ECE 417/598: Homework 5

Max marks: 100 marks

Due on March 22, 2021, midnight, 11:59 PM.

Problem 1 *In figure 1 find the 3D representation of the lane the World coordinate frame, in terms of h (the height of the camera), image-representation of the line $\mathbf{l}$ (provided in figure), camera matrix K (provided in figure). Assume the lane to be a straight line. The Camera is mounted directly on top of the world frame, both of which are aligned to the gravity vector. The road is a perfect plane with a slope such that the equation of road plane in world-coordinate frame is given by $100Y_w - Z_w = 0$ and the lane lies on the road plane. Provide the formula or pseudo-code for computing the 3D representation of the lane, and also substitute in the values. (20 min, 20 marks)*

Implement the solution to problem 9 in homework 4 in C++. Use the line output from fitline.cpp. Structure your code into four functions one for each step of the algorithm as provided in the solutions to HW4:

1. `Eigen::Vector4d image_line_to_plane_3D(const Eigen::Matrix3d& K, const Eigen::Vector3d& l)`
   This function to should convert the line in the image to a plane in 3D.

2. ```
   Eigen::Vector4d plane_from_camera_to_world(
   const Eigen::Matrix3d& wRc,
   const Eigen::Vector3d& wtc,
   const Eigen::Vector4d& plane_c)
   ```
   This function to should convert the plane in camera coordinates to a plane in the world coordinates.

3. ```
   std::pair<Eigen::Vector3d, Eigen::Vector3d>
    plane_plane_intersection(
   const Eigen::Vector4d& plane_p
   const Eigen::Vector4d& plane_q)
   ```
   This function to should find the intersection of to planes and return the parametric representation of line as two 3D vectors where the first vector represents the direction of the line and the other vector represents any point on the line. For example, if the parametric representation of line is $\mathbf{x} = \lambda\mathbf{v} + \mathbf{x}_0$, where λ is a free parameter, $\mathbf{v} \in \mathbb{R}^3$ is the direction of the line and $\mathbf{x}_0 \in \mathbb{R}^3$ is any point on the line.

4. *In the main function, first test your solution for HW4 problem 8 values. Then test it for random representation of a line and random representation of a road plane, 10 times.*

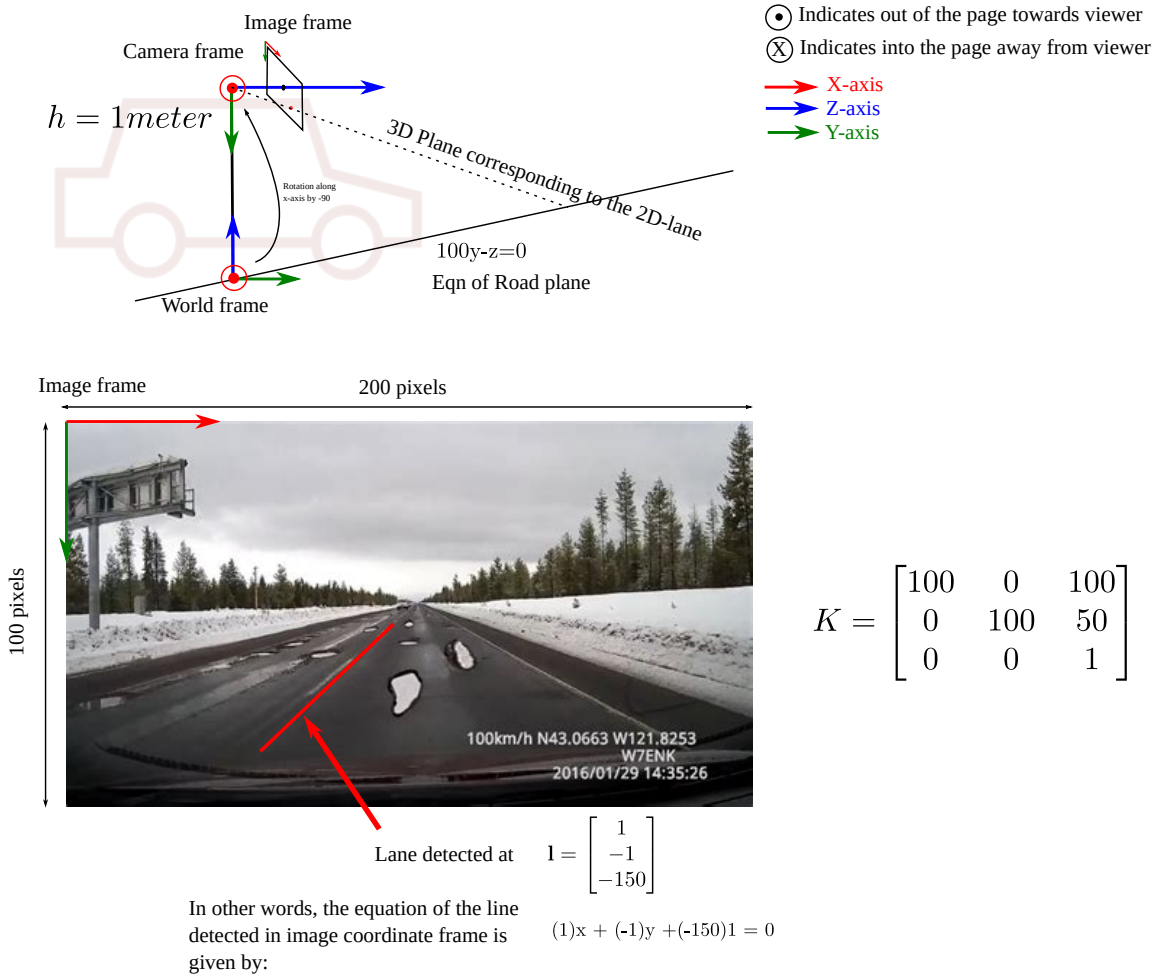

Figure 1: Line-plane triangulation