Face Mask with Active Virus Control

A BETTER BREATH WITH UV TECHNOLOGY EST. 2020

SAN DIEGO STATE UNIVERSITY

Problem Overview:

The COVID-19 pandemic has increased the need for personal protective equipment. The use of cloth and disposable face masks have helped slow the spread of the disease, but are limited in the protection they offer. The team was tasked with the development of a new face mask that is more effective and tackles some of the common issues associated with traditional face coverings.

Requirements:

The system shall…

- Incorporate UV light and a filter for a combined efficiency of greater than 99%
- Not damage or compromise the users' skin or eyes
- Operate for at least 4 hours on a single charge
- Weigh less than 1.5 pounds
- Have a universal fit
- Remain within a $1,000 budget

Design:

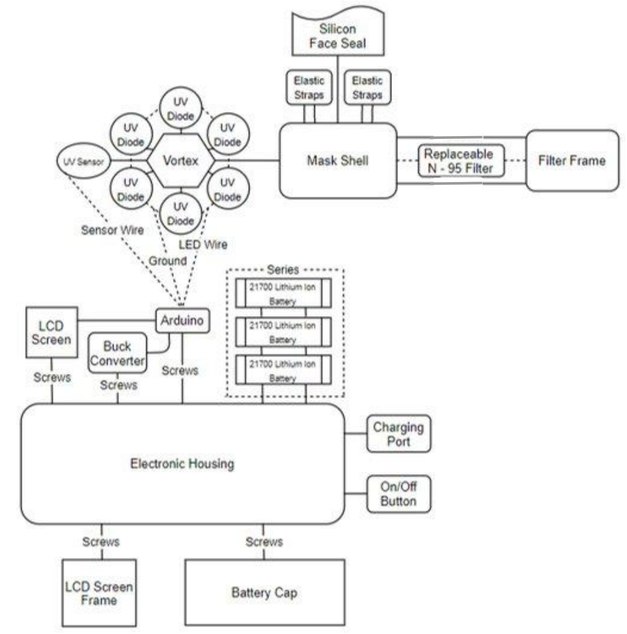
Inactivation Chamber - guides air to be sterilized by the UV diodes

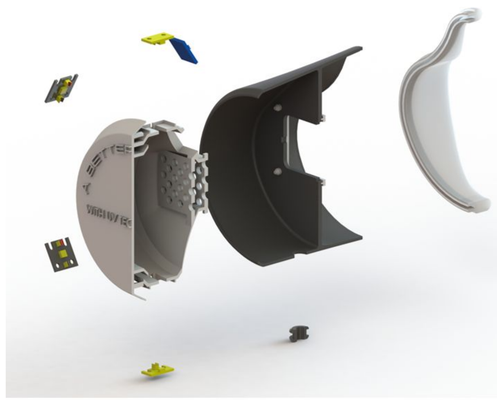
- 3D printed from ABS plastic, lined with polytetrafluoroethylene (PTFE) due to its high UV reflectivity
- 6 x Boston Electronics high output (16 mW) 265 nm UV diodes
- UV sensor to measure UV intensity in real time
- Tangential guiding veins to promote homogenous mixture of air

Battery Pack - houses electrical components and displays information

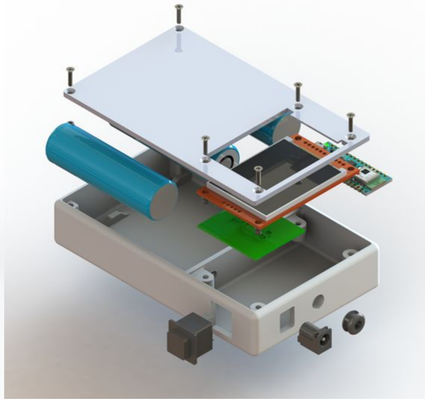
- 3D printed from ABS plastic, embedded with threaded inserts
- 3 x 21700 li-ion batteries (3s1p)
- 2.2" LCD screen to visualize UV intensity in real time
- Arduino Nano w/ Bluetooth for phone connectivity

System Level Diagram:

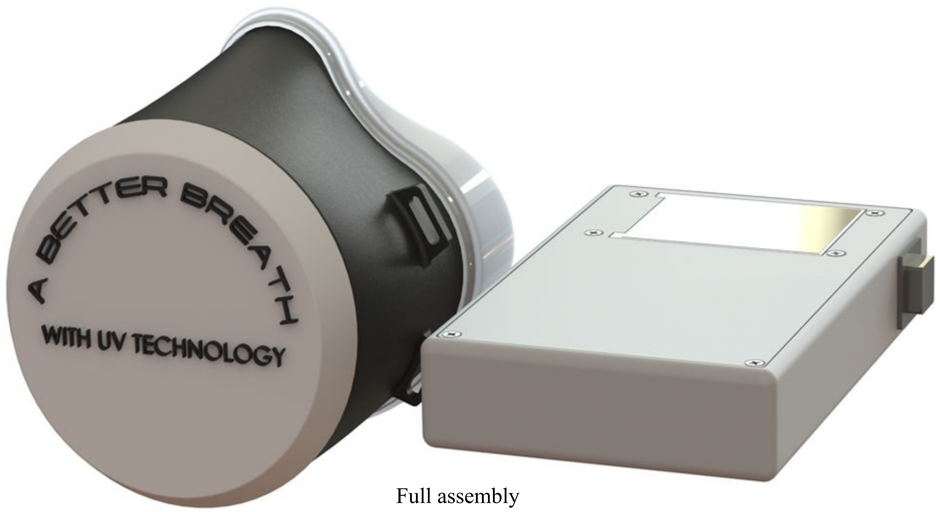




Mask exploded view



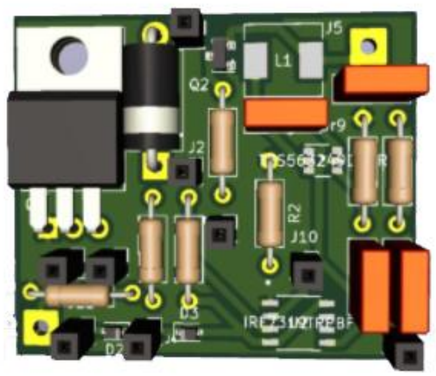
Battery pack exploded view



Full assembly

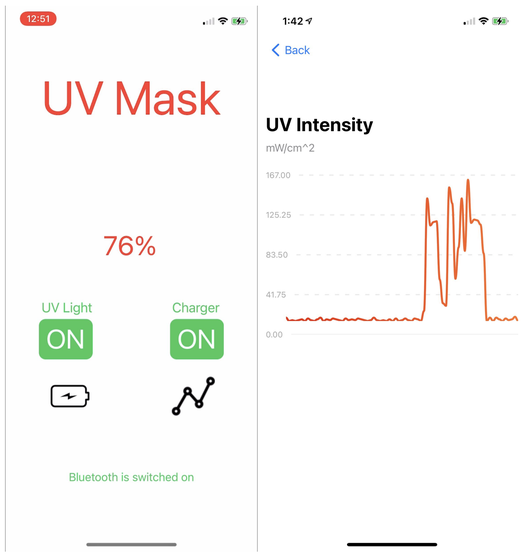
Custom PCB:

- 45.7 x 35.0 x 5.0 mm (L x W x H)
- Steps down 11.1 V from battery to 6.2 V for UV diodes and Arduino
- Protects against overcharge, over-discharge, and over-current
- Monitors battery life
- Single button to turn on/off device and switch information screens



Printed circuit board (PCB) layout

iOS Application:



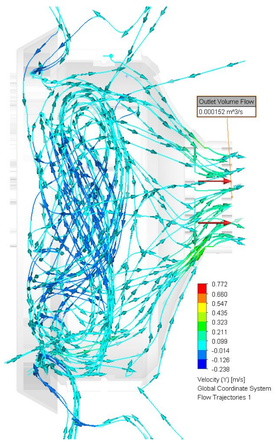
System connects to an Apple device via Bluetooth and is able to communicate important information such as battery life and UV intensity in real time.

Team Members: (Top) Victor Guzman, Ryan Malone, Sophia Smith, Tyler Young, Breanna Tang, (Bottom) Raven Tomas, Faud Siraj, Brandon Hoang, Nathan Pennington, David Nikiforov

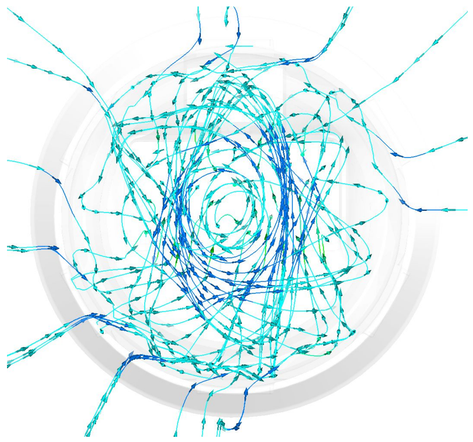
Advised by: Dr. Scott Shaffar and Professor Barry Dorr

Analysis:

It has been experimentally found that UV light has a peak inactivation efficiency (for COVID-19 specifically) at around 265 nm. At this wavelength, a UV dose of 3.7 mJ/cm^2 is sufficient for a 1-log reduction (90%). The dose of our system was estimated using SolidWorks Flow Simulations to determine the UV exposure time.

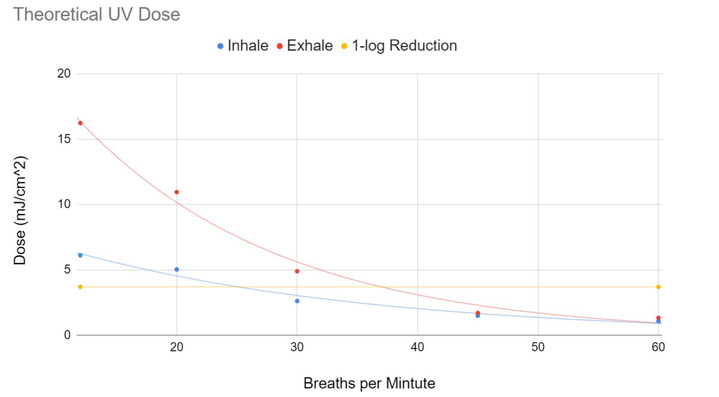


Side



Front

Flow simulation showing the path and velocity of air flowing through the inactivation chamber. The spiral movement of air is due to the tangentially placed guiding veins which help mix the air thus creating a more uniform fluid.



Graph showing the theoretical UV dose at various breathing rates. (Average person takes about 12-20 breaths per minute).

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