Mechanical Engineering Thesis Defense

A Deep Reinforcement Learning Approach for Robotic Bicycle Stabilization

School for Engineering of Matter, Transport and Energy

Shubham Turakhia

Advisor: Dr. Wenlong Zhang

Abstract

Research on bicycle stabilization has become a popular topic because of its interesting dynamic behavior and various scientists have derived a comprehensive set of linearized equations by using some approximations that could be modelled. For stabilization of these highly maneuverable and efficient machines, many control techniques were used which could achieve interesting results but having some limitations. It was when in 1998, Randlov and Alstrom came up with an idea of bicycle control using reinforcement learning technique. This thesis focuses on self-stabilization of bicycle using Deep Deterministic Policy Gradient (DDPG) algorithm based on deterministic policy gradient that can operate over continuous observation and action spaces. This method helps in learning the controller to deliver the action space over the states received from the bicycle in continuous time domain. It uses actor-critic method to calculate the required actions and are updated at every time step for achieving good results. The research involved developing the algorithm with Tensor Flow implementation, conducting software testing using the OpenAI pendulum environment and custom bike environment created using Pandas3D and gym packages. After validation of the software results, the algorithm was incorporated on the hardware setup. The Arizona State University's RISE Lab Bike platform provides set of sensors and actuators designed to aid in understanding and provide active balance control to the bicycle. Validation of testing was done by plotting the real-time states and actions collected during the outdoor testing which included the roll angle of motorcycle.

November 6, 2020; 1 PM;

Zoom Link: https://asu.zoom.us/j/87069024926