AMRITA VISHWA VIDYAPEETHAM

Artificial Neural Network (ANN) based control system for induction motors

TEAM MEMBERS

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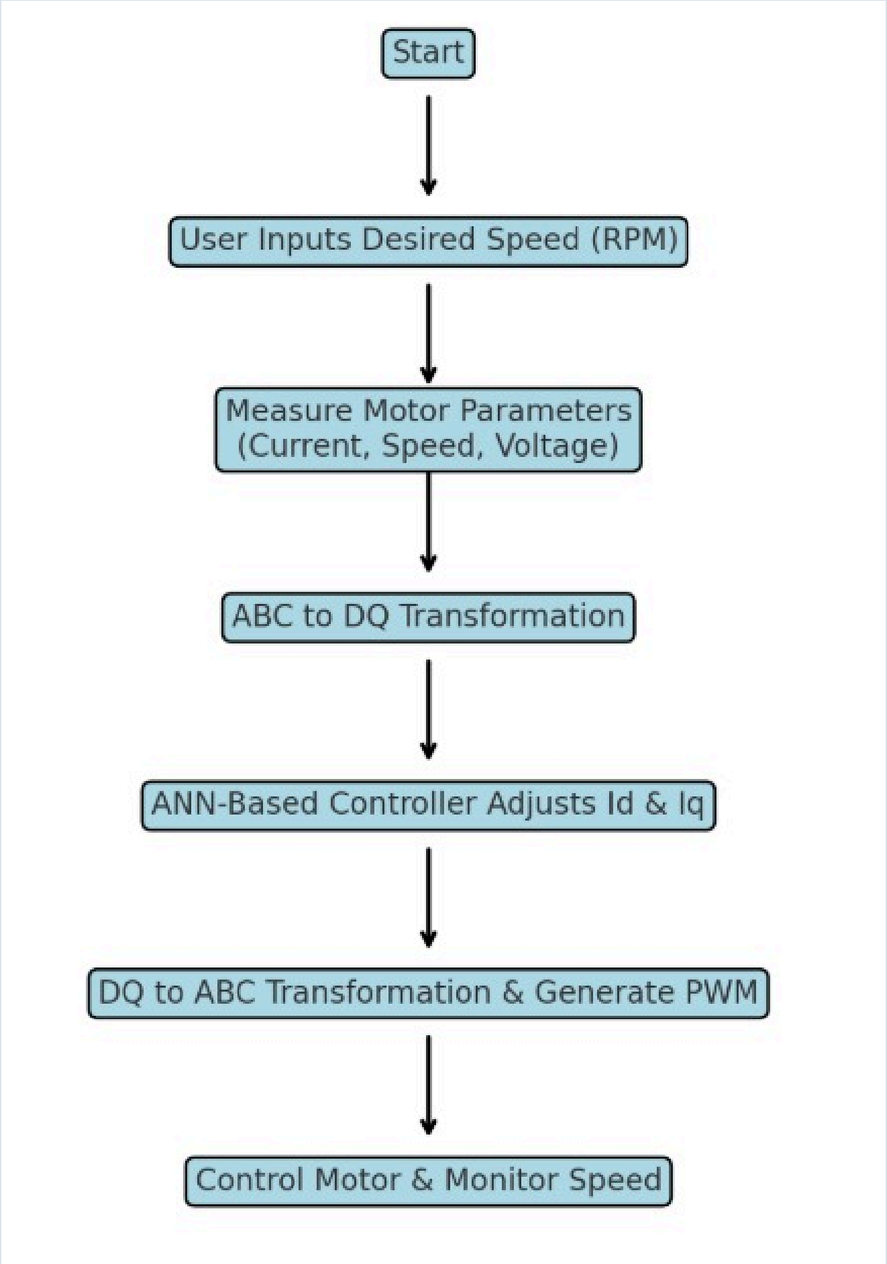
INTRODUCTION

- Speed control in a 3-phase induction motor is crucial for efficiency, performance, and energy savings in industrial and commercial applications
- 3-Phase induction motor is used widely because of its efficiency , reliability and robustness
- An induction motor is a type of AC electric motor that operates on the basis of Faraday's law of electro magnetic induction
- Despite all the advantages of the induction motor, it has always suffered a setback in the area of speed control as it is a highly coupled and proves to be in the class of machines with the most complex speed drive.
- Various speed control methods for induction motors include Volts/Hertz (scalar control), Fuzzy Logic, and Artificial Neural Networks (ANNs). Field-Oriented Control (FOC) enhances motor dynamics, enabling more precise control. ANN-based controllers learn from data, adapt to system changes, and provide intelligent speed regulation.

OBJECTIVES

- Generate a dataset using MATLAB-Simulink
- Make an ANN based speed controlling system
- Train and Test the ANN model for speed regulation
- Compare the efficiency of the model with traditional methods

Working Principle of ANN-Based FOC Speed Control



METHODOLOGY

Dataset Description & ANN Training

- **Dataset generation**
  - Used synthetic data generated to simulate motor behavior.
  - Included key parameters: Stator voltage, rotor speed , load torque , slip, Speed Response(RPM)
  - Will replace synthetic data with MATLAB Simulink-generated dataset
- **Neural Network Training**
  - ANN structure: 1 Input Layer, 7 Hidden Layers, 1 Output Layer.
  - Training Algorithm: Levenberg-Marquardt method.
  - Learns motor behavior & generates optimal control signals.

MATLAB Simulink Model Development & ANN Integration

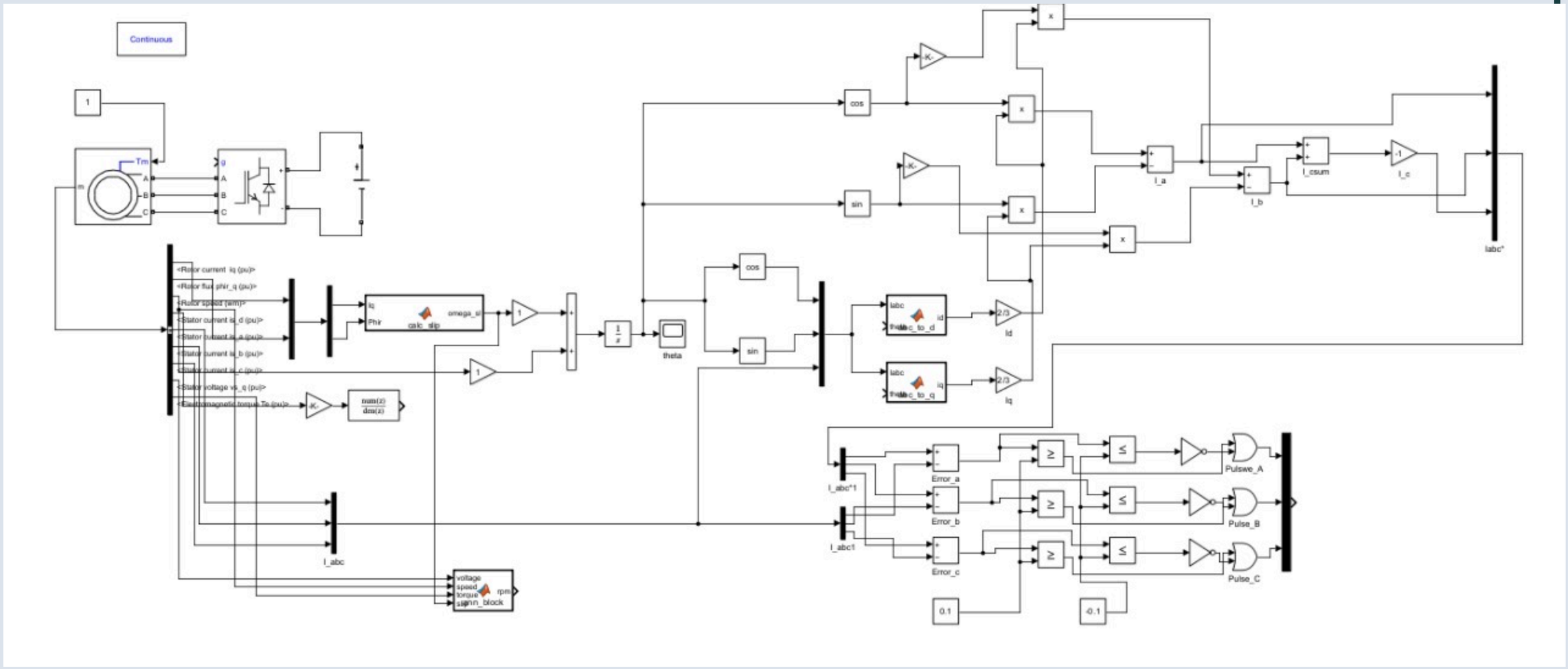
Developing the MATLAB Simulink Model

- Building the Induction Motor Model:
  - Used Asynchronous Machine (Three-Phase) Block in Simulink.
  - Configured motor parameters (Voltage, Frequency, Inductance, Resistance, etc.).
  - Included Voltage Source Inverter (VSI) for controlling motor input.

Field-Oriented Control (FOC) for Speed Regulation & ANN Integration

- **Stator Current Orientation**
  - Stator current vector maintained 90° to rotor flux angle.
  - Achieves maximum torque at any speed.
- **Coordinate Transformation (abc → d-q)**
  - Converts stator current from three-phase (abc) to two-phase (d-q) using Clark-Park transformation.
  - Direct-axis current (I_d) controls flux
  - Quadrature-axis current (I_q) controls current
- **Integrating ANN Code into the Model**
  - Trained ANN in MATLAB using synthetic dataset
  - Exported the trained ANN model as a MATLAB function block and integrate it with a simulink model

MATLAB Simulink model



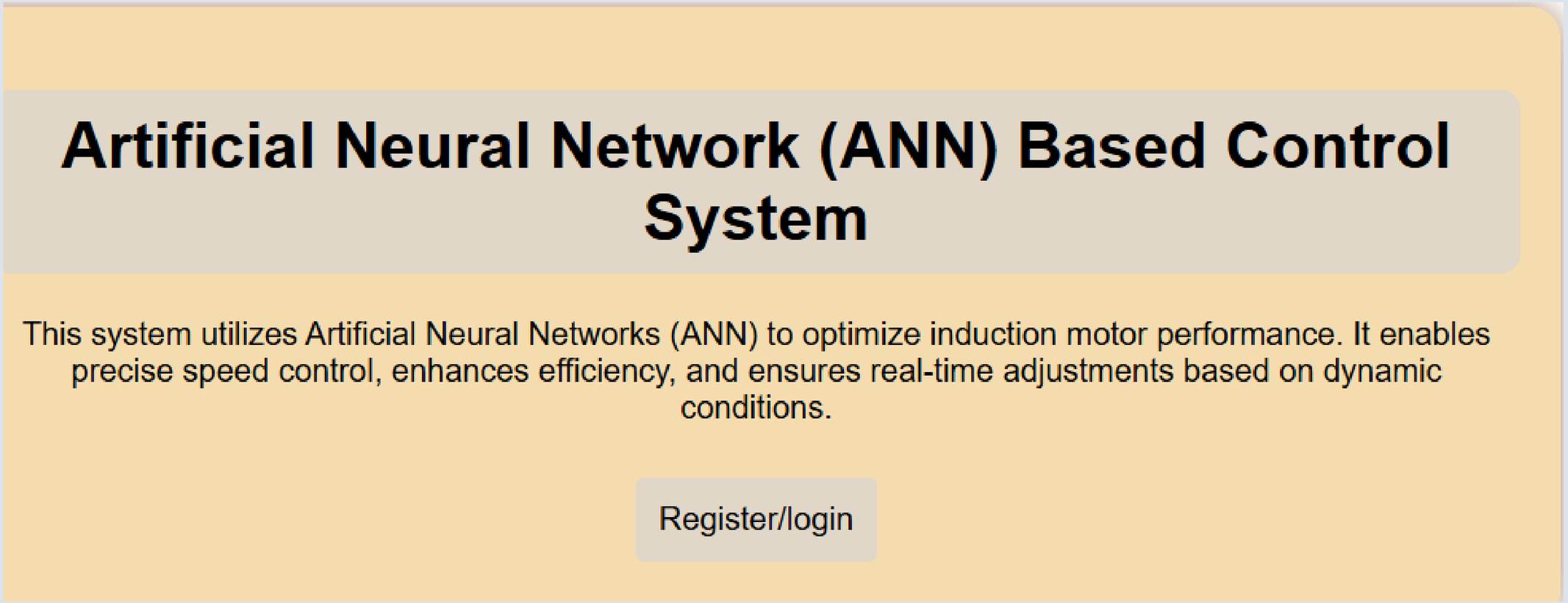
FUTURE WORK

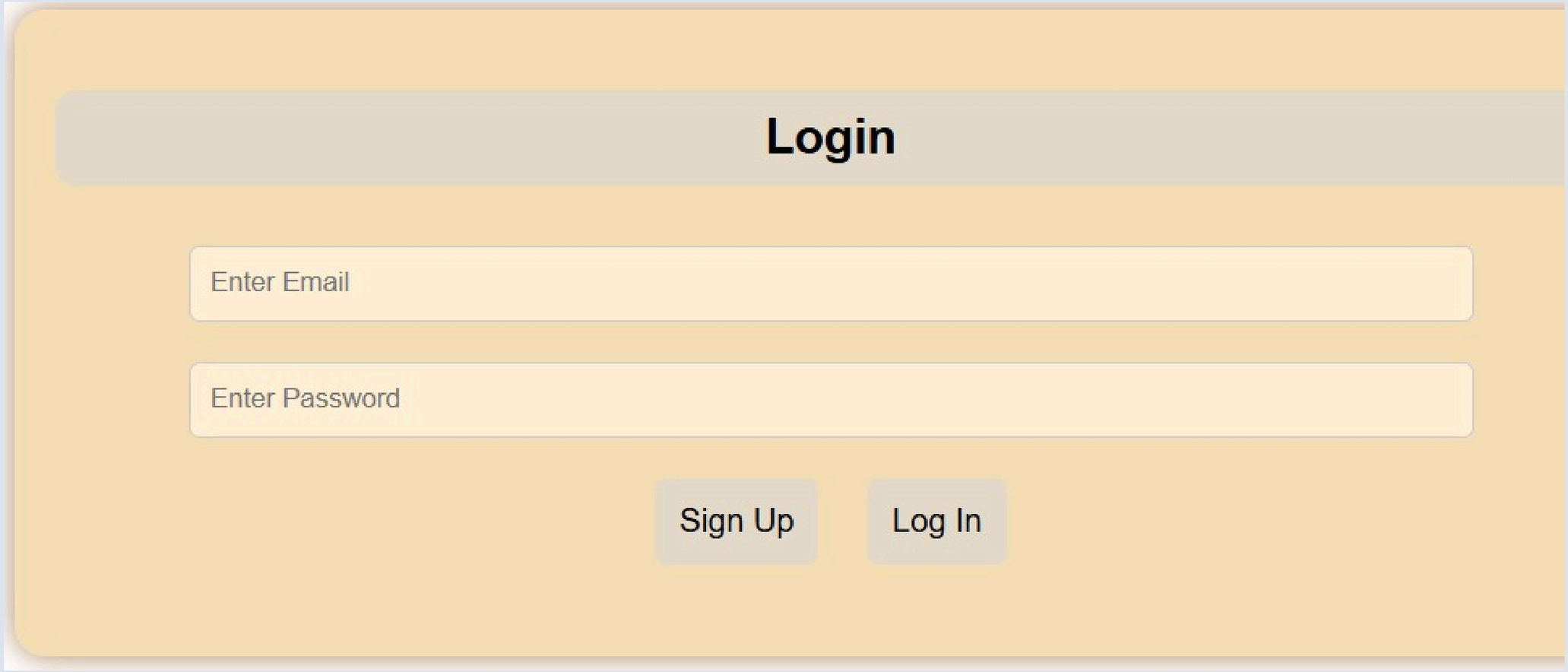
- **Self-Learning Systems** - By developing the self-learning ANN controllers that can learn and adapt the different conditions without retraining
- **Real-Time Implementation** - Deploying ANN-based controllers on advanced microcontrollers for more efficient control
- **Fault Detection and Diagnostics** - To identify motor faults in real time, enhancing reliability and reducing downtime. Implementing predictive maintenance using AI-driven analytics will improve system efficiency and prevent unexpected failures

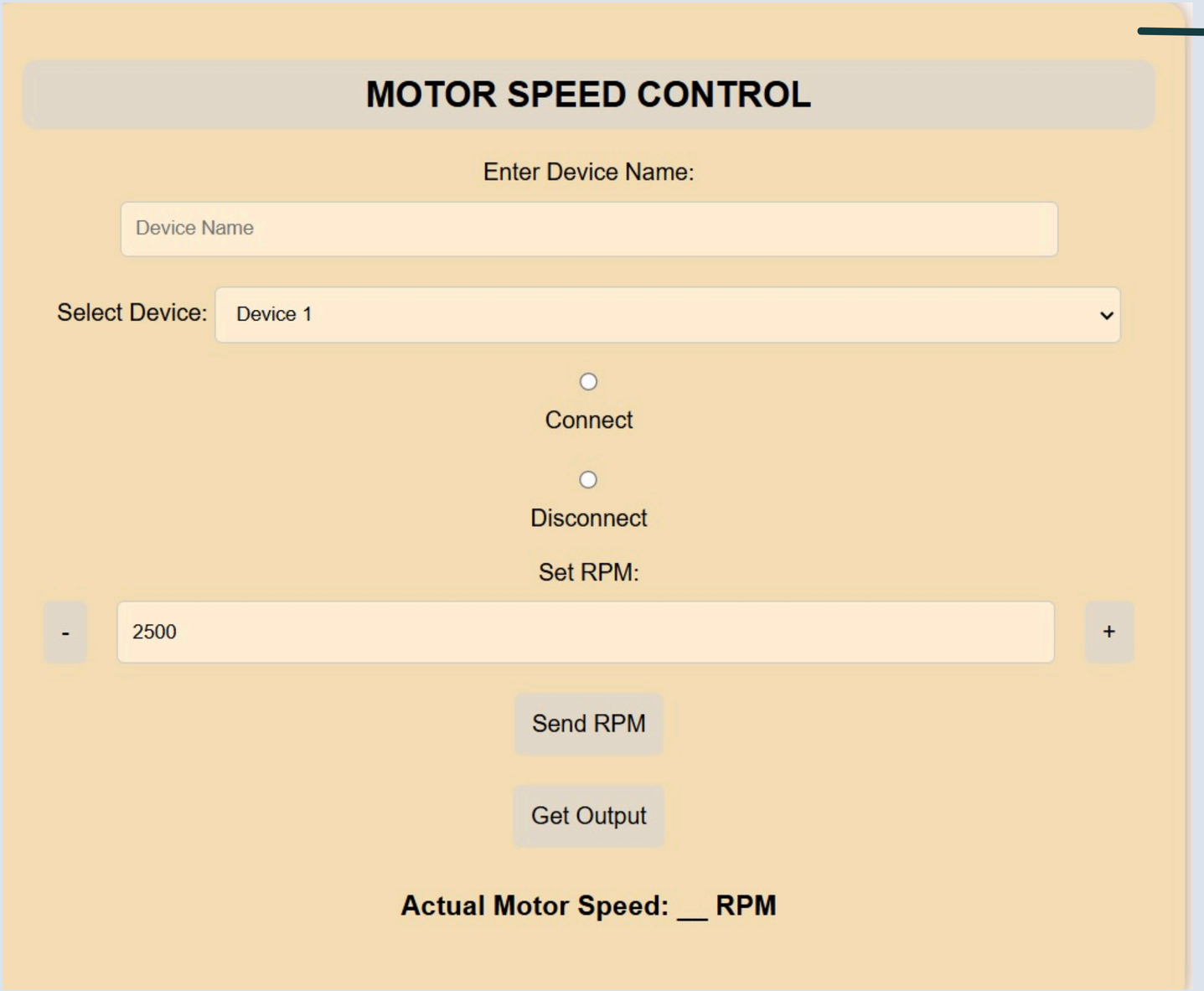
USER INTERFACE DESIGN

- **Frontend (HTML, CSS, JavaScript)**
  - User Interface with Login & Control Panel
  - RPM Control & Device Selection
  - Interactive Buttons for Speed Adjustment
- **JavaScript Functionality**
  - Page Navigation (Landing → Login → Control Panel)
  - User Authentication (Sign Up / Login)
  - RPM Input & API Integration
- **Backend (Flask API)**
  - /set_rpm: Receives RPM input and updates speed
  - /get_speed: Returns real-time motor speed
- **System Flow**
  - User Logs In → Selects Device → Adjusts RPM → Sends to Backend → Retrieves Actual Speed

ANN Motor Control: UI Screenshots




Login
Enter Email
Enter Password
Sign Up
Log In


MOTOR SPEED CONTROL
Enter Device Name:
Device Name
Select Device:
Device 1
Connect
Disconnect
Set RPM:
-
2500
+
Send RPM
Get Output
Actual Motor Speed: __ RPM

REFERENCES

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2. A. Tripathi and N. Asati, "Artificial Neural Network Controller for Induction Motor Drive," International Journal of Science and Research (IJSR), vol. 4, no. 6, pp. 805-812, June 2015.

3. Other online sources

THANK YOU