Computational Intelligence: Homework 1

Topic: Manual Design of Fuzzy Controller for Backing Up A Truck

Kinematics of backing up a truck-emulator

$$\begin{aligned} x' &= x + r\cos(\phi') \\ y' &= y + r\sin(\phi') \\ \phi' &= \phi + \theta \end{aligned}$$

$$\begin{aligned} 0 \le x \le 100 \\ -90 \le \phi \le 270 \\ -30 \le \theta \le 30 \end{aligned}$$

The goal was to make the truck arrive at the loading dock at a right angle (ϕ_f = 90°) and to align the position (x, y) of the truck with the desired loading dock (x_f, y_f). We considered only backing up. The truck moved backward by some fixed distance at every stage. The loading zone corresponded to the plane $[0, 100] \times [0, 100]$, and (x_f, y_f) equaled $(50, 100)$.

At every stage the fuzzy and neural controllers should produce the steering angle θ that backs up the truck to the loading dock from any initial position and from any angle in the loading zone.

Requirement:

The speed r is set to 1. The **triangular** membership functions are used. The defuzzification strategy is **centroid of area**.

1. The execution file (.exe) and source codes.
2. The execution file needs to be able to feed the initial positions and angles.
3. The execution file needs to show the trajectory (positions and angles) from the initial position
4. Written report includes at least
   a. What are the membership functions?
   b. How to execute your file?
   c. What is the average Docking error (over all test trials)? Initial points: x: [20,80], y:[20, 50], phi: [-80,260] (7x4x69 points): x=20,30,40,50,60,70,80; y=20,30,40,50; phi=-80,-75,-70,…,0,5,…,255,260
      Starting from **one initial state**, the docking error for the achieved final state when the truck stops is defined as

      $$\text{Docking error} = \sqrt{\left(\frac{\emptyset_f - \emptyset}{180}\right)^2 + \left(\frac{x_f - x}{50}\right)^2 + \left(\frac{y_f - y}{100}\right)^2}$$

   d. What is the average trajectory error over test trials in (c)?

Trajectory error $= \frac{length\ of\ truck\ trajectory}{distance\ between\ initial\ position\ and\ desired\ final\ position}$ for one starting position.