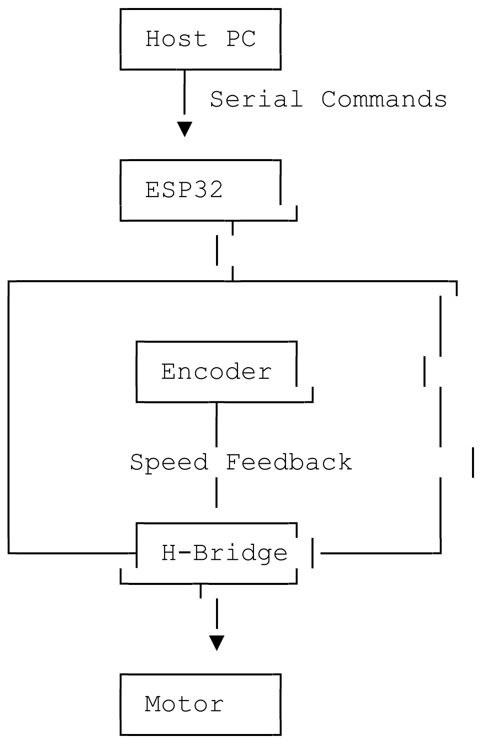
Embedded/Control Systems Problem Statement

1. Introduction

This report outlines the design of a motor control system using an ESP32 microcontroller, an H-Bridge driver, and an OE-37 encoder. The system aims to regulate motor speed through closed-loop control, allowing for user-specified speed and direction via serial commands.

2. System Overview

Block Diagram:



Components:

- Host PC: Sends serial commands to control speed and direction.
- ESP32: Microcontroller for processing commands and implementing control algorithms.
- Encoder: OE-37 Hall effect encoder, providing speed feedback.

- H-Bridge: Drives the motor based on PWM signals from the ESP32.
- Motor: The specific motor type and specifications are yet to be provided.

3. Assumptions and Theoretical Basis

Motor:

- A brushed DC motor is assumed, but confirmation and specifications are needed.

Control Algorithm:

- A simple proportional control algorithm is currently implemented, but PID control is likely to provide better performance. A decision on the final control algorithm is pending.

Feedback:

- The OE-37 encoder provides speed feedback for closed-loop control.

Communication:

- Serial communication is used for setting speed and direction.

4. Engineering Calculations (Placeholders)

- Encoder Resolution: Calculation based on motor speed range and desired accuracy will be provided once motor specifications are available.
- PWM Frequency: Selection based on motor characteristics and control requirements will be determined after motor specifications are known.
- H-Bridge Driver: Selection based on motor voltage and current ratings will be made once motor specifications are provided.

5. Implementation (Partial)

- Hardware Setup:
    - Connections between ESP32, encoder, H-Bridge, and motor (details pending).
    - Power supply configuration (details pending).
- Software Code:
    - Code for reading serial commands, controlling PWM output, and reading encoder feedback has been provided.

6. Testing and Results (Pending)

- Testing procedures and results will be documented once the system is implemented.

7. Conclusion (Pending)

- Summary of key findings and recommendations for further improvements will be provided upon completion of the design and testing phases.

Mathematatic calculation

1. Encoder Resolution:

- We need the motor's maximum RPM and desired speed control accuracy.

Calculation:

- Let PPR be the encoder resolution (pulses per revolution).
- Let Max_RPM be the motor's maximum RPM.
- Let Delta_RPM be the desired minimum detectable speed change.

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PPR = (Max_RPM * 60) / Delta_RPM
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Example:

- For a Max_RPM of 3000 and a Delta_RPM of 10, PPR would be:

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PPR = (3000 * 60) / 10 = 18000
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2. PWM Frequency:

- We need the motor's electrical characteristics and desired control accuracy.

Calculation:

- Let f_PWM be the PWM frequency.
- Let T_motor be the motor's torque constant.
- Let V_motor be the motor's rated voltage.
- Let Delta_T be the desired minimum detectable torque change.

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f_PWM = 1 / (2 * pi * T_motor * Delta_T / V_motor)
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3. H-Bridge Driver Selection:

- We need the motor's voltage and current ratings.

Selection:

- Choose an H-Bridge driver capable of handling the motor's maximum voltage and continuous current.
- Consider efficiency, switching frequencies, and thermal management.

Additional Calculations:

- Once you provide the motor specifications and control algorithm choice, we can calculate additional parameters like:
    - Proportional gain for the controller (Kp)

- Integral gain (Ki) and derivative gain (Kd) for PID control (if chosen)
- Duty cycle range for PWM output