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# Deep Model Predictive Control for Quadrotor

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## Introduction / Motivation

- Deep MPC is a deep learning based model predictive control algorithm
- It utilizes a deep learning based adaptive mechanism to mitigate disturbances
- Error and environment unavoidable in practice and Deep MPC helps mitigate these uncertainties while maintaining safety and performance

Plant:

$$x_{t+1} = f(x_t) + g(x_t)(u_t + h(x_t))$$

Where:

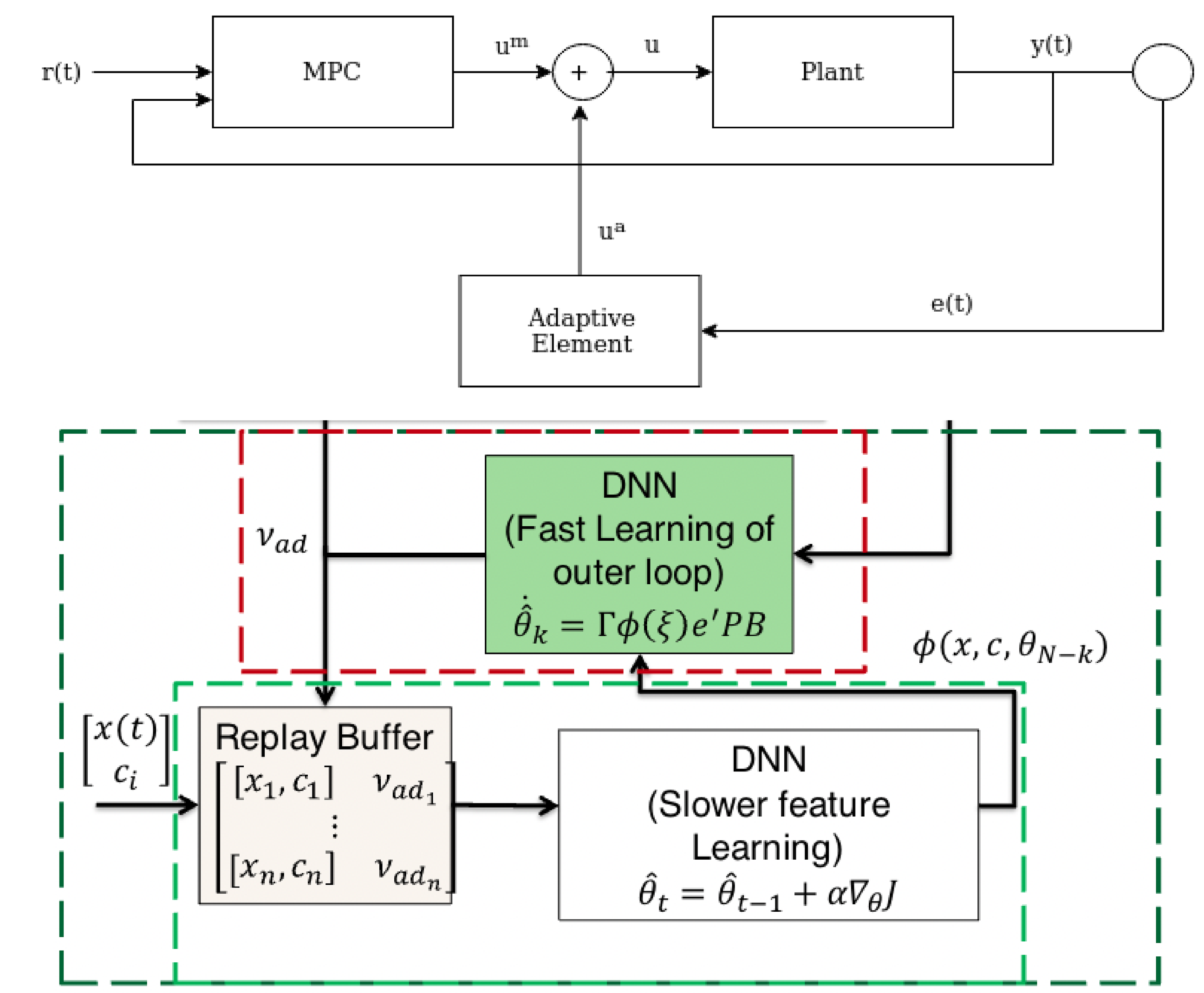
- $x \in X$ : system states
- $U \in U$: system control inputs where $u_t = u_a + u_m$
- f, g : known continuous functions
- h : unknown and continuous function representing system uncertainties

## Approach

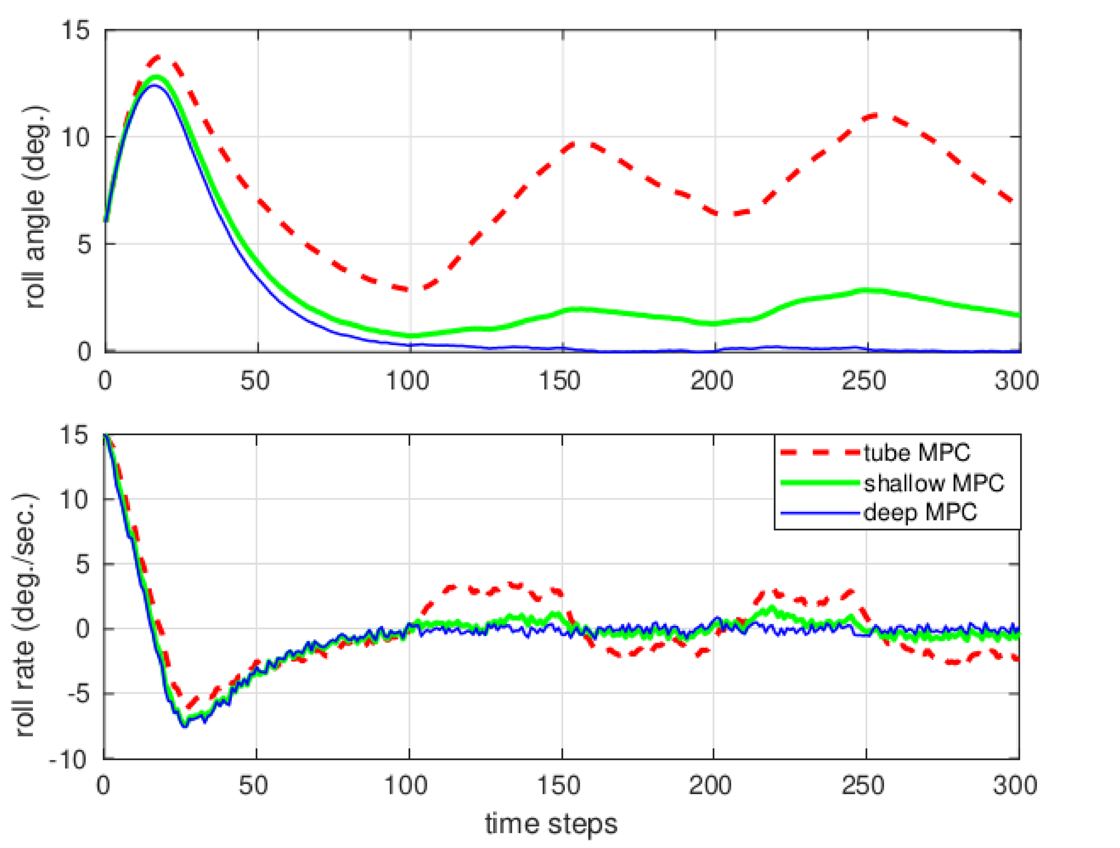
**Algorithm 1** deep MPC

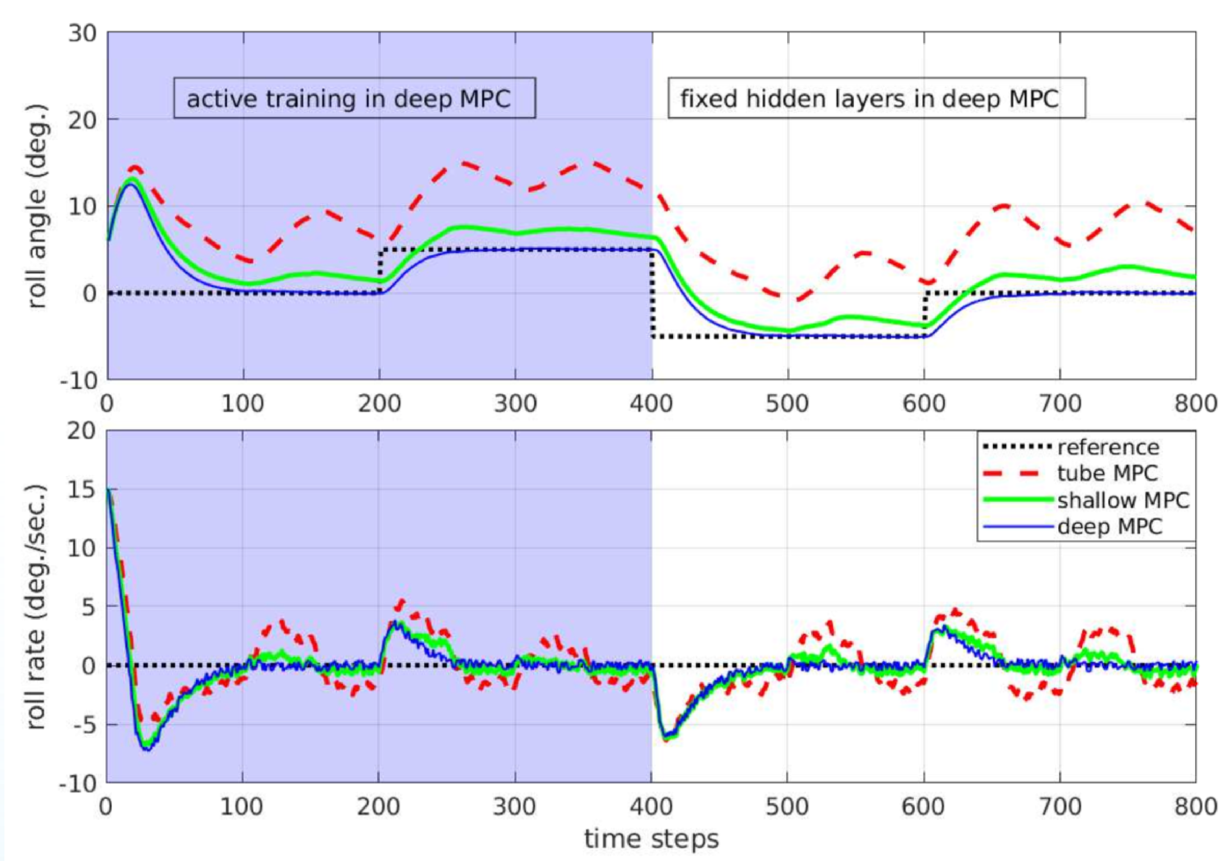
**Require:** $x_0, (t_j)_{j \in \mathbb{Z}_+}$

1: choose $\theta < 1$
2: Generate the reference trajectory (12)
3: initialize $K_0 = \mathbf{0}$, $t = 0$ and randomly assign weights of hidden layers of DNN to get $\phi_0$
4: initialize a generative network with a buffer on a secondary machine according to §III-B
5: **for** each $t$ **do**
6: if $t = t_j$ then update $\phi = \phi_j$, otherwise move to the next step
7: compute $u_t^a = -K_t^\top \phi(x_t)$
8: solve (21), set $u_t^m = u_{t|t}^*$
9: apply $u_t = u_t^m + u_t^a$ to the system and measure $x_{t+1}$
10: compute $K_{t+1}$ by the weight update law (9) and (10)




## Current Status/ Results (If any)




## Next Steps/ Future Work

Next Steps

- Subject quadrotor to sources of uncertainty
- Apply Deep MPC for control of a quadrotor
  - Wind Bias
  - Propeller Damage/Failure
  - Hanging Mass
- Compare performance to nominal control algorithms

Future Work

- Experiment with deep learning architecture to improve capability
- Explore different neural network architectures such as Recurrent Neural Networks
- Experiment with Approximate MPC, a MPC based control algorithm that utilizes a neural network to approximate control inputs, thus cutting down computational cost



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