LOW COST PERFORMANCE TESTING OF FACE MASK AGAINST RESPIRATORY DISEASES

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Abstract: Since the outbreak of COVID-19, many people have resorted to producing their own DIY face masks due to supply shortages and to allow health care workers the proper PPE they need. The efficacy of homemade face masks is a disputed to picin recent times with a lot of misinformation spreading, often without any significant scientific backing. The goal for this project is to create an in expensive device that can obtain quantitative results on how well a face mask can filter particulates. The sensor used in this project can measure particles that are1.0µm,2.5µm and 10.0 µm in diameter.

1. INTRODUCTION

The recent outbreak of COVID-19 was discovered in 2019 and it is caused by the SARS COV-2 or Severe Acute Respiratory Syndrome. Scientists researched and announced the arrival of a slowly growing pandemic. Now, 208 countries around the globe are fighting with this deadly virus. On one side our medical team is trying its best to find its cure where as on the other side it is our duty to help them by following the safety measures like wearing masks, following social distancing, and washing hands-on frequent intervals, etc. The doctors and nurse who treat the patients get direct contact with the patient by manually attaching the ventilators. In the second Wave tons of people were affected by the lack of Oxygen, Even the hospitals also had the limited amount of cylinders, considering all these existing issues, many people have resorted to producing their own DIY face masks due to supply shortages. A system is designed to create an inexpensive device that can obtain quantitative results on how well a face mask can filter Particulates. The sensor used in this project can measure particles that are 1.0 µm, 2.5 µm and 10.0 µm in diameter. which in turn reduces the spread in go virus and makes management of COVID more effective and simpler.

2. LITERATURE REVIEW

There are various issues faced by doctors and patients in management of COVID. This alarming pathetic scenario motivated to search for an idea to develop a system which provides solution to all the existing issues and various proposals have been studied to develop this system.

[1]Hiroshi Ueki, Yuri Furusawa, Et.al ,American Society For Microbiology [2020] (Effectiveness of Face Masks in Preventing Airborne Transmission of SARS-CoV-2) The efficiency of mask against airborne diseases has been tested by using nebulizer and ventilator. Demerits: It is Very Costly and it can only be conducted in Biosafety level 3 facilities.

[2]Steven.J.Johnston,Philip.J.Basford,Et.al,Multidis ciplinary Digital Publishing Institute [2019] (City Scale Particulate Matter Monitoring N Based Air Using LoRaWA Devices Quality IOT) The city wide air quality is monitored by using low cost particulate matter sensors.

[3]Dr. kevin P Fennelly, Pulmonary Branch, The Lancet [2020] (Particle sizes of Infectious aerosols: implications for infection control.) Deals about different infectious aerosols, their particlee.

sizes and average distance travelled by those particles.

3. PROPOSED SYSTEM

The block diagram for the proposed system is shown in [Fig 1]. The system is controlled by Arduino uno. Arduino uno microcontroller is used to execute our task of getting the information from the sensors and displaying them. The input block consists of [Fig 2] AO-03 Oxygen sensor which is usually capable to detect the oxygen level present in the atmosphere. It is used here to check whether sufficient amount of oxygen is present to breathe without any suffocation.[Fig 3] PMS5003 Particulate sensor uses laser scattering principle to detect the concentration of the particles. This device is used to detect the particles present in the atmosphere .After it sends the commands to Arduino uno. Arduino uno in turn control the output block based on the commands given by these two sensors. The arduino sends the command to the output to shown value taken by this sensor. The output block consists of a Microsoft data streamer to display and save those data.

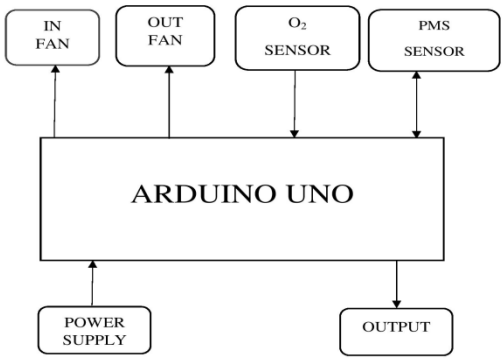


Fig. 1 Block diagram of proposed system

To test how well different fabrics filter particulates when deciding on a material to create a mask from. To perform a 'fit test'. The physical fit of a face mask is important to consider. This device will allow you to seethe Effect of this on the mannequin head, and improve the design of the mask to get better results. Compare DIY masks to commercial masks, such as the N-95 or surgical mask. Face masks tend to lose their filtration quality over time. This device can record data using Excel and Microsoft Data Streamer, so you can keep track of the mask quality with regular testing.

Fig. 2 AO-03 Oxygen Sensor

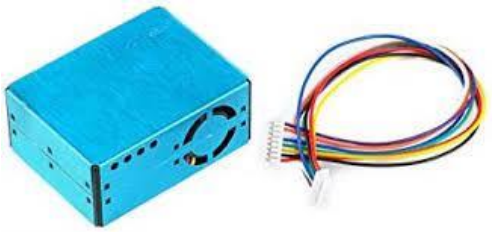


Fig. 3 PMS5003 PARTICULATE SENOR

4. METHODOLOGY

The design of this device is meant to simulate a person inhaling and exhaling through a face mask. There are two "intake" fans that suck air into the mannequin head enclosure (inhalation), and two "exhaust" fans that blow air back out (exhalation). The particulate sensor takes a reading each time the intake fans cycle on and off and records the PM-1.0, PM-2.5 and PM-10.0 data in Excel. The test is set to run for 6 minutes until a green LED turns on. To assemble the mannequin head, to zip tied the four fans together in the formation shown above with two fans facing in and two out. Then use some wire to secure it to the mannequin in front of the mouth cut out. Use some duct tape around the fan to act as a shrouden closure to

Create better suction. Finally, use Velcro to attach the sensor [fig 4]

Fig 4 The Mechanism of DC fan

To seal the mannequin head closed, to cut a piece of plastic tupperware with a lid and glued that onto the bottom of the head. This allows you to still be able to get the sensor and fans out easily. to cut a small hole in the side of the plastic to thread the wires through, and sealed it with sealant. It is very important that the assembly is well sealed to get accurate results. For this reason, to recommend cutting as little holes as possible when building. This is a picture of the breakout board that came with the PMS5003sensor

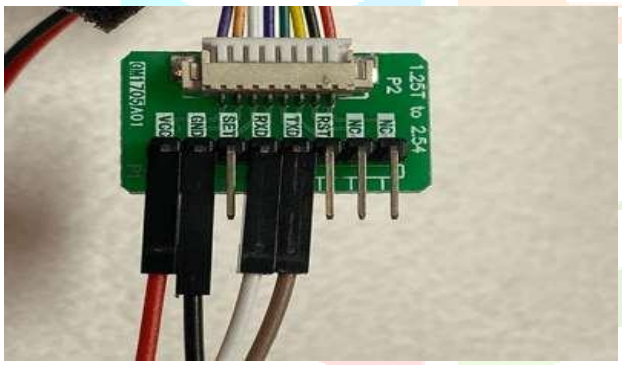


Fig 5 breakout board of PMS 5003 particulate sensor

The picture below shows the circuitry for powering the fans in this project. The orange and yellow wires go to the positive and negative terminals on the fan, respectively. A transistor is needed in this case because the fans require too much current to be powered by the pins of the Arduino alone. The blue wire receives PWM (pulse width modulation) signal and is used to control the speed of the fans [fig 5] A fly back diode is necessary to protect the Arduino pins from sudden voltage spikes by the inductive load of the fans.[fig6]If you want to learn more about this circuitry, there are some great articles and resources explaining them in References!

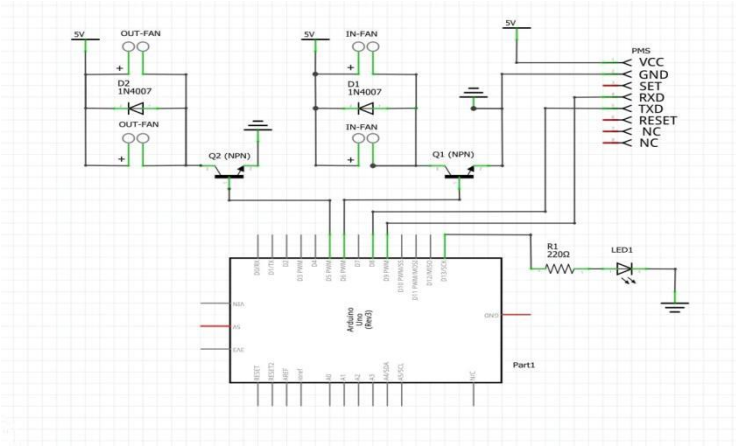
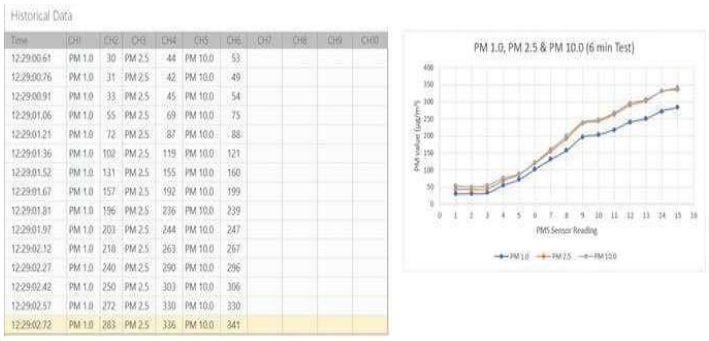


Fig 6 circuit

Finally, a sensor behind the mask senses particles of different sizes provides as the data. From this data we can compare the particle sizes to the size of virus particles and find efficiency of the mask. By testing the masks made of different material we can identify which material is more suitable to make DIY masks.

5. RESULTS AND DISCUSSION

Here is an example of 4 tests that we did. We tested a DIY mask made from a thick yellow fabric with coffee filters inside (shown in the thumbnail), a surgical mask, a T-shirt wrapped around the face a single time, and no mask.

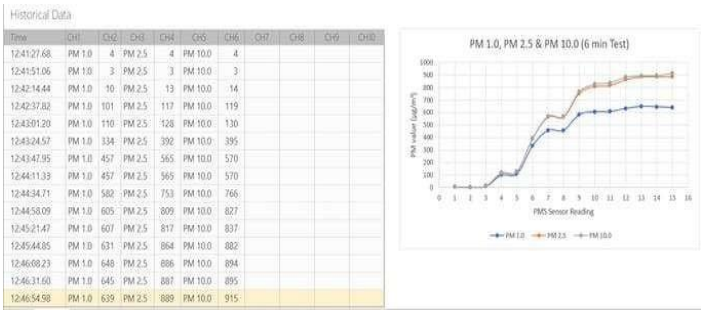


DIY Yellow mask

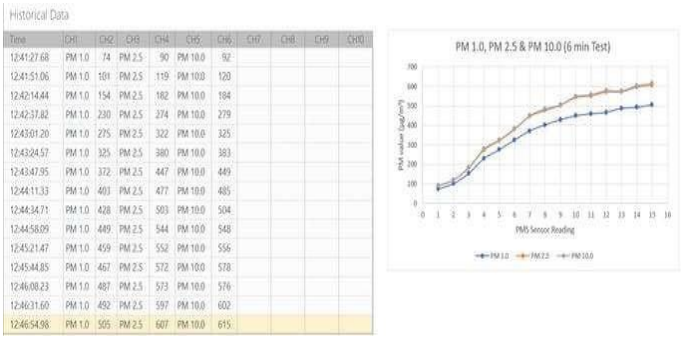
The DIY mask had the best results of the four tests. This is most likely because it is tight- fitting unlike the surgical mask, and a more effective material compared to the t-shirt

No Mask

With no mask, the PM levels increase much faster and reach the highest levels of all the tests.



Although the surgical masks is made of an effective material,it is not very tight fitting. For this reason, it seem to allow more particulate matter through. The PM levels do not increases as quickly as with no mask though



T- shirt wrapped around a single time

The t-shirt has a good fit, although it is a thin material that allows a lot of particulate matter through. For this reason, it has about double the PM value's of the DIY yellow mask.

6. CONCLUSIONS

There is clear technical potential for testing of face mask during this and future pandemics using this open source designs that can be rapidly fabricated using distributed manufacturing.it is a low-cost construction. Future work is needed to achieve the potential of this approach not only on the technical side, but also by developing policies, updating regulations and securing funding mechanisms for the development and testing of open source testing of face masks for both the current COVID19 pandemic, as well as for future pandemics and for everyday use in low-resource settings

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