AQeye

Problems:

1. Cities around the world, and especially in India, are getting increasingly polluted which poses a serious health risk
2. People in many of these cities, especially in Indian cities, are not aware of the need to wear masks to protect themselves from the pollution
3. People do not enjoy wearing masks, and do not know when they need to wear a mask and when not to, so they avoid wearing masks

Aims of Product

AQeye is a product aimed to increase awareness about the need to wear masks, and to give its users accurate on location data of the air quality in their immediate atmosphere, so that they know whether they need to wear a mask or not

Product:

AQeye is a mask that lights up and changes colour [LED's change colour] depending on the air quality around you. This aims to send a message to those around you to wear a mask, through the use of stark colours.

AQeye also has sensors including a Dust Sensor, capable of measuring particles up to 0.3 microns small (smaller than PM2.5), and a CO2 gas sensor. It sends live data recorded from these sensors to your phone for you to check, and can alert you when you need to wear a mask based on this data.

Inspiration for product:

I had personally lived in the Delhi NCR region, one of the most polluted areas, for 4 years, and frequently visited it even during the highly polluted Diwalli and Winter times. While walking outside the Delhi airport, I nearly collapsed and fainted as I realised that I was unable to breathe, and couldnt walk for a long time, causing me to almost miss my flight. This incident made me wonder whether I could have protected my lungs and myself by wearing a mask in that situation, and made me wonder why I, and those around me, did not wear a mask. Thus I came up with AQeye to solve this.

The name AQeye is a spinoff of the term AQI (Air Quality Index) and was named with the idea that it allows the users to keep an "**eye**" on the **A**ir **Q**uality around them.

How it works:

The Product consists of two parts: The LED strip on the mask (The mask can be any disposable N95 mask and can be easily interchanged without needing a new LED system), and the main hub

First Prototype:

This prototype had the Dust Sensor, electronics and the batteries in a box shaped hub which could be attached to a backpack or other wearable via clips. This was connected to the LED's on the mask by wire.

In the First prototype, I also attempted to collect Air Quality data from an online API with the help of a GPS sensor which returned latitude and longitude data, which the API took as an input to return data.

a. The idea was that the user would carry a small hub containing the main heavier or bulkier electronics and sensors, that could be attached to a pocket, bag or strapped to an arm or otherwise, and would allow the user to wear a mask wirelessly without the trouble of having an uncomfortable mask, as masks are already not favoured by many.
   While intended to be wireless, with code and hardware already ready, we ran out of time and were unable to get the particular nRF24l01 transceivers to recognise each other, and there were no other transceivers immediately available.
   i. Hub:
      1. This is where the main electronics and sensors are stored
      2. It should ideally be as small as possible, with the current electronics could possibly be reduced to the size of an uno card pack (maximum)
         Note: Currently it is much bigger as I have not used a single pcb board for the electronics, and most of the space is taken up by wiring, as the final prototype was assembled last minute without time to shorten connections, and readymade jumper cables were used.
      3. It contains an esp wifi board, 7 pin LCD display (with I2C interface), A breadboard power board, 2 9v batteries (one for the board, one for the other electronics, though with the right wiring one is enough), a dust sensor (Compact Optical Dust Particle Sensor GP2Y1010AU0F) (can sense down to pm2.5)
      4. It was also intended to contain a GPS module and a radio transceiver module*
      5. Current functionality: Senses the dust particle density in the air, and depending on this, controls the LED ring on the mask via cables. It also displays this data on a screen.
      6. Intended functionality (could not be achieved, due to time constraints): Aside from the dust sensor, the esp would also use data from an API which returns AQI values from the nearest meteorological data center, as fitting an "AQI" sensor is unrealistic, as it depends on too many factors, while dust and particulate matter not only is damaging, but varies more from place to place, and can be filtered out by an n95/n99 mask (most).
         The board would thus use this data to calculate the colour the mask should reflect, and then using the transceiver sends data to the mask
   ii. Mask:
      1. A disposable n95 mask (for the project the disposable 3M Vflex mask was used due to its spilloff areas on the sides, which provided more space to mount electronics if needed (though not used), and has a flat bottom, so an led ring can be easily stuck

2. This mask currently has an led ring that is attached to the mask (Was intended to be an LED strip, but a ring consumes less power and proved to be more reliable and easier to interface)
3. It was intended to have an arduino nano (or smaller board) attached to a transceiver and then this LED ring, allowing for wireless transmission between the hub and mask to ensure the mask is as light as possible.

2. Planned features (Aside from some of the main intended features of the first prototype mentioned above)
    a. A notification feature that notifies users on their phone when the air quality of a certain area that they are in exceeds a certain amount
    b. A "forecast" feature that would allow users to tell whether they need to take their mask in the morning, by checking the color it is glowing

        The idea behind this was that many people hang their masks on their front door or near their exit (used to during covid) for easy access, and this could provide a visual aide as to whether the air quality outside (according to API data) is good or bad, like a rain forecast
    c. A map integrated feature that allows you to look at places that you visited and their corresponding air quality near you (from recorded data when you visited, to help you plan ahead.
3. Some other constraints:
    a. The api feature would need a permanently on hotspot, which may not be ideal, but could work for the home forecast feature
    b. Scaling down the hub and making it more robust and user friendly is always an issue

Problems faced:

Initially, a wireless connection was planned between the LED's on the mask and the main hub using NRF24L01 Radio transceivers, and an additional arduino board and battery separately on the mask to allow this, however a connection could not be reliably established, after several tries and different boards.

Additionally, the hub was large and difficult to carry around, even though most of the volume inside the hub was occupied by jumper cables that could be eliminated via the use of a PCB.

There was also the safety concern of having batteries on the users face if a wireless connection was to be used, which was not ideal.

Finally, an LED ring was used instead of an LED strip as the LED strips that had been purchased stopped working, and due to the time constraints of the Maker's Asylum Innovation School Program where this was developed, an LED ring that was immediately available was used as an alternative.

More information on the first prototype can be found here:

The second prototype:

Video (Presenting working prototype at Make, Break, Create Summit, Museum of Solutions, Mumbai in partnership with the UNDP):
https://www.instagram.com/reel/C6Vq0jooUJX/?utm_source=ig_web_button_share_sheet&igsh=MzRlODBiNWFlZA==

To create a disposable n95 mask attachment that reacts to the air quality around it in real-time, and reflects it by glowing different colors. Real-time data of air pollution measurements/values in their immediate environment also need to be sent to the user's phone so that they know when to wear a mask and when they are safe or not

The second prototype built on the first, but abandoned the wireless transmission due to the lack of reliability and safety concerns of batteries on the face.

Description:
The second AQeye prototype consists of a mask with an LED strip, similar to the one in the first prototype, which is connected by a short wire to a neckband which the user can wear around their neck comfortably. This runs on rechargeable battery power. It boasts a Dust Sensor and a gas sensor capable of detecting CO2 concentrations, with Data sent directly to the user's phone.

The mask displays 3 colours: Green (Good), Yellow (Poor) and Red (Extremely Injurius).

Design of the second prototype:

The hub was also redesigned to become a neckband, which connects to the LED's on the mask via a short wire, which increases the comfort of carrying it around, and also allows the mask and hub to become one unit. A neckband may also be more socially acceptable due to the wide variety of electronics filled neckbands on the market, such as those with bluetooth earphones and the Bose Soundwear Companion Wireless Wearable Speaker, which inspired the product's design.

The screen to display the air quality, which was included in the initial prototype, was abandoned as a screen would not be easy to view on a neckband, and sending data to a phone not only saves space, but also allows more information to be displayed due to a larger screen. It also reduces the volume and weight.

Finally, the Air Quality API that was planned to be used in the first prototype was abandoned, as later it came to light that it would not be as useful as having on location data. Additionally the API data is offered to everyone directly on their phones, therefore the AQeye mask would not be helping the user much by giving them data they already had access to.

Problems Faced:

- The second prototype's neckband design was rushed, resulting in a large bulky neckband with open spaces to allow modification of the electronics due to time constraints.
- Additionally, Wifi was used as a means to transmit data from the neckband to the user's phone [Blynk App] as this was the easiest and fastest way to achieve this goal in the short time period of the Maker's Asylum SDG Acceleration Program where it was improved upon. In a future model, bluetooth will be used for transmission. However a custom app will have to be created.
- (The ESP32 board used has built in BT capabilities)
- A latch system needs to be designed for the LED's on the mask so that the mask can be easily changed
- A higher capacity battery probably needs to be used, and an operating voltage optimal for all components set, preferably without a buck converter as it consumes a lot of power.
- Finally, the product has to be made more aesthetically pleasing, comfortable, compact and lightweight so that it appeals to users. This can be achieved to some extent through:
    - Using a singular custom Flex PCB shaped to the neckband's size. This will make it more compact and robust
    - The neckband itself can be 3d printed and be fully enclosed to make it more aesthetically pleasing, compact and comfortable

Components used:

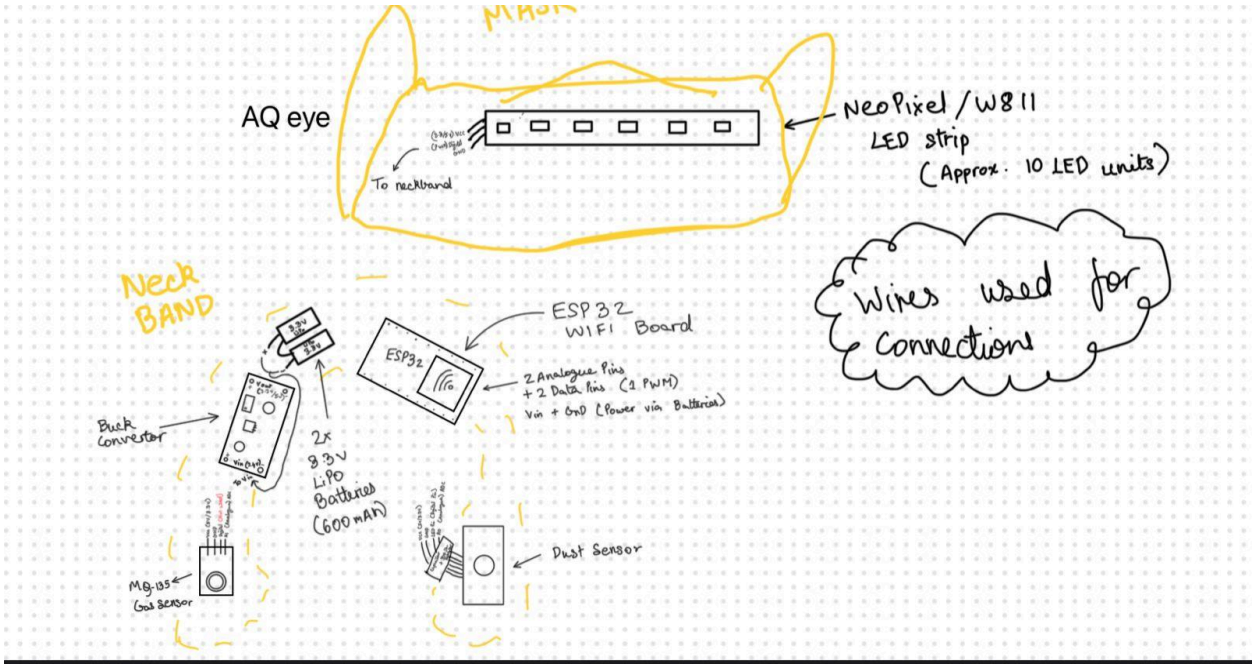
- 1x ESP32 (Main Board)
- 1x Lm2596 DC Buck Converter Step Down Power Module
- 2x 3.3V 600mAh LiPo Batteries (Wired in series to give 7.6V to the buck converter)
- 1x WS2812B LED Strip (12 LED's) / NeoPixel LED Strip
- 1x Sharp GP2Y1010AU0F Optical Dust Sensor
- 1x MQ-135 Gas Sensor

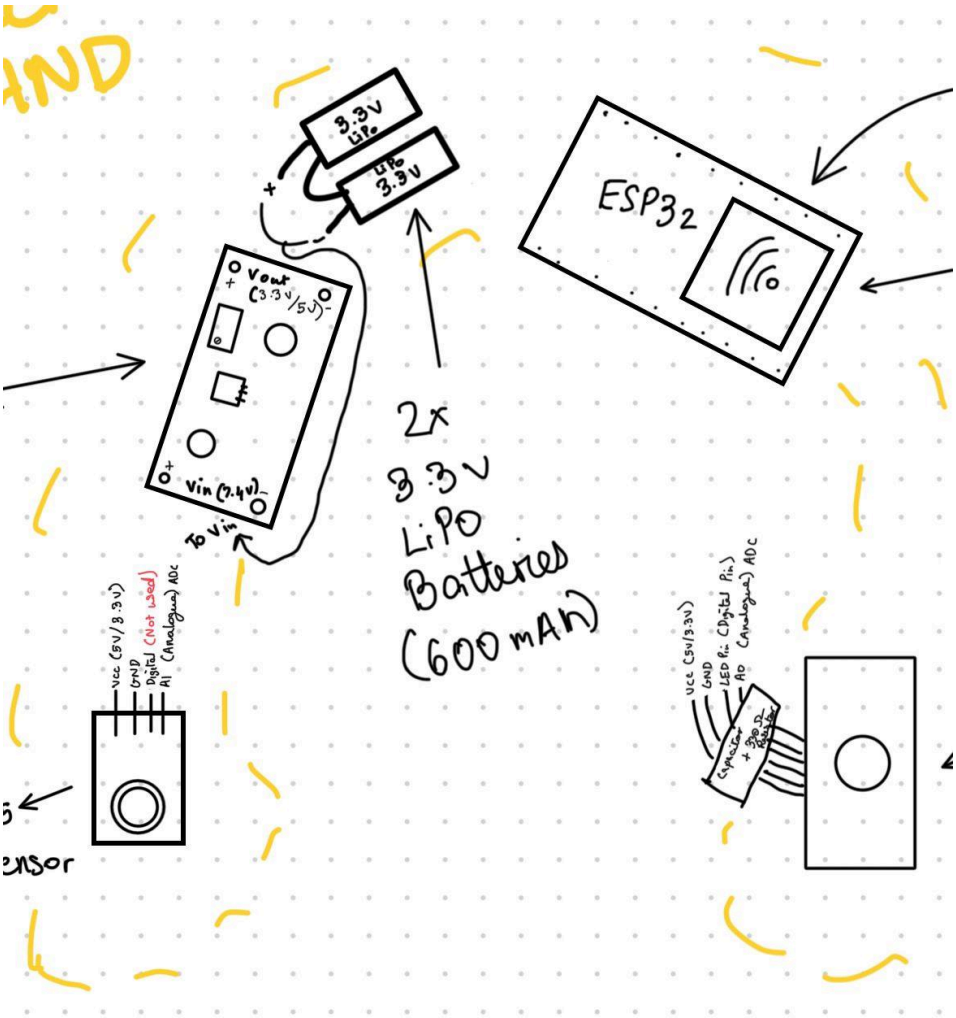
Ideas for improvements:

a. A notification feature that notifies users on their phone when the air quality of a certain area they are in exceeds a certain amount
b. A "forecast" feature that would allow users to tell whether they need to take their mask in the morning, by checking the color it is glowing
   The idea behind this was that many people hang their masks on their front door or near their exit (used during COVID) for easy access, and this could provide a visual aide as to whether the air quality outside (according to API data) is good or bad, like a rain forecast
c. A map-integrated feature that allows you to look at places that you visited and their corresponding air quality near you (from recorded data when you visited, to help you plan.

Sketches, diagrams and images of the prototypes:

Picture of the first prototype (Extremely rough version, led ring not properly attached, hub made out of thin plywood hot glued together and batteries taped on.)


AQ eye
NeoPixel / W811
LED strip
(Approx. 10 LED units)
To neckband
Wires used for connections
Neck BAND
ESP32
WIFI Board
2 Analogue Pins
+ 2 Data Pins (2 PWM)
Vin + GND (Power via Batteries)
Buck Convertor
2x
3.3V
LiPo
Batteries
(600 mAh)
MQ-135
Gas Sensor
Dust Sensor


3.3V
LiPo
3.3V
ESP32
Vout
(3.3V/5V)
Vin (3.4V)
To Vin
2x
3.3V
LiPo
Batteries
(600 mAh)
Vcc (5V/3.3V)
GND
Digital (Not used)
AI (Analogue) ADC
Vcc (5V/3.3V)
GND
LED Pin (Digital Pin)
Ao (Analogue) ADC

Note: the voltage requirements of the ESP32 (3.3V) is lower than the operating voltage of the sensors (5V) and LEDs which was not accounted for.