Automation of a Wind Tunnel Smoke Flow Visualization (SFV) Rig

When analyzing the properties and features of flow around aerodynamic devices, there are quantitative techniques such as particle image velocimetry (PIV) and hot-wire anemometry, while the SFV method provides a simpler set-up and qualitative look at the flow field. The SFV technique consists of a nichrome wire that is coated in propylene glycol and is heated to create lines of smoke through the wind tunnel. It allows for the visual identification of key features such as boundary layers, laminar or turbulent flow and vortex shedding. Currently, each instrument in the setup is controlled manually and is only effective for flow speeds under 5 m/s, therefore limiting the precision of equipment usage for unsteady conditions and the range of possible cases to study. This project aims to increase the efficiency, precision, and versatility of the SFV setup by automating the components using a microcontroller, as well as implementing capacitors to rapidly discharge high levels of current for usage above 5 m/s. The desired circuit and code design will obtain inputs either from an encoder signal or a manual trigger and output precise, timed controls to the wire heating, the dispensing of propylene glycol, the camera, and the capacitors. Design solutions will be evaluated based on the metrics of usability, compatibility and responsiveness. Ultimately, this system maximized the usage of SFV and aided in the studies of laminar separation bubbles. Through iterative design and evaluation of metrics, the created design was able to produce informative images in a consistent manner while additions are being made to augment the usage of the instruments through the ability to read and save data.