

Problem

- Electronic throttle bodies (ETB) control airflow into a car engine.
- Replaced old mechanically linked throttle bodies with drive by wire.
- Can be programmed to change the driving characteristics of the car

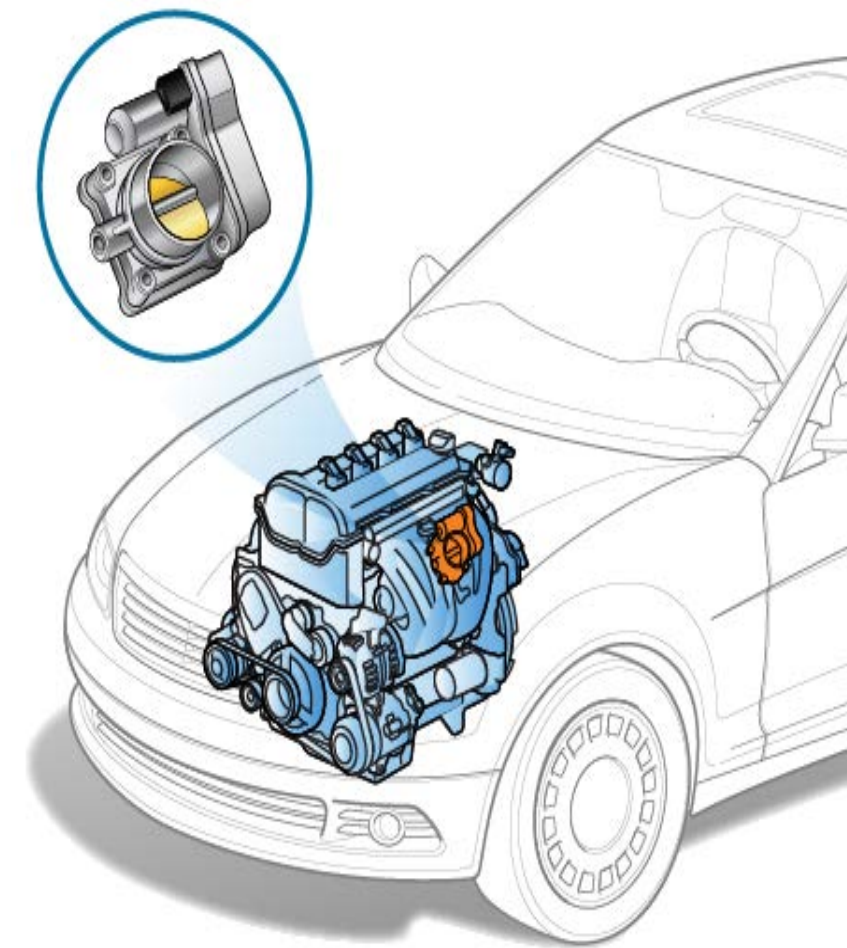


Figure 1: ETB in engine [1]

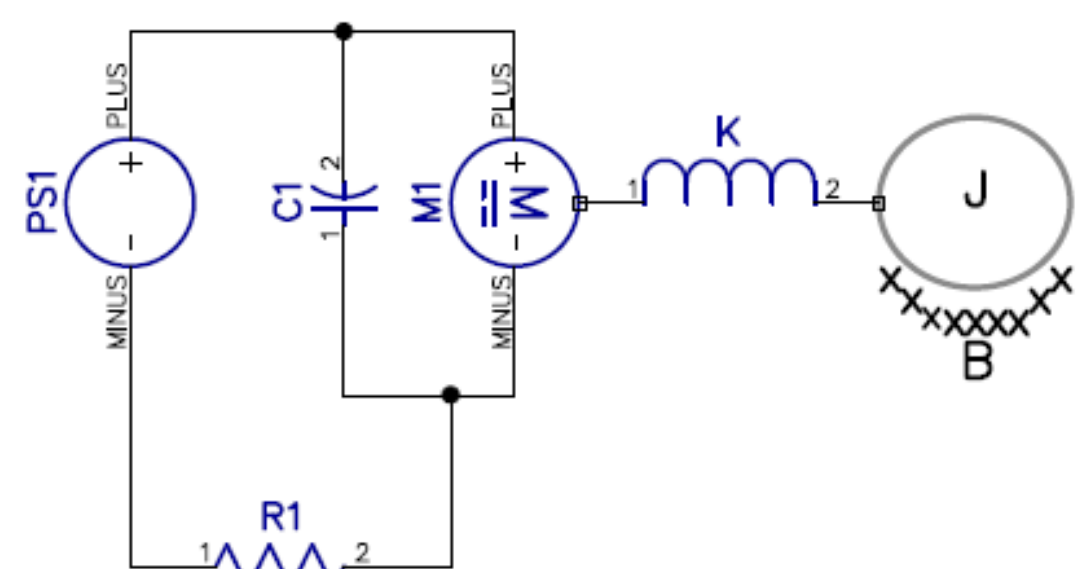


Figure 2: Model of ETB and control electronics

Hardware Setup

- Arduino used for readout and control circuitry
- Hall effect sensor for valve position readout
- External power supply used to power ETB

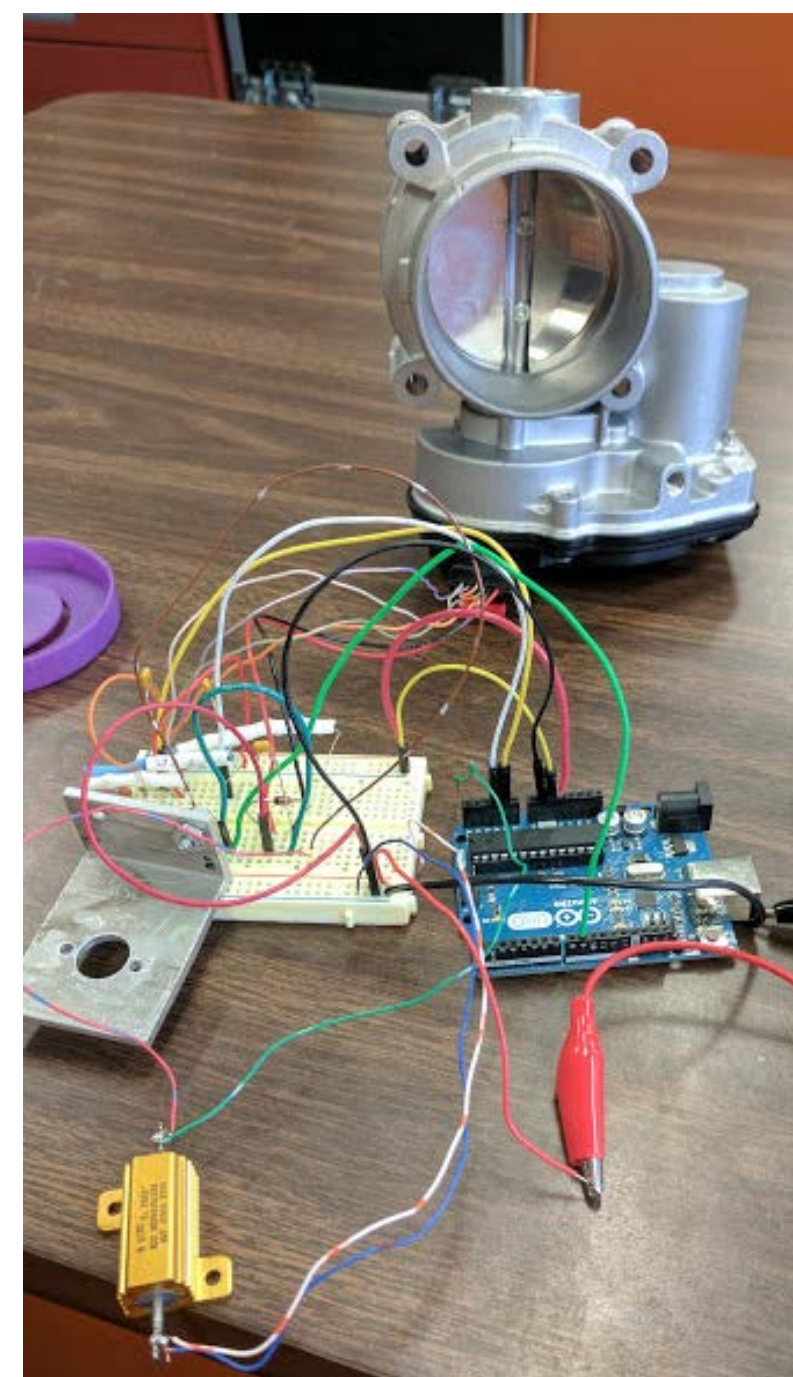


Figure 3: ETB and controller setup

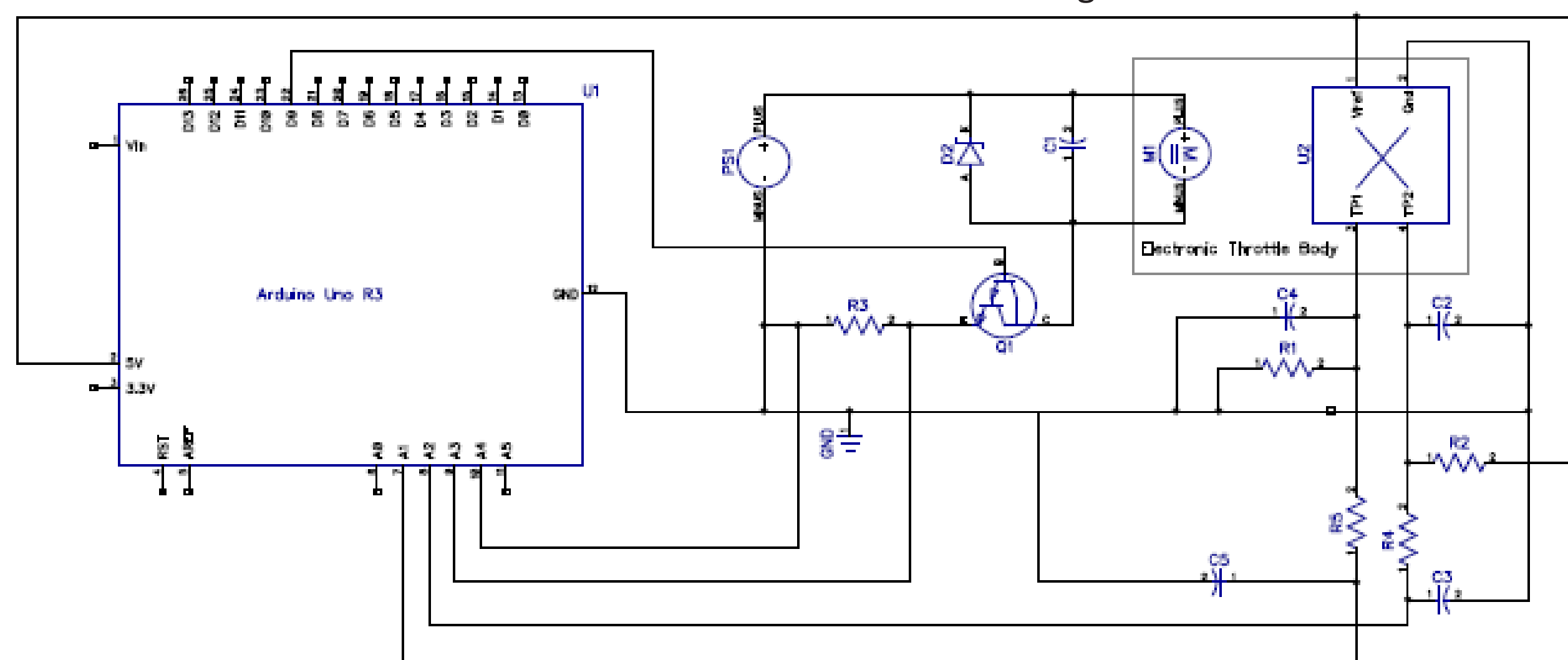


Figure 4: ETB wiring diagram

Data analysis

- Response to a known signal was recorded
- Valve angle as a function of time
- Second order system
- Iterative method used to find characteristic equation:

$$\ddot{\theta} + 73.524\dot{\theta} + 308.14\theta = U$$

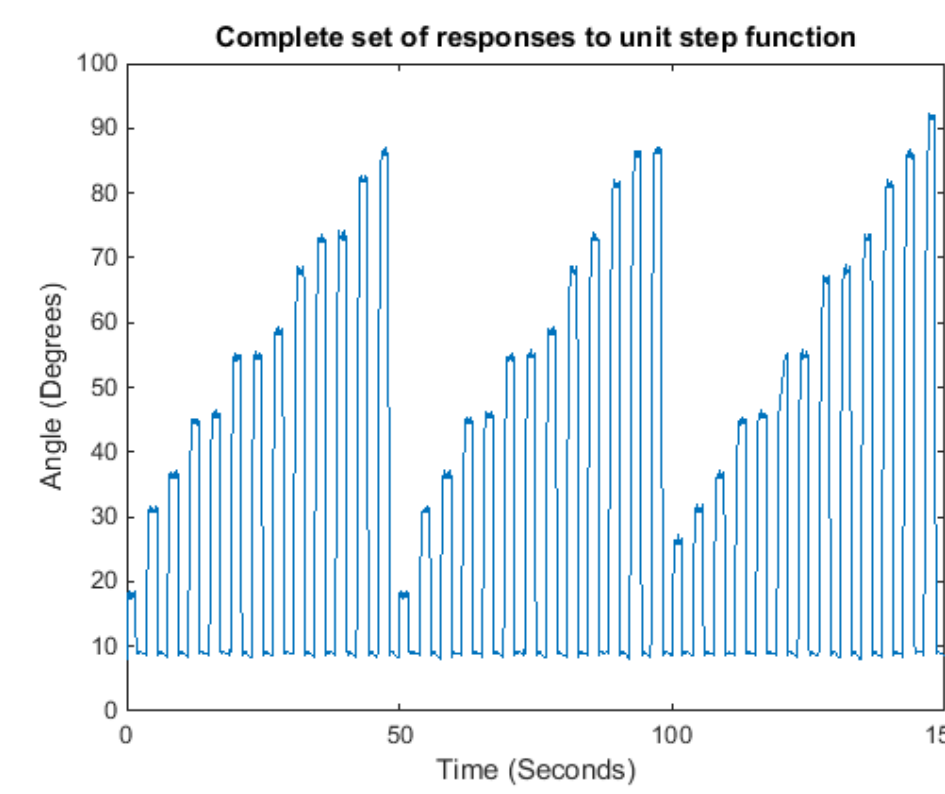


Figure 5

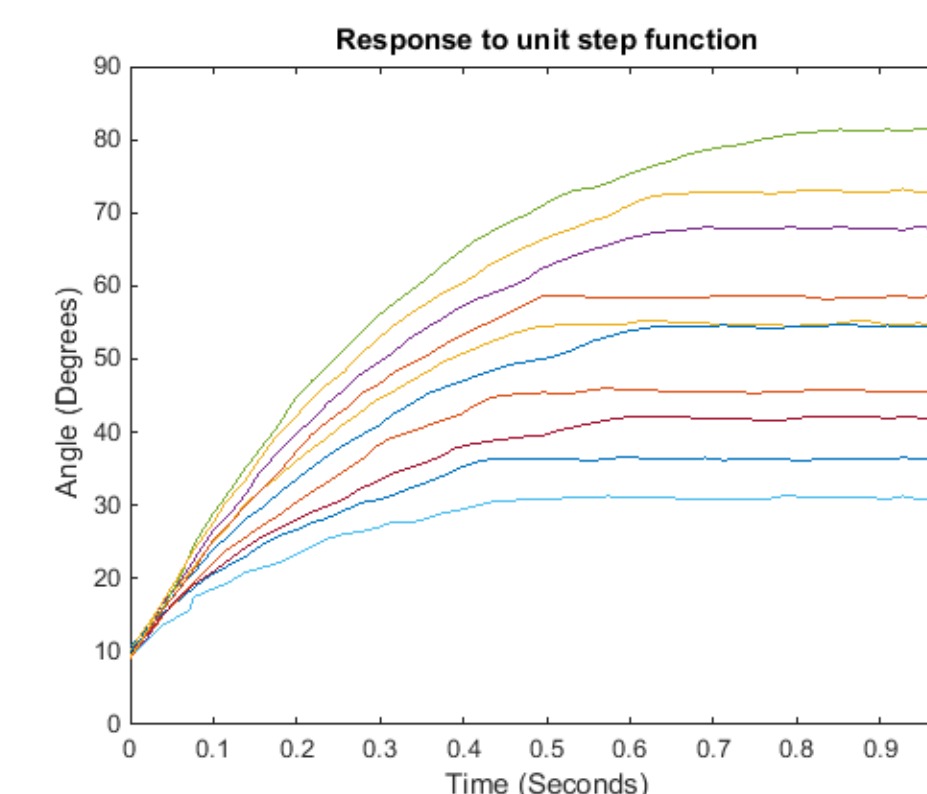


Figure 6

Controller

- A Proportional Integral Derivative (PID) controller was implemented
- Controller runs at 16Hz
- Tuned using MatLab's[®] pidtune function
- PID coefficients:

$$k_p=43.49, k_I=0, k_D=.0399$$

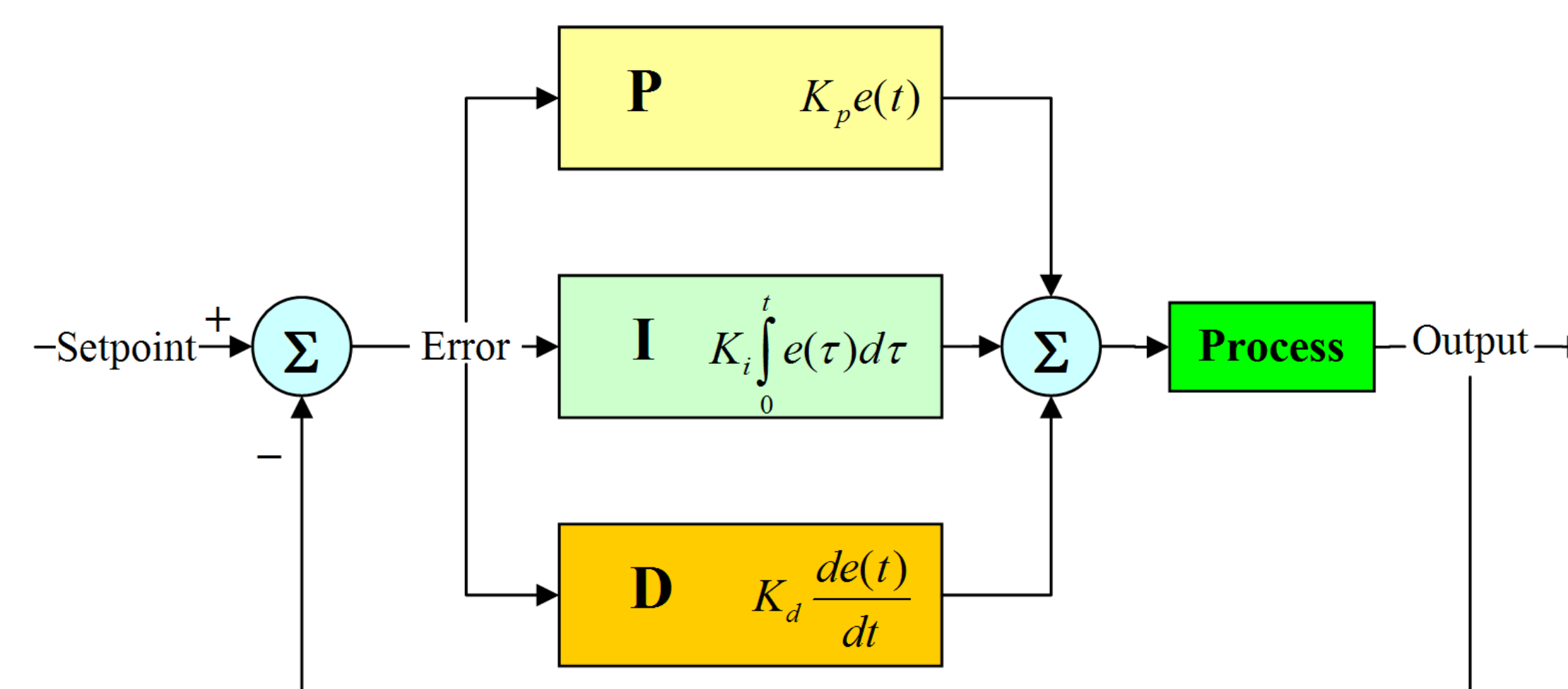


Figure 7: Simplified PID controller [2]

Tuning GUI

- Used to provide a better understanding of how PID parameters change response characteristics.
- Compares simulation to real world results.

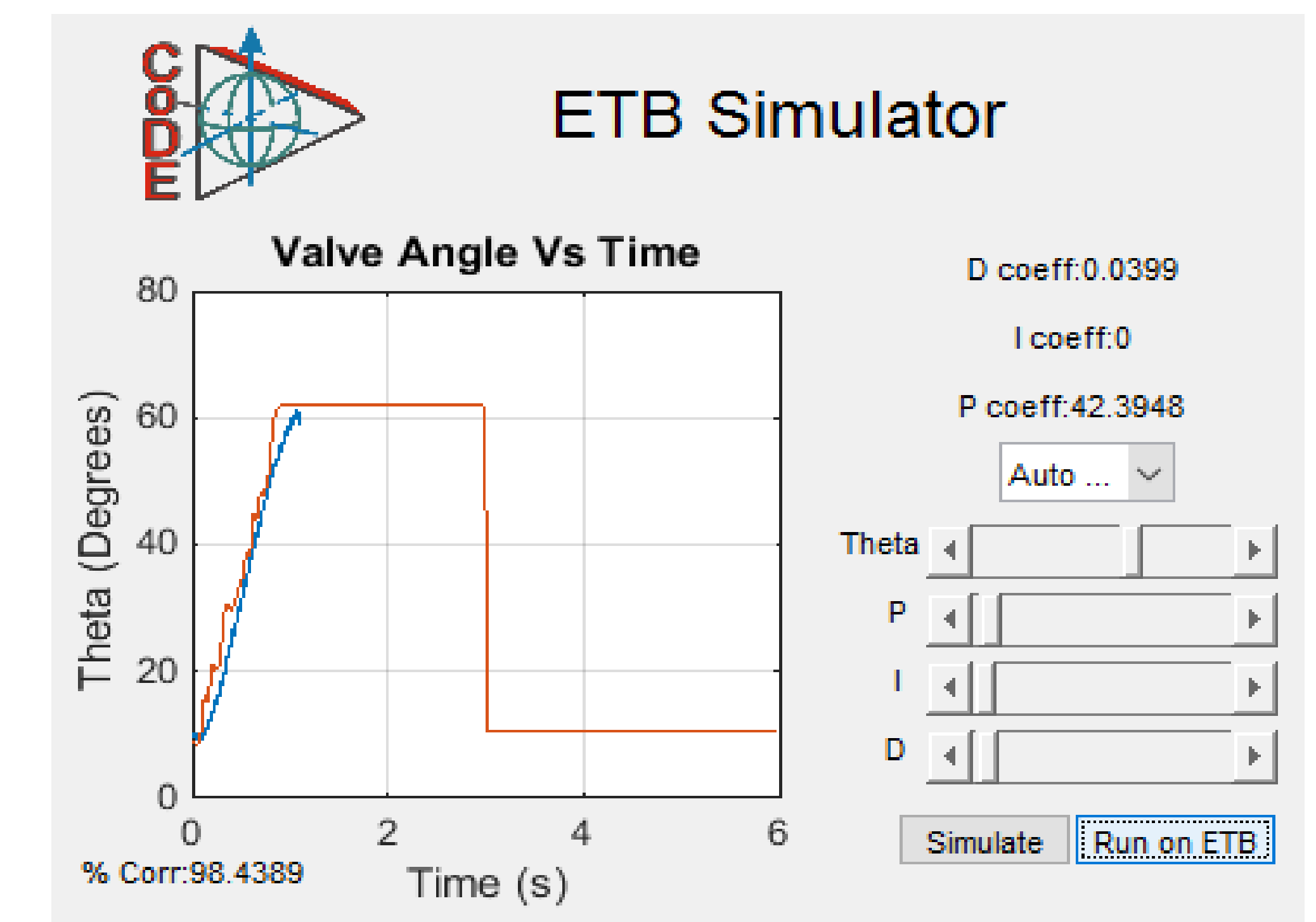


Figure 8: Tuning GUI

Conclusions

- Characteristic equation for ETB identified
- PID controller implemented and tuned
- GUI developed for real-time prototyping

Acknowledgments



References

1. RepairPal, "Electronic throttle unit," in RepairPa, RepairPal, 2011. [Online]. Available: <http://repairpal.com/electronic-throttle-unit>. Accessed: Feb. 18, 2017.
2. Radhesh, "PID controller simplified," My Weblog, 2008. [Online]. Available: <https://radhesh.wordpress.com/2008/05/11/pid-controller-simplified/>. Accessed: Feb. 22, 2017.