DEPARTMENT OF MECHANICAL ENGINEERING

TEAM 9

Imani's Treadmill

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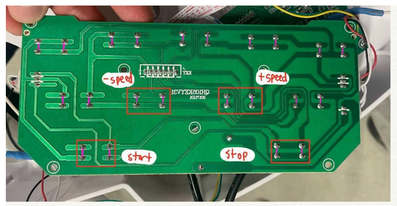
Problem Definition

The team was tasked with designing and building a voice activated and controlled treadmill for a blind 3'3" lady (Imani) through Amazon Alexa. The treadmill must use voice commands to control the treadmill and receive voice responses to understand how to make adjustments to the treadmill for optimal use.

Design Calculations & Analysis

The photo to the right shows the treadmills Printed Circuit Board (PCB). After analyzing the board, we were able to determine which leads to connect to control the different functions of the treadmill.

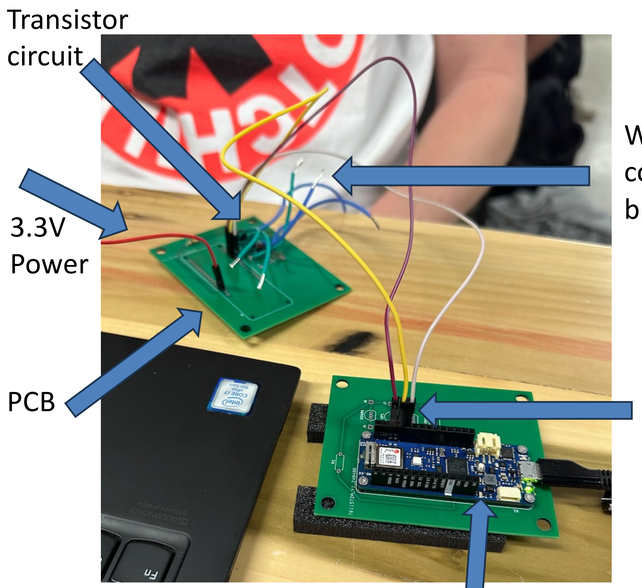


Important Numbers Found:

- The frequency input range for Alexa is up to 20 kHz, which will satisfy both male and female commands
- The comprehension accuracy of Alexa is roughly 94%
- The frequency output range of Alexa is 30 Hz to 24 kHz, which will satisfy the human needs for frequencies
- Due to safety standards, all holes drilled for the wiring cannot be more than .1753 in^2 in diameter
- Through testing, the Alexa response and execution time was found to be as quick as 1.13 seconds and as long as 1.98 seconds

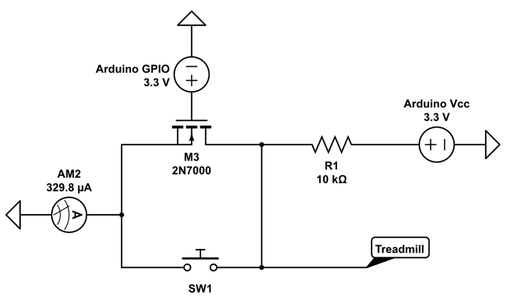
Final Design

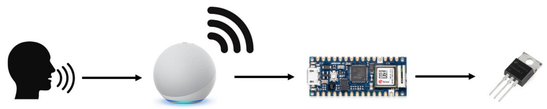
In the end, the team decided to go forward with the electrically based solution. This was largely because of the ability to solve the problem without greatly altering the treadmill, limiting the number of potential failures, and creating an overall safer design.



Wires to be connected to button leads

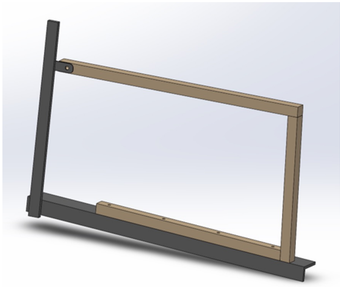
Wires for activating transistor



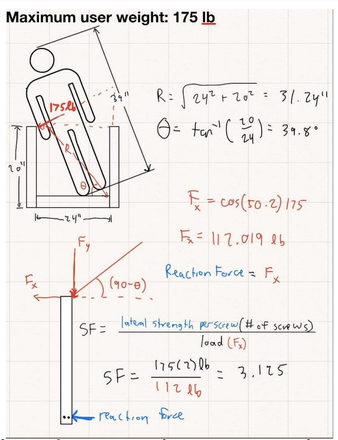


By connecting the Arduino and Alexa to the same WIFI network, the two can communicate through Arduino IDE and the Alexa app. This will allow the commands spoke by the user to be understood by the Arduino's setup.

The electrical solution essentially short circuits the button when desired. Wires will be attached to each lead of the button connected through a N-channel MOSFET transistor. This transistor, powered with 3.3V through a current limiting resistor, would allow the button to be short circuited when a signal was sent from the Arduino. This signal would be sent when Alexa recognized a command such as "speed up," activating the transistor.



The team was also tasked with creating safer, more sturdy handrails than the existing set. The picture above shows the final setup of the handrails. These rails are bolted into the base of the treadmill and attached to the metal supports of the console for maximum sturdiness throughout.



Simulated Finite Element Analysis (FEA), was not conducted due to the inconsistent isotropic properties of wood. Instead, hand analysis of the wooden handrail joint was considered.

Prototype & Test Results

The team prototyped two different potential solutions, a mechanical and an electrical solution.

The photo to the **left** shows the prototype for a mechanically based solution in which servo motors rotate when desired to press the buttons. Results showed that this would work but be very invasive to the treadmill, causing irreparable damage.

The photo to the **right** shows the testing for an electrically based solution in which the electrical current bypasses the buttons when desired, simulating a button being pressed. Results showed that this concept would work and would require less physical modifications to the treadmill.