Area: Control, Intelligent System & Robotics

Host: Assistant Professor Zhao Lin

TOPIC	:	**Neural Moving Horizon Estimation for Robust Flight Control**
SPEAKER	:	**Mr. Wang Bingheng** **Graduate Student, ECE Dept, NUS**
DATE	:	**Monday, 10 April 2023**
TIME	:	**2:00PM to 2:30PM**
VENUE	:	**Join Zoom meeting:** **https://nus-sg.zoom.us/j/83667111996?pwd=elU3Zlg3enpKQ2dYYTVqWDFMY2ZkUT09** **Meeting ID: 836 6711 1996** **Passcode: 912475**

ABSTRACT

Estimating and reacting to external disturbances is crucial for robust flight control of quadrotors. Existing estimators typically require significant tuning for a specific flight scenario or training with extensive ground-truth disturbance data to achieve satisfactory performance. In this paper, we propose a neural moving horizon estimator (NeuroMHE) that can automatically tune the key parameters modeled by a neural network and adapt to different flight scenarios. We achieve this by deriving the analytical gradients of the MHE estimates with respect to the weighting matrices, which enables a seamless embedding of the MHE as a learnable layer into neural networks for highly effective learning. Interestingly, we show that the gradients can be computed efficiently using a Kalman filter in a recursive form. Moreover, we develop a model-based policy gradient algorithm to train NeuroMHE directly from the quadrotor trajectory tracking error without needing the ground-truth disturbance data. The effectiveness of NeuroMHE is verified extensively via both simulations and physical experiments on quadrotors in various challenging flights. Notably, NeuroMHE outperforms the state-of-the-art neural network-based estimator, reducing force estimation errors by up to 91.6%, while using only 7.7% of the network parameters of that estimator. The proposed method is general and can be applied to robust adaptive control of other robotic systems.

BIOGRAPHY

Mr. Wang Bingheng is currently pursuing his Ph.D. at the Department of Electrical and Computer Engineering, National University of Singapore under the supervision of Prof. Zhao Lin. His research area lies in learning-based control and motion planning for aerial robots.

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