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3D Augmented Reality Marker-based Mobile Apps Design of Face Mask Layer

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***Abstract*—The outbreak of COVID-19 has spread rapidly across the globe, affecting how people interact, work and experience their daily lifestyles. The face mask is essential to personal protective equipment (PPE) even though COVID-19 is endemic today. A face mask is required to protect humans, and its description is important. Augmented reality is one new attractive technology for distributing information. This research presents a 3D augmented reality mobile application that visualizes a protective face mask and its material layers called 3DAR-FML. It was designed by utilizing 3D marker-based images on an Android smartphone platform. Ten types of protective face masks and each layer were designed in 3D images using Blender Animation and Unity 3D software. Vuforia Engine applications were used to build a personalized mobile Augmented Reality application. This initiative educates society and markets products in interactive ways that allow visualization of the 3D model of various face masks from android phones. Results present that successful mobile apps were developed. A survey shows that 70% of respondents agreed on the design app based on menu interactivity. This app also has been identified as a helper tool for The National Institute for Occupational Safety and Health (NIOSH) agency Malaysia for safety and health apps for the market and public. This product is significant in societies to gain information on face mask characteristics that help to contribute content based on the standard mask in Malaysia.**

***Keywords*— Augmented reality; marker-based, unity 3D; face mask layer; android mobile; vuforia engine; safety and health.**

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I. INTRODUCTION

Over the last two years, the Covid-19 epidemic, also known as Coronavirus, has affected our daily lives, disrupting socializing, working, and even schooling. There is a need for protection against Covid-19, which may be transmitted by respiratory droplets created when an infected person sneezes or coughs loudly [1]. This motivated everyone, from medical experts to governments, businesses, and organizations, to encourage strategies to minimize viral transmission, such as wearing a face mask, avoiding public places, and emphasizing handwashing [2]. With the rising importance and demand for face masks, a variety of options are accessible for customers to choose from in the ever-growing market to combat the virus in the current crisis or to anticipate the mask industry's future [3].

The N95 mask is the most commonly used by medical professionals in fighting the virus for their own lives and helping their patients. In contrast, the public generally uses surgical masks made of polypropylene, or in other words, plastic, when going into public areas while complying with social distancing to overcome the virus [4]. Aside from that, there are popular washable and reusable cloth masks that people may buy in stores or make themselves, showing their effectiveness in wearing [5].

Using a face mask or respirator is a crucial component of personal safety equipment (PPE) to return to the norm [6]. When going outside, one is required to wear a face mask. However, some individuals still do not want to know or do not care if their face mask is adequate or fits their faces [7]. If the face mask is not properly fitted to the wearer, a virus might slip through the gap and be inhaled by the wearer [8]. As a result, it is necessary to convey information to society, and one means it is through augmented reality, which features an interactive display to gather information [9]-[11]. Augmented reality technologies combine real-world settings with computer-generated synthetic items. This is performed by

employing markers or triggers detected by Vuforia Engine and Unity 3D [12]. As a result, AR mobile platform has the opportunity to transform how people obtain information [13]. This research study has allowed users to scan images of the masks that compose the markers using their smartphone's camera. The 3DAR-FML application will display a 3D object of the matching mask on the smartphone's screen. In addition, a 3D model of the face mask can be adjusted in real time for a better experience. For example, you may rotate and zoom the model to get a better look at the details of the masks [14]. Another study discovered that many applications that utilize augmented reality and connect it to mobile apps, such as education [15], automobile[16] and even tourism [17]-[19].

The first issue with this research is that societies have difficulty getting approved mask information and identifying relevant content [20]. Following that, a lack of exposure to the current technological environment causes the presentation to be dull for learning concepts [21]. Finally, society lacks understanding regarding the usage of protective face masks, which leads some people to be infected with the virus [22]. Thus, employing AR to provide the particular information for the protective face mask would provide users with an intriguing manner to learn. Several studies indicate the usefulness of an AR-enabled mobile application for various medical schooling [23]-[25]. The application is connected to the database and works on both the mobile platforms of the learners and the trainers at the same time [26]. This option allows the trainer to track the trainee's progress and modify the training scenario to evaluate the trainee's actions during training[27]. Regardless of the virtual setting, students will understand how to acquire and apply the skill [28]-[30].

This study had three main objectives. The first was comparing ten types of protective face masks and mask characteristics based on user testing. The aim is to produce a 3D augmented reality smartphone application that shows information about the protective face mask and material for each layer. Lastly, the creation of Mobile AR based on marker 3D images of protective face mask model in its technical design and user experience with the app will be examined. This study assists healthcare users and society in identifying appropriate daily-use protective masks.

II. Materials and Method

This section explains the technique and design of the research development. The flowchart and activities explained in detail the desired deliverables.

A. System Flowchart

Figure 1 shows the flowchart for the 3DAR-FML application. First, the user opens the application. There is a menu page that shows two modes. First is the Mask Information mode, which shows the array of 2D images of the dos and don'ts of wearing a protective face mask. Next, selecting the normal mode will launch the smartphone's camera to scan the AR marker. The AR marker is based on an image of the Protective face mask. When the camera detects a marker-based, the 3D model for that marker-based is superimposed on the camera display, providing an augmented environment with the 3D model.

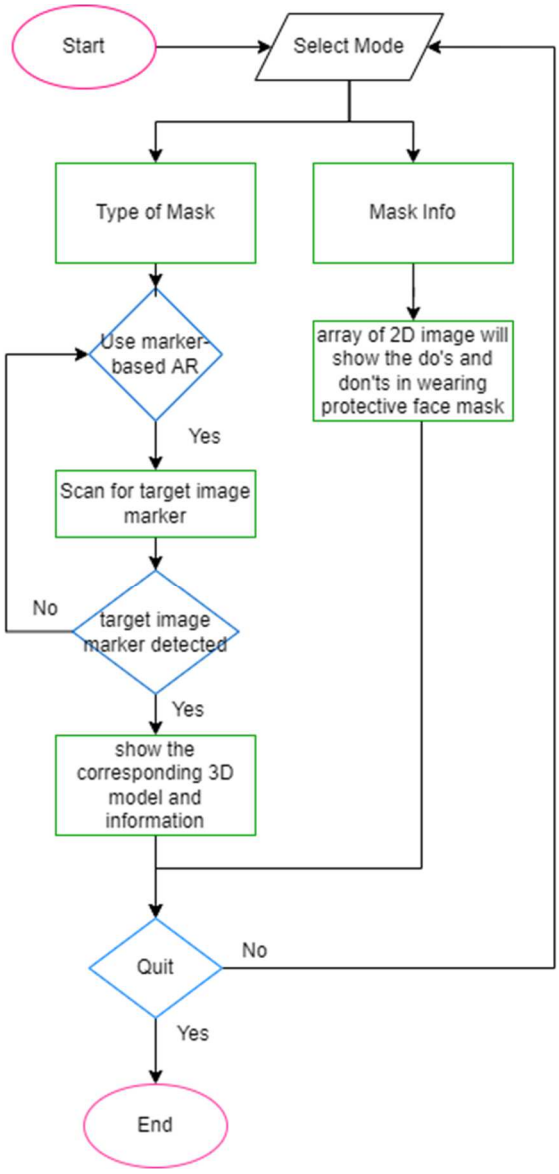
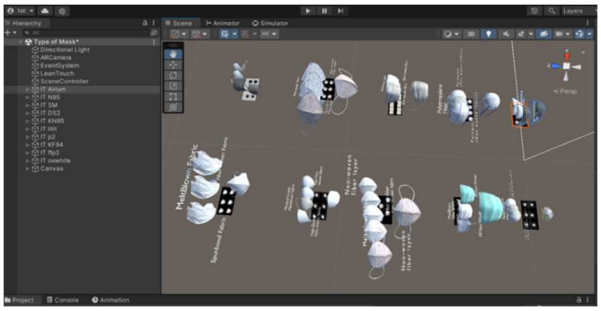


Fig. 1 System Flowchart

B. Architecture Diagram

The application was designed for mobile devices by using Unity3D with mobile support. Markers were then designed and placed, as each protective face mask has its distinct marker to distinguish it from the others. The smartphone has the AR application installed. The device's camera displays the target's 3D model assigned marker when the target image is detected. Unity 3D is often used to structure the 3D model. The model is interactive and able to respond to the device. Figure 2 depicts the design's architecture. Figure 2 (a) is the face mask 3D models developed using the Blender Animation tool. Figure 2 (b) is one of the targeted image markers used in the 'Type of Mask' mode to overlay the corresponding 3D model face masks. Figures 2 (c) and (d) are the output for the 'Type of Mask.' The AR app runs on a smartphone. The mobile camera is used as a scanner to identify the AR sign. The tracking app is called Vuforia. Once the marker has been identified, the 3D image of the associated marker is overlaid on the smartphone screen. The design is built using Unity 3D software. The model then displays the 3D image of the protective face mask and its details description on the app.

The output allows users to view the 3D models overlaid on top of the targeted image and view the dos and don'ts in wearing face masks.



(a)

(b)

(c)

(d)

Fig. 2 Architecture Diagram

C. 3D Modelling Marker-Based Parameter

Enhanced reality is a hybrid of reality and virtual reality that allows real-world items to be augmented. As a result, including a 3D picture within the apps would make it more fascinating and provide better visualization. Unity 3D will create the 3D model and be the platform for showcasing it. The smartphone camera may be used as a scanner to identify augmented reality markers that use the Vuforia as an image tracker. Under all situations, an excellent marker-based is rapidly and reliably visible. As a result, precise factors for selecting an appropriate marker-based need to be considered. The marker-based detection parameter is shown in Table 1.

TABLE I
MARKER DETECTION PARAMETER

Parameters
Marker-based Image of 4 to 5 Star Rating
Distance Between 30 cm to 2 meters
Colour Image is RGB and CYMK
High Resolution in 8 bit and 24-bit image pixel

III. RESULTS AND DISCUSSION

This research used augmented reality to examine masks, with participants using important knowledge in their daily lives. The augmented reality marker will be identified using the smartphone's camera. When a marker is found, a 3D model of the mask is overlaid over it. The 3D model may also be rotated and played to create a more immersive presentation of the information. Users will be encouraged to apply this strategy to increase their understanding of how to wear a mask appropriately. 3DAR-FML is the first augmented reality application effort to provide information about the mask and material for each layer pleasantly and engagingly.

A. Prototype Mobile Design

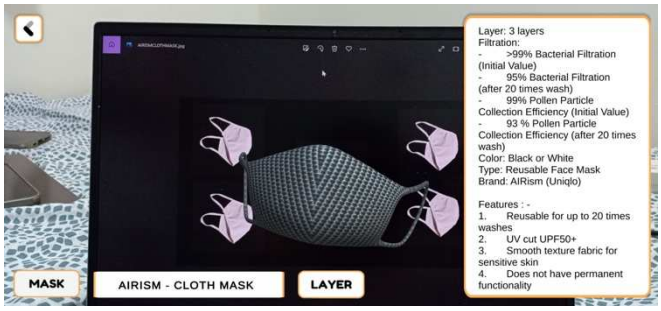
This application was developed using Unity 3D software. Figure 3 shows the menu interface, while figures 4 (a) and (b) show mask info for dos and don'ts of wearing a face mask. Figure 5 shows the application's interface in showing different types of protective face masks divided into different types such as a respirator, disposable masks, and cloth masks. Figure 6,7, and 8 shows the application's interface in showing different types of protective face masks divided into different types such as a respirator, disposable masks, and cloth masks. The figure shows the information and 3D image when scanned for the target images of all masks designed. Other than that, basic information regarding the dos and don'ts of wearing a face mask would be included inside the application. Users could learn and gain this knowledge.

Fig. 3 Menu Interface

(a)

(b)

Fig. 4 (a) and (b) The do's and don'ts Menu of wearing mask



(a)

(b)

Fig. 5 (a) and (b) Cloth Mask 3D AR Design

(a)

(b)

Fig. 6 (a) and (b) Respirator Mask 3D AR Design

(a)

(b)

Fig. 7 (a) and (b) Disposable Mask 3D AR Design

Other than that, basic information regarding the dos and don’ts of wearing a face mask would be included inside the application. Users could learn and gain this knowledge. Figure 7 shows the Mask Information in wearing a mask.

Fig. 8 Mask Information in Wearing Face Mask

B. Analysis on 3DAR-FML

The 3DAR-FML evaluation analysis was done among society and was completed by 50 participants. A set of Google Forms questions is deployed for each respondent. This analysis is based on customers using the apps and getting their feedback for the design Mobile apps of the 3D AR face mask maker images. The categories include the respondents' backgrounds, experience with augmented reality, experience with the 3DAR-FML application, further ideas on the apps, and future mobile app design recommendations.

1) Respondent’s Background: The app is intended for users of all ages, especially those aged 18 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, and 65 and above. Figure 9 illustrates the findings, which indicate that 34% of respondents are between the ages of 18 and 24. The age distribution analysis illustrates that the young respondents are at the most at 34%, compared to working and retired people. Figure 10 shows that 74% of respondents are working and 4% are not working, and 22% are in the progress of finding jobs.

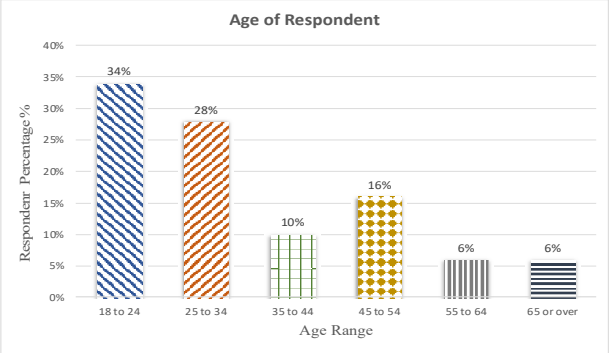


Fig. 9 Age of Respondents analysis

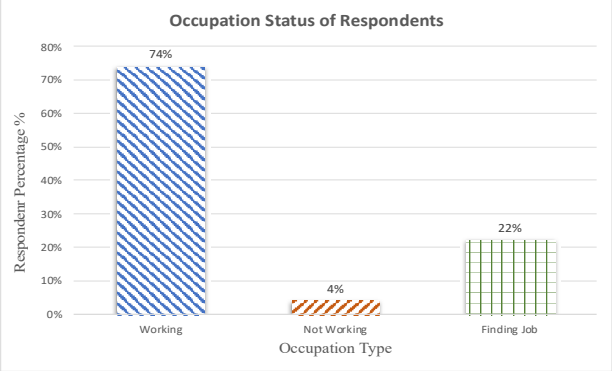


Fig. 10 Occupation Respondents analysis

2) Respondent's experience with Augmented Reality: Figure 11 illustrates respondents' analysis regarding their experience with Augmented Reality (AR). A scale from 1 to 5, ranging from no experience to extremely experienced, has been derived in the evaluation. Analysis has shown that 52% have no experience using AR apps, and 18% also have low experience in using AR apps. 8% of respondents are neutral and 4% rated themselves as having agreed they have experience, and 18% of respondents indicated that they were extremely experienced.

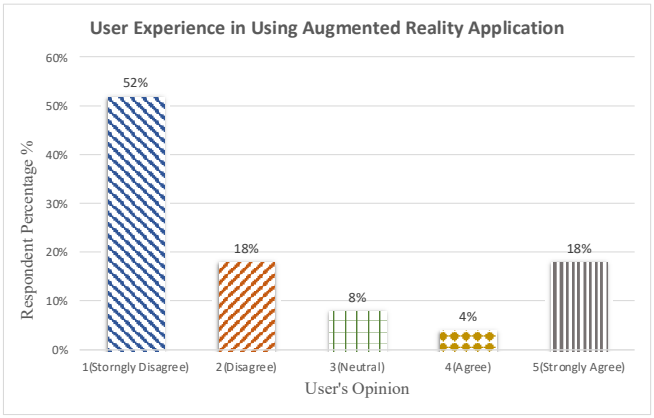


Fig. 11 User Experience in Using AR Application

Figure 12 examines respondents' perspectives on how augmented reality may be used to transmit information and awareness. 74% of respondents felt that augmented reality might help to transmit knowledge and awareness, whereas 22% and 4% were doubtful or had no experience, respectively.

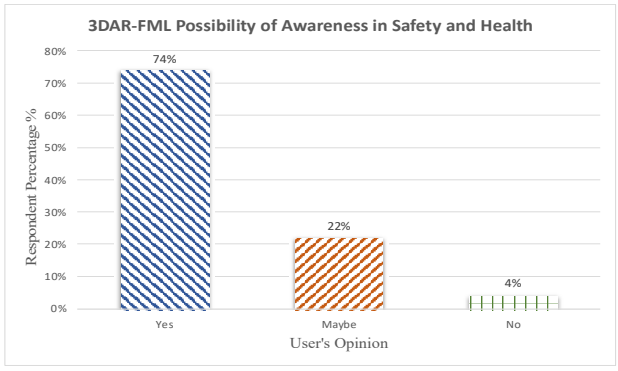


Fig. 12 Possibility for 3DAR-FML to Spread Awareness

Figure 13 represents an examination of respondents' responses to whether augmented reality may aid future schooling. 78% of respondents said augmented reality would improve future training, while 20% were unsure, and 2% said it would not improve student performance.

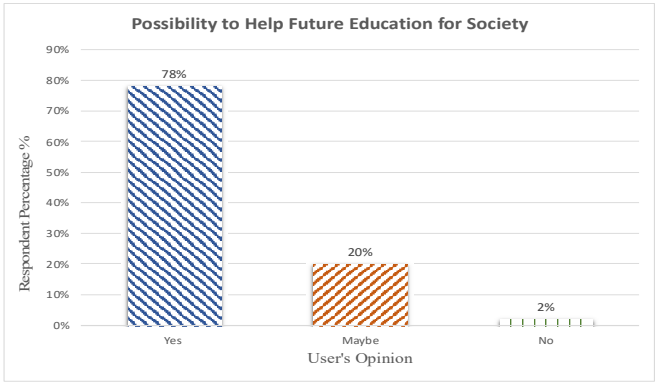


Fig. 13 Possibility to Help Future Education

3) Respondent's experience with 3DAR-FML: This section actively seeks participant input on their experience with the 3DAR-FML application. The responses are graded on a scale of 1 to 5, with one being strongly opposed and five being highly agreed. Figure 14 demonstrates respondents' impressions of how simple it is to scan the target image to present face mask information using 3DAR-FML. Only 2% of respondents said 3DAR-FML was difficult to use, while 8% said it was neutral. Furthermore, 90% of participants agree that 3DAR-FML is simple to use for accessing data about masks.

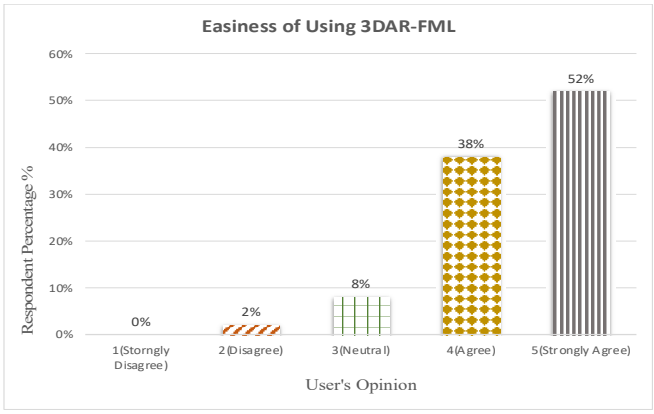


Fig. 14 Easiness for the user to scan image target analysis

Figure 15 demonstrates the response to the issue of whether 3DAR-FML assists users in recognizing face masks. Only 4% of respondents believe 3DAR-FML is useless, while the remaining 26% are ambivalent. Meanwhile, 70% of respondents believe that 3DAR-FML can help them discover face masks.

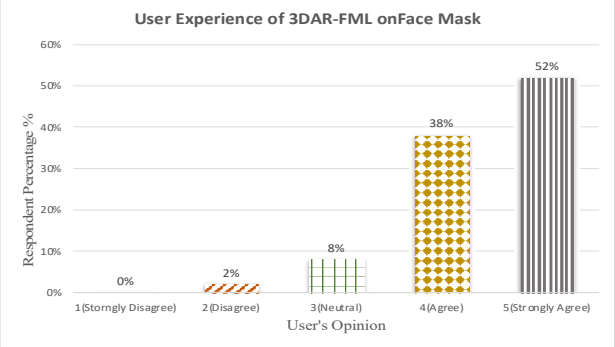


Fig. 15 User experience when using 3DAR-FML analysis

Figure 16 examines respondents' impressions of 3DAR-FML as an information transmission medium. 2% of respondents disagree, and 10% are unsure. 88% of the remaining respondents believe that 3DAR-FML may be used to spread information.

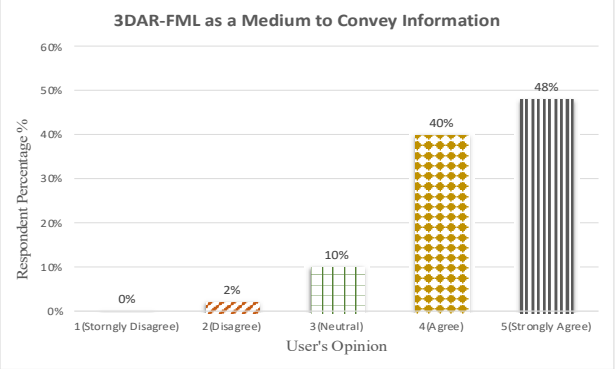


Fig. 16 3DAR-FML as a Medium to Convey information

Figure 17 displays the pace for 3DAR-FML business and design components. Only 2% of participants stated that 3DAR-FML did not have a system. In addition, 28 % of respondents are unsure. Meanwhile, 70% of respondents thought the style of 3DAR-FML was excellent.

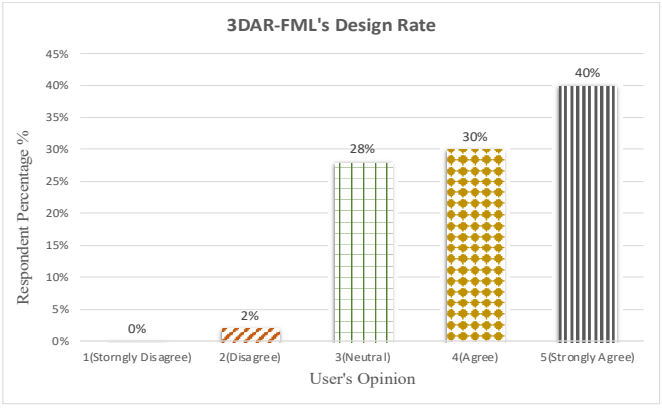


Fig. 17 3DAR-FML's Design Rate analysis

4) Suggestions on 3DAR-FML and Augmented Reality: This section collects opinions and recommendations from responders about 3DAR-FML and augmented reality applications. Figure 18 represents respondents' responses when queried if they would suggest 3DAR-FML to relatives and friends. 76% of respondents are eager to provide ideas, while 22% are doubtful.

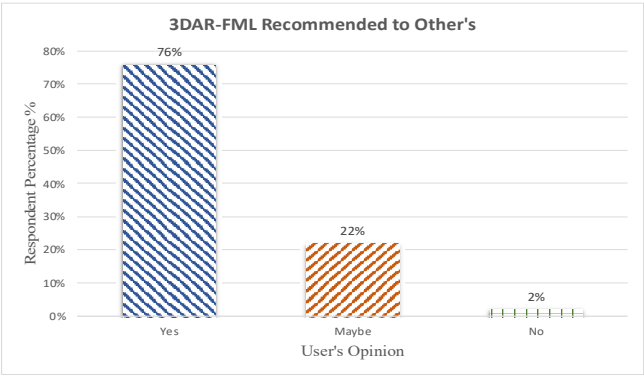


Fig. 18 Willingness to Suggest 3DAR-FML analysis

Table 2 summarizes respondents' proposals for 3DAR-FML enhancements. Because the other respondents are inexperienced with the AR application and have no clue what to enhance, just a few of the 50 responses provide ideas.

TABLE II
SUGGESTIONS ON 3DAR-FML IMPROVEMENTS

	Suggestions on 3DAR-FML's Improvements
1	Add more features video of wearing each face mask.
2	State the rating for the respective mask.
3	To make use of this application in getting knowledge
4	Insert audio explaining the differences between the masks.
5	To access the application on a different medium

IV. CONCLUSIONS

Face masks are essential in protecting humans in today's normal daily lives when dealing with COVID-19. Hence, this research initiative has created awareness in society about choosing a suitable and comfortable mask that suits the user. The 3DAR-FML has been successfully developed using unity 3D Software, Blender Animation, and Vuforia Engine. Users can move and scale the 3D models while obtaining critical information about the masks. It creates an interesting and entertaining way to raise awareness about the proper use of various types of masks. In this research improvement, a new feature such as measures the face of the user using the face tracking function to give a suitable fit size that matches the user. In conclusion, this research study could help the community to have easy and faster access to AR apps that can visualize the protective face mask and grasp the knowledge to use an appropriate mask for daily use.

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REFERENCES

[1] J. H. Hashim, M. A. Adman, Z. Hashim, M. F. Mohd Radi, and S. C. Kwan, "COVID-19 Epidemic in Malaysia: Epidemic Progression, Challenges, and Response," (in eng), *Front Public Health,* vol. 9, p. 560592, 2021, doi: 10.3389/fpubh.2021.560592.

[2] M. H. Chua *et al.*, "Face Masks in the New COVID-19 Normal: Materials, Testing, and Perspectives," *research,* vol. 2020, p. 7286735, 2020/08/07 2020, doi: 10.34133/2020/7286735.

[3] A. Tcharkhtchi, N. Abbasnezhad, M. Zarbini Seydani, N. Zirak, S. Farzaneh, and M. Shirinbayan, "An overview of filtration efficiency through the masks: Mechanisms of the aerosols penetration," *Bioactive Materials,* vol. 6, no. 1, pp. 106-122, 2021/01/01/ 2021, doi: https://doi.org/10.1016/j.bioactmat.2020.08.002.

[4] K. O'Dowd *et al.*, "Face Masks and Respirators in the Fight Against the COVID-19 Pandemic: A Review of Current Materials, Advances and Future Perspectives," *Materials,* vol. 13, no. 15, p. 3363, 2020, doi: http://dx.doi.org/10.3390/ma13153363.

[5] A. A. Chughtai, H. Seale, and C. R. Macintyre, "Effectiveness of Cloth Masks for Protection Against Severe Acute Respiratory Syndrome Coronavirus 2," (in eng), *Emerg Infect Dis,* vol. 26, no. 10, Oct 2020, doi: 10.3201/eid2610.200948.

[6] J. Howard *et al.*, "An evidence review of face masks against COVID-19," *Proceedings of the National Academy of Sciences,* vol. 118, no. 4, p. e2014564118, 2021, doi: doi:10.1073/pnas.2014564118.

[7] E. J. Yuan, C. A. Hsu, W. C. Lee, T. J. Chen, L. F. Chou, and S. J. Hwang, "Where to buy face masks? Survey of applications using Taiwan's open data in the time of coronavirus disease 2019," *Journal of the Chinese Medical Association,* vol. 83, no. 6, pp. 557-560, Jun 2020, doi: 10.1097/jcma.0000000000000325.

[8] A. A. Azlan, M. R. Hamzah, T. J. Sern, S. H. Ayub, and E. Mohamad, "Public knowledge, attitudes and practices towards COVID-19: A cross-sectional study in Malaysia," *PLOS ONE,* vol. 15, no. 5, p. e0233668, 2020, doi: 10.1371/journal.pone.0233668.

[9] K. Miundy, H. Badioze Zaman, A. Nosrdin, and K. H. Ng, "Evaluation of Visual Based Augmented Reality (AR) Learning Application (V-ARA-Dculia) for Dyscalculia Learners," *JOIV : International Journal on Informatics Visualization,* vol. 3, 11/09 2019, doi: 10.30630/joiv.3.4.321.

[10] Y. Chen, Q. Wang, H. Chen, X. Song, H. Tang, and M. Tian, "An overview of augmented reality technology," *Journal of Physics: Conference Series,* vol. 1237, no. 2, p. 022082, 2019/06/01 2019, doi: 10.1088/1742-6596/1237/2/022082.

[11] N. Elmqaddem, "Augmented Reality and Virtual Reality in Education. Myth or Reality?," *International Journal of Emerging Technologies in Learning (iJET),* vol. 14, no. 03, pp. pp. 234-242, 02/14 2019, doi: 10.3991/ijet.v14i03.9289.

[12] X. Liu, Y.-H. Sohn, and D.-W. Park, "Application Development with Augmented Reality Technique using Unity 3 D and Vuforia," 2018.

[13] M. Kassim and M. N. H. M. Said, "Data analytics on interactive indoor cycling exercises with virtual reality video games," in *2018 4th International Conference on Control, Automation and Robotics (ICCAR)*, 2018, pp. 321-326, doi: 10.1109/ICCAR.2018.8384693.

[14] N. Saidin, N. Halim, and N. Yahaya, "Framework for Developing a Mobile Augmented Reality for Learning Chemical Bonds," *International Journal of Interactive Mobile Technologies (iJIM),* vol. 13, p. 54, 07/11 2019, doi: https://doi.org/10.3991/ijim.v13i07.10750.

[15] O. Keat, N. Wahid, N. Murli, and R. A Hamid, "Augmented Reality to Induce Enjoyment in Edutainment Mobile Game," *JOIV : International Journal on Informatics Visualization,* vol. 2, p. 188, 06/06 2018, doi: 10.30630/joiv.2.3-2.139.

[16] S. Osman, D. Phon, N. Omar, M. R. Mohd Rameli, N. Ahmad, and T. Gusman, "Using Augmented Reality Application to Reduce Time Completion and Error Rate in PC Assembly," *JOIV : International Journal on Informatics Visualization,* vol. 4, p. 166, 09/30 2020, doi: 10.30630/joiv.4.3.245.

[17] P. Haryani, "The Designing of Interactive Learning Media at Yogyakarta's Sandi Museum Based on Augmented Reality," *JOIV : International Journal on Informatics Visualization,* vol. 4, 02/21 2020, doi: 10.30630/joiv.4.1.157.

[18] A. Liang, N. Wahid, and T. Gusman, "Virtual Campus Tour Application through Markerless Augmented Reality Approach," *JOIV : International Journal on Informatics Visualization,* vol. 5, p. 354, 12/25 2021, doi: 10.30630/joiv.5.4.743.

[19] E. E. Cranmer, M. C. tom Dieck, and P. Fountoulaki, "Exploring the value of augmented reality for tourism," *Tourism Management Perspectives,* vol. 35, p. 100672, 2020/07/01/ 2020, doi: https://doi.org/10.1016/j.tmp.2020.100672.

[20] B. N. J. Persson, "Side-leakage of face mask," *The European Physical Journal E,* vol. 44, no. 6, p. 75, 2021/06/05 2021, doi: 10.1140/epje/s10189-021-00081-2.

[21] J. T. Zhu, X. J. He, S. Guffey, L. Wang, H. F. Wang, and J. W. Cheng, "Performance Comparison of N95 and P100 Filtering Facepiece Respirators with Presence of Artificial Leakage," (in English), *Annals of Work Exposures and Health,* Article vol. 64, no. 2, pp. 202-216, Mar 2020, doi: 10.1093/annweh/wxz086.

[22] C. M. Lai, Y. C. Liu, R. C. Chang, J. W. Chapman, and C. H. Lin, "Pandemic Response and Crisis Informatics: An Imperative for Public Health Messaging," in *2020 International Computer Symposium (ICS)*, 2020, pp. 570-575, doi: 10.1109/ICS51289.2020.00116.

[23] C. Sik-Lanyi, "Virtual reality healthcare system could be a potential future of health consultations," in *2017 IEEE 30th Neumann Colloquium (NC)*, 2017, pp. 000015-000020, doi: 10.1109/NC.2017.8263275.

[24] K. H. Leung, K. Hung, C. P. Ko, and S. F. Lo, "Design and Development of an Augmented Reality Mobile Application for Medical Training," in *2019 IEEE 6th International Conference on Engineering Technologies and Applied Sciences (ICETAS)*, 2019, pp. 1-4, doi: 10.1109/ICETAS48360.2019.9117464.

[25] M. F. Hossain, S. Barman, N. Biswas, and A. K. M. B. Haque, "Augmented Reality in Medical Education: AR Bones," in *2021 International Conference on Computing, Communication, and Intelligent Systems (ICCCIS)*, 2021, pp. 348-353, doi: https://doi.org/10.1109/ICCCIS51004.2021.9397108.

[26] R. Barratt, M. Wyer, S.-y. Hor, and L. Gilbert, "Medical interns' reflections on their training in use of personal protective equipment," *BMC medical education,* vol. 20, p. 328, 09/23 2020, doi: 10.1186/s12909-020-02238-7.

[27] R. Palmarini, J. A. Erkoyuncu, R. Roy, and H. Torabmostaedi, "A systematic review of augmented reality applications in maintenance," *Robotics and Computer-Integrated Manufacturing,* vol. 49, pp. 215-228, 2018/02/01/ 2018, doi: https://doi.org/10.1016/j.rcim.2017.06.002.

[28] M. Kassim and M. T. H. Md Zubir, "Design of augmented reality for engineering equipment in education," *International Journal of Advanced Trends in Computer Science and Engineering,* Article vol. 8, no. 6, pp. 2773-2781, 2019, Art no. 15, doi: 10.30534/ijatcse/2019/15862019.

[29] M. Kassim and A. S. A. A. Bakar, "The Design of Augmented Reality Using Unity 3D Image Marker Detection for Smart Bus Transportation," *International Journal of Interactive Mobile Technologies (iJIM),* vol. 15, no. 17, pp. 33-48, 01/09/2021 2021, doi: 10.3991/ijim.v15i17.22071.

[30] C. K. S. B. Poonpong Boonbrahm, "Interactive Marker-based Augmented Reality for CPR Training," *International Journal of Technology,* vol. 10, no. 7, pp. 291-319, 2019/11/29 2019, doi: https://doi.org/10.14716/ijtech.v10i7.3267.