The Design of Mobile 3D Augmented Reality on Marker Visual Inspection Mask

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Alisa Rafiqah Adenan[1], Murizah Kassim[1,2](✉), Nur Amirah Kamaluddin[1]
[1] School of Electrical Engineering, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia
[2] Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia.
murizah@uitm.edu.my

Abstract—Augmented reality is a ground-breaking technology that allows users to communicate with an enticing real-world experience to receive messages or knowledge. Today, mask inspection is essential to relay information to society through an augmented reality where extensive information about masks is required and identifying them is challenging. Furthermore, with augmented reality, society may have access to the fascinating way of getting information on the masks, assisting in spreading knowledge, particularly during this pandemic. The augmented reality on a visual inspection mask (ARVIM) was created utilizing 3D images on an Android smartphone platform. The models were created using Blender Animation and Unity 3D software. Vuforia Engine and Android Studio applications were used to build a personalized mobile Augmented Reality application. Google Cloud was used to store data that is accessible to users. ARVIM has facilitated teaching and interaction with 3D AR effects enjoyable for users. The analysis results on the use of ARVIM revealed that ARVIM obtained a high easiness rating of 80%. While 83% of respondents say ARVIM can help distinguish between different types of masks, 88% of respondents agreed that ARVIM's design is acceptable and approachable. This initiative enhances society's education in interactive and mixed-reality innovation settings through a long-distance and innovative teaching method that gives a comprehensive Google Platform experience.

Keywords—augmented reality, mobile apps, 3D image, marker detection, face mask, blender animation, unity 3D

1 Introduction

Knowledge is crucial and serves as a kind of social consciousness. The process of exchanging knowledge can be refreshed periodically as an era passes and updated as technology advances [1]. The younger generations are expected to adapt to new technologies and alter their everyday access to knowledge. Not to be underestimated, the older generation could partake in the new era of technological integration into daily life. Although the approach is distinct, the goal of awareness and comprehension may also be accomplished by acquiring knowledge or skills through research, practice, or education [2].

Augmented reality is a comparatively new phenomenon that proliferates among technology enthusiasts. Because Augmented Reality (AR) will superimpose visual knowledge on a mobile device, connecting hands-on interactions to theories is a viable choice. In addition, Augmented Reality is a feasible method for relating context to physical activity [3, 4]. Therefore, mobile applications embrace augmented reality as a vital and valuable new feature in social interaction. Augmented reality refers to technologies that incorporate real-world environments with computer-generated simulated objects [5]. This is achieved by using markers or triggers perceived by an augmented reality system. The marker may be written or drawn on actual objects or photographs to enable the system to detect them [6]. With mobile augmented reality, a digital data layer is added to reality. Some application that has been done using AR was in education [7, 8], healthcare [9, 10], gaming [11, 12], and tourism [13, 14]. As a result, augmented mobile reality can radically alter the way people receive knowledge [15]. This project will enable users to scan images of the masks comprising the markers using their smartphone's camera. This will show a three-dimensional image of the matching mask on the smartphone's screen. Additionally, the augmented image can be played with. For instance, users could rotate and zoom the model to get a closer look and read the details of the masks. The framework's data will be stored in Google Cloud for ease of access and use [16].

The initial problem with this research shows less exposure to the current technology environment resulting in the presentation of an obsolete and uninteresting educational concept. This problem widens the gap between society and AR technology [17]. Next, society faces difficulties accessing authorized masks' information on identifying appropriate materials, depending on the scenario, without incorporating computer vision and object recognition towards the latest technologies [18]. Lastly, the unattractive approach to educating society on mask inspection's critical features would contribute to a lack of understanding and awareness of vital information [19].

This research project has identified three main objectives for ARVIM development. The first is to study the AR animation and its platform using Google Cloud, presenting masks detailed information on the cloud [20]. This will make easier access and enhance natural environments that deliver perceptually enhanced educational experiences with advanced AR technologies. Secondly is to design 3D animation models of augmented reality for mask inspection by computer-generated perceptual knowledge using Unity 3D software. The 3D model would present the characteristic of augmented reality for virtualizing the designed equipment on an android platform. Thirdly is to analyze the use and practicality of the designed prototype of ARVIM on actual users. The platform on android mobile phones for long-distance communication by engaging and absorbing high levels of interaction and additive to the natural environment will be attractive and able to gain users' interest.

2 Design and architecture of ARVIM

2.1 Research Flowchart

Figure 1 shows the flowchart for the ARVIM application. To begin, users must have the target images that correspond to each mask. When they scan their image targets via their smartphones, the corresponding 3D model and details about the mask are displayed on the phone's screen. They could simultaneously scan for several target images as long as they fit on the screen of their phone.

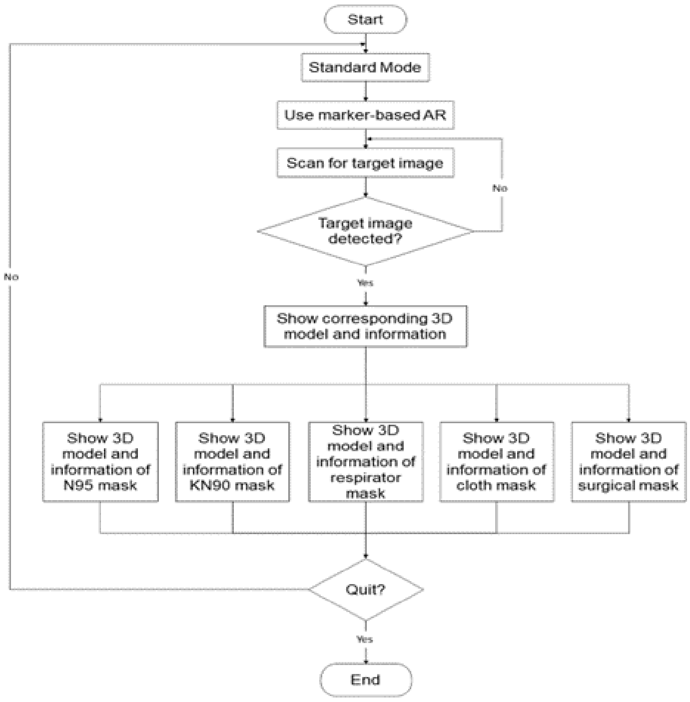


Fig. 1. System flowchart

2.2 AR Design marker-based parameters

Augmented reality is relatively a mixture of both reality and virtual that allows real-world objects to be augmented. Thus, adding a 3D image inside the apps would make it more exciting and have better visualization. Unity 3D will build the 3D model and act as the platform displaying the 3D image. The data is then saved in Google Cloud and may be accessed at any time by the users. The camera on the smartphone may be used as a scanner to detect the augmented reality marker-based that employs the Vuforia as an image tracker. As the matching marker-based found, the 3D model of the marker-based will overlay on the image. An excellent marker-based is quickly and consistently visible under all conditions. Therefore, specific parameters for choosing a suitable marker-based are needed to pay attention. Table 1 shows the marker-based detection parameter [21].

Table 1. Marker detection parameter

Parameter	Explanation
Marker-based Image	• 4 to 5 Star Rating The more structures the marker-based, the faster camera is detected.
Distance	• Between 30 cm to 2 meter From the marker-based and it should be parallel for the image to overlay on the screen.
Color Image	• RGB and Contrast color between the background and the marker-based. The camera needs to focus on the marker-based rather than other marker-based.
High Resolution	• 8-bit and 24-bit image pixel Clearer image for the user to visualize

2.3 System architecture design

Figure 2 illustrates the architecture diagram of the project. Unity 3D can build a 3D model and act as a platform for displaying the 3D model. The data is then stored in Google Cloud.

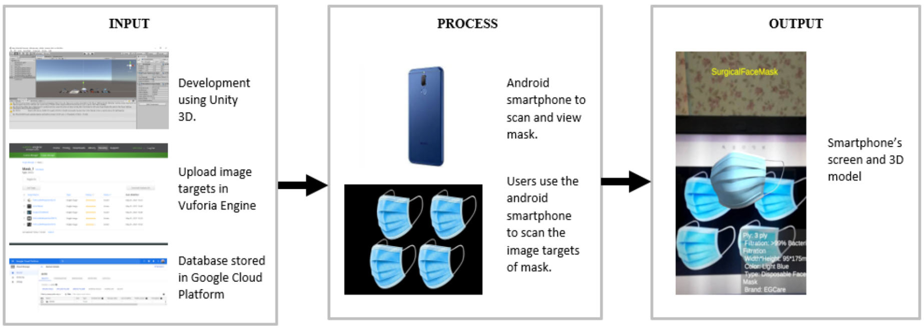


Fig. 2. ARVIM architecture design

The cloud storage also includes the 3D model data, marker information, and programming code. This has made the application more accessible from any location with an internet connection. Users can now have simpler access to the application for updates. The smartphone's camera can be used as a scanner to identify the augmented reality marker that makes use of the Vuforia as an image tracker. When the corresponding marker is identified, the 3D model of the marker is superimposed on the smartphone's screen.

2.4 ARVIM prototype

Figure 3 shows the prototype that includes three critical components to ensure the application runs appropriately; an Android smartphone and camera and an image target set to the specified mask. The target image (C) will be scanned and displayed on Android's screen by the camera (B). Apart from displaying the 3D model, users will engage with it and read the information shown on the smartphone's screen (A). Therefore, a different image target (C) will provide a 3D model of a different mask.

Fig. 3. Project prototype

3 Result and discussion

This project used augmented reality to inspect masks, as users would then use the pertinent information in their everyday lives. The application is compatible with Android smartphones. The camera on the smartphone will be used to detect the augmented reality marker. When a marker is found, a 3D model of the masks is superimposed over it. Additionally, the 3D model can be rotated and played to create a more immersive form of information dissemination. Users will be urged to use this mechanism to increase their knowledge of the appropriate way to wear a mask. Additionally, it is advantageous that the application's data is stored in Google Cloud, enabling remote access. This is a new initiative to assist society, particularly during this new pandemic. Among all previous augmented reality application projects, ARVIM is the first to take the initiative to deliver information about the mask in a fun and engaging manner, which is an excellent method to raise awareness.

3.1 Prototype design

This application was developed using Unity 3D software. Figure 4 shows the application’s interface when it scanned for the target images of all masks designed.

Fig. 4. ARVIM interface

Basic information about the mask will be displayed for each of the masks. This includes the filtration percentage, the number of plies, the size and color, and the type and brand of the mask used in this project. Users can compare the different types of masks based on the information provided in ARVIM. Users can interact with the corresponding 3D models by dragging, rotating, and scaling them apart from seeing the basic information as shown in Table 2.

Table 2. Information Provided in ARVIM Application

Mask	Information provided in ARVIM
Surgical Face Mask	Ply: 3 plies Filtration: >99% Bacterial Filtration Width*Height: 95*175 mm Color: Light blue Type: Disposable Face Mask Brand: EGCare
Particulate Respirator 8210 (N95 Mask)	Layer: 4 layers Filtration: >95% Particle Filtration Width*Height: 60*146 mm Color: White Type: Disposable N95 Dust Mask Brand: 3M
Particulate Respirator 9001V (KN90 Mask)	Layer: 3 layers Filtration: >90% Particle Filtration Width*Height: 115*180 mm Color: White Type: Disposable KN90 Dust Mask Brand: 3M
Particulate Respirator 9210 (Respirator Mask)	Layer: 3 layers Filtration: >95% Particle Filtration Width*Height: 89*213 mm Color: White Type: Disposable Respirator Mask Brand: 3M
Airism Mask (Cloth Mask)	Layer: 3 layers Filtration: >99% Bacterial Filtration Width*Height: 216*140 mm Color: Black or White Type: Reusable Face Mask Brand: Uniqlo

3.2 Analysis of the ARVIM

A total of 42 people answered the ARVIM-related questionnaire. A set of Google Forms questions is used to collect their responses. Each respondent is given four types of questions to get their opinions on various concerns. The respondents' backgrounds, their experience with augmented reality, their experience with the Augmented Reality on Virtual Inspection Mask (ARVIM) application, other suggestions on ARVIM and AR applications, and improvements for future adjustment are the categories.

3.3 Respondents' background

The application is designed for people of all ages, including those under 20, between 20 and 50 years of age, and above 50. Figure 5 shows that the respondents consist of eight individuals under 20 years of age, 24 between 20 and 50 years old, and ten beyond age 50. The results suggest that 57.1% of respondents are between the ages of 20 and 50. Figure 6 presents, that 22 of the 42 respondents are students, 15 are employed, and five are retired. The statistics for the age of respondents explain why students have the highest percentage in the occupation sector, at 52.4%, compared to working and retired individuals.

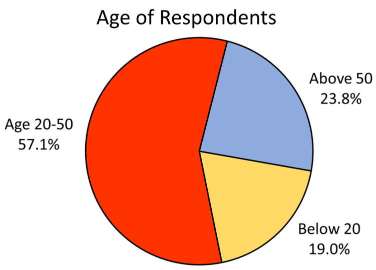


Fig. 5. Age of respondents

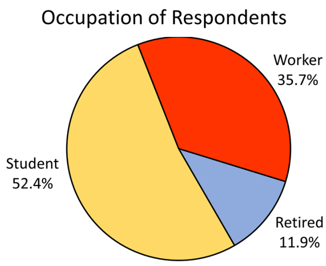


Fig. 6. Occupation of respondents

3.4 Respondents' experience with augmented reality

This section's questions were designed to ascertain participants' general knowledge of augmented reality. Figure 7 illustrates respondents' replies to the first question indicating their familiarity with augmented reality applications. The results indicate that 57.1% of respondents are familiar with augmented reality, 26.2% stated they were not familiar, and 16.7% were unsure.

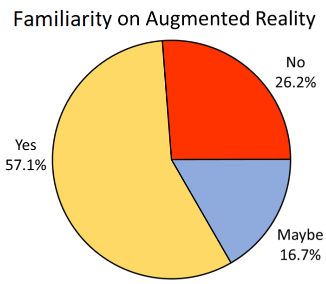


Fig. 7. Familiarity with augmented reality

Figure 8 displays the responses to a question on the respondents' experience rate with Augmented Reality (AR) on a Likert scale of 1 to 5, from no experience to very experienced. 45.2% and 26.2% of respondents, respectively, responded to the '1' and '2' scales. 14.3% of respondents evaluated themselves on a '3' scale, whereas 11.9% ranked themselves on a '4' scale. Only one responder, or 2.4% of respondents, responded with a '5' scale, indicating highly experienced.

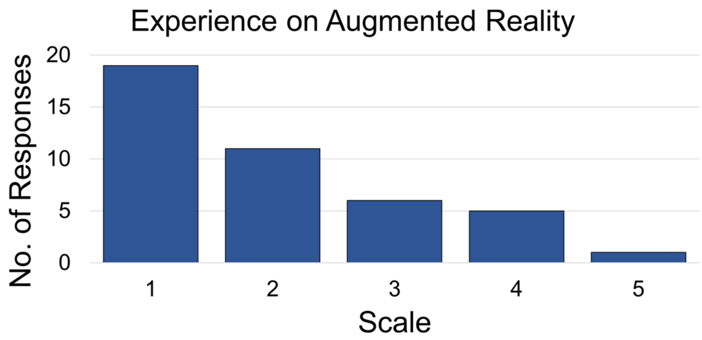
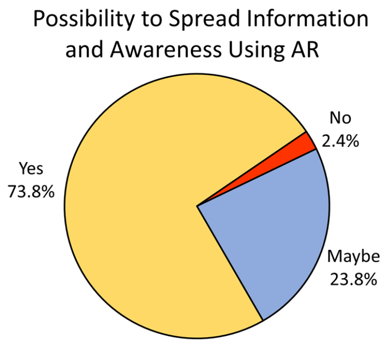


Fig. 8. Experience in augmented reality

Figure 9 presents the analysis of respondents' perceptions about how augmented reality can be utilized to convey knowledge and awareness. 73.8% of respondents agreed that augmented reality could help to convey information and awareness, while 23.8% and 2.4%, respectively, are unsure or had no experience. Figure 10 shows a comparison of respondents' preferences for augmented reality (AR) and books. According to the pie chart, 45.2% of respondents prefer augmented reality over books, while the remaining 38.1% are unsure, and 16.7% prefer books over augmented reality.



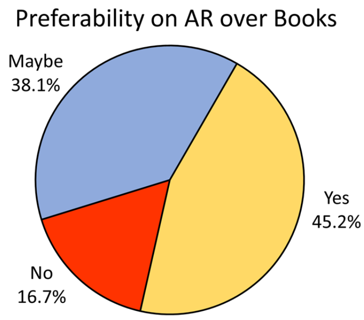


Fig. 9. Spread information and awareness using AR **Fig. 10.** Preferability of AR over books

Figure 11 illustrates the analysis of respondents' responses to whether augmented reality will take advantage of today's learning environment. 76.2% of respondents indicated that augmented reality would benefit today's learning environment, while 23.8% expressed uncertainty.

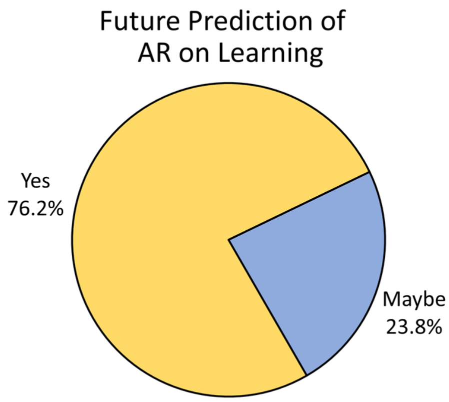


Fig. 11. Future prediction of AR on learning

3.5 Respondents' experience with ARVIM application

This section solicits feedback from participants regarding their experience with the ARVIM application. Figure 12 displays respondents' perceptions of how easy it is to obtain information on the masks using ARVIM. The answers are evaluated on a 1 to 5 scale, with '1' being the most challenging and '5' being the easiest. Only 4.8% indicated that ARVIM is challenging to use, while 14.3% say they are neutral. Additionally, 80.9% of participants believe that ARVIM is easy to use to obtain information on the masks.

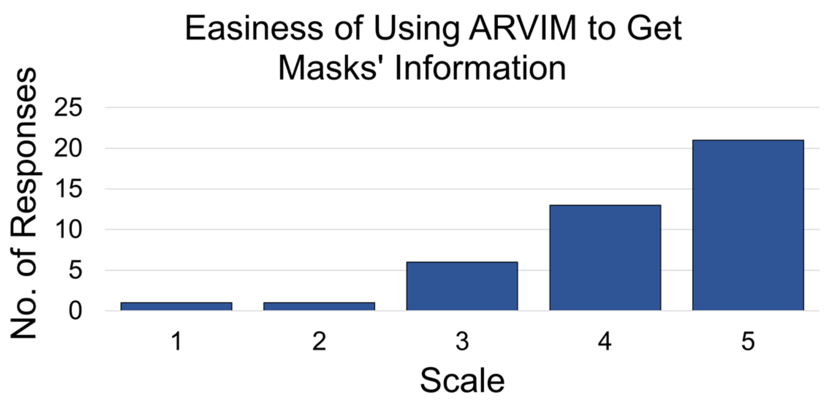


Fig. 12. Easiness of using ARVIM to get masks' information

Figure 13 shows the answer to the question of either ARVIM helps users to differentiate masks. This is on a scale of 1 to 5, with '1' indicating the least helpful and '5' indicating the most helpful. Only 2.4% of respondents state that ARVIM is ineffective, while 14.2% state that they are neutral. Meanwhile, 83.4% of respondents agree that ARVIM can assist them in differentiating the masks.

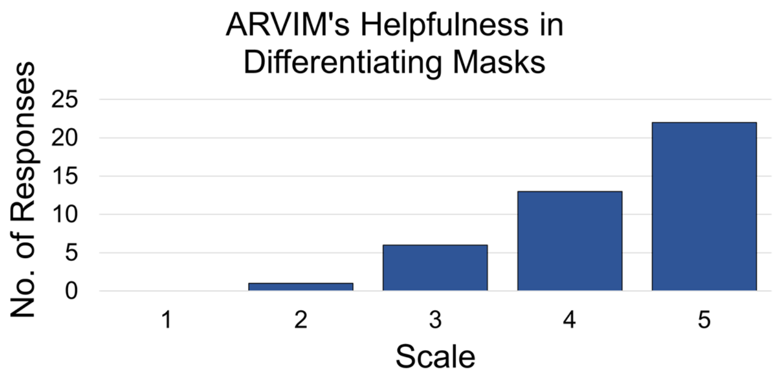


Fig. 13. ARVIM's helpfulness in differentiating masks

Figure 14 illustrates the analysis of respondents' perceptions of ARVIM as a medium for information dissemination. 4.8% of respondents disagree, and 11.9% are uncertain. 83.3% of the remaining respondents agree that ARVIM can serve as a medium for disseminating information.

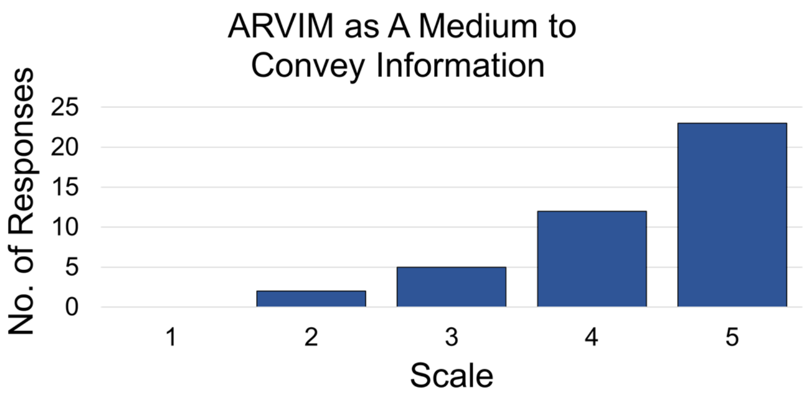


Fig. 14. ARVIM as a medium to convey information

Figure 15 shows the response on the easiness to handle ARVIM, on a scale of 1 to 5, from challenging to easy. 4.8% of the respondents answered that it is challenging, 26.2% give the score of '3', which is unsure, and 69% of the respondents think that ARVIM is easy to handle.

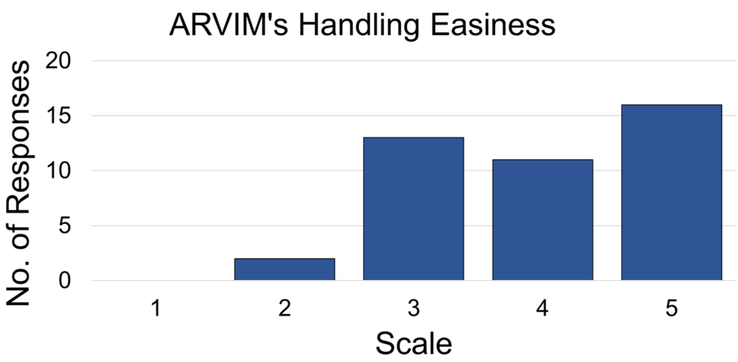


Fig. 15. ARVIM's handling easiness

Figure 16 depicts the rate for the design and technical aspects of ARVIM. Answers are graded on a scale of 1 to 5, from bad to best. Only 2.4% of participants responded that ARVIM does not have an outstanding design. In addition, there are 9.5% of uncertain respondents. Meanwhile, 88.1% of the respondents rated ARVIM's design as excellent.

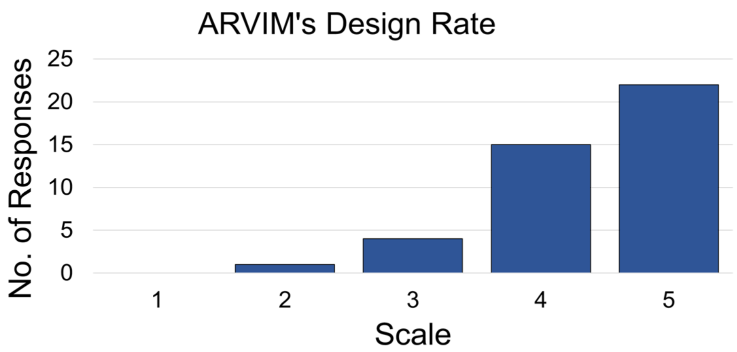


Fig. 16. ARVIM's design rate

3.6 Suggestions on ARVIM and augmented reality

This section is intended to collect the respondents' feedback and suggestions regarding ARVIM and augmented reality applications. Figure 17 displays respondents' opinions when asked if they would recommend ARVIM to their family and friends. 78.6% of respondents are willing to make suggestions, while 21.4% are unsure. Figure 18 represents the responses to whether augmented reality will be used in educational settings in the future. 90.5% of respondents favor the possibility, while the remaining 9.5% are unsure of it.

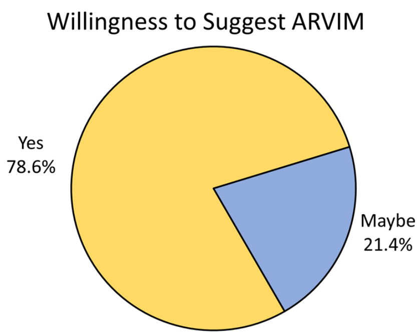


Fig. 17. Willingness to suggest ARVIM

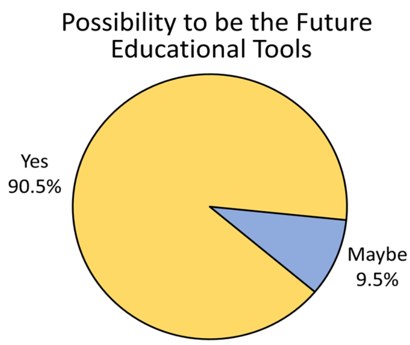


Fig. 18. Possibility to be the future educational tools

Table 3 lists the suggestions for ARVIM improvements made by respondents. Only a few of the 42 replies propose recommendations because the other respondents are unfamiliar with the AR application and have no idea what to improve.

Table 3. Suggestions for ARVIM's improvements

Suggestions for ARVIM's Improvements	
1	Try to show the non-quality mask that has on the market.
2	State the rating for the respective mask.
3	Try to make it enable to scan masks on people's face
4	Insert audio explaining the differences between the masks.
5	To make use of ARVIM to get knowledge of anything besides masks
6	Please provide more mask
7	Try to make the masks as the filter so users can act as if they are wearing the mask
8	Add more features
9	Make it more user-friendly for every age group
10	To access the application on a different medium

4 Conclusion

This initiative aims at a society that uses daily masks. It is about using augmented reality to provide essential mask inspection data to create an interactive, comprehensive guide. ARVIM has been successfully developed using Blender Animation Tools, Unity 3D software, Vuforia Engine, and Google Cloud Platform. This would draw users' interest, making them more aware of the value of wearing a suitable mask. This effort also promotes innovation in education, including ongoing awareness of a real-world environment that can improve productivity and the process of a long-term efficient and exciting education. This project will also give users another perspective as they will engage directly with the 3D mask models. Users can move and scale the 3D models along with obtaining the crucial information on the masks, creating an interesting way to get the awareness of the right usage for different types of masks. There are many ways to improve ARVIM, such as providing more types of masks, using a markerless augmented reality, or adding the right method to wear each mask. In conclusion, this project could improve visibility and make it easier for end-users to grasp suitable masks for their everyday use.

5 Acknowledgment

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6 References

[1] M. Kassim, "Design of Augmented Reality for Engineering Equipment in Education," *International Journal of Advanced Trends in Computer Science and Engineering,* vol. 8, pp. 2773-2781, 12/15 2019, https://doi.org/10.30534/ijatcse/2019/15862019.

[2] N. Mazlan, "Rehabilitation Hand Exercise System with Video Games," *International Journal of Advanced Trends in Computer Science and Engineering,* vol. 9, pp. 545-551, 02/15 2020, https://doi.org/10.30534/ijatcse/2020/74912020.

[3] H. Hedberg, J. Nouri, P. Hansen, and R. Rahmani, "A Systematic Review of Learning Through Mobile Augmented Reality," *International Journal of Interactive Mobile Technologies (iJIM),* vol. 8, 03/07 2018, https://doi.org/10.3991/ijim.v12i3.8404.

[4] N. A. A. Nordin, N. A. Abd Majid, and N. F. Ainun Zainal, "Mobile augmented reality using 3D ruler in a robotic educational module to promote STEM learning," *2020,* Augmented reality; Dynamic; Educational games; Robotic; STEM vol. 9, no. 6, p. 8, 2020-12-01 2020, https://doi.org/10.11591/eei.v9i6.2235.

[5] A. Paliling, "IMPLEMENTATION OF AUGMENTED REALITY TECHNOLOGY FOR HUMAN SKELETONS LEARNING BASED ON ANDROID," *Journal of Information Technology and Its Utilization,* vol. 2, p. 34, 12/19 2019, http://dx.doi.org/10.30818/jitu.2.2.2343.

[6] H. Qin, D. A. Peak, and V. Prybutok, "A virtual market in your pocket: How does mobile augmented reality (MAR) influence consumer decision making?," *Journal of Retailing and Consumer Services,* vol. 58, p. 102337, 2021/01/01/ 2021, https://doi.org/10.1016/j.jretconser.2020.102337.

[7] B. A. Koca, B. Çubukçu, and U. Yüzgeç, "Augmented Reality Application for Preschool Children with Unity 3D Platform," in *2019 3rd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT)*, 11-13 Oct. 2019 2019, pp. 1-4, https://doi.org/10.1109/ISMSIT.2019.8932729.

[8] G. Singh, A. Mantri, O. Sharma, R. Dutta, and R. Kaur, "Evaluating the impact of the augmented reality learning environment on electronics laboratory skills of engineering students," *Computer Applications in Engineering Education,* vol. 27, 11/07 2019, https://doi.org/10.1002/cae.22156.

[9] B. M. Garrett, C. Jackson, and B. Wilson, "Augmented reality m-learning to enhance nursing skills acquisition in the clinical skills laboratory," *Interactive Technology and Smart Education,* vol. 12, no. 4, pp. 298-314, 2015, https://doi.org/10.1108/ITSE-05-2015-0013.

[10] 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, https://doi.org/10.3991/ijim.v13i07.10750.
[11] 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)*, 20-23 April 2018 2018, pp. 321-326, https://doi.org/10.1109/ICCAR.2018.8384693.
[12] B. Zhang and W. Hu, "Game special effect simulation based on particle system of Unity3D," in *2017 IEEE/ACIS 16th International Conference on Computer and Information Science (ICIS)*, 24-26 May 2017 2017, pp. 595-598, https://doi.org/10.1109/ICIS.2017.7960062.
[13] M. Kassim and 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, p. 33, 09/06 2021, https://doi.org/10.3991/ijim.v15i17.22071.
[14] R. Schnürer, C. Dind, S. Schalcher, P. Tschudi, and L. Hurni, "Augmenting Printed School Atlases with Thematic 3D Maps," *Multimodal Technologies and Interaction,* vol. 4, no. 2, 2020, https://doi.org/10.3390/mti4020023.
[15] H.-Y. Chang, Y.-S. Hsu, H.-K. Wu, and C.-C. Tsai, "Students' development of socio-scientific reasoning in a mobile augmented reality learning environment," *International Journal of Science Education,* vol. 40, pp. 1-22, 06/02 2018, https://doi.org/10.1080/09500693.2018.1480075.
[16] A. Gupta, P. Goswami, N. Chaudhary, and R. Bansal, "Deploying an Application using Google Cloud Platform," in *2020 2nd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA)*, 5-7 March 2020 2020, pp. 236-239, https://doi.org/10.1109/ICIMIA48430.2020.9074911.
[17] T. Khan, K. Johnston, and J. Ophoff, "The Impact of an Augmented Reality Application on Learning Motivation of Students," *Advances in Human-Computer Interaction,* vol. 2019, p. 7208494, 2019/02/03 2019, https://doi.org/10.1155/2019/7208494.
[18] S. Chen, W. Liu, and G. Zhang, "Efficient Transfer Learning Combined Skip-Connected Structure for Masked Face Poses Classification," *IEEE Access,* vol. 8, pp. 209688-209698, 2020, https://doi.org/10.1109/ACCESS.2020.3039862.
[19] M. Ippolito *et al.*, "Medical masks and Respirators for the Protection of Healthcare Workers from SARS-CoV-2 and other viruses," (in eng), *Pulmonology,* vol. 26, no. 4, pp. 204-212, Jul-Aug 2020, https://doi.org/10.1016/j.pulmoe.2020.04.009.
[20] G. Chatzithanasis and C. Michalakelis, "The Benefits of Cloud Computing: Evidence From Greece," *International Journal of Technology Diffusion,* vol. 9, pp. 61-73, 04/01 2018, https://doi.org/10.4018/IJTD.2018040104.
[21] S. Sendari, A. Firmansah, and Aripriharta, "Performance Analysis of Augmented Reality Based on Vuforia Using 3D Marker Detection," in *2020 4th International Conference on Vocational Education and Training (ICOVET)*, 19-19 Sept. 2020 2020, pp. 294-298, https://doi.org/10.1109/ICOVET50258.2020.9230276.

7 Authors

Alisa Rafiqah Adenan obtained her first degree in Electronics Engineering from the Faculty of Electrical Engineering, Universiti Teknologi MARA, Shah Alam, Selangor Malaysia in 2020. This was her first project development on a Mobile application based on 3D Augmented Reality (Email: Alisarafiqah25@gmail.com).

Murizah Kassim is currently working as a Senior Fellow at the Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Centre of Excellence, Kompleks Al-Khawarizmi, Universiti Teknologi MARA, Shah Alam. She is an Associate Professor from the School of Electrical Engineering, College of Engineering, Universiti Teknologi MARA, Shah Alam, Selangor. She received her Ph.D. in Electronic, Electrical, and System Engineering in 2016 from the Faculty of Built Environment and Engineering, Universiti Kebangsaan Malaysia (UKM). She has published about 125 indexed papers related to computer networks, data analytics, IoT, Web, and Mobile development applications research. She has experience of 19 years in the technical team at the Centre for Integrated Information Systems, UiTM. She is also a member of Enabling Internet of Things Technologies (ElIoTT) research group UiTM. She joined the academic in January 2009 and is currently a member of MBOT, IEEE, IET, IAENG, and IACSIT organizations (Email: murizah@uitm.edu.my).

Nur Amirah Kamaluddin obtained her first degree in Electronics Engineering from the Faculty of Electrical Engineering, Universiti Teknologi MARA, Shah Alam, Selangor Malaysia in the year 2020. Currently, she is pursuing her master's in Electric Engineering from the School of Electrical Engineering, College of Engineering, Universiti Teknologi MARA, Shah Alam, Selangor. She is interested in researching more development in augmented reality and mobile applications to improve society (Email: nuramirahkamaluddin97@gmail.com).

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