

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, this diffusion model will accomplish three main tasks:

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 of controllable plants.

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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