Design of Smart Air Purifier Facial Mask

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***Abstract*—Air pollution is a menacing issue in this current era. The atmosphere is composed of unwanted, non-efficient respiratory particles that are harmful to humans. The air people breathe is full of harmful contaminated particles resulting in many non-infectious respiratory diseases. The world-threatening COVID-19 pandemic has led the people to care about their personal hygiene and a mask is turning out to be an eminent requirement for every human to prevent the first stage of attack by the deadly coronavirus. Indeed, asthma is turning worse amidst humans, mostly because of these toxic and life-wrenching allergens that coexist in the atmosphere. To realize a knowledge-based sample a design of smart mask is proposed in the paper.**

Keywords—Smart Mask; Air pollution; COVID-19; Allergic Asthma; Filters.

I. INTRODUCTION

The quality of the air inhaled by people is undoubtedly polluted. The quality of polluted air exceeds the WHO (World Health Organization) guideline limits. The WHO fact reveals that there exists a strong link between air pollution exposure and cardiovascular diseases. The air is composed of unwanted particles and is quite infectious for all the living organisms. The earth's atmosphere is full of harmful substances which results in non-infectious respiratory diseases that exist to be life-threatening. The demonic asthma is turning up to be a trauma amidst humans as it consists of allergens and chemical pollutants. Scientific ideas and modern instruments can be used for prevention purposes.

The COVID-19 pandemic that arose in China is spreading rapidly around the globe by one-one contact and the respiratory droplets get transfused easily. Allergic asthma is mainly caused due to allergic particles that the people inhale. A facial mask can be used to avoid such infections with advanced embedded technology which involves filter layers in it. The filters used are activated carbon filters and HEPA (High Efficient Particulate Arresting) filters. The carbonated filters of thickness 0.35mm are used to filter out the smoke fumes, chemicals, and odours while breathing. There are many harmful substances in the air like VOCs (volatile organic compounds), viruses, bacteria which are air-borne chemicals that mostly inculcate into the respiratory tract. Hence, a VOC Gas test enables to record the amount of purified air filtered from activated carbon and a graph which shows the analysis (in Fig.1.) of the VOC Gas test. The carbonated filters fail to filter allergens like bacteria, chemical compounds. Thus, carbonated filters should also be replaced frequently. HEPA filters of thickness 0.5mm can be used to overcome this problem. The HEPA filters are generally used to separate dust particles from the air.

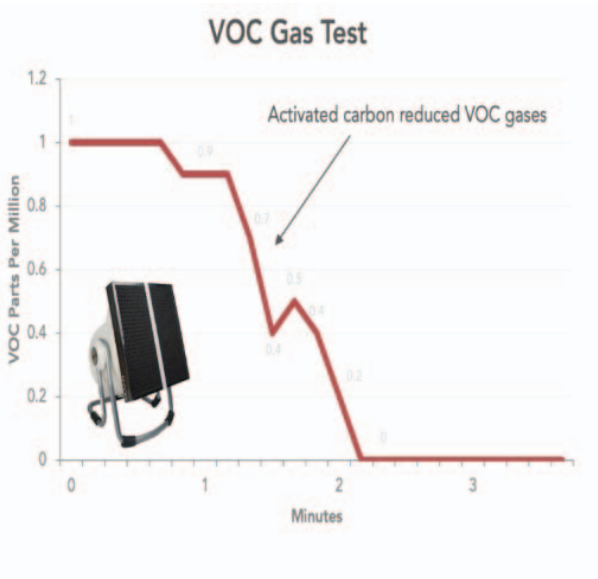

Fig. 1. A sample graph analysing the VOC Gas test. Image Source: Smartairfilters.com

II. LITERATURE REVIEW

Sato et al., propose [1] an article about carbon activated masks with chemical absorptivity for health workers. Activated carbon adsorbs various chemicals. During preparation, a worksheet that consists of activated carbon adsorbed anticancer drug droplets scattered. Therefore, it was expected to protect against vaporized anticancer drugs by the activated carbon mask with the absorption ability. Here the three different mask PAM PCM SAM have been experimented, and all three have certain limitations. But, Stereoscopic type activated carbon mask (SAM) has an upper hand with comparatively more beneficial features and this has been proved. Air filters account for a demerit, that the potentially shed small fibres would be risky to inhale. A filter must consist of two layers of cotton fiber in order to make it usable. It is important to remember that a mask must not contain any gaps with leakage proof and perfect conditions.

This article is based on the mask design knowledge base development [2], that is expected to put forth a mask design

system which is more personalised. A perceptual descriptive space of the mask is developed to understand the knowledge base. The description made is based on functional and aesthetic perceptions of the mask. The mask element matrix is formed from developed ontology. On research, knowledge-based with personalized design is the first task that is related to the knowledge base development. Sensory evaluation and fuzzy logic integrated method is used for the design knowledge of the base proposed. The four dimensions include a pair of mask perception for aesthetic descriptive space, which can describe and excite consumer expectations of mask aesthetic demands. They are Simple-Complicated, Daily-Professional, Practical-Aesthetic, and Mature-Lovely. It is concluded that the proposed knowledge base is valid and it can be further developed to an automatic mask design system.

This article elucidates that technology [3] is evolving from voluminous state to the enormous miniature feature size devices. According to the technology the patterning process changes are made by improving the quality of producing a tiny device. The low-cost photolithography technique which is a critical part of the fabrication process begins when mask design is introduced. The only drawback is that the printing dimension must not be less than 100μm, certainly the bigger the size, the better the resolution of transparency. It is concluded that simple inject printing with AutoCAD software mask design is convenient, less time consumption and, low-cost of completing a conventional fabrication process, however the only drawback that small feature size is unable to be patterned using this method due to the ink expansion problem and porosity issue. Design using AutoCAD is not only only easy or convenient but it can also be altered as per one's convenience.

This article explains that, if modern technology [4] is induced into a mask with every layer, then it may protect from air pollution. If so, then it will be a safer mask to use. The paper aims to develop a more advanced mask with a different layer of protection from dust, bacteria and hazardous elements of the air at the lowest cost with wirelessly airflow control systems. The product ensures that 94% of air is purified with its embedded technology. It also includes bacteria-killing by UV light protection. The mask can remove the fine particles of below 0.3 microns and Nanoparticles easily and efficiently whereas normal masks can't provide all the protections. In this product, the smokes, fumes, odours, and chemicals are removed through the carbon filter. The HEPA filter in general, separates the dust, particles larger than 0.3 microns, etc. A polarizer is used for the advanced bacteria protection and detachment of the particles from the air and also with a Nano filter, it also removes the other particles which are the size of Nano level. The air pump used in this product will provide sufficient air flow. It gives wireless connectivity up to 10 meters. It is concluded that the main aim of this research is designing and building a low cost, wirelessly controlled advanced air purifying facial mask. The mask is containing wireless and manual control.

Sublett, J. L compares different air filters [5] and filtration techniques such as HVAC, PRAC, etc. It is advantageous for its ventilation action against microbes and faces a lot of disadvantages including poor filter fit, duct leakage, growth of microbes, etc. After a thorough analysis, it found that the HEPA filter is more efficient and relatively has fewer demerits.

Guo et al., [6] describe the HEPA filters purifying techniques that remove intense particulate matters and harmful substances. The system proves to be unique by filtering the dust within the house premises that cause pulmonary infection. The system suffers a challenge that even though it captures and removes particles above 0.3 microns, there are possibilities for smaller particles to sweep through which is hazardous present in the air.

Sportelli et al.,[7] propose a particulate air filtration system designed to capture 99.97% of fine particles larger than 0.3 microns. This has the advantage to eliminate viruses, bacteria, airborne fungi from the air buildings. Despite the advantage, when mold and bacteria assemble inside the air system on the HEPA filter, these organisms have the inheritance to grow within the filter. The microorganisms multiply rapidly and are released back into the air.

The article reviews "Activated Carbon Filters",[8] that are employed in filtering out the organic carbon compounds and distilling free chlorine from water, thereby converting the water to be discharged and for making it available for the constructing processes. There are enormous types of futuristic activated carbon filters present for purification systems in production units. Activated carbon gives execution characters based upon the strata from where it originates especially like bituminous coal. The processes used to produce the AC materials are highly patented. And this turns out to be the reason to get a needful activated carbon filter with necessary need.

The article "Activated Carbon Air filters", [9] explains activated carbon has distinct properties that removes volatile organic compounds (VOC's), odours and other gaseous pollutants from the air. The Carbon Filters are unique from other air purifiers like HEPA that only filters pollution particles in the air. The Carbon air filters are mostly used to remove gases. A bed of activated carbon (also called activated charcoal) filters the gases and are usually used to combat volatile organic compounds (VOC's) released from common household products. They cannot remove fine particles like mould, dust or pollen from the air.

Harnish et al., proposes [10] about whether carbon works out as a filter. Carbon mixed with HEPA filters is checked based on its filtration process by open methods. Burning three cigarettes in a room demonstrates VOC's reduced carbon. The PID lamp with eV ratings 10.6 determines what type of VOCs PID machines can develop. In addition to the IQ air tests and pre filter tests with control conditions, carbon HEPA filters can remove an overall of 95 % of dust particles in the filters. Disadvantage is the outdoor of PM2.5 is not stable. The filter moves up to 4 micrograms from start to finish.

III. METHODOLOGY

A. General approach

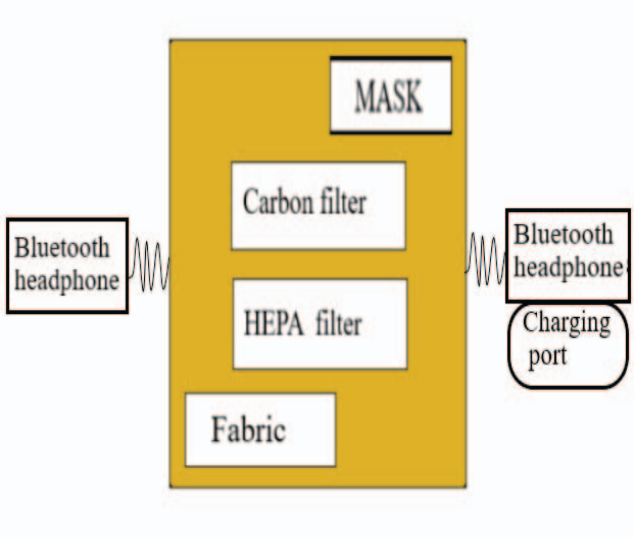

Fig. 2. Block diagram of the mask designed

The mask is designed to meet the air pollution causing diseases like asthma and hardcore viruses that spread through the air like COVID-19. As shown in the block diagram Fig.2, the mask is made of cotton fabric containing carbon layer that would be capable of filtering dust, smoke and, other chemical fumes and followed by HEPA layer which is capable of removing mold, dust and other allergens both together used for improving inhaled air quality. The mask is attached to Bluetooth headphones with charging option, and magnets placed making it reusable, re-washable hence helping it for long life. The mask serves a purpose of functional and aesthetic view with smart technology.

B. Development and design :-

The mask is proposed with an idea of filtering out the dust allergens of diameter 100micrometer impede the coronavirus which is of diameter 125nm as it falls within the particle-size range that HEPA filters capture0.01 micron(10nm) and even above the mentioned range. The carbonated filter of thickness 0.35microns and it can filter out the chemical fumes of thickness ranging from 0.5-5000 microns.

As illustrated in Fig.3. The primary layer has the outer cotton fabric which enables easy wash thus making it reusable. The succeeding layer is the activated carbon filter which is the key filtrate of slightly larger particles (chemical agents, dust particulates, smoke fumes). Though the carbonated filters relieve out unwanted particles it fails to filter the tiny allergens, viruses and other harmful microorganisms and this is overcome with HEPA that filters the microscopic organisms. The Fig.4. shows the interior and front view of the mask designed.

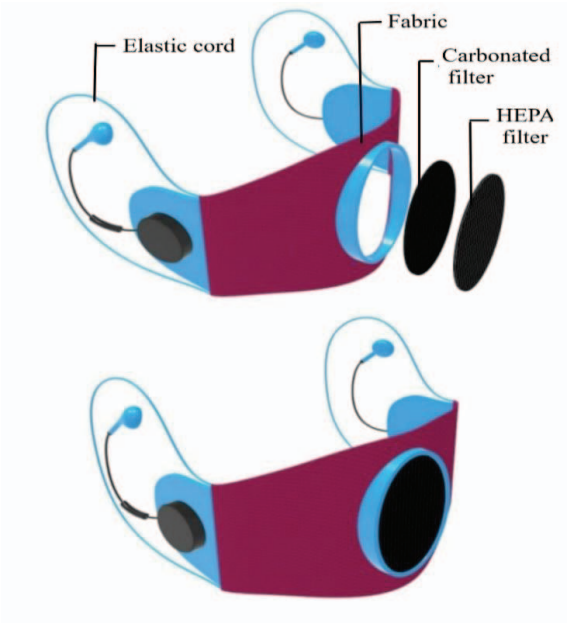

Fig. 3. Mask detailed section and parts

TABLE I

Aesthetic Evaluation and explanation

Aesthetic evaluation	Explanation
Basic-Complex	Basic: extravagant and ostentatious
	Complex: includes enormous layers interconnected
Daily-Professional	Daily: washable after every usage
	Professional: Designed for professional use with Bluetooth enabled headphone attachment
Practical-Aesthetic	Practical: Efficient design to protect from environmental factors
	Aesthetic: Made in a perceptive and exquisite to look at
Mature-Lovely	Mature: Comprehensive in natural development
	Lovely: Magnificent and comfortable

The TABLE I as depicted explains the aesthetic criteria of the mask designed and thus it stands out to be unique. As we are in the era of improving technology day by day, we have introduced a new technology included in the facial mask. Bluetooth earphones on both the sides with mic and the charging point are available for a long battery effect, which makes it more comfortable for the customer who uses it for travelling purposes, etc. It is a reusable mask where the Bluetooth speakers can be detached while washing. So it becomes a re-washable product and provides a long-lasting life.

We have designed this using AUTODESK-FUSION 360 which is done by a single cloud-based platform CAD or CAM CAE.A tool that is used for unifying design in engineering and manufacturing. It designs with iteration, performs stimulations, animations, and tools for sculpting that review form and tools to model that can create astounding features. FUSION 360 also

includes organic shapes modelling and a comprehensive package. As shown in the TABLE II THE features of the mask is analysed with clear explanation and it highlights the distinctive features.

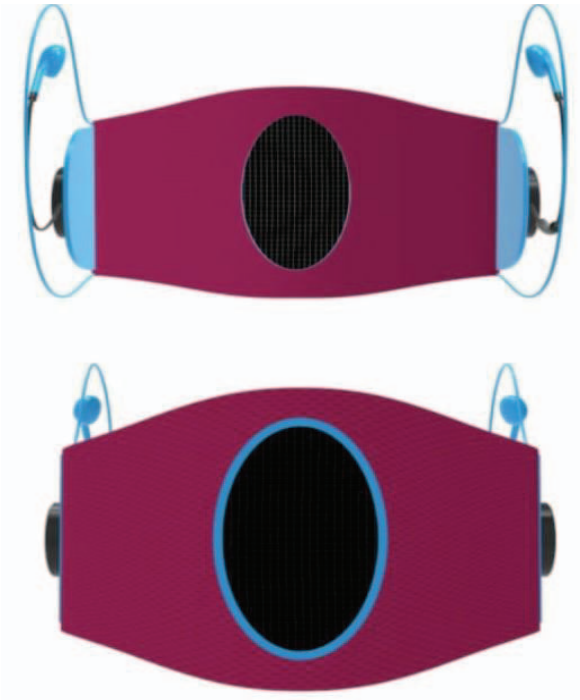

Fig. 4. Interior view and exterior view respectively

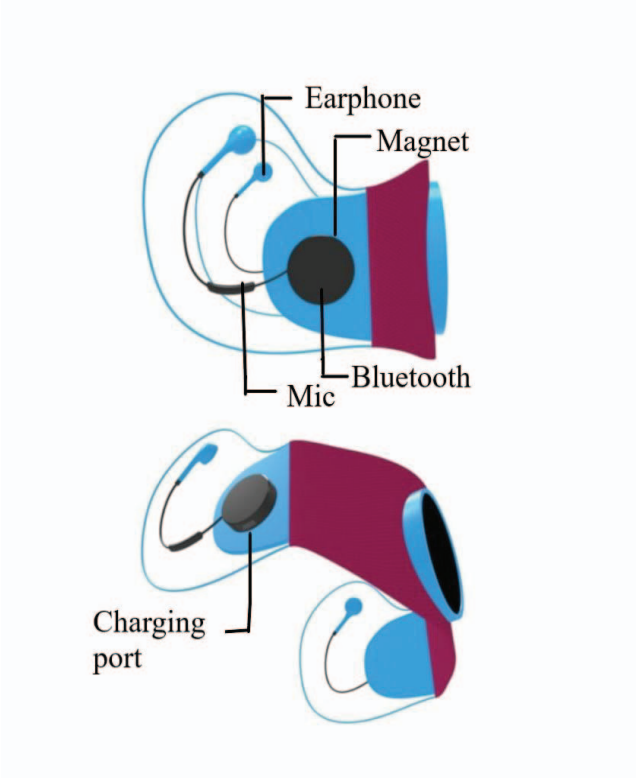

Fig. 5. Bluetooth enabled headphones connected with mask

TABLE II

Perceptual Feature Evaluation and their explanation

Perceptual Features Evaluation	Explanation
Filter	Carbon and HEPA filters
Bluetooth headphone	A pair of headphones with mic
Breath ability	The ability of breathing smoothly
Cost-efficient	Extravagant and lucrative
Flexible	Stretchable, fits for ages
Smog Prevention	Avert smog inhalation into nasal cavity
Dust Prevention	Avert dust inhalation into the nasal cavity

IV. CONCLUSION

At present, there are enormous amounts of air related diseases including the life-wrenching coronavirus and asthma. The mask design proposed with advanced filters and techniques is an initiative for the welfare of mankind. It is designed with multiple objectives to protect both asthma patients getting affected from the infectious diseases and protect the normal users from the fatal COVID-19 viruses. Making it distinctive, a pair of removable Bluetooth headphones with a mic is attached to ease the use of masks by professionals in the work environment.

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