T513: Mathworks Engine Controller

Internal combustion engines will continue to be used into the near future, so it is important to improve how the engine performs. Improving fuel efficiency and reducing emissions to keep up with new standards all help keep combustion engines on the road. The design of the engine can have the biggest impact on some of these challenges. These issues can be improved by controlling and estimating how air flows through an automotive engine. Engine emissions can also contain harmful particles that can enter the human bloodstream. Airflow control can help reduce these emissions. For our senior design project, we are working with Mathworks to implement a modular controller for the airflow components of a simulated engine. The controller will help to modernize Mathworks’  Powertrain Blockset, using a multi-input multi-output (MIMO) approach.

More than one component affects the airflow into the engine. MIMO is therefore a strong choice for effective control of each actuator. The specific parts to be controlled are the throttle, which brings air into the engine, and the wastegate, which diverts exhaust gas into a turbine wheel to compress more air into the cylinder, creating more power. These two valves play the largest roles in engine airflow. A good control approach for this application is a model predictive controller (MPC). This handles MIMO systems well and is already used in some cars today.

The MPC will take in the current simulation values for the throttle, wastegate and desired torque as inputs, returning improved values as outputs of our system. With these new values, the Blockset will calculate the instantaneous (actual) torque created by the simulated engine and compare those values to the torque commanded (desired) by the system. We aim to reduce the error between the desired and actual torque by 50%.