Project 1: Automatic Door Opener

ECE 298 S2021

Problem Statement

Businesses want to limit the number of entry-point surfaces touched by their customers because of the COVID-19 pandemic. Your design will automate an entry/exit doorway to a customer site that senses customers automatically with programmable trigger levels for proximity. Additionally, your design must have a time-efficient door opening/closing operation to limit the energy losses due to heating and cooling. Your design must provide safe door operation, and the door motor drive must be power efficient.

Functional Interfaces to be Considered

Sensors

- The **Outside Distance Proximity Sensor** senses the nearness of objects approaching a door from the outside direction.
- The **Inside Distance Proximity Sensor** senses the nearness of objects approaching a door from the inside direction.
- Software is required to control the proximity sensor distance, timing, and rate for each direction.
- **Door Position Limit Switches** (2) must stop the door motion at the minimum and maximum door travel limits.
- A **Collision Switch** mounted on the door must immediately stop the door travel. Door travel may resume once the switch is open again, but at a limited linear rate.
- The door travel, including position, speed, and acceleration, will be determined by monitoring the number of motor revolutions using a **Door Motor Sensor**.

Actuators

- The **Door Motor** is used to open and close the door.
    - The ratio of motor revolutions to linear door travel is 1.5 rev/ft (motor revolutions per foot of linear travel).
    - The motor must activate with a speed ramp-up and ramp-down when starting and stopping.
    - The software must monitor the number of motor revolutions to control the speed ramp-up and ramp-down properly.
    - The door opening is 8 ft wide.

User Inputs

- **User Inputs** (switches, pushbuttons, a keypad, etc.) must be available to:
    - Select the mode of operation (Locked, Setup, or Run Mode)
    - In Setup Mode:
        - Select from a list of parameters
        - Set parameter values directly (enter a value) or through adjustment (increase/decrease)
    - In Locked Mode:
        - Set the door fully open or fully closed (see Operating Modes)

User Outputs (Indicators)

- **LCD Display** to indicate the Mode, Parameter Name and Parameter Value in Setup Mode

- **Green LED1** showing that the Outside Distance Proximity Sensor detects an object within P1 distance (see below)
- **Green LED2** showing that the Inside Distance Proximity Sensor detects an object within P2 distance (see below)
- **Red LED** (flashing) to indicate Door Motor is in motion
- **Yellow LED** (flashing) to indicate a collision state has occurred

Operating Modes

- There are three modes of operation: **Locked Mode**, **Setup Mode**, and **Run Mode**.
    - In **Locked Mode**, the software will bring the door to either fully open or fully closed depending on which of two switches is pressed in this mode. Door Motor power will be disabled after reaching the position.
    - In **Setup Mode,** the Door Motor must be disabled. The LCD Display must display the Mode ("Setup"), Parameter Name, and Parameter Value. The User Inputs allow the user to select a Parameter from the list of parameters and set or adjust the parameter Value. The Parameters and their respective range of values are:
        - P1 (Outside Sense Distance: 2, 4, 6, 8 feet)
        - P2 (Inside Sense Distance: 2, 4, 6, 8 feet)
        - P3 (time to remain open after reaching full position: 5, 10, 15, 20 seconds)
        - P4 (speed ramp-up constant*)
        - P5 (speed ramp-down constant*)

        **You can use these values at your discretion to determine how quickly the door accelerates and decelerates.*
    - In **Run Mode,** the LCD Display must display the Mode ("Run"). The software is to operate the system using the parameter values established in the Setup Mode. The software must monitor the Door Position Limit Switches and Collision Switch to stop or restore Door Motor power. Door Motor power must be stopped immediately when these switches close. When the collision switch opens again, the door speed must be limited to 0.5 ft/sec until the door is closed.

Constraints

1. Only parts from the Proteus Libraries may be used in this project (none from the web).
2. The Sensors, Actuators, User Inputs, and User Outputs (Indicators) will be connected to the Prototype Adapter Board through wiring harnesses to connectors on that board.
3. The PCB shape (Sometimes called the "form factor") must be as per the PCB layout template in ECE 298 Lab 4.
4. The Prototype Adapter Board PCB has receptacle connectors to mate with the development board. They must not be changed in type or physical location.
5. The final schematic and PCB design must include suitable decoupling capacitors for power supply voltage filtering.
6. This project must employ voltage level translations (3.3 V → 5 V, 5 V → 3.3 V) for signals between the STM32 MCU (3.3 V) and 5 V devices **where appropriate** (refer to the part datasheets).

Responsibilities

Team Member 1: Sensors, User Inputs, and Software

Team Member 2: Actuators (Door Motor), User Outputs, and Software