Report of the first project of Motion Planning

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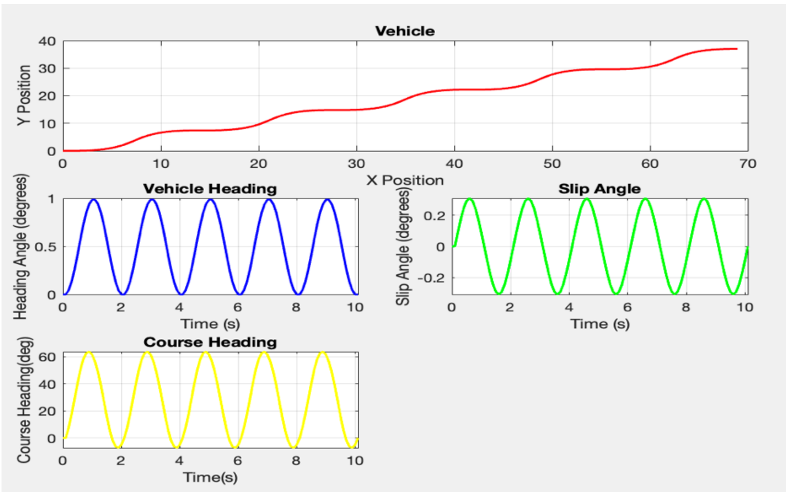
I. Introduction

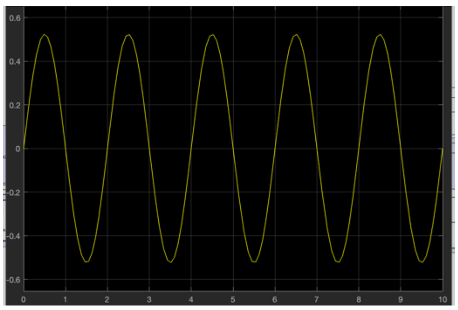
Our assignment involved addressing the initial challenges in modeling the car. To begin, we delved into examining the car's bicycle model, which essentially represents the car as a bicycle. In the initial segment, we explored the kinematic model of the car, focusing solely on the car's geometry and disregarding the influence of physics. Moving on to the subsequent section, we examined the car's dynamics, initially focusing on its lateral dynamics and subsequently considering the lateral dynamics within a road-aligned system.

II. First Task

Deriving from the ODE system equation, we recognize that the state is characterized by [X, Y, phi], representing the global position of the Center of Gravity (CoG) of the car. At this juncture, our task was to depict the connection between x and x_dot using MATLAB and generate plots using the ODE45 function. The outcomes we obtained are as follows:



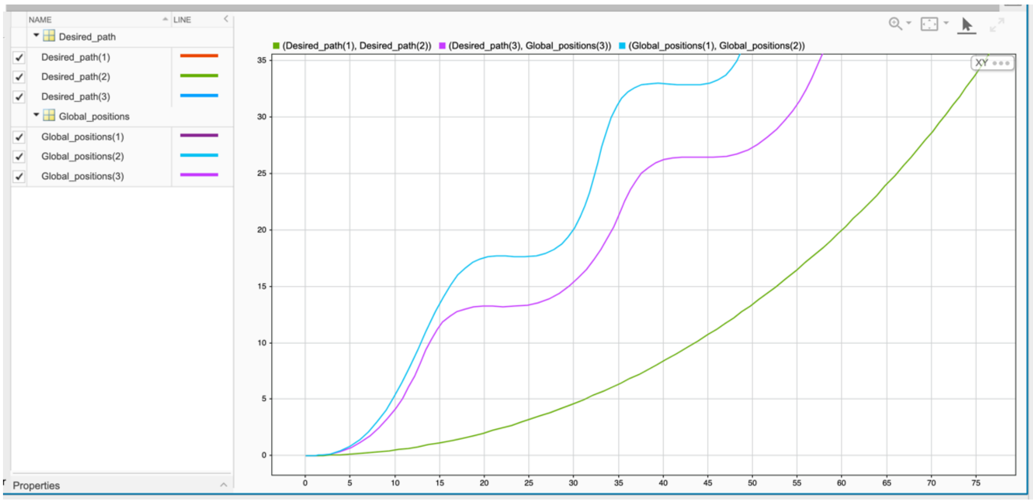
The sinusoidal input, as illustrated in the image below, is clearly responsible for the non-linear trajectory of the positions:



III. Second Task

In this phase of the project, our emphasis was on developing the dynamic model for lateral motion, and we chose to execute it within the Simulink environment. The elucidation will be provided through images. We utilized the State-Space Simulink block to incorporate the model, employed the Integrator for handling various integrals, and employed the Scope and XY Graph to visualize the data.
Utilizing the well-established lateral dynamic model, we proceeded to construct Simulink blocks. Prior to this, we meticulously defined all the requisite parameters, multiple matrices, and their computations, as depicted in the task2 files. Our primary objective during this stage was to design the model using Simulink blocks.

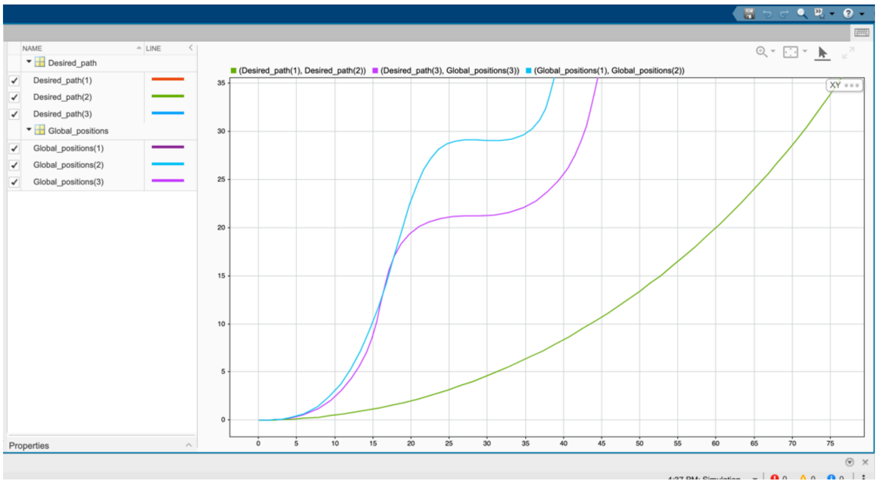
a. V = 50 km/h



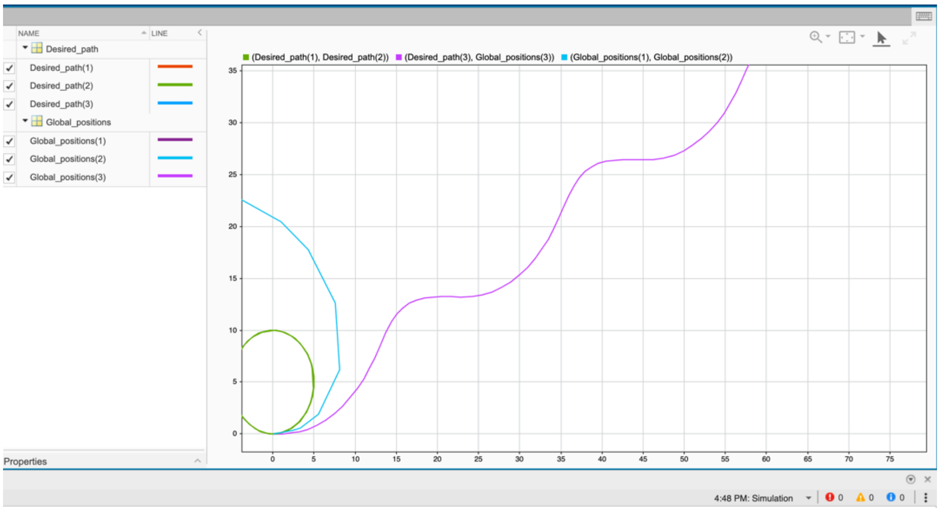
The desired path is represented in green, while the lateral dynamic is denoted in pink, and the road-aligned lateral dynamic is shown in blue.
Observing the trajectories, it's evident that both the lateral dynamic and the road-aligned lateral dynamic exhibit approximately the same path, which aligns with the kinematic model. However, neither of them precisely follows the desired path. This is expected since we haven't implemented any control mechanism yet; the system is influenced solely by the sinusoidal input.

b. V= 70km

At 70 kph we see that the 2 dynamic model are a little bit closer to each other but they still do not follow the path.



Now we asked ourselves what would happen for smaller radius trajectory,



As we expected the road aligned model is much more affected by this change of parameters.

c. Conclusion

The studied cases are well known for a modelling of the lateral dynamic of the car but without control input it’s impossible to reach our control goals of reducing the errors.