Crane Style Report v2

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1 Introduction

This project aims to design, model, and control a gantry crane system to safely and efficiently move loads. The focus is on developing a robust control strategy that balances theoretical modeling with practical integration. Our project control purpose is to have the crane avoid hitting obstacles while translating in one dimension to maintain safety and prevent workplace accidents.

2 Experimental Methods and Apparatus

The gantry crane hardware consists of a motorized trolley, hoisting mechanism, and supporting frame. Initial performance tests were performed to evaluate consistency and reliability under varying load conditions.

While a First Order Plus Dead Time (FOPDT) model is useful for simple processes with dynamic variables, the model is ineffective for describing this system because the load height actuator (winch) is an integrating system without startup lag or disturbances, and its response is linear and easily measurable—arrival at the setpoint is proportional to setpoint change.

A closed loop controller was designed to detect obstacles in the path of the load and raise the load before traveling over them; we implemented a P-only controller to adjust the actuator response speed based on the distance to the new setpoint.

Gain value (K_c) was 100/1023 * 3.3V / cm error.

3 Results and Discussion

The hardware function was unpredictable at best—a swinging crane load is not fun—and ultrasonic sensors are noisy and suffer from reflection and wave scattering. These observations reinforced the limitations of simplified models and the importance of iterative testing in refining controller design.

We pursued disturbance rejection by gating sensor input values, seen in Figure 1.

4 Conclusions

Through this project, we gained practical experience in translating control theory into hardware implementation. We also learned the limitations of simplified models and the value of iterative refinement when faced with sensor noise and

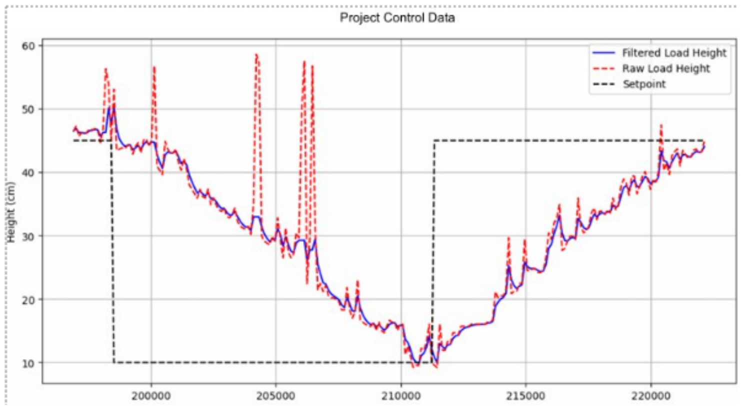

Figure 1: Example of disturbance rejection

nonlinear behavior. Beyond engineering, attention to safety protocols, teamwork, and clear communication ensured the system was not only functional but also responsibly developed and operated.

5 Learning Outcomes

Through this project, we gained practical experience in translating control theory into hardware implementation. We also learned the limitations of simplified models and the importance of iterative testing in refining controller design. The hardware function was unpredictable at best — a swinging crane load is not fun, and ultrasonic sensors are noisy and suffer from reflection and wave scattering.

6 Non-Technical Considerations

Beyond engineering, the project required attention to safety protocols, teamwork, and clear communication. These considerations ensured that the system was not only functional but also responsibly developed and operated.

Safety, Public Health, and Welfare: The gantry crane must prioritize operator safety and minimize risks to nearby personnel. Clear protocols, emergency stops, and load-handling guidelines protect public welfare.

Global, Cultural, Social, and Economic Factors: Crane systems are used worldwide, requiring designs that respect cultural practices and economic constraints. Cost-effective, adaptable materials support accessibility and equitable growth.

Environmental Impact and Sustainability: Energy efficiency and responsible material choices reduce environmental footprint. Durability, repairability, and minimal waste support long-term sustainability.

Ethical Implications and Societal Benefits: The crane should enhance productivity without compromising worker rights or safety. It contributes to infrastructure development and industrial efficiency, benefiting society beyond technical performance.