Physical Model of the Simulated Vehicle
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HL

1. Option 1 for steering the vehicle direction: Stepper motor is utilized to steer the wheel of the vehicle. (Note: Option 2 for steering the vehicle direction is based on two front motorized wheels, to be discussed later.) The following table gives the stepping information:

Table 1. Stepper motor

Step type	Angle in degree per step	Note
Full step	360/200 = 1.8 degree	
½ step	0.9 degree	Micro step
¼ step	0.45 degree	Micro step
1/8 step	0.225 degree	Micro step

2. Drive stepper motor with motor driver IC which requires two inputs from embedded system CPU, one is PWM, and the other is directional information. Use f_pwm = 500 Hz as the input source to drive the motor.
3. The time interval of each PWM pulse, T_pwm = 1/ f_pwm, e.g., T_pwm = 1/500 Second.
4. The lateral distance is sampled with sampling frequency f_sample = f_twm to make sure the minimum lateral distance can be detected due to motor actuation. (Or overall sampling frequency can be defined to measure lateral displacement due to random disturbance, for example 2 samples per each PWM pulse.)

   5. The minimum lateral distance can be calculated based on the formula:
   angularSpeed = stepConfiguration * Number-pulses-per-second
   distance = angularSpeed * 2 * pi * R (where R is from the wheel radius)
   dist_min = distance * sin (theta) ... (1)
5. which projects the distance traveled to the desired direction.
   since theta = 0.225 (degree), very small, we can estimate sine function by its angle directly.

   6. Note the maximum lateral distance per PWM pulse can be calculated based on the similar equation, except 0.225 (1/8 full step) can be replaced with 1.8 degree.

   7. For the first round of PID simulation, use 0.225 degree.
   (END)