ECE 417/598: Review

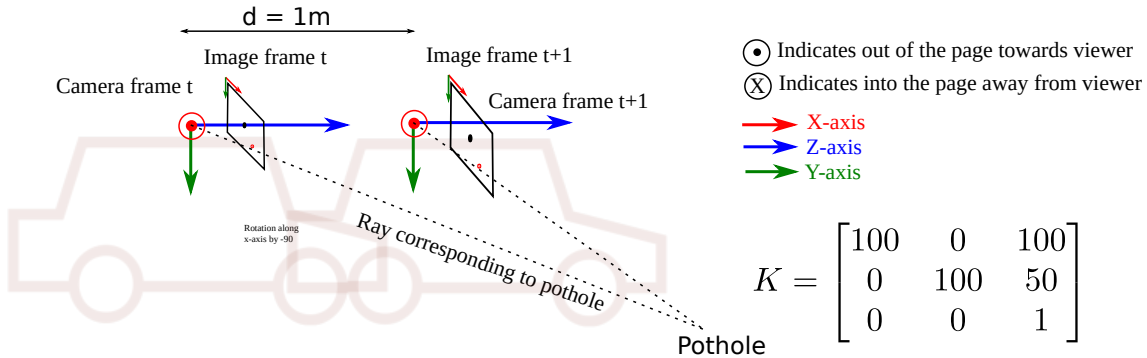
Vikas Dhiman

March 25, 2022

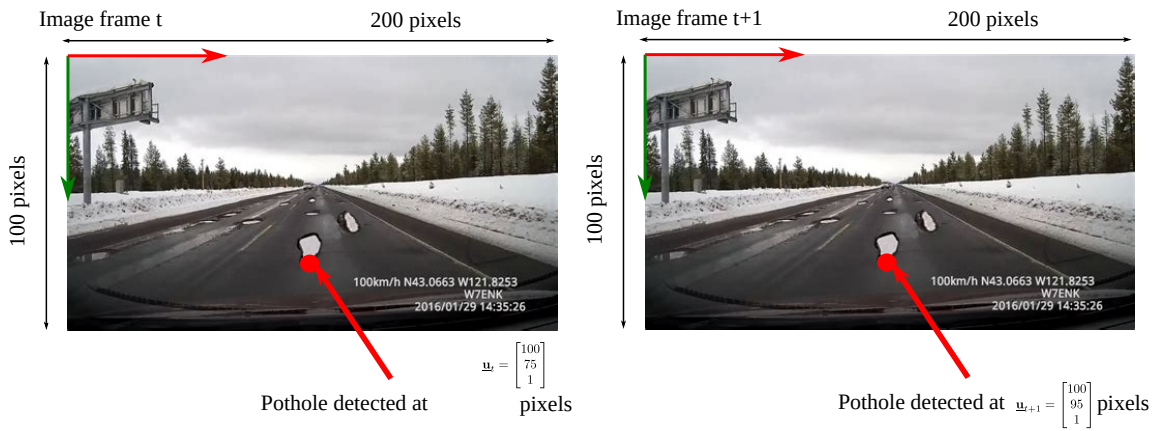
Concepts to review and remember

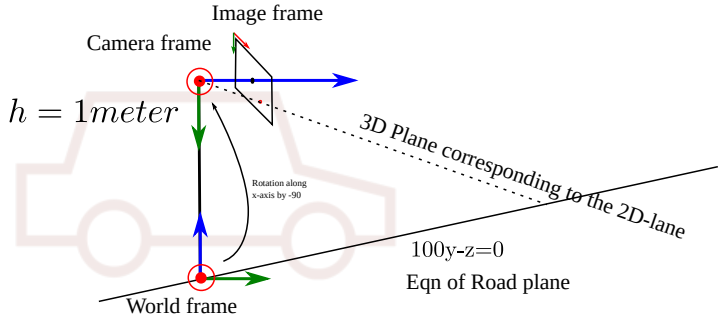
1. 2D/3D Rotation, translation, and transformation matrices
2. 3D Rotation from euler angles and vice versa
3. 3D Rotation from axis-angle and vice versa
4. Pinhole camera model. Image point to 3D ray and 3D point to image point.
5. Image line to 3D plane.
6. Least squares solution by function minimization
7. Line-plane intersection
8. Line-line intersection
9. Plane-plane intersection
10. SVD in terms of eigen values and vectors. Properties of eigen values, eigen vectors and SVD matrices.
11. Null space and column space
12. Implicit and explicit equations of lines and planes.
13. Conversion of any linear system of equations into $Ax = b$ form or $Ax = 0$ form.

Find the 3D position of the pothole the $t+1$ coordinate frame, in terms of $d = 1$ (the movement of the camera), image-coordinates of the pothole $\underline{\mathbf{u}}_t$, $\underline{\mathbf{u}}_{t+1}$ (provided in figure), camera matrix K (provided in figure). The car has moved from directly forward along Z_t-axis by $d = 1$m without any rotation. We get two images at time t and at $t+1$. The detection of the pothole at time t is $\underline{\mathbf{u}}_t = [100, 75, 1]^\top$ and $\underline{\mathbf{u}}_{t+1} = [100, 95, 1]^\top$. Provide the formula or pseudo-code for computing the pothole coordinates.



$$K = \begin{bmatrix} 100 & 0 & 100 \\ 0 & 100 & 50 \\ 0 & 0 & 1 \end{bmatrix}$$





⊙ Indicates out of the page towards viewer

⊗ Indicates into the page away from viewer

X-axis

Z-axis

Y-axis

Lane detected at $\mathbf{l} = \begin{bmatrix} 1 \\ -1 \\ -150 \end{bmatrix}$

In other words, the equation of the line detected in image coordinate frame is given by:

$(1)\mathrm{x} + (\text{-}1)\mathrm{y} + (\text{-}150)1 = 0$

$$K = \begin{bmatrix} 100 & 0 & 100 \\ 0 & 100 & 50 \\ 0 & 0 & 1 \end{bmatrix}$$