Mechatronics Course Project - Implementation Steps

Degree Level: Bachelor's

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Introduction

The objective of this document is to provide the necessary documentation for carrying out the Mechatronics course project. Given the vast and open nature of mechatronic systems, we aim to clarify the project's structure and address ambiguities by explaining the implementation steps in detail.

Mechanical Implementation

Various mechanisms can be considered for the mechanical design of the robot. Based on available resources and capabilities, three well-known walking mechanisms have been reviewed:

1. **Strandbeest Mechanism:**
    - Invented in 1990 by Theo Jansen, this Dutch mechanism mimics animal-like movement through a series of linked elements.
    - It produces smooth motion but is complex to implement and mainly suitable for demonstration purposes.
2. Official website

3. **Klann Mechanism:**
    - Patented by Joseph Klann in 2001, inspired by animal walking gaits.

    - It consists of a set of four-bar linkages and provides stable walking motion with fewer limitations than other mechanisms.
4. **Chebyshev Plantigrade Mechanism:**

    - Developed in 1878, it converts rotational motion into linear motion with a constant speed.

Steps for Mechanical Implementation:

- Selecting the preferred walking mechanism.
- 3D modeling in SolidWorks.
- Motion analysis using SolidWorks simulation tools.
- Layout planning for motors, battery, and electronic components.
- Analyzing dynamic equations (optional for extra credit).
- Assessing feasibility and constructing the mechanical structure.

Electronics Implementation

The electronic components required for the project include:

1. **Arduino Board:**
   You can choose any of the following models, depending on your preference and project requirements:

    - Arduino Uno
    - Arduino Mega
    - Arduino Nano
    - Arduino Pro Mini
    - Arduino Due
2. **Motors:**

    - Two DC motors are required for the walking motion.
    - The recommended model is the TT Motor from a Chinese manufacturer.
      More details: TT Motor Website
3. **Motor Driver Module:**

    - The L298 motor driver is recommended for controlling the motors.
    - Complete setup guides and sample code are provided.
4. **Sensors:**

    - **Ultrasonic Sensor (SRF04/SRF05):** For obstacle detection.
    - **Gyroscope (MPU6050):** For angle measurement and stability control.

Electronic Circuit Design Steps:

- Selecting appropriate electronic components.
- Designing and wiring the circuit.
- Programming microcontrollers.
- Testing sensor integration.

Programming and Control Pattern Development

Control patterns will be implemented in two stages:

1. **Open-loop control:**
    - Basic motion control without feedback.
    - Simple motor speed adjustments.
2. **Closed-loop control:**
    - Utilizing feedback from sensors (ultrasonic and gyroscope).
    - Implementing control algorithms (e.g., PID control) to optimize movement.

Robot Performance Evaluation

Key considerations for robot performance assessment include:

- Evaluating the robot's walking pattern, which follows a sinusoidal trajectory.
- Ensuring synchronized movement of the left and right legs.
- Adjusting motor control based on sensor feedback to achieve smoother motion.

Project Timeline

The project must be completed by the end of the semester, with the following milestones:

- Weekly or biweekly reports.
- Final presentation and demonstration.

Important Notes:

- The project evaluation will heavily depend on the practical implementation of both mechanical and electronic aspects.
- Aesthetic and design quality will also be considered in the final assessment.

(This document has been translated using ChatGPT-4o)