Hough Transform

1 Hough Transform

1. Detect straight lines in an image using the Hough transform. Implement the following algorithm:
   - Input is an edge image E_h of dimension $M \times N$. $E_h(x, y) = 1$ if an edge is present and $E_h(x, y) = 0$ if no edge was detected at location x, y. Reuse the code of Exercise 2 or use `cv::Canny` to obtain E_h. In order to detect lines, we regard every edge point as a candidate point for a line computed by

     $$\rho = x\cos(\theta) + y\sin(\theta).$$

     Note: $\rho \in [0, \sqrt{M^2 + N^2}]$, $\theta \in [0, \pi]$. With $\delta\rho$ and $\delta\theta$ we denote the step size, e.g. the resolution of the Hough parameter space.
   - Compute the number of intervals R and T for sampling of ρ and θ using $\delta\rho$ and $\delta\theta$.
   - Initialize the Hough space H with dimensions $R \times T$ and set each entry to 0.
   - For each pixel $E_h(x, y) = 1$ and for $h = 1 \dots T$
     - compute
       $$\rho_h = x\cos(h \cdot \delta\theta) + y\sin(h \cdot \delta\theta),$$
     - determine the index $k = 1 \dots R$ which is closest to ρ_h,
     - and increment $H(h, k)$ by one.
   - Find all local maxima in $H(h, k)$ where $H(h, k) > \tau$, where τ is a user-defined threshold.
   - Output the detected edges, the final Hough space, and the detected lines as images.