective projection:

$$\begin{cases} u = f(X/Z) \\ v = f(Y/Z) \end{cases} \qquad (2)$$

where f is the camera focal parameter.

c) Radial optical distortion:

$$\begin{cases} u = x_d(1 + K \cdot r_d^2) \\ v = y_d(1 + K \cdot r_d^2) \end{cases} \text{ with } r_d^2 = (x_d^2 + y_d^2) \qquad (3)$$

where K is the radial distortion factor.

d) Image sampling:

$$\begin{cases} x = (s_x/dp_x).x_d + C_x \\ y = (1/dp_y).y_d + C_y \end{cases} \qquad (4)$$

where (C_x,C_y) are the image center coordinates in pixels, dp_x, dp_y and s_x are

factors related to the pixel size.

2) Example of a param.cam file

Line of param.cam file	*Meaning and [units]*	***Parameter name***
MicroCamera	*Camera Id*	**-**
D:\Calibrage\image003.dat	*Data filename used for calibration*	**-**
CalibGrille	*Name of used calibration algorithm*	**-**
4/ 3/2002	*[date] Date of calibration*	**-**
365x276	*[pixels] image size (horizontal × vertical)*	**-**
6.0000000000e+000,1.6000000000e+001	*Corners of the calibration area within the image*	**-**
3.5700000000e+002,1.6000000000e+001		**-**
6.0000000000e+000,2.2300000000e+002		**-**
3.5700000000e+002,2.2300000000e+002		**-**
5.8200000000e+002	*[cells] number of cells (axis X)*	Nc_x
3.6500000000e+002	*[pixels] number of pixels out of the acquisition board (axis X)*	Nf_x
7.2000000000e-003	*[mm/cell] cell size (axis X)*	d_x
8.2500000000e-003	*[mm/cell] cell size (axis Y)*	d_y
4.5300000000e-003	*[mm/pixel] horizontal pixel size (axis X)*	$dp_x=(d_x.Nc_x)/Nf_x$
4.5600000000e-003	*[mm/pixel] vertical pixel size (axis Y)*	$dp_y=d_y$
1.7332525482e+002	*[pixel] horizontal coordinate of the image center*	C_x
1.4600958839e+002	*[pixel] vertical coordinate of the image center*	C_y
1.0000000000e+000	*[ ] extra scale factor (axis X)*	s_x
1.2325155688e+000	*[mm] focal*	f
4.0660112885e-001	*[mm^{-2}] radial distortion factor*	K
-2.2789169032e-002	*[mm] translation along axis X*	t_x
6.9994357911e-001	*[mm] translation along axis Y*	t_y
1.0713151183e+000	*[mm] translation along axis Z*	t_z
2.5627222141e+000	*[rad] rotation around X axis*	R_x
1.1357644644e-002	*[rad] rotation around Y axis*	R_y
4.9923207876e-002	*[rad] rotation around Z axis*	R_z
0.0000000000e+000	*Not used*	**-**
0.0000000000e+000	*Not used*	**-**