MOTIVATION

- The purpose of this experiment is to demonstrate the principle of PID (Proportional Integral Derivative) feedback control of DC Motor.
- Fine-tuning a PID control is provably more efficient than conventional greedy approaches to control aspects of a DC motor, say the angle of rotation.
- The experiment should be conducted at a remote location and should be accessible on the global domain.
- We aim to provide students with the facility to perform this experiment and provide them with a learning experience.
- We hope to provide a cost and material efficient method for people with access to just the internet to perform this experiment.

IMPLEMENTATION

Hardware Setup -

- DC motor with input voltage controlled through ESP32
- Motor driver to adjust the motor to give the desired angle acting as an interface between the DC motor and controller(ESP32)
- Motor encoder tracks the angular position of the motor shaft and provides closed loop feedback signals
- ESP32 camera gives live footage of our hardware setup.

IMPLEMENTATION

Dashboard - Similar to Remote Labs IIITH

- Dashboard gives an easy to use graphical user interface that allows the users to remotely perform the experiment.
- Our dashboard will have four major controls -
  - The three PID constants namely K_P(Proportional constant), K_I(Integral constant), K_D(Derivative constant).
  - The desired angle the DC motor should output.
- The user will be able to input these values and observe the corresponding PID response curves while simultaneously displaying the live footage of the experiment.

IMPLEMENTATION

Software - Code written on Arduino IDE

- They are the three main components of the code. These three terms (components) will be calculated in function of the error given by the sensor. Let's call these components functions to simplify things: e.g., *F_i(e)* is the integral function of the error *e*. The original target has reached the set point(desired angle).

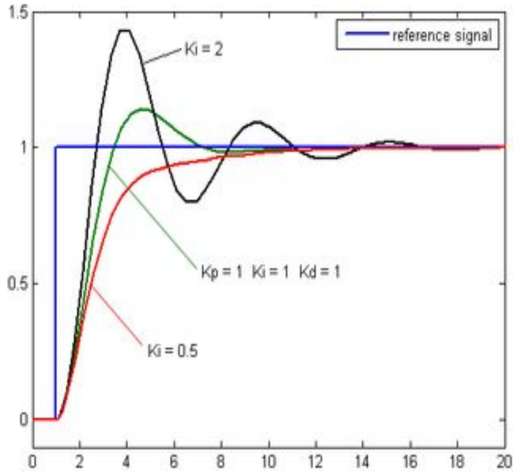
$$Command_{PID} = f_P(e) + f_I(e) + f_D(e)$$

- The PID controller calculates the error, proportional gain, integral gain, and derivative gain to achieve the desired result.
- Refer to this link for more details.

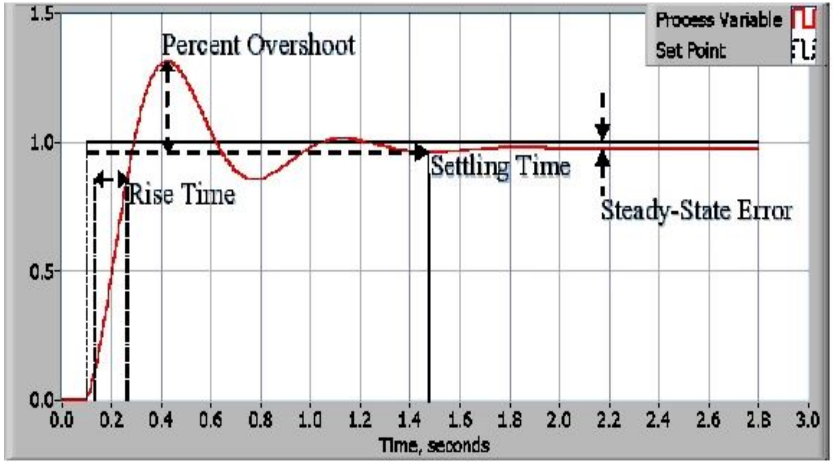
DATA ANALYSIS

- As we track the angle of the DC motor over time using a line graph, it will start off linearly as we are trying to reach the desired angle.
- When the angle gets closer to the required angle, the graph oscillates as the error percentage keeps getting minimal and stabilizes once the desired angle is reached.
- We can compare all graphs of each combination of the feedback control laws with specific focus on the time it takes for the DC motor to reach the angle entered by the user to determine which laws give us the optimum performance.
- This analysis will be helpful in coming up with better algorithms to minimize the time taken by the controller to output the desired angle.

DATA ANALYSIS



Response curves over varying values of PID constants



Angle vs TIme graph of DC motor

Analysis: Identifying which set of PID constants leads to minimal settling time given a suitable steady state error range.

SUMMARY - DELIVERABLES

- Give the users access only to the dashboard of the project.
- Input controls should be taken from the dashboard.
- Robust hardware with no specific constraints as the hardware is not visible to the user.
- Host the project on a global domain for universal access.
- Slot booking algorithms should be implemented so that only one user can remotely perform the experiment at one particular time.
- There should be time limit constraints for a user and the session should timeout after.
- Live streaming of the hardware setup so that the experiment can be conducted from anywhere.
- Include sufficient visualization elements to help the user grasp the concept better.