FINAL YEAR RESEARCH PROJECT

Automatic Door Controller

Offered
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Team
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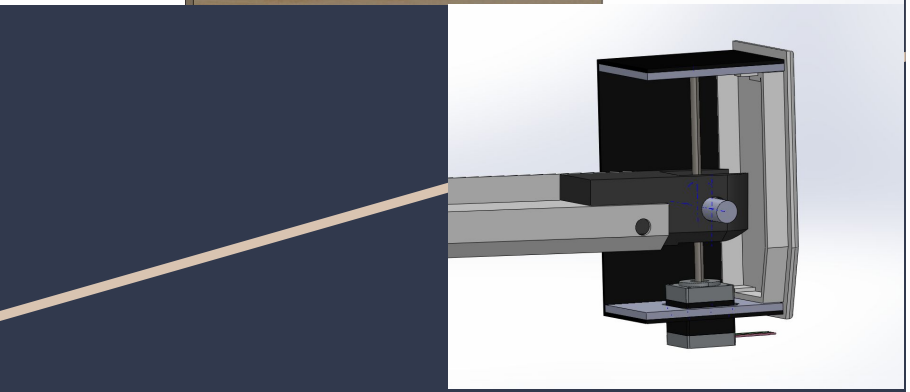
Basic Concept



- We have designed an automatic door system that utilizes gravity to facilitate the door’s movement. The main rail, on which the door slides, can be tilted at a specific angle using motors located on either side of the rail, enabling smooth opening and closing actions.

- Our objective is to design the electronic operational infrastructure necessary for the system's overall functionality. In addition to this, we have the opportunity to propose or develop mechanical actuating mechanisms that will complement the controller design, enhancing the system's performance. Also, we are tasked with developing a PID control program to ensure precise and efficient control of the system.

Scope (Overall)

1. Electronics Operation Infrastructure Design

- To develop the electronic control system that governs the movement of the door and motor operations.
- Design of the control circuits, selecting sensors (such as position or tilt sensors), power management systems, and wiring layout.

2. Mechanical Actuation Mechanism Design

- Propose or design mechanical actuating mechanisms that complement the control system, providing more efficient or reliable movement of the door.
- Exploration of possible actuators (like pneumatic, hydraulic, or electromagnetic systems) that could work with the gravity-assisted mechanism

3. PID Control System Development

- Design and implement a PID (Proportional-Integral-Derivative) control program for the system to manage the tilting angle and movement speed of the door.
- To ensure smooth, precise, and stable door movement by preventing overshoot or undershoot by the system.

Scope (First Half Period)

First Half Period: Research Project Plan & Concept Development

1. **Exploration of Mechanical Ideas**
   - Investigate potential mechanical actuating mechanisms that could complement the gravity-based door system.
   - Compare different mechanical solutions to enhance the door's movement efficiency and reliability.
2. **Component Selection and Circuit Design**
   - Design the preliminary circuit layout
   - Identify and research the necessary electronic components, including:
     - Microcontrollers
     - Relays
     - Voltage regulators
     - Motor drivers
     - Motors
     - Sensors (e.g., position sensors, tilt sensors)
   - Compare off-the-shelf components for performance, cost, and compatibility with your system.
3. **Documentation and Report Writing**
   - Prepare a detailed report summarizing the mechanical ideas explored, the chosen components, and the initial circuit design.
   - Provide a rationale for component choices and discuss how they will integrate into the overall system.

Scope (Second Half Period)

Second Half Period: Detailed Design, Implementation, and Finalization

1. **Detailed Design and Circuit Diagram Development**
   - Use SolidWorks or similar simulation/design software to design detailed diagrams of the electronic circuits and control boards.
   - Finalize the system architecture and create detailed schematics for both mechanical and electronic components.
2. **Control Program Development**
   - Write the control program using MATLAB, focusing on implementing the PID control logic.
3. **Practical Implementation and Testing**
   - Build the full door mechanism, integrating the tilting rail, motor control, and electronics Practically.
   - Test the system, adjust the control program and electronics for smooth operation.
4. **Final Report and Presentation**
   - Document the entire design and implementation process, including any modifications or challenges faced.
   - Prepare a final report and presentation to demonstrate the completed project.

Constraints
Nipun

1. Mechanical Constraints:

- **Motor Alignment:** Requires precise alignment of motors and sensors.
- **Load Capacity:** Must support the door's weight and stress from slope adjustment.
- **Wear and Tear:** Durable materials needed for rails and end caps.

2. Electrical and Control Constraints:

- **Power Supply:** Reliable power required for motors and sensors.
- **Motor Precision:** High precision needed to maintain door slope and movement.
- **Control System:** Complex synchronization of motors with sensor feedback.

3. Sensor and Measurement Constraints:

- **Laser Sensor Accuracy:** High accuracy needed for precise door positioning.
- **Sensor Integration:** Proper integration with control system for accurate adjustments.
- **Environmental Factors:** Sensors must handle dust, temperature changes, and vibrations.

4. Safety Constraints:

- **Safety Mechanisms:** Implement fail-safes to prevent accidents and obstructions.
- **Emergency Operation:** Manual override or emergency mode required.

5. Integration and Compatibility Constraints:

- **Installation Space:** Adequate space needed for motors, sensors, and rails.
- **Compatibility:** Must fit existing door frames and architecture.

Tools

Design and Modeling Tools

1. **Virtual Electronic Diagrams**: SolidWorks Electrical
2. **Virtual Mechanical Design Model**: SolidWorks

Research Resources

1. **Library:** Gather academic resources, technical documentation, and references for both mechanical and electrical designs.

Communication Platforms

1. **Discord**: Coordinate and communicate with your project team in real-time. Use voice channels, direct messaging, and file sharing for seamless collaboration.

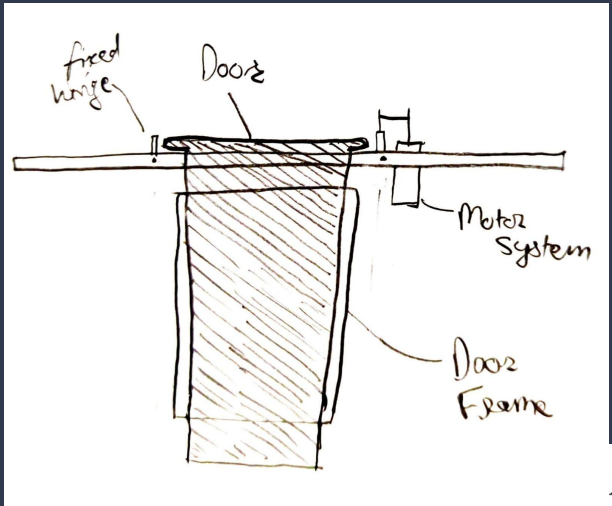
Shared Workspace and Collaboration Tools

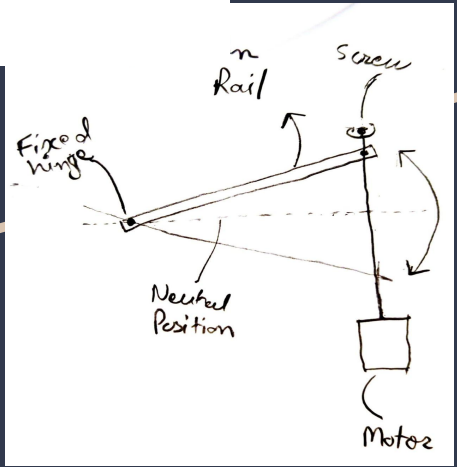
1. **Trello**: Project management and task tracking. Organize and assign tasks, set deadlines, and monitor the project's progress.
2. **Google Docs/Slides:** Collaborative document and presentation creation. Share and edit project reports, notes, and presentations in real time with team members.
3. **Microsoft Office Online:** Use online versions of Word, Excel, and PowerPoint for document creation, spreadsheets, and presentation work when needed.

Timeline

Week	Start Date	End Date	Task Description	Duration (Days)	Notes
Week 4	Monday, Aug 19, 2024	Sunday, Aug 25, 2024	Research Mechanical Ideas	7	Explore various mechanical options.
Week 5	Monday, Aug 26, 2024	Sunday, Sep 1, 2024	Research Mechanical Ideas	7	Finalize mechanical concepts, Start electronic circuit designing
Week 6	Monday, Sep 2, 2024	Sunday, Sep 8, 2024	Presentation	7	Complete the Mid-semester Presentation
Week 7-8	Monday, Sep 9, 2024	Sunday, Sep 22, 2024	Reseach about circuit design	14	continuee on electric circuit (microcontrollers, relays, motors, etc)
Week 9-10	Monday, Sep 23, 2024	Sunday, Oct 6, 2024	Component Comparison & Selection	14	Compare off-the-shelf components and finalize selections.
Week 11	Monday, Oct 7, 2024	Sunday, Oct 13, 2024	Document & Draft Report	7	Start drafting the report with research and design info.
Week 12	Monday, Oct 14, 2024	Sunday, Oct 20, 2024	Document & Draft Report	7	Complete the final report

Research Ideas(Extended door size)





Design Concept Overview

This design concept employs a single motor system to control the movement of the door. The setup features a fixed hinge at one end of the rail and a motor-controlled screw mechanism at the opposite end. The motor drives the screw, which adjusts the tilt of the rail up or down from a neutral position, thereby opening or closing the door.

Pros:

- **Simplicity in Design**: Utilizing only one motor simplifies the design and reduces mechanical complexity compared to systems that use dual motors.
- **Cost Efficiency**: Fewer components mean lower initial costs and potentially reduced maintenance expenses.
- **Energy Efficiency**: The single motor system generally consumes less energy compared to systems with multiple motors, leading to improved operational efficiency.

Cons:

- **Reduced Accuracy**: The reliance on a single motor limits the precision of rail positioning. This can affect the accuracy of door movement.
- **Limited Control**: With only one motor governing the system, there is less ability to finely control the speed and momentum of the door's movement.
- **Mid-Way Door Stop Issue**: The design may struggle with door positioning at intermediate stops. Without additional mechanisms, the system might not effectively handle or hold the door in a mid-way position.

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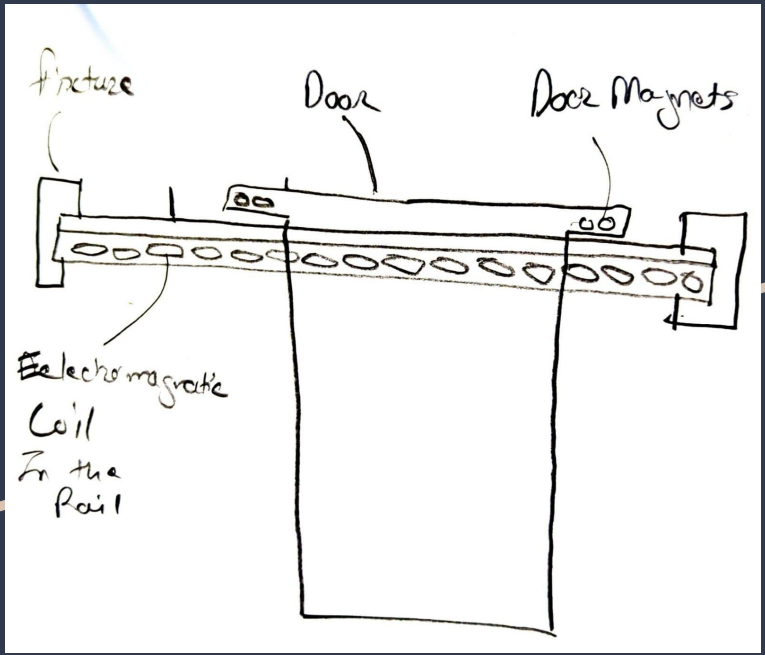
Research Ideas(magnetically levitated door)



Maglev Technology

- Uses magnetic forces for frictionless levitation and propulsion

Coil Placement:

- Embed coils in door frame and door.
- Use **EMS** (attractive forces) or **EDS** (repulsive forces) for levitation.

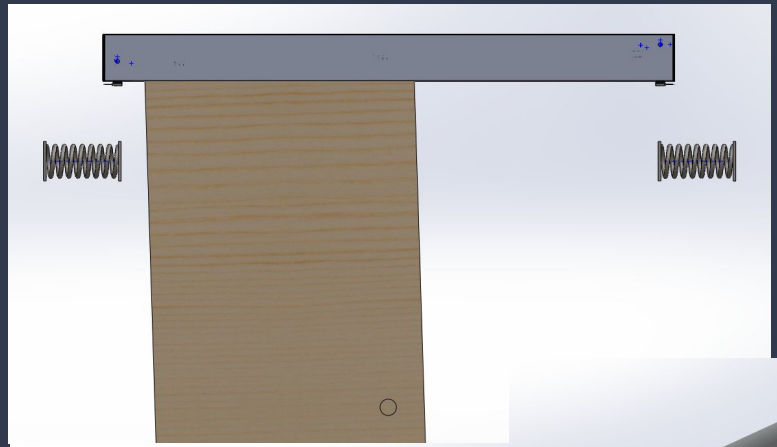
Pros

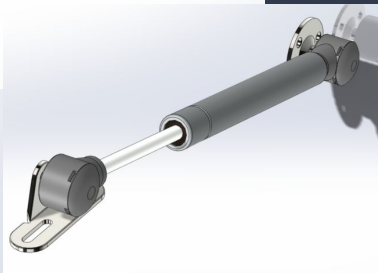
- Regulate magnetic fields with real-time sensors for stability and smooth movement.
- Minimal wear and tear; durable

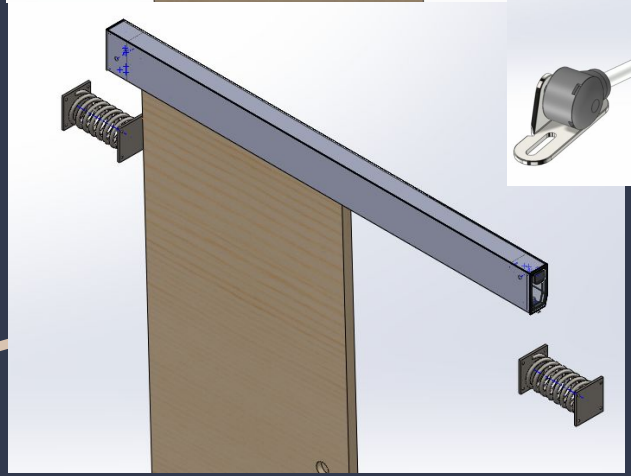
Cons

- High due to advanced coil and magnet systems.
- High energy requirement/operating cost
- Complex manufacturing.

Research Ideas(Mechanical door stopper)







This design approach aims to ensure a smooth and gradual closing of the door as it approaches the frame's closing edge. The mechanism incorporates elastic springs on either side of the door to absorb its momentum and decelerate it gradually.

Design Details:

- **Elastic Springs**: The design features accurately calculated elastic springs positioned on both sides of the door. These springs are intended to absorb the incoming momentum of the door, allowing it to slow down smoothly as it nears the closed position.

Advantages:

- **Smooth Operation**: The springs facilitate a gradual deceleration of the door, enhancing the overall smoothness of the closing action.
- **Reduced Sensor Dependency**: This model does not require constant monitoring of the door's movement and speed, thereby eliminating the need for various sensors. This simplifies the control system and reduces overall complexity.

Disadvantages:

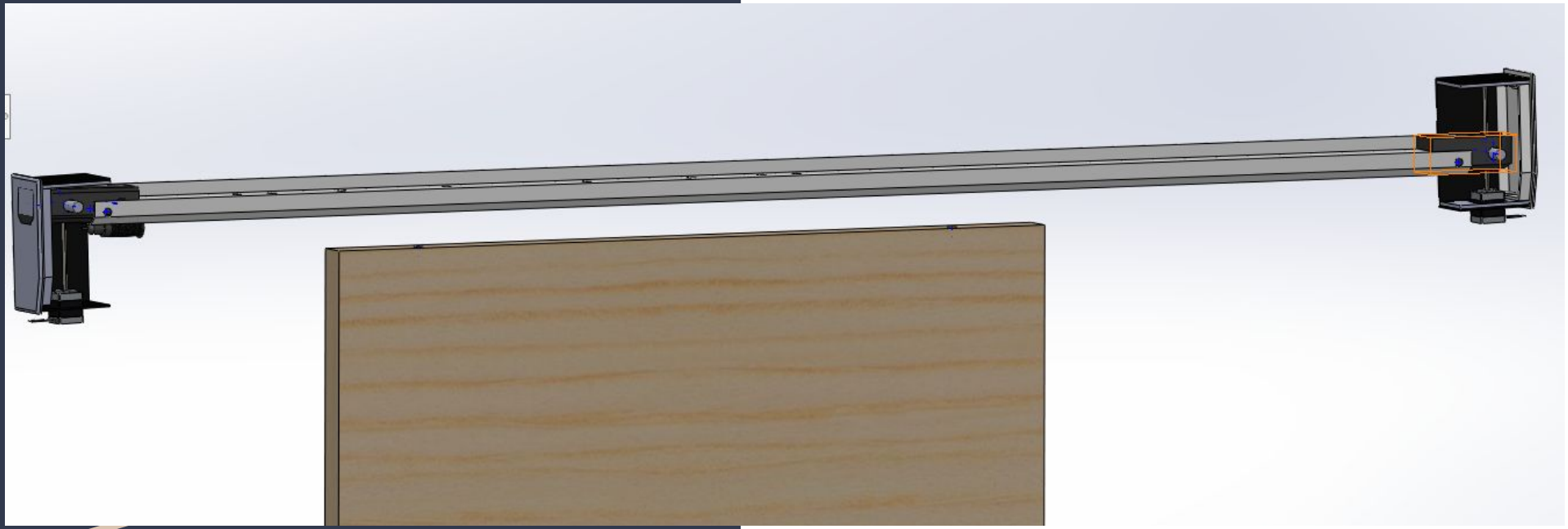
- **Spring Durability**: Over time, the elastic springs may lose their elasticity, potentially diminishing their effectiveness.
- **Alternative to Springs**: To enhance durability and maintain consistent performance, the design can be upgraded by replacing the springs with a regulated oil damper. The oil damper provides a more reliable solution for controlling the door's movement over extended periods

Comparison of different Models

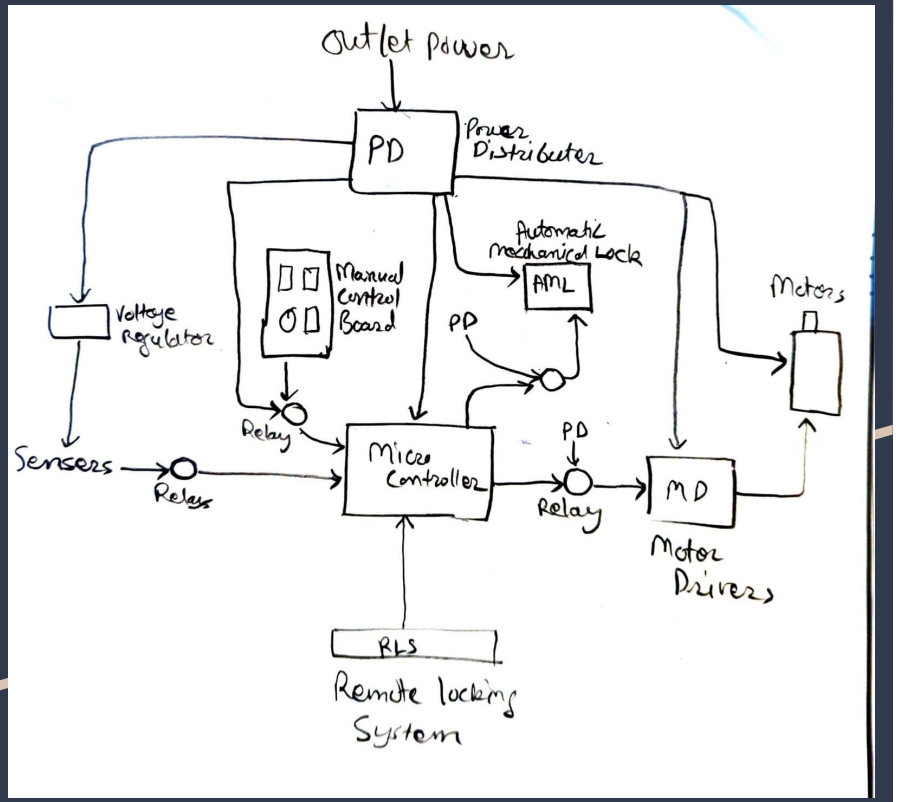
Idea	Standerd 2 motor design	One Motor design	Magnetic levitation	Mechanical door stopper
Cost efficiency	7	9	2	5
Energy Efficiency	7	9	2	8
Durability	8	6	9	7
Ease of Use/manufacture	7	8	2	7
Functionality	10	6	10	7
Final score	7.8	7.6	5	6.8

Selected design

2 motor standard design



Electronic infrastructure/ circuit design



Basic Circuitry Design and its Components:

- **Microcontroller**: The central control unit that governs the entire system. It processes sensor inputs and controls the motors via motor drivers.
- **Mechanical Automatic Lock**: An automatic lock system controlled by the microcontroller to secure the doors.
- **Remote Locking System**: A remote interface or software that sends signals to the microcontroller for locking and unlocking the doors.
- **Motors**: Actuate the door movement as directed by the microcontroller.
- **Sensors**: Provide input data to the microcontroller for accurate door operation.
- **Relays**: Manage switching and control electrical currents between different circuit components.
- **Power Distributor**: Transfers high voltage power from the outlet to various circuit components.
- **Voltage Regulators**: Ensure stable voltage levels for the various components.
- **Motor Drivers**: Precisely control the speed and operation of the motors for accurate door movement.

Thank you

Questions?