PORTFOLIO

Dawei Sun

Systems Engineering and Design

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GitHub: https://github.com/DaweiSun1/Portfolio/tree/main

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Academic backgrounds

Bachelor of Science in Systems Engineering and Design
University of Illinois at Urbana-Champaign
Expected Graduation Date: May 2025
GPA: 3.57/4.0
Honors: Dean's List (SP 2022)

Relevant Coursework Highlighted:

Digital Control Systems: Developed expertise in the theory and methodologies for controlling dynamic processes through digital computing. Focused on linear discrete systems, digital filtering, signal sampling and reconstruction, digital design, state-space methods, and state estimators. Enhanced technical proficiency through applied laboratory techniques.

Mechatronics: Studied and applied mechatronics concepts, including the integration of sensors and actuators with computer systems for real-time programming and control. Gained hands-on experience in data acquisition, human-machine interface design, and the development of mechatronic systems for both manufacturing and consumer applications.

Engineering Design Analysis: Explored stress-strain relationships and their application to engineering design, utilizing both analytical and numerical solution techniques, including CAD tools. Analyzed diverse engineering materials and configurations to develop and apply design analysis criteria effectively. Conducted structural and thermal analysis using ANSYS. Modeled and simulated

Design of Structures & Mechanism: Specialized in the analysis and design of structural and mechanical components using both classical methods and computer-based tools. Covered key concepts such as external loads, internal forces, and displacements in statically determinate and indeterminate systems. Explored kinematics of linkages, gears, and cams, as well as static force analysis in machinery.

Control Systems: Developed a strong foundation in control systems and control technology, focusing on sensors, actuators, and physical system modeling. Gained expertise in designing and implementing feedback controllers, analyzing linear continuous systems using Laplace transforms and transfer functions, and ensuring system stability and performance. Explored controller design through frequency response methods and addressed simple nonlinearities in system behavior.

Internship Experience:

Manufacturing Engineering Intern

Charles Industries | May 2024 – Dec 2024

Rantoul, Illinois

Overview:

As a Manufacturing Engineering Intern, I optimized production workflows by integrating robotics and mechanical engineering principles. I designed and programmed FANUC robotics systems for welding and material handling, developed user-friendly automation frameworks, and streamlined manufacturing processes to enhance precision and efficiency. This role allowed me to apply advanced robotics and design concepts to improve productivity in a dynamic manufacturing environment.

Key Contributions:

1. **Industrial Robot Programming**
    - Designed a flexible FANUC robot welding program where operators could define cube dimensions as input parameters, increasing operator usability and setup efficiency.
    - Replaced traditional teaching panel methods with a simulation-based approach.
    - Enhanced operator training quality and efficiency by developing clear instructional manuals and simulations.
2. **Automation of Administrative Tasks**
    - Developed Python-based tools to automate the manual information transfer system in the facility, converting manual forms into electronic formats.
    - Created automated Excel file generation scripts, enabling supervisors to monitor task progress and operators to track assignments.
    - Improved folder organization workflow to ensure quick access to critical production data.
3. **Production Workflow Optimization**
    - Conducted in-depth self-research on industrial optimization tools and implemented FlexSim software to analyze and reconstruct workflows for turret, press break, PIF, and welding processes, effectively eliminating inefficiencies.

- Used simulation models to test various production scenarios, enabling a 15% reduction in delays by designing an optimized part categorization system that grouped workpieces based on procedure compatibility.

Technical Skills Applied:

- **Programming & Automation:** Python, FANUC robot simulation, Excel VBA
- **Manufacturing Systems:** Industrial robotics, welding processes, part categorization
- **Design Tools:** AutoCAD, SolidWorks
- **Process Optimization:** FlexSim, Workflow analysis, lean manufacturing techiniques

GitHub Link: Access the Python script for digitalizing tasks here.

Illustrative Demonstration:

Research Experience

Undergraduate Research Assistant

Soft Robotics Lab, University of Illinois at Urbana-Champaign

November 2023 – May 2024

Overview:

As an undergraduate Research Assistant, I contributed to advancing the design and manufacturing of actuators for soft robotics. The procedure involved leveraging programming, mechanical design, and automation techniques to develop a semi-automated production system, significantly improving efficiency and precision in actuator fabrication.

Key Contributions:

1. **Semi-Automated Actuator Production System Development**
    - Designed an Arduino-based embedded system to automate critical stages of actuator fabrication, reducing manual intervention by approximately 30%.
    - Programmed microcontrollers to integrate sensors and feedback loops, ensuring consistent quality control during production.
    - Conduct iterative prototyping using 3D-printed and injection-molded components, refining the system's reliability and adaptability.
2. **Collaboration and Documentation**
    - Assisted a PhD student in developing modular actuator components by providing technical insights on material selection and system integration.
    - Authored a comprehensive instruction detailing the semi-automated system setup, calibration, and operation to enable seamless transfer to future researchers.

Technical Skills Applied:

- **Programming & Automation:** Arduino, Python, real-time control systems.
- **Design & Simulation Tools:** AutoCAD, MATLAB
- **Fabrication Techniques:** 3D printing, injection molding

Technical Projects

1.Autonomous System and Robotics Design Project

Introduction: The Autonomous system and Robotics Projects (Mechatronics class content) was an intensive competition designed to challenge participants to program a robot to autonomously navigate a course while performing specific tasks. My team's objective was to guide the robot through five designated points, collect and sort gold balls by color, avoid obstacles, and accurately report the gold balls' locations using LABVIEW. The hands-on experience showcased the integration of motion control, sensor fusion, and advanced software development.

Skills demonstrated:

- **Robotic Programming:** Designed and implemented algorithms (A^* algorithm and Dijkstra's algorithm) for precise navigation using a combination of dead reckoning and motion tracking corrections via OptiTrack and Kalman filtering.
- **Sensor Integration:** Utilized data from Ladar sensors for obstacles avoidance and accurate gold ball detection.
- **Control Systems:** Integration of real-time feedback loops to improve robot positioning and task execution.
- **Graphical User Interface Development:** Created and interactive LABVIEW application to visualize the robot's trajectory, detected obstacles, and golf ball coordinates.
- **Problem-Solving and Creativity:** Developed unique strategies to enhance robot performance and minimize contest time by optimizing navigation paths and task execution.

Technical Details:

- **Software Used: LABVIEW** for developing an interactive user interface to monitor and visualize the robot's movement, obstacle detection, and golf ball positions. **Code Composer Studio** and **Linux-based programming tools** were also employed for embedded system development.
- **Precision and Localization:** The robot's movement was guided by a combination of A^* pathfinding algorithm and Kalman filtering. The A^* algorithm precisely calculated the most efficient and obstacle-free path to the robot's destination, while the Kalman filter integrated data from wheel encoders and the OptiTrack motion tracking system to reduce drift and ensure accurate localization.
- **Control and Analysis Methods:**

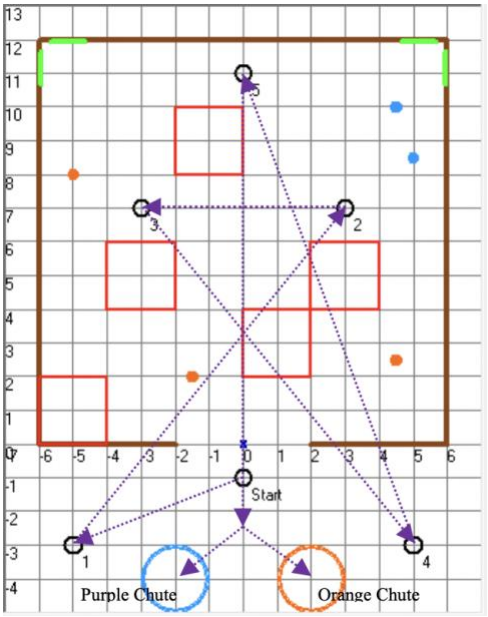
1. **Obstacle Avoidance:** Real-time processing of Ladar sensor data allowed the robot to dynamically adapt its paths to avoid collisions.
2. **Path Planning Optimization:** Python was utilized to enhance the trace of the robot, refining the calculated paths generated by the A* algorithm for smoother and faster navigation while fulfilling task requirement.
3. **Golf Ball Collection and Decomposition:** Designed a reliable mechanism to collect and deposit golf balls accurately, with real-time data communication to LABVIEW for further verification.

- **Performance Optimization:**
    1. The combination of the A* algorithm and Python-driven path optimization enabled the robot to complete the course with minimal time and maximum efficiency.
    2. The robot achieved precise identification of gold balls' colors and coordinates, ensuring compliance with project requirements and earning additional bonuses.

Link to video:

Watch the robot navigating the randomized course in this demonstration video.

Graphical Demonstration:



2.CAD Modeling and Design Project

Introduction: As a lead contributor the Toy Farm Tractor Design Project, I played a crucial role in creating a detailed 3D model that replicates the structural and functional aspects of a real tractor.

My contributions spanned from conceptual design and CAD modeling to assembly integration and functional analysis, showcasing my ability to apply engineering skills to develop innovative and practical solutions.

Skills demonstrated:

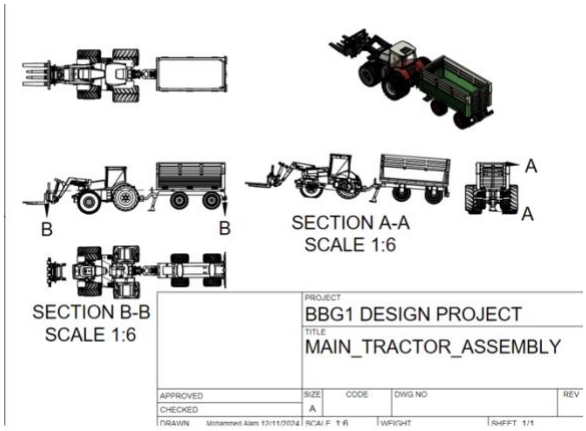
- **Mechanical Design**: Developed Precise CAD models of tractor components with reverse engineering skills, including gears, chassis, and hydraulic mechanisms.
- **3D Modeling and Simulation**: Created detailed part assemblies and performed motion studies to verify functional integrity.
- **Team Collaboration**: Coordinated tasks across subassemblies to meet project deadlines and maintain a cohesive design approach
- **Product Improvement**: Proposed and implemented design enhancements, such as modular attachments and improved hydraulic mechanisms.

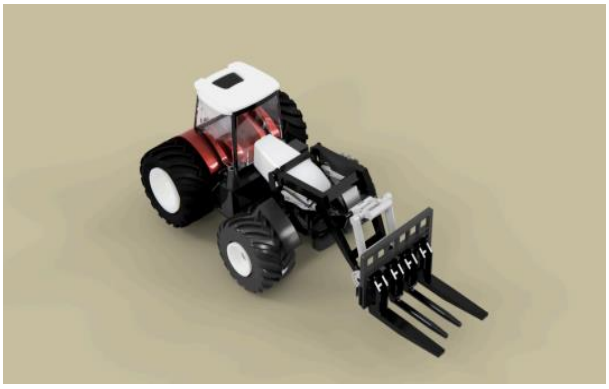
Technical Details:

- **Software Used:** Autodesk Fusion 360 for modeling, assembly, and rendering.
- **Material Choice:** Simulated ABS plastic and rubber for realism and functionality.
- **Analysis Methods:** Stress Analysis performed on the chassis under dynamic loads; tolerance analysis ensured fit and reliability of moving parts.

Illustrative Representation (selected elements highlighted):

Full Assembly Drawing **Rendered Image**





GitHub Link:

*Access the **Full Design Report** and the images from here.(ALL drawings listed in appendix)*

*Access the **Animation** from here.*

3.RotoFit Knee Brace Design Project

Introduction: As a core contributor to the ROTOGEAR project, I played a pivotal role in designing and implementing innovative solutions to address knee injury prevention. My involvement ranged from concept development to technical prototyping and market analysis, reflecting my ability to apply multidisciplinary skills in a practical and impactful manner.

Skills Demonstrated:

- Injection molding and 3D printing
- Material Selection and Prototyping
- Biomedical design and Analysis
- Business Strategy and Market Analysis

Technical Details:

- **Software Used:** Autodesk Fusion 360 for modeling, simulation, and rendering; Python for data analysis and automation.
- **Material Choice:** Natural rubber and PLA for sustainable, high-performance components with environmental responsibility.
- **Analysis Methods:** Fluid resistance mechanism validation; stress analysis performed on key components under dynamic loads; tolerance analysis to ensure structural reliability and durability.

GitHub Link:

Access the Full Written Report here.

4.Digital Control System Design

All Code Template are credited to Professor Dan Block from University of Illinois at Urbana-Champaign.

The content in the link exclusively covers the sections I have directly contributed to.

Introduction:

As a participant to control systems design and laboratory experimentation, I approached in analyzing, simulating, and implementing advanced control strategies to enhance system performance. My involvement ranged from theoretical modeling and digital implementation to hands-on laboratory practices with a focus on innovative applications like the Furuta Pendulum.

The experience reflects my ability to apply interdisciplinary skills and technical expertise to address complex engineering challenges effectively and impactfully.

Part 1: In-class Theoretical Design

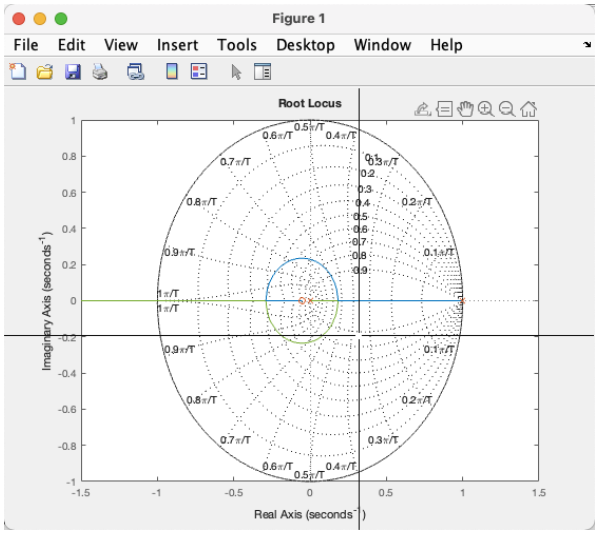
Skills Demonstrated:

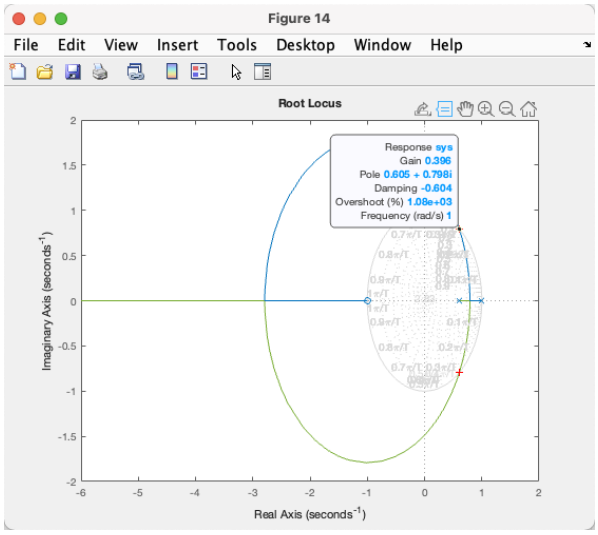
- Simulating system stability using root locus, Bode plots, and Nyquist diagrams to analyze and refine control strategies.
- Designing lead and lag compensators and utilizing Z-transform methods to achieve specific phase margin targets.
- Converting continuous-time models to descrete-time models using pulse transfer functions for digital implementation.

Technical Details:

- **Software Used:** MATLAB, including functions such as rlocus, bode, step, pzmap, c2d.etc.
- **Toolboxes Used:** MATLAB Control Systems ToolBox

Illustrative Demonstration:





GitHub Link: *Access the* ***MATLAB code and results*** *here.*

Part 2: Laboratory Design Practice

Skills Demonstrated:

- Implemented optical encoder angular feedback and PWM output for precision feedback control.

- Identified discrete transfer functions of DC motors through system modeling and analysis
- Designed and tuned PI controllers for motor speed control applications.
- Developed position control systems using PD, PID, and hybrid control strategies.
- Applied discrete full-state feedback control for stabilization of the Furuta Pendulum.
- Controlled the Furuta Pendulum using a full-order observer for dynamic state estimation.

Technical Details:

- **Software Used:** C++ in Texas Instruments Code Composer for programming and control system implementation. MATLAB for optimization dynamic systems.
- **Visualization Tools:** MATLAB for simulation and result analysis.

GitHub Link: *Access the* ***MATLAB code and results*** *here*