Dynamics and Control:State Space Modeling

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What is State-Space Modeling?

State space modeling is when high-order differential equations or systems of high-order differential equations are transformed into a system of first-order equations. This is desirable for analysis because as soon as this transformation is achieved, tools of linear algebra can then be applied. From them, the stability of the system and even its characteristic response can be retreived. State space modeling is also useful in control system design, especially for multiple-input-multiple-output (MIMO) systems.

For an example of what is done in state-space modeling, consider a lone second-order differential equation derived from an RLC circuit.

$$\ddot{i} + \frac{R}{L}\dot{i} + \frac{i}{LC} = 0.$$

Now, how would one transform this into a system of first-order differential equations? A first step would be to introduce some extra variables into the system. Notice that right now we only really have a single variable i, along with its derivatives. However, we can change this by introducing some variables as follows,