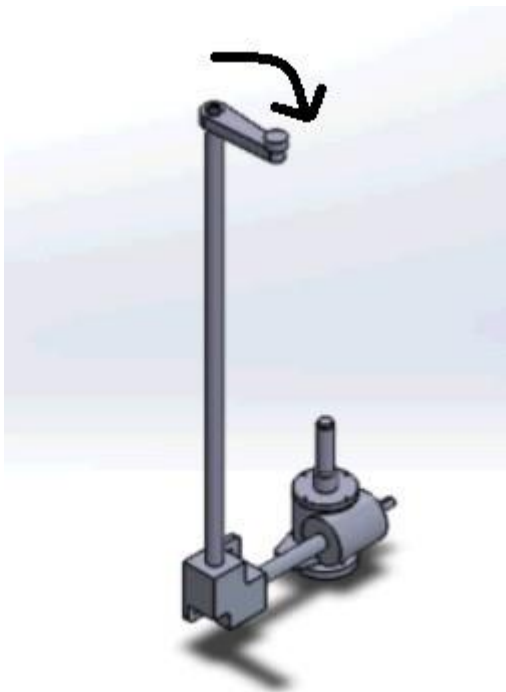The Multifunctional Wheelchair is a project conducted in Smart Medical Devices Lab @UWB under Dr. Jong Yoon's Supervision&Direction.

Project Participants were (1) Supervisor (2) 2 students from Mechanical Engineering (3) me.

Prior to our coming, a team before (Danny R. & Perapat T.'s works shown on the 2 of the following pictures) had developed a lift mechanism that can adjust the height of the wheelchair.

It was used by Users placing their hands on the grip and rotating the mechanism. This was the first proof-of-concept design of a height-adjustable wheelchair.

After we took on the following of the project, Dr. Yoon had set the scope of the project: Redesign the lift mechanism to control the height of the wheelchair via electricity.

Hence, we did some research to find out the materials we need.

Below are the materials used for the project:

- TB6600 Stepper Motor Driver
- NEMA 23 780076-01T22NRLC-LD-N-NS-00 (Minimum Holding Torque = 280 oz-in)
- Arduino Mega 2560 Rev3 (Input Voltage = 7~12V)
- Li-ion 18650 Battery: 28.8V 3000mAh

The tasks I self-started for the project and the ones assigned by the supervisor is as follows:

- Design the code that can operate two stepper motors simultaneously, while being able to adjust the elevation of the wheelchair seat.
- Devise circuitry of 4-level height adjustment push-button panel and emergency stop push-button panel which are accessible by the user sitting in the wheelchair.
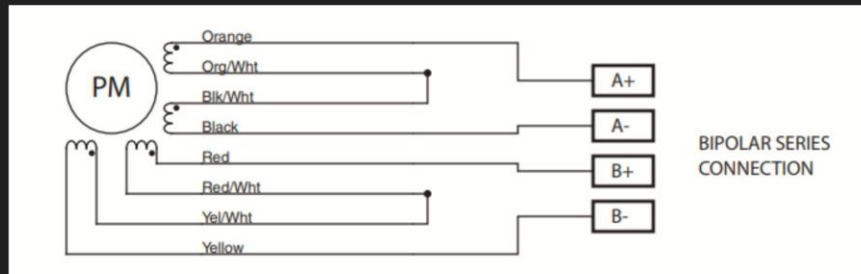
Push Button Panel Circuit Diagram
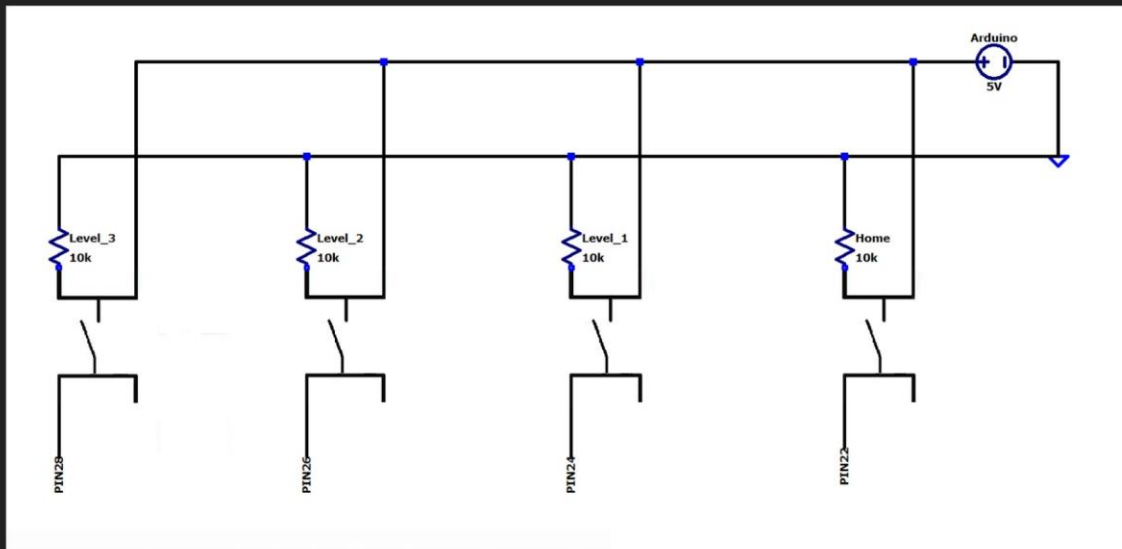
- Organize the documents related (Theory of Operation, Specifications, Software Flowchart, etc.)

Software Flowchart
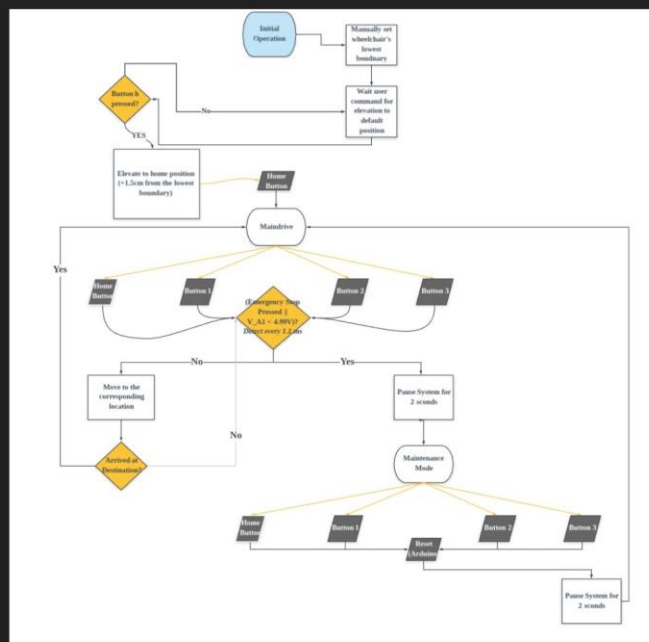
- In charge of wiring between motor driver, motors, Arduino, 4-level height adjustment push-button circuit, emergency stop push-button circuit.

Motor wiring diagram

- Document weekly reports to facilitate decision making.
- Define edge cases and find improvements to the overall mechanism.

-Attaching RC circuit to Arduino for use in securing a wheelchair height position data to EEPROM at immediate power disconnection between the Arduino battery and Arduino.
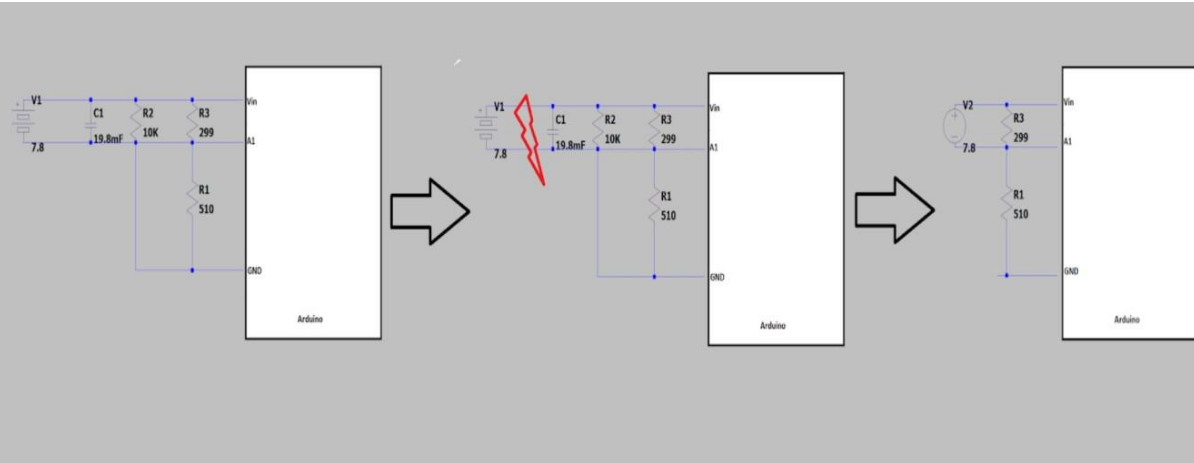
Capacitors are fully charged before the moment V1 disconnects from the circuit. This can be signified as 0^- of time.
- Arduino has embedded "analogRead()" method which can be utilized to measure 0~5V.
- When battery splits off from the circuit, C1 and R2 can be considered as a battery = 7.8V at time = 0^-
Capacitors starts to discharge after the moment V1 disconnects from the circuit. This can be signified as 0^+ of time.
- C1 and R2 behaves as a battery until Arduino receives below 5V (Least Operating Voltage)
- Circuit becomes Voltage Divider

$$Vs = Vin$$

$$V_{A1} = Vs \frac{R_1}{R_1 + R_3}$$

$$\text{When } Vs = 8V, \quad V_{A1} = 8 \frac{510}{299 + 510} = 5.043V$$

$$\text{When } Vs = 7.5V, \quad V_{A1} = 7.5 \frac{510}{299 + 510} = 4.728V$$

- Current System is chosen to stop working at instant when incoming voltage to A1 < 4.99V.
- When Vs = 7.9V, the system will trigger Maintenance Mode (To be Shown in next Flowchart)
- The value of which Arduino determines the status of power loss is highly flexible according to resistors used to make the circuit and the target value within the program.

- Present quarterly accomplishments.

What we solved!

- Power Loss Detector triggering when Incoming Voltage to Arduino < 7.9V has been designed and implemented
- Two-seconds delay before and after pushing buttons within maintenance mode has been designed and implemented to prevent the following scenario: users accidentally pressing buttons immediately after Maintenance Mode is triggered.
- Emergency stop has been implemented to stop the rotation of motor shaft during level transition
- Increased height adjustment speed from approximately 1.437 rps to 5 rps, increase

Below is the quality assura testing for the algorithms of the Arduino software. The red circle shown on the Software Flowchart indicates real-time updates on the execution of various software algorithms.

One of the challenges that I personally had was to learn Arduino. Utilizing online resources (Arduino Forum, Youtube, etc.) to find ways to begin was a huge help in my case.

A word of thanks to Dr. Yoon (Supervisor), Daryl, Nick (ME Student).