iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** X **Month of publication:** October 2022

DOI: https://doi.org/10.22214/ijraset.2022.47025

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue X Oct 2022- Available at www.ijraset.com

Mask and Respirators: Disease Control and Prevention

Rohit Ghulanavar[1], Pallavi Sagare Ghulanavar[2]
[1]*Asst. Prof. KITCoEK, (Autonomous) Kolhapur, Maharashtra, India*
[2]*Asst. Prof. DADSCOE, Bhadgaon, Gadhinglaj, Maharashtra, India*

Abstract: ***The current pandemic has pushed everyone to seek solutions for a reusable, stable and 100% effective face mask. This is due to common filter masks tend to gradually lose the ability to filter viruses and bacteria. All available masks for Covid-19 are mostly efficient 95%. These masks protect face from droplets released by another person in atmosphere which may contain Corona virus molecules. But these masks have efficiency of only up to 95% and these masks actively do nothing to stop Covid-19 from spreading. Thus, this type of masks is called Passive Masks On the contrary, Active Mask is absolutely stable because it does not only filter but inactivates the virus and/or bacteria, according to the systems used to tackle the viruses and bacteria. Active Masks are not only minimally 99.99% effective but also user has access to free airflow and thereby these types of masks are also comfortable for elderly or people with respiratory illness.***
Keywords: Respirators, N95 Mask, KN95, Filtering facepiece (FFP), Active Mask.

I. INTRODUCTION

Respiratory Diseases pandemic like Covid-19 have disrupted almost every social, industrial and educational system and changed the norms of social conduct significantly. Many solutions and equipment are used to counter respiratory disease virus and tackle it to save lives. Hand sanitizers, vaccines, social distancing and much more ways have made their way into day-to-day lives; but most significant is face masks. All available masks for respiratory disease like Covid-19 are mostly efficient 95%. These masks protect face from droplets released by another person in atmosphere which may contain virus molecules. But these masks have efficiency of only up to 95% and these masks actively do nothing to stop virus from spreading. Thus, this type of masks is called Passive Masks. Active masks on the other hand are 100% efficient to stop virus from spreading through air. Active masks have mainly 4 components as follows

1) *Inlet and Exhaust fans for Producing Air Flows:* As this mask is air tight, two pathways are created to produce Airflow. Size of these fans are preferably compact to make the design less bulky.
2) *Air Tight Material to Protect Face:* Size and shape of mask is such that no single air molecule will enter into mask besides through inlet and exhaust fans. Materials used to make this should not let air pass through itself.
3) *Shield for Virus Like Covid-19:* Virus like Covid-19 must be stopped before it enters through inlet fans. So, a shield concept will be used to stop or destroy virus. Same shield is going to be used after exhaust to prevent virus molecules from escaping into atmosphere; provided that the one wearing it is virus affected.
4) *Control Of Fans And Power Supply:* PCB with microcontroller and sensors will be used to control this fans rpm and monitor mask. Power supply can be done with lightweight batteries. Main challenges will be of power management and to make whole system efficient

II. METHODOLOGY

A. Design of Mask

1) Functions of Hard-body Structure of Mask

This part of mask the most crucial part as it has following functions:

a) Encasing nasal area as well as mouth and chin of person from any particle of air. It is an airtight seal of hard material protecting wearer of mask from all particles from water droplets to fine air molecules.
b) This hard body structure gives support for system used for airflowa. Fans and Motors b. Air Filters c. One-way Valves
c) Also Control system of airflow is fitted on Hard Body of Maska. PCB b. Micro-controller c. Power Supply d. Wire connections
d) And last and important function is to give support for virus.

©IJRASET: All Rights are Reserved

2) *Design Considerations:* Main design criterion is the dimensions of human facial structure. Design must be made in a way that it will accommodate all types and varieties of facial structure and will cover as much face as possible that which will be protected from virus. The facial landmarks are taken into consideration to decide measurements of mask are a. Nose top b. Stomion and Menton c. Left and Right Nose side d. Left and Right Mouth corner e. Left and Right Zygomatic f. Nasion

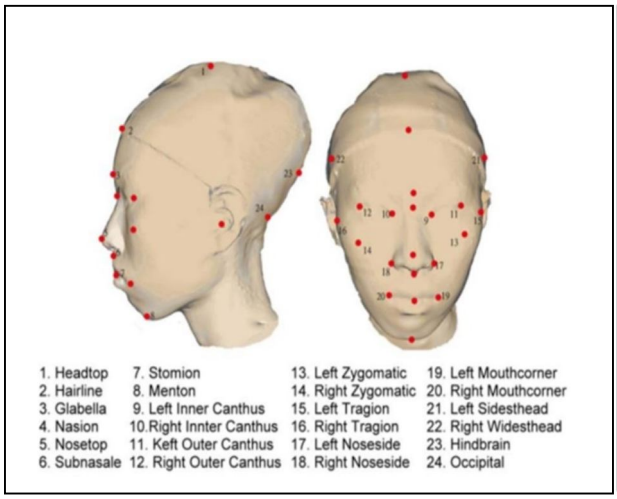


Fig. Illusion of Facial Landmarks

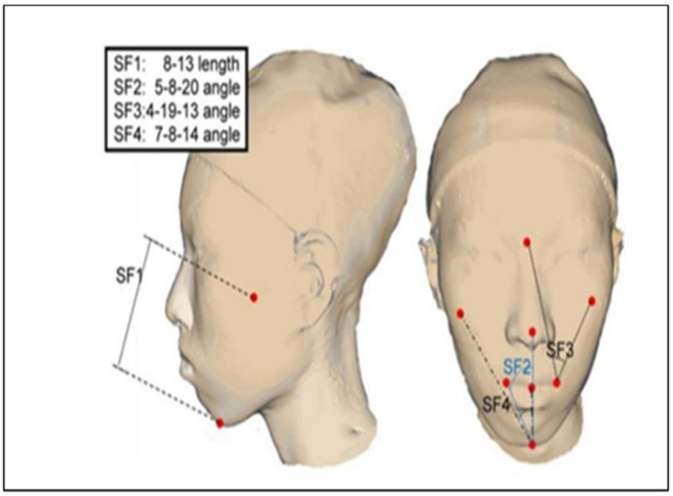


Fig. Four Distance parameters considered for Mask Design

While designing the basic structure, 1 length and 3 angles are considered so that the mask will cover face more efficiently. These parameters are_

a) Distance between Menton and Left Zygomatic (It is also equal to distance between Menton and Right Zygomatic) – 80 to 90mm
b) Angle between Nose top-Menton-Right Mouth corner – 15° to 25° (Same for Right Side)
c) Angle between Nasion-Left Mouth Corner-Left Zygomatic - 35° to 45° (Same for Right Side)
d) Angle between Stomion-Menton-Left Zygomatic - 30° to 40° (Same for Roght Side)

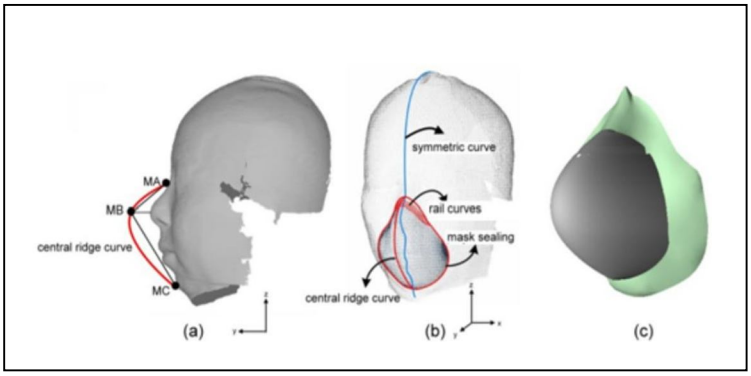


Fig. Mask Shape Generation Process

According to the measurements taken 4 basic models were created; each of different size and shape that will accommodate different features.

3) *Specifications of Mask*
a) 4*4 cm slots for intake and exhaust fans
b) 4 slots (2 on each earpiece) for straps
c) In general, 14cm*15cm size. Suitable for adult size L.
d) Two rest pads at bottom to support mask while mask is stay put.
e) Two support pieces at top juncture (near end of ear piece) for strength and support for wiring
f) Weight: 100 grams



Fig. 3D CATIA model

III. MODELING AND ANALYSIS

A. *Wiring Positions*

There are three connections made along the inner surface of the mask.

a) From connector to exhaust fan

b) From connector to microphone and pressure sensor

c) From connector to intake fan

Fans are controlled by microcontroller placed inside battery pack. Their speed is regulated through program burned on microcontroller chip. Microcontroller will monitor pressure inside mask through readings sent by pressure sensor. Microphone will record the voice of user and it will pass it to battery pack. Using electronic circuit, voice will be boosted and passed to speaker placed on one side of battery pack.

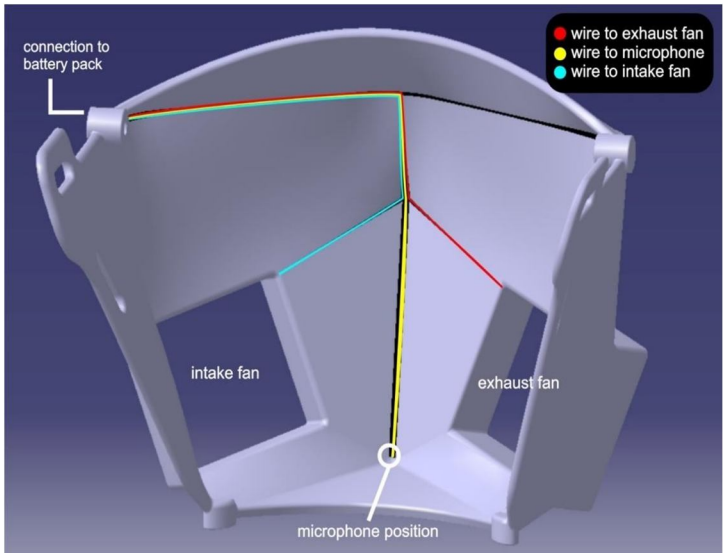


Fig. Wiring positions and connections inside mask

1) *Airway:* Airway must be provided inside mask so that airflow coming inside mask through intake fan and filters must be in such a way that user will have comfort while in breathing. User should not suffocate due to lack of air or smothered due to high air pressure. Naturally, if airflow is in direction along cheeks to nose it is comfortable to breath. So, airway is provided in mask. It is detachable and easy fir inside mask. It creates path for air sothat user will be comfortable.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue X Oct 2022- Available at www.ijraset.com

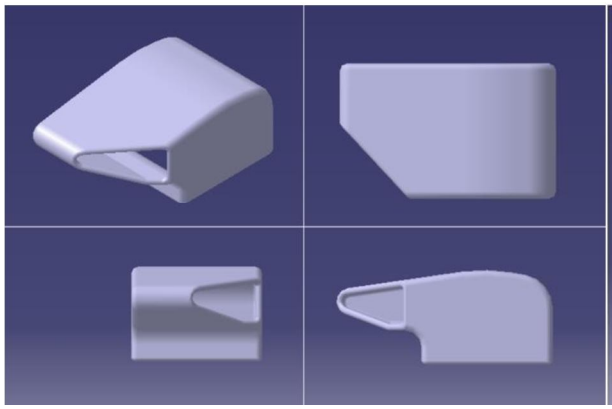


Fig. Airway Piece

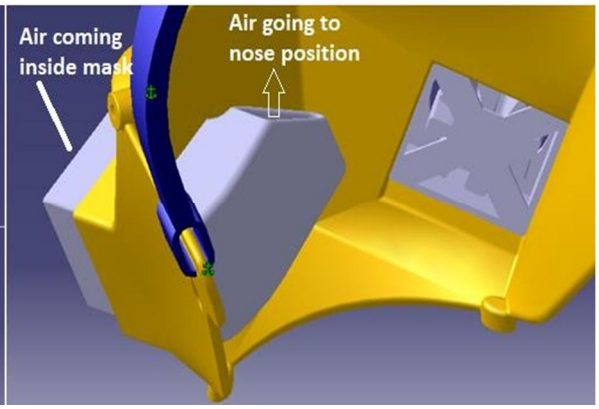


Fig. Schematic Airflow through airway pieces

2) *Rest Pads:* These features serve two purposes at a time. One is to keep mask stablewhen mask is in stay put condition that is user is not wearing mask. Second purpose is to strengthen the hard body of mask in critical positions.
3) *Elastomer Strap:* Their function is to support the mask. There are two straps used.One going over the head and other around the upper neck just below ears. The one going over the head will carry major load and will support the mask. In order to be comfortable to wear, material used to make straps will be smooth, elastic and lightweight.

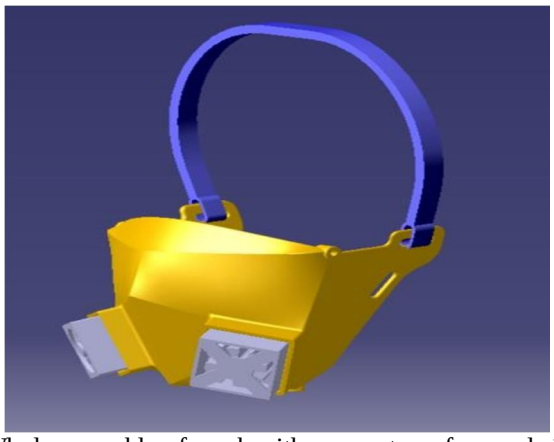


Fig. Whole assembly of mask with upper strap, fans and airway piece

B. Working Of Mask

There are four vital components used in effective working of the whole mask, those are Inlet and exhaust fans, air tight material to protect face, Shield and lastly the components to control fans and power.

1) Initially air which is breath in goes inside the mask through intake fan which are preferably compact to make the design less bulky. Before this comes the dust, particles filters which are HEPA (high-efficiency particulate absorbing) which approximately passes the filtered air about 99.67 % of efficiency.
2) After the intake fan the Activated Carbon Filters are placed next which are replaceable and very efficient against the dust and virus as well.
3) PCB with microcontroller and sensors is used to control this fans rpm and monitor mask. Power supply can be done with lightweight batteries. Main challenge ere will be of power management and to make whole system efficient.
4) Another crucial part is UV LEDs for sterilization of intake air. This UV LED very effectively neutralizes Virus Bacteria Other microorganisms. If we increase the exposure time, potentially with a circuitous path for the air to travel while exposed to the UV light, we can prevent large amount of virus by instant killing because of radiation.
5) Now comes exhaust portion from which air goes outside the mask through exhaust fan. This exhausts N95 filter after exhaust fan to trap virus inside mask in case user is already infected. The filtration material on the mask is an electrostatic non-woven polypropylene fiber.

©IJRASET: All Rights are Reserved

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue X Oct 2022- Available at www.ijraset.com

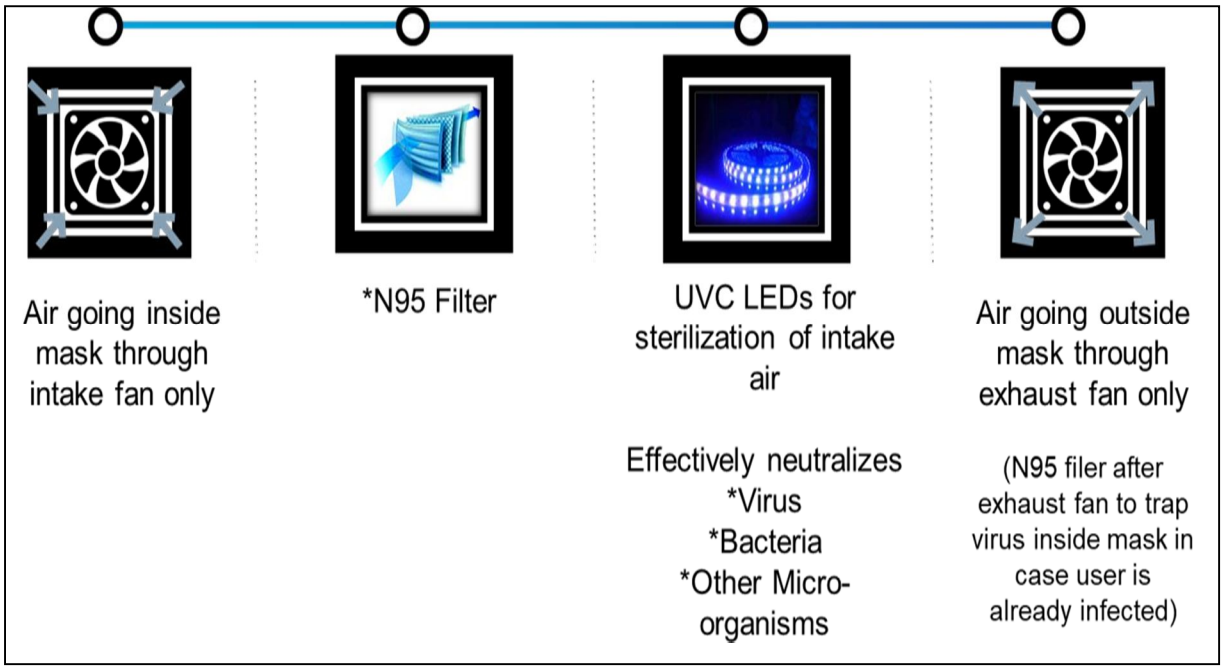


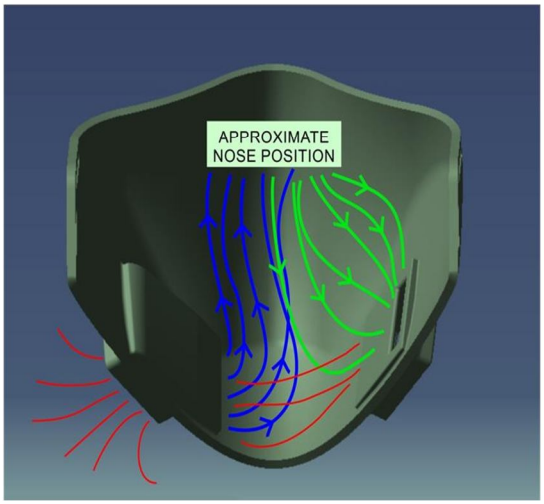
Fig. Working of mask

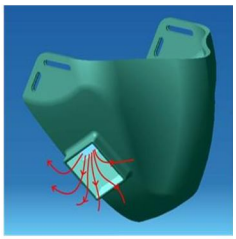
As shown in figure, there are two valves intake and exhaust .The air flow through intake fan and then flows inside mask. The overall breath rate and other required considerations are studied through different research published . Here approximation nose positions , standard size of mask and other parameters are studied by detail analysis of the standard aspects provided. Finally, the exhaust of air flow where air is blown by the one-way process though exhaust valve itself where air is again filtered to some extent and then passed outside the mask.



Intake Air Flow Through fan

Air Flow Inside Mask





Exhaust Air Flow Through one-way valve

Fig. Air Flow inside the mask

©IJRASET: All Rights are Reserved

IV. RESULTS AND DISCUSSION

A. *Comparison Of Other Masks With Active Mask*

Type	Description	Protection
Bandana	Triangular or square piece ofcloth worn as head or neck covering.	Provides some protection against droplets and sneezerelated spray without any covering dropletscan spray more than 8 feet, wearing Bandana can reduce it to 4 feet
Homemade cloth mask	Homemade cloth mask singleor doble layer	Single layer mask provides 1%particle filtration Double layer cotton mask filters about 35% of small particles decrease droplet spray from 8 feet to 2.5 inch
Store bought cloth mask	Tight weave 100% cottoncloth with 3 or more layer	Typical mask can provide atleast 50% protection High quality mask provides80%-95 % protection
Cloth mask with filter	Mask with pocket provided toplace filter	Filter can increase filtration efficiency of cloth mask from 35% to almost 70%.
Neck gaiters and balaclavas	A tube of fabric that's worn around neck and can be pulled down	Provide nearly same filtrationas single cloth mask i.e. about 10%
Disposable surgical mask	Flat, thin, paper-like mask	Can filter out about 60% of smaller, inhaled particles Primarily intended to stop spay of droplet
N95	Critical for health care workers and medical first responders	Capture about 95% of particles in air
P100	Worn by painters, woodworkers, industry use	Don't provide any protection from COVID-19 Protects from lead, asbestos, chemicals
KN95	Similar to N95	Capture about 95% of particles in air
Self-Contained breathing apparatus	To breath clean air in dangerous situation.	Used by firefighters No need to use during COVID-19
Full face respirator	Used by those who have breathing problem while using another mask such as surgical mask	Can filter about 70% - 90% of smaller particles
***Active Mask**	Air tight mask made of hard body with soft edges sealing facial area with inlet and exhaust system for air flow	Can filter 99.99% bacteria and virus, pollens, dust particles and acid fumes in industrial area. Comfortable air pressure inside the mask

B. *Cost Estimation*

Active mask Quotation	Price (In Rs.)	Quantity
UV LED	150	
40 mm Axial Fan	120	2
Microcontroller - Node MCU	349	1
sAir Quality Sensor	129	1
Mic	49	1
Speaker	42	
Amplifier circuit	50	
Wires	100	
Pressure Sensor	100	
PVC 3D printing material	1000	
Rubber Straps	80	
18650 Cells	100	3
Power Bank circuit	100	1
N 95 Filter	50	4
Total cost	2419	

V. CONCLUSION

Working on this project has made us think on present critical socio-economic problems aswell and also motivated us to work for the people's welfare in the possible way we can and this helped us to enhance the technical approach in various sectors of development, research, design and at last the health care sector as well. Also the survey and reviews taken helped to know the current scenario in the perspective of public using this product including common man to that of practitioners and doctors.

REFERENCES

[1] CDC (2020) COVID-19 and Your Health, Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cloth-face-cover-guidance.html (Accessed: 16 December 2020).

[2] Chua, M. H. et al. (2020) Face Masks in the New COVID-19 Normal: Materials, Testing, and Perspectives, Research. Science Partner Journal. doi: https://doi.org/10.34133/2020/7286735.

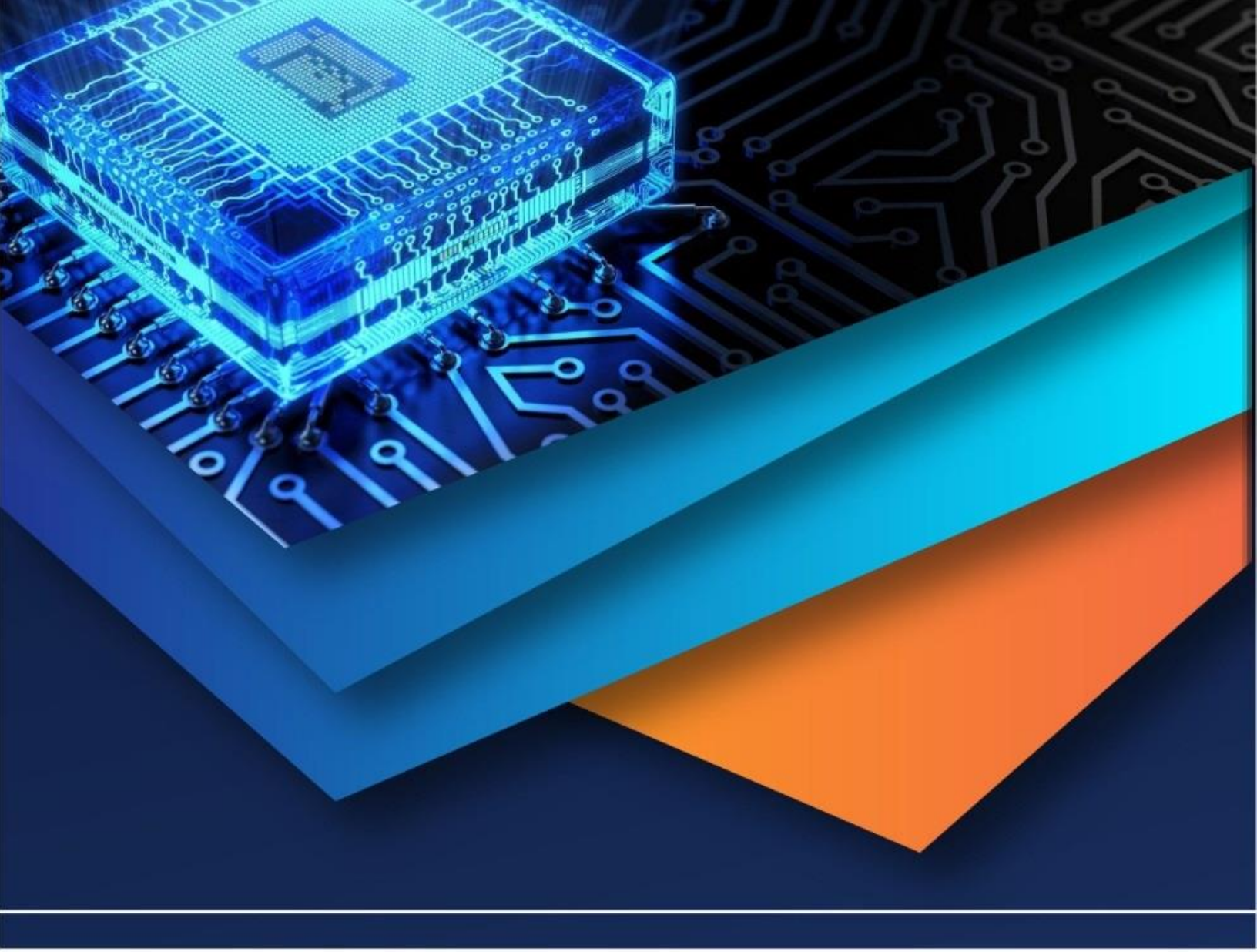
[3] Ionizing air affects influenza virus infectivity and prevents airborne-transmission | Scientific Reports (no date). Available at: https://www.nature.com/articles/srep11431 (Accessed: 16 December 2020).

[4] Konda, A. et al. (2020) 'Aerosol Filtration Efficiency of Common Fabrics Used in Respiratory Cloth Masks', ACS Nano, 14(5), pp. 6339–6347. doi: 10.1021/acsnano.0c03252.

[5] McDevitt, J. J., Rudnick, S. N. and Radonovich, L. J. (2012) 'Aerosol Susceptibility of Influenza Virus to UV-C Light', Applied and Environmental Microbiology, 78(6), pp. 1666–1669. doi: 10.1128/AEM.06960-11.

[6] Parlin, A. F. et al. (2020) 'A laboratory-based study examining the properties of silk fabric to evaluate its potential as a protective barrier for personal protective equipment and as a functional material for face coverings during the COVID-19 pandemic', PLOS ONE, 15(9), p. e0239531. doi: 10.1371/journal.pone.0239531.

[7] Wang, Zijun et al. (2020) 'Three-dimensional printing of functionally graded liquid crystal elastomer', Science advances, 6. doi: 10.1126/sciadv.abc0034



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)