Aaron Omadutt

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Education

Swarthmore College - Swarthmore, Pennsylvania   May 2024
B.S. in Engineering & B.A. in Mathematics   GPA: 3.30 / 4.00

Experience

Undergraduate R&D Engineer – Swarthmore College   June 2023 – January 2024

- Developed a biomimetic robotic system for the NSF-funded project (*NSF-IOS 2136018*, "Hydrodynamic Consequences of Spines on Zooplankton") to replicate barnacle nauplii swimming techniques.
- Designed the housing for nitinol springs using Fusion360 CAD software to ensure accurate limb movement and biological accuracy, and conducted CAD test fittings to confirm component compatibility.
- Designed a custom PCB and programmed a control circuit using an ESP32 microcontroller, MOSFETs, and resistors to autonomously regulate nitinol spring actuation for multi-limb movement.
- Developed C-based control algorithms in Arduino IDE to automate synchronized limb movements, achieving biologically accurate sinusoidal motion.
- Analyzed robotic actuation patterns in MATLAB, achieving a $90\% \pm 5\%$ match with nauplii swimming patterns by validating synchronization with biological models through motion tracking data alignment.
- Presented research at the SICB Conference, recognized as a Best Student Presentation Finalist for contributions to robotics and biological modeling.

Projects

Omnidirectional Sorting Robot   github.com/Swarthmore-Robotics/Swerve-Drive

- Led a team of three in designing, assembling, and programming an omni-directional robot equipped with a web camera for intelligent sorting and transfer of colored boxes, simulating industrial workplace scenarios.
- Using Fusion360 for CAD modeling and CNC milling, optimized the gripper mechanism to reduce backlash, increase torque, and minimize weight, enhancing robot performance.
- Assisted in Java-based control systems programming, including implementing swerve drive kinematics, PID control tuning, and development of tele-operational and autonomous object detection movement.
- Coordinated electrical integration by implementing motor controllers and encoders for precise wheel control. Integrated a Raspberry Pi 4B, Logitech C920 Webcam, and network switch for Python-based color and object recognition. Configured network protocols and CAN bus communication for efficient autonomous and tele-operational functionality.
- Achieved autonomous detection and navigation precision with a 2-inch margin of error and 90% sorting accuracy in a controlled environment.

Modeling Path Trajectories and Object Avoidance for a Differential Drivetrain Robot

- Developed a mathematical model for a differential drivetrain robot, integrating guidance, control systems, and trajectory path planning to enhance navigation across various environments.
- Derived kinematic equations and applied differential equations to model the robot's motion, dynamics, and responses to external forces.
- Utilized potential field methods to create virtual environments, creating algorithms for attractive potential fields to guide the robot and repulsive potential fields to establish collision barriers around obstacles.
- Implemented and programmed kinematic models and trajectory planning functions in MATLAB, integrating guidance and control systems for both real-time and predetermined trajectories.
- Simulated and validated trajectory paths in MATLAB, ensuring accurate navigation and obstacle avoidance.

Skills

Programming Languages: MATLAB, Java, C/C++, Python
Mathematical & Computational Analysis: Mathematical Modeling, Stochastic & Numerical Methods, Partial Differential Equations, Differential Equations, Data Analysis
Engineering Design: CAD Design (Fusion360), 3D Printing, CNC Machining, PCB Schematic Design, Laser Cutting, Arduino, Mechanical Design