Diffusion Generative Models For Unstructured Uncertainty Perturbations

The goal of this research is to use a generative diffusion model to create unstructured perturbations of a nominal plant. If this research is successful, we will be able to use a diffusion generative model to do the following:

1. Generate Bode plots based on training data of example dynamic systems
2. Perturb a nominal plant in an unstructured manner with a controllable amount of uncertainty
3. Approximate a set of controllable plants by generating a large number of perturbed examples

The diffusion generative model has shown great promise in creating novel and realistic samples from training data. This research will train a generative model to create Bode plots of transfer functions. This model will be given a nominal plant as an input and then generate a perturbed plant. Once created, this perturbed plant can be evaluated if it belongs to the set of controllable plants for a desired controller. This process will be repeated several times to generate enough plants to approximate the set.

These generated plants can be used to verify robustness of controller implementations. A model of a controller can use robust control theory to establish the set of controllable plants, but an actual implementation of a controller can not be verified as robust in the same way. Instead, it must be verified experimentally using elements of the set. Extracting elements of the set is not a trivial task, but if this research is successful, a generative model can reduce the effort required to create perturbed plants.

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