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E-lab project proposal

Decontaminating Facemasks with UV-C

Abstract:

Due to the SARS-COV-2 pandemic, there is a global shortage of protective surgical and N95 face masks. This has led to broad reuse of otherwise single-use face masks. While necessary because of cost and unavailability this comes with exposure risk since the mask fibers can retain the virus for days. Thankfully, medical researchers and government agencies have detailed effective methods of mask decontamination for COVID-19 and other diseases. The two methods that stand out are the use of heat or UV-C radiation as both are relatively cheap, easy to implement and use. Most importantly no chemicals need to be handled or refilled. Since heating has been shown to degrade the face mask fabric I am choosing to use UV-C radiation exclusively for disinfection. The goal is to build a cost effective and safe face mask disinfection box using UV-C radiation that meets guidelines set out by medical researchers and is designed for ease of use.

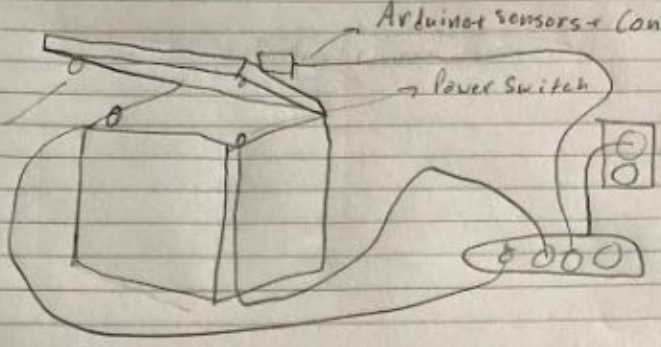
Design Features:

- Box
  - Box with roughly 50 cm by 50 cm dimensions in length and width.
    - Use wood to allow drilling holes easily
    - Hold 3-4 face masks
  - Attach UV-C lamp(s) to the box, on the lid (and bottom).
  - Desired Safety Measure: Lid triggered safety switch
    - When the lid is open the switch opens that cuts current to UV lamps. This prevents UV-C exposure if the lid is opened.
  - Start/Stop switch on box to begin decontamination cycle
  - After these components "grating" will be added to hold the masks needs to be set up
    - Likely using wire or string.
- Sensor Design
  - Along with the box there will be a user interface and an internal quality check
  - For user interface there will be a pushbutton, an LCD display, and possibly a speaker.
    - Pushbutton will be used to start a cycle (turn on display and begin data collecting)
    - LCD display will show two outputs:
    - Expected completion time of cycle
    - Current UV-C light intensity
    - Speaker would alert to either an error or a complete cycle along with LCD display message.

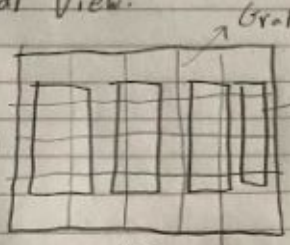
- Crucially, inside the box there will be a light sensor
    - This measures UV-C light intensity in the box.
        - Position sensor in box to receive minimum light
        - Arduino collects current UV-C light intensity
        - Since cycle time is intensity dependent we can use time averaged intensity measurements to calculate a cycle time.
        - Once Arduino calculates end of cycle display message will trigger and speaker will alarm.

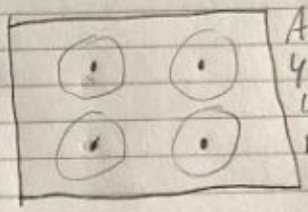
Schematics:

Rough Design:

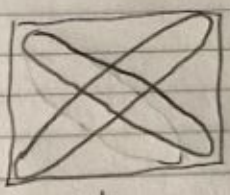


Internal View:



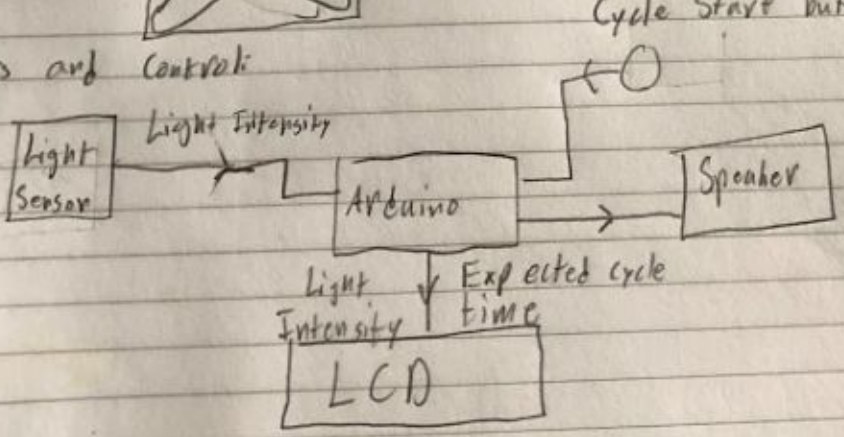


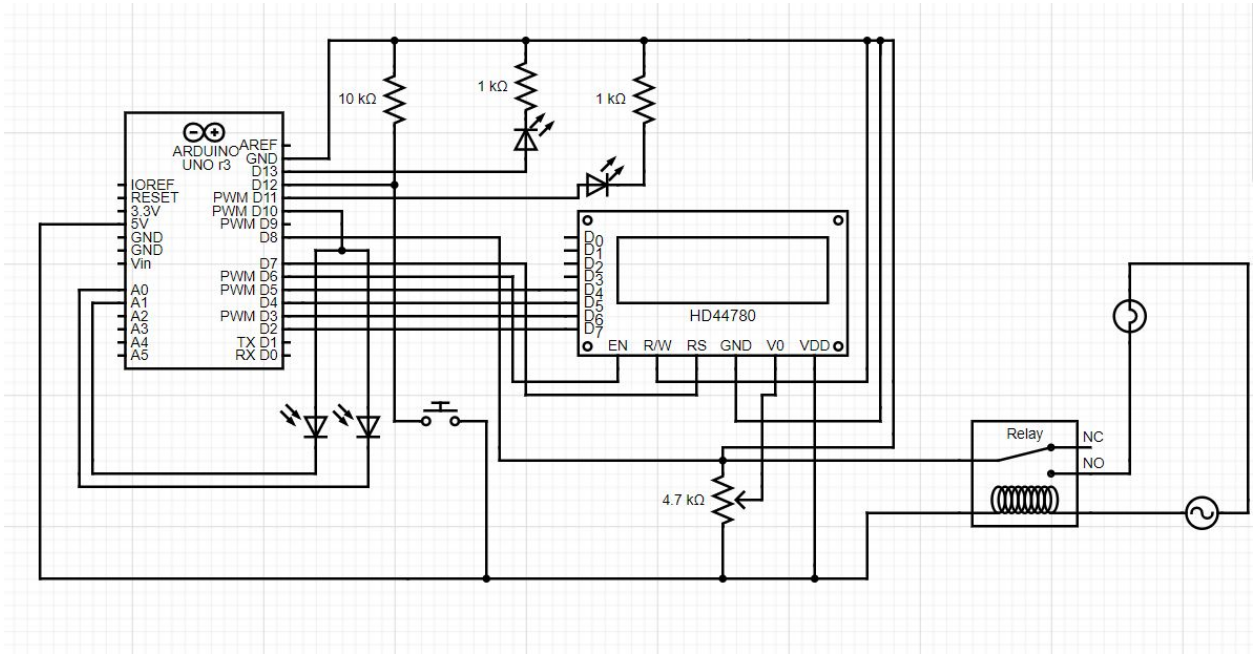
Lighting:



Cross Lights to provide better illumination, one on top, one on bottom.

Sensors and Control:





Parts Required:

- Parts Available:
  - Resistors (10k,1k,220 ohms)
  - 10k potentiometer
  - LCD
  - Pushbutton
  - Relay
  - Breadboard
  - Wires
  - Red/green LED
  - Arduino
- Parts to be Purchased:
  - UV Lamps
  - Box
  - String
  - (3+) UV Sensors

References:

Buonanno, Manuela, et al. “Far-UVC Light Efficiently and Safely Inactivates Airborne Human Coronaviruses.” *Nature*, 2020, doi:10.21203/rs.3.rs-25728/v1.

N95DECON, www.n95decon.org/.

“Recommended Guidance for Extended Use and Limited Reuse of N95 Filtering Facepiece Respirators in Healthcare Settings.” *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 27 Mar. 2020, www.cdc.gov/niosh/topics/hcwcontrols/recommendedguidanceextuse.html.

Reed, Nicholas G. “The History of Ultraviolet Germicidal Irradiation for Air Disinfection.” *Public Health Reports*, vol. 125, no. 1, 2010, pp. 15–27., doi:10.1177/003335491012500105.

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