DEVELOPING A DEVICE THAT TRACKS THE INSTANT SIDE EFFECTS OF FACE MASK USE IN DAILY LIFE

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INTRODUCTION

Various methods have been tried to combat infectious diseases throughout human history. In the coronavirus epidemic that emerged in 2019, the use of face masks have been mandatory in many countries. In our country, it has been made mandatory to wear face masks both indoors and outdoors as of May 2020. In May 2022, mask obligation is canceled except healthcare organizations. During the 2-year period when masks were mandatory, a wide variety of masks were used, from masks produced under unsanitary conditions to masks in N95 standards. Few scientific studies have been conducted on the long-term use of masks outdoors or indoors. In this study, we developed an electronic device to measure the side effects of the daily life use of N95 standard masks on the human body. With the developed device, we monitored biological parameters such as the carbon dioxide concentration in the mask, the oxygen rate in the blood and the pulse rate during the use of the mask.

Indoor air quality is one of the factors that directly affect human health. In addition, poor air quality can cause sudden deaths. The World Health Organization (WHO) has published a large number of data in its guide called "Indoor Air Quality" (World Health Organization Europe, 2010). In recent years, carbon monoxide (CO), carbon dioxide (CO), formaldehyde 2 ($HCHO$), volatile organic compounds (UOB), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) have come to the fore as the main pollutants (Chen et al, 2007).

WHO has identified three main groups of indoor pollutants that are particularly harmful to our environmental health; biological indoor pollutants such as moisture and mold, pollutant-specific pollutants from chemical pollution, and pollutants from the combustion of indoor fuels. The ideal way to monitor such harmful organic and non-organic substances, such as CO or CO_2, is to install an indoor air quality monitor that can alert you when your health is at risk. Poor indoor air quality can be caused by a variety of sources found in homes, commercial buildings, and other workplaces. According to the WHO, hundreds of different types of bacteria, molds and fungi can multiply in your environment when there is sufficient humidity in the atmosphere. WHO has identified some specific chemical pollutants that have a negative impact on our air quality by 50 experts working in-house (Table 1). Parts Per Million is used to express the amount of a chemical in the air. For example, if the measured value is 1000ppm, 1000 measured chemicals were found per million particles. That means 0.1%.

Table 1. Some Chemicals Affecting Human Health Negatively And Threshold Values In The Air

Chemical	Treshold Limit Value	Chemical	Treshold Limit Value
Benzene	0.1 ppm	Formaldehyde	0.1 – 0.3 ppm
CO	35 ppm	Naphthalene	10 ppm
NO_2	3 ppm	Polycyclic aromatic hydrocarbons	Ranges depending to chemical

Due to the Covid-19 outbreak, the use of face masks has been made mandatory in many countries. Even outdoors, masks were mandatory. Few studies have been conducted on the effect of mask use on the spread of the virus. However, no enough studies have been conducted on the negative effects of long-term use of masks on human health. Surgical masks, once a piece of cloth used only by a doctor or nurse, are today

manufactured using non-woven fabrics made from plastics such as polypropylene to filter and protect. They are also available in many different styles and grades depending on the level of protection the wearer needs (Henneberry, 2021). Like most types of plastics, polypropylene is made from substances derived from hydrocarbon fuels such as petroleum oil. First, propylene monomer is extracted from crude oil in gaseous form, and this monomer is then subjected to a process called chain growth polymerization to form the polymer polypropylene. (https://sewport.com/fabrics-directory/polypropylene-fabric).

METHOD

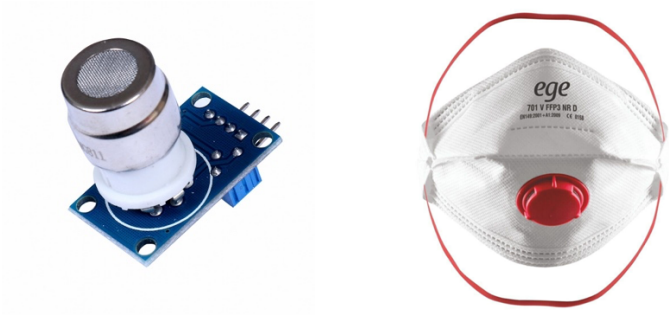
In its study in March 2020, WHO recommended that face masks should not be used for more than 4 hours (WHO, 2020). This study was conducted to indicate the side effects of using masks for more than 4 hours by healthcare workers. The source of the study is another study conducted in the same institution in 2009. When the mask is used for a long time and it starts to bother the wearer, there will be a tendency to touch it frequently with wearers hands. This contact will increase the risk of infection. Re-attaching the face mask after removal will also increase the risk of inhaling viral particles. In addition, when the mask gets wet, its electrostatic properties are reduced, so it holds fewer particles and reduces air permeability. In this case, the user can breathe less healthily. For this reason, it is preferable to change the mask at most every 4 hours.

Another risk associated with face mask use is inhaling too much CO_2, which is a long-lived greenhouse gas that accumulates in the atmosphere (Vermeulen et al, 2020). In many studies, CO_2 level above 1000ppm has been defined as risky for human health.

Table 2. CO2 Hazard Scale

CO2 level (ppm)	Air Quality
200.000	Certain death
50.000	Intoxication
30.000	Serious Health Risk (10-15 min)
8.000	Submarine
1.000	Upper comfort boundary
600	City air
280	Pre-industrial air

Face masks are classified according to the level of permeability. In addition, some masks have a valve mechanism called a valve. N95 mask was used in this study. N95 is an American standard administered by NIOSH, part of the Center for Disease Control (CDC). In these masks, the criterion called FFP (Filtering Face Piece) is used. In this study, FFP3 valve mask, which provides at least 94% protection, was used. We used the MG811 CO_2 sensor to measure the amount of carbon dioxide accumulated in the mask. This sensor is a highly sensitive sensor with which we can measure the CO_2 concentration very quickly via an analog pin. When MG 811 detection material reacts with carbon dioxide, it will produce electromotor force (Aziz et al., 2018). The mask and CO_2 sensor used are shown in Figure 1.



(a) (b)

Figure 1. (a) MG811 CO_2 Sensor (b) FFP3 Mask

If there is a high carbon dioxide and low oxygen concentration in the inhaled air, the amount of oxygen in the blood may also decrease after a while. The oxygen level in the blood is measured with an oximeter. In a healthy person, this level is between 95% and 100%. Factors such as daily activity and fatigue can affect the oxygen level. If the oxygen level falls below 90%, it is risky for human health.

Figure 2. MAX30100 Heart Rate And O_2 Concentration Sensor

The circuit diagram of the developed device is shown in Figure 3. The device counts and records the CO_2 amount measured in the mask, the oxygen concentration and pulse rate values read from the fingertip sensor once per second to the txt file on the SD card.

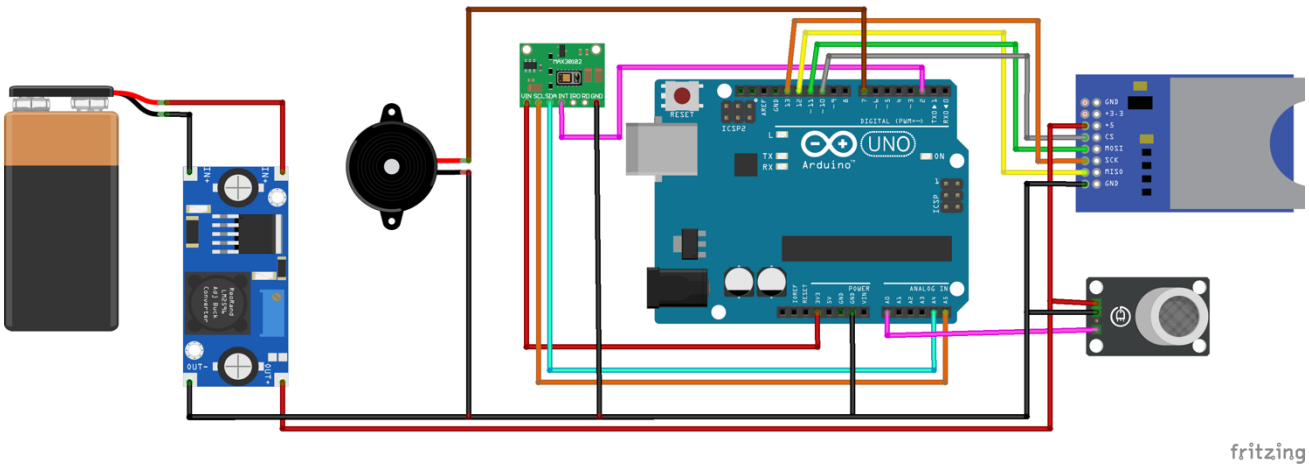


Figure 3. Circuit Diagram Of The Developed Device

RESULTS

With the device developed in this study, the immediate effects of long-term use of masks by healthy people can be examined. The effects in environments where wearing a mask is mandatory for a long time, such as the work environment, gym, school, public transportation vehicles, can be examined. In addition, the biological responses of sick and healthy people to the use of face masks can be monitored.

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