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**ADAPTIVE INTERACTION DESIGN MODEL FOR LOCATION-  
BASED AUGMENTED REALITY IN CULTURAL HERITAGE  
SITES**



**MASTER OF SCIENCE (MULTIMEDIA STUDIES)  
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Awang Had Salleh  
Graduate School  
of Arts And Sciences

Universiti Utara Malaysia

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## ABSTRAK

Realiti terimbuh (AR) telah membolehkan industri pelancongan untuk maju melangkaui penyediaan maklumat konvensional. Realiti terimbuh berasaskan lokasi adaptif (LBAR) boleh membantu dalam menyediakan media dinamik dan interaktiviti yang memerlukan set teknik interaksi baharu untuk mempertingkatkan dan memperkayakan penggunaan aplikasi oleh pelawat di tapak warisan budaya. Walau bagaimanapun, penyelidikan dalam model reka bentuk interaksi yang bersesuaian masih kurang terutama untuk interaksi adaptif dalam realiti luasan berdasarkan lokasi (LBAR) di tapak warisan. Objektif kajian ini adalah mengenal pasti modaliti teknik interaksi yang penting untuk LBAR; mengenal pasti keperluan pengguna dan teknik interaksi pilihan apabila menggunakan LBAR di tapak warisan budaya; membangunkan model reka bentuk interaksi adaptif berdasarkan keperluan pengguna yang dikenal pasti dan teknik interaksi pilihan ke atas LBAR; serta mengesahkan model interaksi melalui pengesahan pengguna. Kajian ini menggunakan kaedah penyelidikan sains reka bentuk, yang merangkumi perbincangan kumpulan fokus, ulasan pakar, keperluan pengguna, dan ujian kebolehgunaan. Kes penggunaan dan persona pengguna dibangunkan semasa perbincangan kumpulan fokus yang membawa kepada pengenalanpastian keperluan pengguna dan teknik interaksi pilihan pengguna. Kaedah ini dan kajian sebelumnya telah menghasilkan modaliti iaitu unimodal, multimodal, dan adaptif yang kemudiannya dimasukkan ke dalam model reka bentuk interaksi adaptif. Seterusnya, empat pakar telah menyemak dan menyimpulkan bahawa model reka bentuk interaksi adaptif tersebut boleh digunakan untuk pembangunan aplikasi AR berdasarkan lokasi tapak warisan budaya. Kemudian, sebuah prototaip MelakAR telah dibangunkan sebagai bukti konsep dan diuji oleh 35 peserta dari segi kebolehgunaannya. Berdasarkan ujian kebolehgunaan, peserta bersetuju dengan kemudahan penggunaannya; kebergunaan yang dirasai; dan kepuasan. Keputusan menunjukkan bahawa para peserta sememangnya berpuas hati menggunakan aplikasi MelakAR di tapak warisan budaya Melaka. Hasil utama kajian ini adalah model reka bentuk interaksi adaptif yang memberikan panduan kepada pembangun masa depan untuk memasukkan strategi interaksi adaptif bagi LBAR di tapak warisan budaya.

## ABSTRACT

Augmented Reality (AR) has enabled travel and tourism industries to advance beyond the conventional sources of information providers. Adaptive Location-Based Augmented Reality (LBAR) may assist in providing dynamic media and interactivity, which needs a new set of interaction techniques to enhance and enrich the application usage by visitors in cultural heritage sites. However, research in adaptive interaction design models remains scarce, especially on adaptive interaction in LBAR in cultural heritage sites. Therefore, the objectives of this study are to identify the modalities of interaction techniques which are essentials for LBAR; to identify users needs and preferred interaction techniques when using LBAR in cultural heritage sites; to develop an adaptive interaction design model based on identified user needs and preferred interaction techniques on LBAR; and to validate the interaction model using user validation. This study employed the design science research method, which includes focus group discussion, expert review, user requirements, and usability testing. Use cases and user persona were developed during focus group discussion, which led to the identification of user needs and preferred interaction techniques. This and previous studies have yielded modalities which are unimodal, multimodal, and adaptive and were then included in the adaptive interaction design model. Next, four experts reviewed and concluded that the adaptive interaction design model is usable for the development of location-based mobile AR applications for cultural heritage sites. Then, a prototype named MelakAR was developed as a proof-of-concept and tested by 35 participants in terms of its usability. Based on the usability testing, participants agreed on its ease of use; its perceived usefulness, and its satisfaction. The results show that the participants were indeed satisfied with using the MelakAR app in Melaka cultural heritage sites. The main outcome of this study is an adaptive interaction design model that provides guidelines for future developers to incorporate adaptive interaction strategies for LBAR in cultural heritage sites.

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# CHAPTER ONE

## INTRODUCTION

### 1.1 Overview

This chapter presents the background of the research and the focus. It then discusses the motivation, problem statement, and the overview on adaptive interaction design model. Then it discusses the research questions, the research objectives, research scope and finally the research significance.

### 1.2 Background

In recent years, mobile phones and particularly smartphones, have developed into an ideal platform for augmented reality (AR) applications. AR can be effective to build user interest in cultural heritage sites by engaging users, piquing their interest, and prompting their participation with a specific site. According to Angelopoulou et al. (2012) studies have shown that AR could provide an alternative mean for navigation, interaction and orientation, especially when a specific site do not have the adequate amount of information on it.

The traditional tour guides in cultural heritage sites are in the form of books, maps, leaflets, booklets, and a person, which is difficult to entertain tourists, transfer the real experience, and stimulate learning intention during their visit (Kim et. al., 2021). In most cases, cultural heritage sites do not have useful information or they lack user guides which affect the visiting experience (Kempiak et. al., 2017). It becomes worse when the sites are large and certain artefacts or building are already demolished.

## REFERENCE

Department of Statistics Malaysia, Ministry of Economy

<https://www.dosm.gov.my/portal-main/release-content/975c3266-8b81-11ed-96a6-1866daa77ef9>

United Nations Educational, Scientific and Cultural Organization. *Convention Concerning the Protection of the World Cultural and Natural Heritage.*

<https://whc.unesco.org/en/conventiontext>

United Nations World Tourism Organization (n.d.). *What Is Tourism Innovation.*

<https://www.unwto.org/what-is-tourism-innovation>

Malaysia: National heritage Act 2005 p. 12.

Ministry of Tourism, Arts and Culture Malaysia, (2019). Malaysia Tourism Quality Assurance (MyTQA).

<https://www.motac.gov.my/en/services/registration/mytqa>

Abidin, R. Z., Arshad, H., and Shukri, S. A. A. (2017). A framework of adaptive multimodal input for location-based augmented reality application, *J. Telecommun. Electron. Comput. Eng.*, vol. 9, no. 2–11, p. 97–103.

Bakar, J. A. A., Hanafi, E. H. M., Abidin, R. Z., Pendit, U. C., & Arshad, H. (2024). Augmented reality meets artificial intelligence towards personalised user experience in cultural heritage sites. In *The Future of Human-Computer Integration* (pp. 134-148). CRC Press.

Abowd, G. D., Dey, A. K., Brown, P. J., Davies, N., Smith, M., & Steggles, P. (1999). *Towards a Better Understanding of Context and Context-Awareness. Lecture Notes in Computer Science, 304–307.* doi:10.1007/3-540-48157-5\_29

- Amir, S., Osman, M. M., Bachok, S., and Ibrahim, M. (2015). Sustaining local community economy through tourism: Melaka UNESCO world heritage city. *The 5th Sustainable Future for Human Security (Sustain 2014)*.
- Angelopoulou, A., Economou, D., Bouki, V., Psarrou, A., Jin, L., Pritchard, C., and Kolyda, F. (2012). *Mobile Augmented Reality for Cultural Heritage*.
- Aziz, K. A., and Tan, G. S. (2014). Virtual Reality and Augmented Reality Combination as a Holistic Application for Heritage Preservation in the UNESCO World Heritage Site of Melaka. *International Journal of Social Science and Humanity*. Vol. 4, No. 5.
- Aziz, R. A. (2017). HERITAGE CONSERVATION: AUTHENTICITY AND VULNERABILITY OF LIVING HERITAGE SITES IN MELAKA STATE. *Kajian Malaysia* 35(Supp.1): 39–58.
- Azizan, M. A., Noriman, N. Z., Desa, H., Ishak, N., Dahham, O. S., Umar, M. U., and Latip, N. A. (2020). The challenges in conservation practices in Malaysia: A study in UNESCO heritage site, Georgetown, Penang, Malaysia. *AIP Conference Proceedings* 2213(1).
- Azuma, R. T. (1997). A Survey of Augmented Reality. : *Teleoperators and Virtual Environments* 6, 4 (August 1997), 355-385.
- Billinghurst, M. (2004, 27-31 March). Introduction to Augmented Reality [Paper Presentation]. *IEEE Virtual Reality Conference 2004*. Chicago, IL, United States.
- Boboc, R., Duguleana, M., Voinea, G., Postelnicu, C., Popovici, D. M., Carrozzino, M. (2019). Mobile Augmented Reality for Cultural Heritage: Following the Footsteps of Ovid among Different Locations in Europe. *Sustainability*. 11. 1167.

- Boboc, R.G., Bautu, E.; Gîrbacia, F., Popovici, N., and Popovici, D. M. (2022) Augmented Reality in Cultural Heritage: An Overview of the Last Decade of Applications. *Appl. Sci.* 2022, 12, 9859. <https://doi.org/10.3390/app12199859>
- Boletsis, C., & McCallum, S. (2016). Augmented Reality Cubes for Cognitive Gaming: Preliminary Usability and Game Experience Testing. *International Journal of Serious Games*, 3(1). <https://doi.org/10.17083/ijsg.v3i1.106>
- Brown, T., and Wyatt, J. (2010). Design Thinking for Social Innovation IDEO.
- Burkard, S., Fuchs-Kittowski, F., Humberger, S., Fischer, F., and Pfennigschmidt, S. (2017). Springer International Publishing. Mobile Location-Based Augmented Reality Framework.
- Carmigniani, J., Furht, B., Anisetti, M., Ceravolo, P., Damiani, E., and Ivkovic, M. (2011). Augmented reality technologies, systems and applications,” *Multimed. Tools Appl.*, vol. 51, no. 1, 341–377.
- Carrigy, T., Naliuka, K., Paterson, N., Haahr, M. (2010). ACM Press the 6th Nordic Conference - Reykjavik, Iceland (2010.10.16-2010.10.20)] Proceedings of the 6th Nordic Conference on Human-Computer Interaction Extending Boundaries - NordiCHI '10 - Design and evaluation of player experience of a location-based mobile game.
- Cartier, C. L. (1996). Conserving The Built Environment and Generating Heritage Tourism in Peninsular Malaysia, *Tourism Recreation Research*, 21:1, 45-53.
- Dam, R. F. (2021). *The Encyclopedia of Human-Computer Interaction*, 2nd Ed.. Aarhus, Denmark: The Interaction Design Foundation.
- Chung, N., Lee, H., Kim, J. Y., and Koo, C. (2017). The Role of Augmented Reality for Experience-Influenced Environments: The Case of Cultural Heritage tourism in Korea.

- Datcu, D., and Lukosch, S. (2013). Design Guidelines for Adaptive Multimodal Mobile Input Solutions. *Free-Hands Interaction in Augmented Reality*.
- Dumas, B., Solórzano, M., and Signer, M. (2013). Design guidelines for adaptive multimodal mobile input solutions,” *Proc. 15th Int. Conf. Human-computer Interact. with Mob. devices Serv. - MobileHCI '13*, p. 285
- Dunser, A., Billingham, M., Wen, J., Lehtinen, V., and Nurminen, A. (2013). Exploring the use of handheld AR for outdoor navigation..
- Ellenberger, K. (2017). Virtual and Augmented Reality in Public Archaeology Teaching.
- Ertan, T., and Egercioglu, Y. (2015). The Impact of UNESCO World Heritage List on Historic Urban City Centers and Its Place in Urban Regeneration: The Case of Melaka, Malaysia and Tire, Turkey. *Urban Planning and Architecture Design for Sustainable Development, UPADSD 14- 16 October 2015*
- Exner, K., Ängleslevä, J., Bähr, B., Nagy, E., Lindow, K., & Stark, R. (2015). A transdisciplinary perspective on prototyping. *Proceedings of the 2015 IEEE International Conference on Engineering, Technology and Innovation/International Technology Management Conference (ICE/ITMC)*, Belfast, pp. 1–8
- Giariskanis, F., Kritikos, Y., Protopapadaki, E., Papanastasiou, A., Eleni Papadopoulou, and Mania, K. (2022). The Augmented Museum: A Multimodal, Game-Based, Augmented Reality Narrative for Cultural Heritage. In *ACM International Conference on Interactive Media Experiences (IMX '22)*, June 22–24, 2022, Aveiro, JB, Portugal. ACM, New York, NY, USA, 5 pages. <https://doi.org/10.1145/3505284.3532967>
- Gilbert, G. E., & Prion, S. (2016). *Making Sense of Methods and Measurement: Lawshe's Content Validity Index. Clinical Simulation in Nursing*, 12(12), 530–531. doi:10.1016/j.ecns.2016.08.002

- Goodman, E., Stolterman, E., & Wakkary, R. (2011). Understanding interaction design practices. Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems - CHI '11. doi:10.1145/1978942.1979100
- Han, D. I., and Jung, T. (2018). Identifying Tourist Requirements for Mobile AR Tourism Applications in Urban Heritage Tourism
- Haahr, M. (2017). Creating Location-Based Augmented-Reality Games for Cultural Heritage.
- Harun, S. N. (2011). Heritage Building Conservation in Malaysia: Experience and Challenges. The 2nd International Building Control Conference 2011.
- Hollerer, T., Feiner, S., Terauchi, T., Rashid, G., and Hallaway, D. (1999). Exploring MARS: developing indoor and outdoor user interfaces to a mobile augmented reality system.
- Hürst, W., and Van Wezel, C. (2011). Multimodal Interaction Concepts for Mobile Augmented Reality Applications, 157–167.
- Irshad, S., Rambli, D. S. A., Sulaiman, S. (2019, December 2-4). An Interaction Design Model for Information Visualization in Immersive Augmented Reality platform [Paper presentation]. Proceedings of the 17th International Conference on Advances in Mobile Computing & Multimedia, Munich, Germany. doi:10.1145/3365921.3365939
- Jacob, J. T. P. N., Coelho, A. F. (2011). *Issues in the Development of Location-Based Games. International Journal of Computer Games Technology, 2011()*, 1–7
- Jamali, S., Shiratuddin, M. F., and Wong, K. (2014). An Overview of mobile-Augmented Reality in Higher Education, vol. 11, no. 1.

- Jung, T., M. C. tom Dieck. (2018). *[Progress in IS] Augmented Reality and Virtual Reality || Augmented Reality for Mobile Devices: Textual Annotation of Outdoor Locations.* , 10.1007/978-3-319-64027-3(Chapter 24), 353–362.
- Kempiak, J., Hollywood, L., Bolan, P., & McMahon-Beattie, U. (2017). *The heritage tourist: an understanding of the visitor experience at heritage attractions. International Journal of Heritage Studies*, 23(4), 375–392. doi:10.1080/13527258.2016.1277776
- Kim, J., Shinaprayoon, T., Ahn, S. J. G. (2021). *Virtual Tours Encourage Intentions to Travel and Willingness to Pay via Spatial Presence, Enjoyment, and Destination Image.* *Journal of Current Issues & Research in Advertising*. 43. 1-16. 10.1080/10641734.2021.1962441.
- Jiang, J.-R.; Subakti, H. An Indoor Location-Based Augmented Reality Framework. *Sensors* **2023**, 23, 1370. <https://doi.org/10.3390/s23031370>
- Kleftodimos, A.; Moustaka, M.; Evagelou, A. Location-Based Augmented Reality for Cultural Heritage Education: Creating Educational, Gamified Location-Based AR Applications for the Prehistoric Lake Settlement of Dispilio. *Digital* **2023**, 3, 18–45. <https://doi.org/10.3390/digital3010002>
- Kleftodimos, A.; Evagelou, A.; Gkoutzios, S.; Matsiola, M.; Vrigkas, M.; Yannacopoulou, A.; Triantafillidou, A.; Lappas, G. Creating Location-Based Augmented Reality Games and Immersive Experiences for Touristic Destination Marketing and Education. *Computers* **2023**, 12, 227. <https://doi.org/10.3390/computers12110227>
- Ko, S. M., Chang, W. S., and Yong, G. J. (2013). Usability Principles for Augmented Reality Applications in a Smartphone Environment. *Intl. Journal of Human–Computer Interaction*, 29: 501–515.

- Kumar, K. G. (2019). Future Generation Education on Augmented Reality. *International Journal of Computer Sciences and Engineering*. Vol.-7, Special Issue-8, Apr 2019.
- Lee, M., Billingham, M., Baek, W. *et al.* A usability study of multimodal input in an augmented reality environment. *Virtual Reality* **17**, 293–305 (2013). <https://doi.org/10.1007/s10055-013-0230-0>
- Liarokapis, F. (2006). An exploration from virtual to augmented reality gaming. *SIMULATION & GAMING*, Vol. 37 No. 4, December 2006 507-533.
- Lim, Y.-K., Stolterman, E. & Tenenberg, J. (2008) The anatomy of prototypes: prototypes as filters, prototypes as manifestations of design ideas. *ACM Transactions on Computer-Human Interaction (TOCHI)* 15, 7
- Maguire, M., Bevan, N. (2002). User Requirements Analysis. In: Hammond, J., Gross, T., Wesson, J. (eds) *Usability*. IFIP WCC TC13 2002. IFIP — The International Federation for Information Processing, vol 99. Springer, Boston, MA. [https://doi.org/10.1007/978-0-387-35610-5\\_9](https://doi.org/10.1007/978-0-387-35610-5_9)
- Matviienko, A., Günther, S., Ritzenhofen, S., and Mühlhäuser, M. (2022). AR Sightseeing: Comparing Information Placements at Outdoor Historical Heritage Sites using Augmented Reality. *Proc. ACM Hum.-Comput. Interact.* 6, MHCI, Article 194 (September 2022), 17 pages. DOI: <https://doi.org/10.1145/3546729>
- Mayer, R. E. (1989). Models for Understanding. *Review of Educational Research*, 59(1), 43–64. doi:10.3102/00346543059001043
- Milgram, Paul & Takemura, Haruo & Utsumi, Akira & Kishino, Fumio. (1994). Augmented reality: A class of displays on the reality-virtuality continuum. *Telemanipulator and Telepresence Technologies*. 2351. 10.1117/12.197321.
- Möller, A., Diewald, S., Roalter, L., & Kranz, M. (2014). M3I: A Framework for Mobile Multimodal Interaction. *Message Understanding Conference*.

- Nielsen, J., & Landauer, T. K. (1993). *A mathematical model of the finding of usability problems. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '93*. doi:10.1145/169059.169166
- Nielsen, J. (2000). *Why You Only Need to Test with 5 Users*. Nielsen Norman Group. <https://www.nngroup.com/articles/why-you-only-need-to-test-with-5-users/>
- Nizam, S. M., Abidin, R. Z., Hashim, N. C., Lam, M. C., Arshad, H., Majid, N. (2018). A Review of Multimodal Interaction Technique in Augmented Reality Environment. *International Journal on Advanced Science, Engineering and Information Technology*. 8. 1460.
- Oviatt, S., and Lunsford, R. (2005). Multimodal Interfaces for Cell Phones and Mobile Technology. *International Journal of Speech Technology* 8, 127–132.
- Pang, Y., Nee, A. Y. C., Ong, S. K., and Yuan, M. (2006). Assembly feature design in an augmented reality environment. *Assembly Automation*, Vol. 26 Iss 1 pp. 34 - 43.
- Park, J., & Han, S. H. (2011). *Complementary menus: Combining adaptable and adaptive approaches for menu interface. International Journal of Industrial Ergonomics*, 41(3), 305–316.
- Paucher, R., and Turk, M. (2010 June 13-18). *Location-based augmented reality on mobile phones* [Paper Presentation]. IEEE Computer Society Conference on Computer Vision and Pattern Recognition Workshops (CVPR Workshops) San Francisco, CA,USA. doi. 10.1109/CVPRW.2010.5543249
- Peffer, K., Tuunanen, T., Rothenberger, M., Chatterjee, S. (2007). *A Design Science Research Methodology for Information Systems Research*. *J. Manage. Inf. Syst.* 24, 3 (Number 3 / Winter 2007-2008), 45–77. <https://doi.org/10.2753/MIS0742-1222240302>

- Rajapakse, A. (2018). Exploring the Living Heritage of Galle Fort: Residents' Views on Heritage Values and Cultural Significance.
- Ramtohul, A., Khedo, K., K. (2023). An Engaging User Experience Framework for Mobile Augmented Reality, 23 June 2023, PREPRINT (Version 1). <https://doi.org/10.21203/rs.3.rs-3080680/v1>
- Razzouk, R., and Shute, V. (2015). What Is Design Thinking and Why Is It Important? Review of Educational Research September 2012, Vol. 82, No. 3, pp. 330–348.
- Reitmayr, G., Schmalstieg, D. (2003). Location based Applications for Mobile Augmented Reality.
- Saoud, J., and Jung, T. (2018). An Ethical Perspective of the use of AR Technology in the Tourism Industry.
- Seeliger, A., Weibel, R. P., & Feuerriegel, S. (2022). Context-Adaptive Visual Cues for Safe Navigation in Augmented Reality Using Machine Learning. *International Journal of Human-Computer Interaction*, 40(3), 761–781. <https://doi.org/10.1080/10447318.2022.2122114>
- Tenemaza, M., de Antonio, A., & Ramírez, J. (2007). The User Model, Vocabulary and Logical Architecture for Adaptive Augmented Reality. Proceedings of the Latin American Conference on Human Computer Interaction - CLIHC '15.
- Tenh, H. K., & Shiratuddin, N. (2022). Components of Adaptive Augmented Reality Model for Heritage Mobile Application. *International Journal of Interactive Mobile Technologies (IJIM)*, 16(02), pp. 17–27. <https://doi.org/10.3991/ijim.v16i02.27317>
- Tzima, S., Styliaras, G., and Bassounas, A. (2020). Augmented Reality applications in Cultural Heritage: Technology or Content?

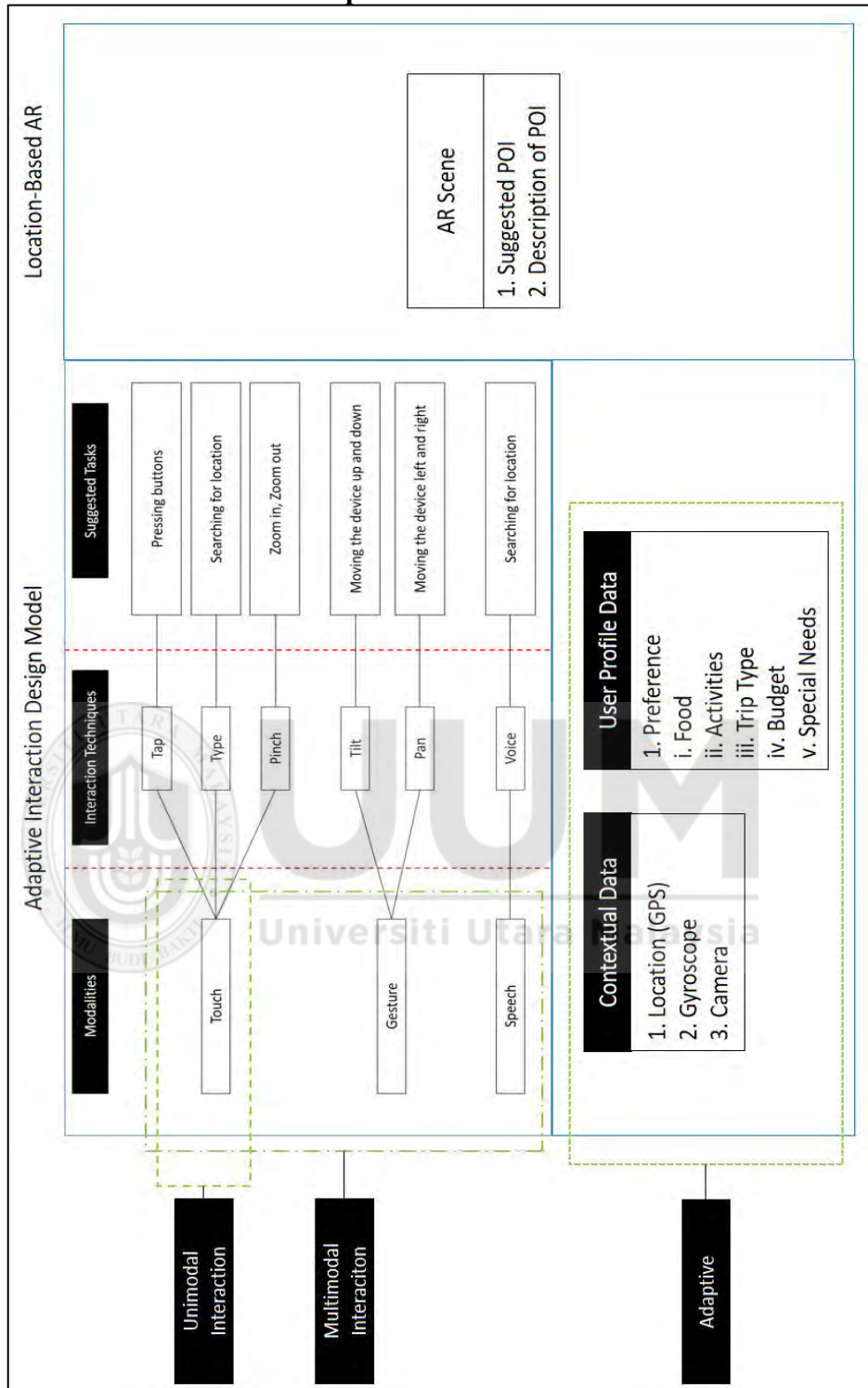
- Warfel T. Z. (2009) "Prototyping. A practitioner's guide," New York: Rosenfeld Media
- van Aken, J. E. (2004). *Management Research Based on the Paradigm of the Design Sciences: The Quest for Field-Tested and Grounded Technological Rules*. *Journal of Management Studies*, 41(2), 219–246. <https://doi.org/10.1111/j.1467-6486.2004.00430.x>
- Williams, T. (2010). Melaka and World Heritage Status. conservation and mgmt of arch. sites, Vol. 12 No. 3, August, 2010, 197–208.
- Yu, F., Pasinelli, M., & Brem, A. (2017). *Prototyping in theory and in practice: A study of the similarities and differences between engineers and designers*. *Creativity and Innovation Management*, 27(2), 121–132. doi:10.1111/caim.12242
- Zarvic, N., Duin, H., Seifert, M., Thoben, K., & Bierwolf, R.E. (2009). Collecting end user requirements playfully. 2009 IEEE International Technology Management Conference (ICE), 1-8.. 10.13140/2.1.4967.6483.
- Zoellner, M., Stricker, D., Bleser, G., & Pastarmov, Y. (2007). iTACITUS - Novel Interaction and Tracking Paradigms for Mobile AR

## APPENDICES A

### Expert Review Sheet, Instrument Validation Sheet, and Usability Questionnaire



## Expert Review Sheet



Adaptive Interaction Design Model for Location-Based Augmented Reality in Cultural Heritage Sites

1. Based on the *Adaptive Interaction Design Model for Location-Based Augmented Reality in Cultural Heritage Sites*, please tick (/) your choice.

<b>Proposed Interaction Design Model Elements</b>	<b>Description</b>	<b>Definitely Not Relevant</b>	<b>Maybe Relevant</b>	<b>Relevant</b>
Modalities	A form or a channel of input of interaction between a user and a device (Nizam et. al, 2018).			
Interaction Techniques	Several types of AR interaction techniques includes 3D interactions, natural interactions, tangible interactions, spatial awareness interactions, and unimodal and multimodal interactions (Nizam et. al, 2018).			
Suggested Tasks	Tasks that are suitable to perform using interaction techniques of a specific modality.			
Unimodal Interaction	Unimodal interaction technique only allows user to interact with AR content by using one modality such as gesture, speech, click, etc. (Nizam et. al, 2018).			
Multimodal Interaction	Multimodal interaction is using more than one modality			

	(simultaneously or sequentially) for input and output (Möller et al, 2014)			
Adaptive	Adaptive refers to the capability of device to adapt their behavior based on interaction context variations (user, environment) and the device itself. Sensors equipped in a device can provide input information such as user' current location, environment factors such as weather, temperature, ambient light, video, picture, sound etc. that can be adapted by the system (Abidin et. al. 2017).			
Contextual Data	Appropriate content based on real-time information will be display based on characteristic of users and real-time context (Kuan & Shiratuddin, 2022)			
User Profile Data	Data that is received from the user such as their demographic information and setting preferences.			
Location-Based AR	A location-based AR application is a type of AR that accesses location-specific information like maps, weather, or location-based services using users' real-time			

	locations as an input (Reitmayr, 2003).			
AR Scene	Display screen of suggested point-of-interest (POI) and the description of POI.			

Suggestions on improving the adaptive interaction design model



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## Instrument Validation Sheet

### SENARAI SEMAK PENGESAHAN INSTRUMEN SOALAN SOAL SELIDIK

Kajian kebolehpenggunaan pelancong terhadap Aplikasi Augmentasi Realiti Berasaskan Lokasi Pelancongan Warisan Budaya (MelakAR)

Tuan/Puan,

Tujuan kajian ini dilakukan adalah untuk memperoleh tindak balas anda terhadap aplikasi Augmentasi Realiti personalisasi berasaskan lokasi pelancongan barisan budaya (MelakAR). MelakAR merupakan aplikasi augmentasi realiti (AR) berasaskan lokasi pelancongan warisan budaya yang mempunyai ciri personalisasi berdasarkan pilihan dan minat pelancong.

Soalan – soalan ini adalah untuk mengkaji kebolehpenggunaan pelancong terhadap aplikasi MelakAR. Sila baca soalan kajian di bawah dan tanda (/) pada bahagian yang disediakan. Cadangan dan pandangan anda amat dihargai bagi membantu kami untuk mempertingkatkan kualiti aplikasi MelakAR. Terima kasih untuk kerjasama anda

BAHAGIAN A: DEMOGRAFI	Semakan Pakar		
	Ya	Tidak	Catatan
1. Gender / <i>Jantina</i> <input type="radio"/> Male / <i>Lelaki</i> <input type="radio"/> Female / <i>Perempuan</i>			
2. Age Range / <i>Lingkungan Umur</i> <input type="radio"/> Below 19 / <i>Bawah 19</i> <input type="radio"/> 20 - 24 <input type="radio"/> 25 - 30 <input type="radio"/> Above 30 / <i>Lebih daripada 30</i>			
3. Nationality / <i>Warganegara</i> <input type="radio"/> Malaysian / <i>Rakyat Malaysia</i> <input type="radio"/> Non Malaysian / <i>Bukan Warganegara</i>			
4. Religion / <i>Agama</i> <input type="radio"/> Muslim <input type="radio"/> Non Muslim			
5. Purpose of travelling to Melaka / <i>Sebab kunjungan ke Melaka.</i>			

<input type="radio"/> Working / Berkerja <input type="radio"/> Holiday / Bercuti  6. Channels used to learn about Melaka / <i>Saluran yang digunakan untuk mengetahui mengenai Melaka.</i> <input type="checkbox"/> Websites/Search Engines/Blogs <input type="checkbox"/> Social Media <input type="checkbox"/> Others																		
7. Do you have prior experience in using location-based AR Mobile Apps? / <i>Adakah anda mempunyai pengalaman menggunakan aplikasi realiti maya?</i> <input type="radio"/> Yes <input type="radio"/> No																		
8. If Yes in question 7, please state below the AR application that you have used. / <i>Jika Jawapan ada ya pada soalan 7, sila nyatakan nama aplikasi tersebut.</i> <input type="text"/>																		
<p><b>9. Section B: Usability of LBAR Mobile Apps MelakAR</b></p> <p>Please answer the following questions by circling the number in the provided space according to the scale below. / <i>Sila jawab soalan berikut dengan membuat bulatan pada nombor di tempat yang disediakan berdasarkan skala di bawah.</i></p> <table border="1" data-bbox="304 1435 916 1715"> <tr> <td>Strongly Disagree</td> <td>Disagree</td> <td>Undecided</td> <td>Agree</td> <td>Strongly Agree</td> </tr> <tr> <td><i>Sangat Tidak Setuju</i></td> <td><i>Tidak Setuju</i></td> <td><i>Tidak Pasti</i></td> <td><i>Setuju</i></td> <td><i>Sangat Setuju</i></td> </tr> <tr> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> </table>				Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	<i>Sangat Tidak Setuju</i>	<i>Tidak Setuju</i>	<i>Tidak Pasti</i>	<i>Setuju</i>	<i>Sangat Setuju</i>	1	2	3	4	5
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree														
<i>Sangat Tidak Setuju</i>	<i>Tidak Setuju</i>	<i>Tidak Pasti</i>	<i>Setuju</i>	<i>Sangat Setuju</i>														
1	2	3	4	5														
<table border="1" data-bbox="304 1765 916 2036"> <thead> <tr> <th colspan="6">Adaptive Interaction Design Model Elements</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>The available modalities are functional and useful for me to interact with MelakAR. / <i>Modaliti (kaedah) yang tersedia adalah berguna dan berfungsi untuk saya berinteraksi dengan MelakAR.</i></td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> </tbody> </table>				Adaptive Interaction Design Model Elements						1	The available modalities are functional and useful for me to interact with MelakAR. / <i>Modaliti (kaedah) yang tersedia adalah berguna dan berfungsi untuk saya berinteraksi dengan MelakAR.</i>	1	2	3	4	5		
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2	Touch functions help me to interact better with MelakAR. / Fungsi sentuhan membantu saya untuk berinteraksi dengan MelakAR dengan lebih baik.	1	2	3	4	5			
3	It was easy to tap the annotations on the screen. / Mudah untuk saya untuk mengetik pilihan saya pada skrin.	1	2	3	4	5			
4	It was easy to type in my preference on the screen. / Mudah untuk saya untuk menaip pilihan saya pada skrin.	1	2	3	4	5			
5	The buttons are easy to tap and are functional. / Butang Papan kekunci mudah digunakan dan berfungsi dengan baik.	1	2	3	4	5			
6	The keyboards are useful and responsive. / Papan kekunci mudah digunakan dan berfungsi dengan baik.	1	2	3	4	5			
7	Voice recognition functions help me to interact better with MelakAR. / Fungsi pengecaman suara membantu saya untuk berinteraksi dengan MelakAR dengan lebih baik.	1	2	3	4	5			
8	Speech function allowed me to use my voice as an input to put in my preference. / Fungsi percakapan membantu saya untuk memasukkan pilihan saya menggunakan suara sebagai input.	1	2	3	4	5			
9	Gesture functions help me to interact better with MelakAR. / Fungsi gerak isyarat membantu saya untuk berinteraksi dengan MelakAR dengan lebih baik.	1	2	3	4	5			
10	Gesture functions helped me to tilt and pan to view the available POI around me. / Fungsi gerak isyarat membantu saya untuk menggerakkan dan mencondongkan kamera untuk melihat POI di sekeliling saya.	1	2	3	4	5			
11	I was able to tilt and pan the camera to view the POI available around me. / Saya berupaya untuk menggerakkan dan	1	2	3	4	5			

	<i>mencondongkan kamera untuk melihat POI yang terdapat di sekeliling saya.</i>								
12	POI displayed on the screen changes every time I put my preference and I move around. / <i>POI yang berada di sekeliling saya berubah-ubah setiap kali saya memasukkan pilihan yang berbeza dan setiap kali saya bergerak.</i>	1	2	3	4	5			
13	Camera function helps me to locate an attraction at a specific location. / <i>Fungsi kamera membantu saya untuk mencari tarikan di sesebuah lokasi.</i>	1	2	3	4	5			
14	GPS functions helps me to pinpoint a location in Melaka. / <i>Fungsi GPS membantu saya untuk menetapkan sesebuah lokasi di Melaka.</i>	1	2	3	4	5			
15	I was able to view the locations based on my preference. / <i>Saya berupaya untuk nampak lokasi di sekeliling saya berdasarkan pilihan saya.</i>	1	2	3	4	5			
16	AR scene helps me to view the available points of interest around me. / <i>Paparan AR membantu saya untuk melihat POI di sekitar saya.</i>	1	2	3	4	5			
17	I was able to read the information displayed in the annotation on the AR scene. / <i>Saya berupaya untuk membaca informasi yang tertera pada anotasi di skrin AR.</i>	1	2	3	4	5			
18	Having many interaction techniques (touch, gesture, and voice recognition) is better than having one interaction technique. / <i>Penyediaan teknik interaksi yang pelbagai adalah lebih baik daripada hanya menggunakan satu teknik interaksi sahaja.</i>	1	2	3	4	5			
<b>Ease of Use / Kemudahan Penggunaan</b>									
1	Learning to operate MelakAR is easy for me. / <i>Mempelajari untuk menggunakan MelakAR adalah mudah bagi saya.</i>	1	2	3	4	5			

2	MelakAR interface is clear and easy to navigate. / <i>Paparan antara muka MelakAR mudah untuk dikemudikan.</i>	1	2	3	4	5			
3	I can read the information in MelakAR clearly. / <i>Saya dapat membaca informasi yang terdapat dalam aplikasi MelakAR dengan jelas.</i>	1	2	3	4	5			
4	Location-based AR mobile app is easy to use. / <i>Aplikasi realiti maya berdasarkan lokasi mudah untuk digunakan.</i>	1	2	3	4	5			
5	Location-based AR increases the process of exploring a specific location. / <i>Aplikasi realiti maya berdasarkan lokasi dapat meningkatkan proses penerokaan sebuah lokasi.</i>	1	2	3	4	5			
6	I find this LBAR MelakAR app is flexible and uncomplicated to interact with. / <i>Saya dapati aplikasi MelakAR ini fleksibel dan tidak sukar untuk berinteraksi dengannya.</i>	1	2	3	4	5			
<b>Perceived Usefulness / Kebergunaan</b>									
1	MelakAR is useful and functional to be used in Melaka. / <i>Aplikasi MelakAR berguna dan berfungsi untuk digunakan di Melaka.</i>	1	2	3	4	5			
2	The functions in MelakAR is adequate for me to interact with it. / <i>Fungsi-fungsi yang terdapat dalam MelakAR adalah cukup untuk saya berinteraksi dengannya.</i>	1	2	3	4	5			
3	The information in MelakAR is adequate to help my understanding about Melaka. / <i>Informasi yang terdapat dalam MelakAR adalah mencukupi untuk saya memahami mengenai Melaka</i>	1	2	3	4	5			
4	Using MelakAR would increase the productivity of my travel to Melaka. / <i>Menggunakan aplikasi MelakAR dapat meningkatkan produktiviti kunjungan saya ke Melaka.</i>	1	2	3	4	5			
5	Using MelakAR would make it easier to do my travels in Melaka. / <i>Menggunakan aplikasi MelakAR dapat</i>	1	2	3	4	5			

	<i>memudahkan pergerakan saya di Melaka.</i>								
<b>Satisfaction / Kepuasanhati</b>									
1	I am satisfied with the touch function of MelakAR. / <i>Saya berpuas hati dengan fungsi sentuh aplikasi MelakAR.</i>	1	2	3	4	5			
2	I am satisfied with the gesture function of MelakAR. / <i>Saya berpuas hati dengan fungsi gerak isyarat aplikasi MelakAR.</i>	1	2	3	4	5			
3	I am satisfied with the voice recognition function of MelakAR. / <i>Saya berpuas hati dengan fungsi pengecaman suara aplikasi MelakAR.</i>	1	2	3	4	5			
4	I am satisfied with the amount of information that MelakAR has about the locations in Melaka. <i>Saya berpuas hati dengan</i>	1	2	3	4	5			
5	I am satisfied with the capability and functions in MelakAR. <i>Saya berpuas hati dengan kemampuan dan fungsi plikasi MelakAR.</i>	1	2	3	4	5			
What are the improvements you would like to see on MelakAR? / <i>Apakah penambahbaikan yang ada mahu lihat pada aplikasi MelakAR?</i>									
<input type="text"/>									

Tanda Tangan Pakar : \_\_\_\_\_

Nama:

Pekerjaan:

Bidang:

## Usability Questionnaire Sheet Questionnaire

This section is intended to get the information about the respondents' demographic background. Please answer the following question in the by ticking ( / ) in the appropriate box.

### Section A: Demographic

1. Gender / *Jantina*

- Male / *Lelaki*
- Female / *Perempuan*

2. Age Range / *Lingkungan Umur*

- Below 19 / *Bawah 19*
- 20 - 24
- 25 - 30
- Above 30 / *Lebih daripada 30*

3. Nationality / *Warganegara*

- Malaysian / *Rakyat Malaysia*
- Non Malaysian / *Bukan Warganegara*

4. Religion / *Agama*

- Muslim
- Non Muslim

5. Purpose of travelling to Melaka / *Sebab kunjungan ke Melaka.*

- Working / *Berkerja*
- Holiday / *Bercuti*

6. Channels used to learn about Melaka / *Saluran yang digunakan untuk mengetahui mengenai Melaka.*

- Websites/Search Engines/Blogs
- Social Media

Others

7. Do you have prior experience in using location-based AR Mobile Apps? / *Adakah anda mempunyai pengalaman menggunakan aplikasi realiti maya?*

Yes

No

10. If Yes in question 7, please state below the AR application that you have used. / *Jika Jawapan ada ya pada soalan 7, sila nyatakan nama aplikasi tersebut.*



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## 11. Section B: Usability of LBAR Mobile Apps MelakAR

Please answer the following questions by circling the number in the provided space according to the scale below. / *Sila jawab soalan berikut dengan membuat bulatan pada nombor di tempat yang disediakan berdasarkan skala di bawah.*

Strongly Disagree <i>Sangat Tiadak Setuju</i>	Disagree <i>Tidak Setuju</i>	Undecided <i>Tidak Pasti</i>	Agree <i>Setuju</i>	Strongly Agree <i>Sangat Setuju</i>
1	2	3	4	5

Adaptive Interaction Design Model Elements						
1	The available modalities are functional and useful for me to interact with MelakAR. / <i>Modaliti (kaedah) yang tersedia adalah berguna dan berfungsi untuk saya berinteraksi dengan MelakAR.</i>	1	2	3	4	5
2	Touch functions help me to interact better with MelakAR. / <i>Fungsi sentuhan membantu saya untuk berinteraksi dengan MelakAR dengan lebih baik.</i>	1	2	3	4	5
3	It was easy to tap the annotations on the screen. / <i>Mudah untuk saya untuk mengetik pilihan saya pada skrin.</i>	1	2	3	4	5
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5	The buttons are easy to tap and are functional. / <i>Butang Papan kekunci mudah digunakan dan berfungsi dengan baik.</i>	1	2	3	4	5
6	The keyboards are useful and responsive. / <i>Papan kekunci mudah digunakan dan berfungsi dengan baik.</i>	1	2	3	4	5
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10	Gesture functions helped me to tilt and pan to view the available POI around me. / <i>Fungsi gerak isyarat membantu saya untuk menggerakkan dan mencondongkan kamera untuk melihat POI di sekeliling saya.</i>	1	2	3	4	5
11	I was able to tilt and pan the camera to view the POI available around me. / <i>Saya berupaya untuk menggerakkan dan mencondongkan kamera untuk melihat POI yang terdapat di sekeliling saya.</i>	1	2	3	4	5
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14	GPS functions helps me to pinpoint a location in Melaka. / <i>Fungsi GPS membantu saya untuk menetapkan sesebuah lokasi di Melaka.</i>	1	2	3	4	5
15	I was able to view the locations based on my preference. / <i>Saya berupaya untuk nampak lokasi di sekeliling saya berdasarkan pilihan saya.</i>	1	2	3	4	5
16	AR scene helps me to view the available points of interest around me. / <i>Paparan AR membantu saya</i>	1	2	3	4	5

	<i>untuk melihat POI di sekitar saya.</i>					
17	I was able to read the information displayed in the annotation on the AR scene. / <i>Saya berupaya untuk membaca informasi yang tertera pada anotasi di skrin AR.</i>	1	2	3	4	5
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<b>Ease of Use / Kemudahan Penggunaan</b>						
1	Learning to operate MelakAR is easy for me. / <i>Mempelajari untuk menggunakan MelakAR adalah mudah bagi saya.</i>	1	2	3	4	5
2	MelakAR interface is clear and easy to navigate. / <i>Paparan antara muka MelakAR mudah untuk dikemudikan.</i>	1	2	3	4	5
3	I can read the information in MelakAR clearly. / <i>Saya dapat membaca informasi yang terdapat dalam aplikasi MelakAR dengan jelas.</i>	1	2	3	4	5
4	Location-based AR mobile app is easy to use. / <i>Aplikasi realiti maya berdasarkan lokasi mudah untuk digunakan.</i>	1	2	3	4	5
5	Location-based AR increases the process of exploring a specific location. / <i>Aplikasi realiti maya berdasarkan lokasi dapat meningkatkan proses penerokaan sebuah lokasi.</i>	1	2	3	4	5
6	I find this LBAR MelakAR app is flexible and uncomplicated to interact with. / <i>Saya dapati aplikasi MelakAR ini fleksibel dan tidak sukar untuk berinteraksi dengannya.</i>	1	2	3	4	5

<b>Perceived Usefulness / Kebergunaan</b>						
1	MelakAR is useful and functional to be used in Melaka. / <i>Aplikasi MelakAR berguna dan berfungsi untuk digunakan di Melaka.</i>	1	2	3	4	5
2	The functions in MelakAR is adequate for me to interact with it. / <i>Fungsi-fungsi yang terdapat dalam MelakAR adalah cukup untuk saya berinteraksi dengannya.</i>	1	2	3	4	5
3	The information in MelakAR is adequate to help my understanding about Melaka. / <i>Informasi yang terdapat dalam MelakAR adalah mencukupi untuk saya memahami mengenai Melaka</i>	1	2	3	4	5
4	Using MelakAR would increase the productivity of my travel to Melaka. / <i>Menggunakan aplikasi MelakAR dapat meningkatkan produktiviti kunjungan saya ke Melaka.</i>	1	2	3	4	5
5	Using MelakAR would make it easier to do my travels in Melaka. / <i>Menggunakan aplikasi MelakAR dapat memudahkan pergerakan saya di Melaka.</i>	1	2	3	4	5

<b>Satisfaction / Kepuasanhati</b>						
1	I am satisfied with the touch function of MelakAR. / <i>Saya berpuas hati dengan fungsi sentuh aplikasi MelakAR.</i>	1	2	3	4	5
2	I am satisfied with the gesture function of MelakAR. / <i>Saya berpuas hati dengan fungsi gerak isyarat aplikasi MelakAR.</i>	1	2	3	4	5
3	I am satisfied with the voice recognition function of MelakAR. / <i>Saya berpuas hati dengan fungsi pengecaman suara aplikasi MelakAR.</i>	1	2	3	4	5
4	I am satisfied with the amount of information that MelakAR has about the locations in Melaka. / <i>Saya berpuas hati dengan</i>	1	2	3	4	5

5	I am satisfied with the capability and functions in MelakAR. / <i>Saya berpuas hati dengan kemampuan dan fungsi aplikasi MelakAR.</i>	1	2	3	4	5
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What are the improvements you would like to see on MelakAR? / *Apakah penambahbaikan yang ada mahu lihat pada aplikasi MelakAR?*



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## APPENDICES B

### Feedback from Experts, Expert Review Answers, Instrument Validation Sheet Feedback



### Feedback from experts in expert review sheet

Experts	Suggestions/Comments
Erik Champion (Curtin University, WA)	<p>(a) Suggested the reference to the paper that was cited which is Nizam et. al, 2018 to be written fully as below:</p> <p>Muhammad Nizam, S.; Zainal Abidin, R.; Che Hashim, N.; meng chun, L.; Arshad, H.; Majid, N. A Review of Multimodal Interaction Technique in Augmented Reality Environment. <i>International Journal on Advanced Science, Engineering and Information Technology</i> <b>2018</b>, 8, 1460. DOI: 10.18517/ijaseit.8.4-2.6824.</p> <p>(b) Suggested to explain the meaning of adaptive.</p> <p>(c) Suggested the researcher speak to experts and the public about what they want to understand when visiting a cultural heritage site and create specific requirements for cultural heritage AR rather than for AR per se.</p> <p>(d) Question on the reason why food is a part of the user profile.</p> <p>(e) Suggested that users getting tired, bored, or lost would be more useful for the researcher to know and also how often and intensely they want or need to look and use their phones.</p>
Gunnar Listol (University of Oslo, Norway)	<p>(a) Suggested that the model is too general but the overall topics are relevant.</p> <p>(b) Suggested that even though models should be general to have value, they also need to be connected to examples and real experience/empirical data.</p> <p>(c) Suggested that to generate the kind of model you are working on here that it builds on experience and multiple cases, tests and evaluations. A long iterative process</p> <p>(d) Questioned whether or not the model is grounded in known cases or is it more of an abstract general sense extracted from literature?</p>
Dr. Lam (UKM, Malaysia)	<p>(a) Iterated that good design no need instruction to user.</p> <p>(b) Suggested for fitness tracker data to be included – detect the health/step condition to determine the “tiredness” of user cultural heritage types – more to user preference on</p>

	<p>which type they like.</p> <p>(c) Suggested to add, cultural heritage operation information – consider the fees, operation hour, facility (Air-condition etc), activities, special event, distance, method to travel to the POI etc.</p> <p>(d) In this case, location-based AR, I assume user will use it mostly on outdoor situation; speech probably is not suitable for outdoor with noise of the environment.</p>
<p>Dr. Junaidi (MMU, Malaysia)</p>	<p>(a) Suggested that tap can also be used to click on AR labels to obtain more information about a particular place.</p> <p>(b) Mentioned that interactions in the model is more towards general mobile phone interaction.</p> <p>(c) Mentioned that the definition for “tilt action” is to move into sloping position instead of ‘move device up and down’, perhaps can change to ‘tilting the camera view up and down” rather than device.</p>



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### Expert Review Answers (1)

1. Based on the *Adaptive Interaction Design Model for Location-Based Augmented Reality in Cultural Heritage Sites*, please tick (/) your choice.

<b>Proposed Interaction Design Model Elements</b>	<b>Description</b>	<b>Definitely Not Relevant</b>	<b>Maybe Relevant</b>	<b>Relevant</b>
Modalities	A form or a channel of input of interaction between a user and a device (Nizam et. al, 2018).			/
Interaction Techniques	Several types of AR interaction techniques includes 3D interactions, natural interactions, tangible interactions, spatial awareness interactions, and unimodal and multimodal interactions (Nizam et. al, 2018).			/
Suggested Tasks	Tasks that are suitable to perform using interaction techniques of a specific modality.			/
Unimodal Interaction	Unimodal interaction technique only allows user to interact with AR content by using one modality such as gesture, speech, click, etc. (Nizam et. al, 2018).			/
Multimodal Interaction	Multimodal interaction is using more than one modality			/

	(simultaneously or sequentially) for input and output (Möller et al, 2014)			
Adaptive	Adaptive refers to the capability of device to adapt their behavior based on interaction context variations (user, environment) and the device itself. Sensors equipped in a device can provide input information such as user' current location, environment factors such as weather, temperature, ambient light, video, picture, sound etc. that can be adapted by the system (Abidin et. al. 2017).			/
Contextual Data	Appropriate content based on real-time information will be display based on characteristic of users and real-time context (Kuan & Shiratuddin, 2022)			/
User Profile Data	Data that is received from the user such as their demographic information and setting preferences.			/
Location-Based AR	A location-based AR application is a type of AR that accesses location-specific information like maps, weather, or location-based services using users' real-time			/

	locations as an input (Reitmayr, 2003).			
AR Scene	Display screen of suggested point-of-interest (POI) and the description of POI.			/



### Suggestions on improving the adaptive interaction design model

Tap can also be used to click on AR labels to obtain more information about a particular place.

The interaction is more towards general mobile phone interaction.

Tilt action definition is to move into sloping position instead of ‘move device up and down’, perhaps can change to ‘tilting the camera view up and down’ rather than device



## Expert Review Answers (2)

1. Based on the *Adaptive Interaction Design Model for Location-Based Augmented Reality in Cultural Heritage Sites*, please tick (/) your choice.

<b>Proposed Interaction Design Model Elements</b>	<b>Description</b>	<b>Definitely Not Relevant</b>	<b>Maybe Relevant</b>	<b>Relevant</b>
Modalities	A form or a channel of input of interaction between a user and a device (Nizam et. al, 2018).			/
Interaction Techniques	Several types of AR interaction techniques includes 3D interactions, natural interactions, tangible interactions, spatial awareness interactions, and unimodal and multimodal interactions (Nizam et. al, 2018).			/
Suggested Tasks	Tasks that are suitable to perform using interaction techniques of a specific modality.		/ (good design no need instruction to user)	
Unimodal Interaction	Unimodal interaction technique only allows user to interact with AR content by using one modality such as gesture, speech, click, etc. (Nizam et. al, 2018).			/

Multimodal Interaction	Multimodal interaction is using more than one modality (simultaneously or sequentially) for input and output (Möller et al, 2014)			/
Adaptive	Adaptive refers to the capability of device to adapt their behavior based on interaction context variations (user, environment) and the device itself. Sensors equipped in a device can provide input information such as user' current location, environment factors such as weather, temperature, ambient light, video, picture, sound etc. that can be adapted by the system (Abidin et. al. 2017).			/
Contextual Data	Appropriate content based on real-time information will be display based on characteristic of users and real-time context (Kuan & Shiratuddin, 2022)			/
User Profile Data	Data that is received from the user such as their demographic information and setting preferences.			/
Location-Based AR	A location-based AR application is a type of AR that accesses			/

	location-specific information like maps, weather, or location-based services using users' real-time locations as an input (Reitmayr, 2003).			
AR Scene	Display screen of suggested point-of-interest (POI) and the description of POI.			/



### Suggestions on improving the adaptive interaction design model

fitness tracker data – detect the health/step condition to determine the “tiredness” of user

cultural heritage types – more to user preference on which type they like

Cultural heritage operation information – consider the fees, operation hour, facility (Air-condition etc), activities, special event, distance, method to travel to the POI etc.

In this case, location-based AR, I assume user will use it mostly on outdoor situation; Speech probably is not suitable for outdoor with noise of the environment.



### Expert Review Answers (3)

1. Based on the *Adaptive Interaction Design Model for Location-Based Augmented Reality in Cultural Heritage Sites*, please tick (/) your choice.

<b>Proposed Interaction Design Model Elements</b>	<b>Description</b>	<b>Definitely Not Relevant</b>	<b>Maybe Relevant</b>	<b>Relevant</b>
Modalities	A form or a channel of input of interaction between a user and a device (Nizam et. al, 2018).			/
Interaction Techniques	Several types of AR interaction techniques includes 3D interactions, natural interactions, tangible interactions, spatial awareness interactions, and unimodal and multimodal interactions (Nizam et. al, 2018).			/
Suggested Tasks	Tasks that are suitable to perform using interaction techniques of a specific modality.			/
Unimodal Interaction	Unimodal interaction technique only allows user to interact with AR content by using one modality such as gesture, speech, click, etc. (Nizam et. al, 2018).			/
Multimodal Interaction	Multimodal interaction is using more than one modality			/

	(simultaneously or sequentially) for input and output (Möller et al, 2014)			
Adaptive	The device adapts their behavior based on interaction context variations such as user, environment and the device itself. Sensors equipped in a mobile device can provide an input information (user' current location, environment factors such as weather, temperature, ambient light, video, picture, sound etc.) that can be adapted by the system (Abidin et. al. 2017).			/
Contextual Data	Appropriate content based on real-time information will be display based on characteristic of users and real-time context (Kuan & Shiratuddin, 2022)			/
User Profile Data	Data that is received from the user such as their demographic information and setting preferences.			/
Location-Based AR	A location-based AR application is a type of AR that accesses location-specific information like maps, weather, or location-based services using users' real-time			/

	locations as an input (Reitmayr, 2003).			
AR Scene	Display screen of suggested point-of-interest (POI) and the description of POI.			/



### Suggestions on improving the adaptive interaction design model

As you can see I find all of the topics relevant. And that is maybe a problem. The model is general. That is, in some respects, OK. Models should be general to have value, but they also need to be connected to examples and real experience/empirical data. I think that is a problem here. To generate the kind of model you are working on here that it builds on experience and multiple cases, tests and evaluations. A long iterative process. My question is then: Is this model grounded in cases you know, or is it an a mor abstract general sense extracted from literature?



#### Expert Review Answers (4)

1. Based on the *Adaptive Interaction Design Model for Location-Based Augmented Reality in Cultural Heritage Sites*, please tick (✓) your choice.

<b>Proposed Interaction Design Model Elements</b>	<b>Description</b>	<b>Definitely Not Relevant</b>	<b>Maybe Relevant</b>	<b>Relevant</b>
Modalities	A form or a channel of input of interaction between a user and a device (Nizam et. al, 2018).			✓
Interaction Techniques	Several types of AR interaction techniques includes 3D interactions, natural interactions, tangible interactions, spatial awareness interactions, and unimodal and multimodal interactions (Nizam et. al, 2018).		✓	
Suggested Tasks	Tasks that are suitable to perform using interaction techniques of a specific modality.			✓
Unimodal Interaction	Unimodal interaction technique only allows user to interact with AR content by using one modality such as gesture, speech, click, etc. (Nizam et. al, 2018).		✓	
Multimodal Interaction	Multimodal interaction is using more than one modality (simultaneously or sequentially)		✓	

	for input and output (Möller et al, 2014)			
Adaptive	The device adapts their behavior based on interaction context variations such as user, environment and the device itself. Sensors equipped in a mobile device can provide an input information (user' current location, environment factors such as weather, temperature, ambient light, video, picture, sound etc.) that can be adapted by the system (Abidin et. al. 2017).		√	
Contextual Data	Appropriate content based on real-time information will be display based on characteristic of users and real-time context (Kuan & Shiratuddin, 2022)			√
User Profile Data	Data that is received from the user such as their demographic information and setting preferences.		√	
Location-Based AR	A location-based AR application is a type of AR that accesses location-specific information like maps, weather, or location-based services using users' real-time locations as an input (Reitmayr,		√	

	2003).			
AR Scene	Display screen of suggested point-of-interest (POI) and the description of POI.		√	



### Suggestions on improving the adaptive interaction design model

I suggest the reference to the paper you cite (Nizam et. al, 2018) is fully described or a link provided.

Is it?

Muhammad Nizam, S.; Zainal Abidin, R.; Che Hashim, N.; meng chun, L.; Arshad, H.; N. A Review of Multimodal Interaction Technique in Augmented Reality Environ  
*International Journal on Advanced Science, Engineering and Information Technology*  
8, 1460. DOI: 10.18517/ijaseit.8.4-2.6824.

I suggest you explain what you mean by adaptive.

I suggest you speak to experts and the public regards what they want to understand more fully when visiting a cultural heritage site and create specific requirements for cultural heritage AR rather than for AR per se.

I don't know why food is part of the user profile. I imagine how easily people tire or get bored or get lost would be more useful to know. And how often and intensely they want or need to look at or otherwise use their phones.



## Instrument Validation Sheet Feedback (1)

### SENARAI SEMAK PENGESAHAN INSTRUMEN SOALAN SOAL SELIDIK

Kajian kebolehpenggunaan pelancong terhadap Aplikasi Augmentasi Realiti Berasaskan Lokasi Pelancongan Warisan Budaya (MelakAR)

Tuan/Puan,

Tujuan kajian ini dilakukan adalah untuk memperoleh tindak balas anda terhadap aplikasi Augmentasi Realiti personalisasi berasaskan lokasi pelancongan barisan budaya (MelakAR). MelakAR merupakan aplikasi augmentasi realiti (AR) berasaskan lokasi pelancongan warisan budaya yang mempunyai ciri personalisasi berdasarkan pilihan dan minat pelancong.

Soalan – soalan ini adalah untuk mengkaji kebolehpenggunaan pelancong terhadap aplikasi MelakAR. Sila baca soalan kajian di bawah dan tanda (/) pada bahagian yang disediakan. Cadangan dan pandangan anda amat dihargai bagi membantu kami untuk mempertingkatkan kualiti aplikasi MelakAR. Terima kasih untuk kerjasama anda

BAHAGIAN A: DEMOGRAFI	Semakan Pakar		
	Ya	Tidak	Catatan
1. Gender / <i>Jantina</i> <input type="radio"/> Male / <i>Lelaki</i> <input type="radio"/> Female / <i>Perempuan</i>	/		
2. Age Range / <i>Lingkungan Umur</i> <input type="radio"/> Below 19 / <i>Bawah 19</i> <input type="radio"/> 20 - 24 <input type="radio"/> 25 - 30 <input type="radio"/> Above 30 / <i>Lebih daripada 30</i>	/		
3. Nationality / <i>Warganegara</i> <input type="radio"/> Malaysian / <i>Rakyat Malaysia</i> <input type="radio"/> Non Malaysian / <i>Bukan Warganegara</i>	/		
4. Religion / <i>Agama</i> <input type="radio"/> Muslim <input type="radio"/> Non Muslim	/		
5. Purpose of travelling to Melaka / <i>Sebab kunjungan ke Melaka.</i> <input type="radio"/> Working / <i>Berkerja</i> <input type="radio"/> Holiday / <i>Bercuti</i>	/		Bekerja

<p>6. Channels used to learn about Melaka / <i>Saluran yang digunakan untuk mengetahui mengenai Melaka.</i></p> <p><input type="checkbox"/> Websites/Search Engines/Blogs</p> <p><input type="checkbox"/> Social Media</p> <p><input type="checkbox"/> Others</p>	/		Perlu translate juga semua perkataan																
<p>7. Do you have prior experience in using location-based AR (LBAR) Mobile Apps? / <i>Adakah anda mempunyai pengalaman menggunakan aplikasi realiti maya?</i></p> <p><input type="radio"/> Yes</p> <p><input type="radio"/> No</p>	/		Realiti Luasan berdasarkan lokasi																
<p>12. If Yes in question 7, please state below the AR application that you have used. / <i>Jika Jawapan ada ya pada soalan 7, sila nyatakan nama aplikasi tersebut.</i></p> <div style="border: 1px solid black; height: 20px; width: 100%;"></div>	/																		
<p><b>13. Section B: Usability of LBAR Mobile Apps MelakAR</b></p> <p>Please answer the following questions by circling the number in the provided space according to the scale below. / <i>Sila jawab soalan berikut dengan membuat bulatan pada nombor di tempat yang disediakan berdasarkan skala di bawah.</i></p> <table border="1" data-bbox="304 1249 914 1525"> <tr> <td style="text-align: center;">Strongly Agree</td> <td style="text-align: center;">Agree</td> <td style="text-align: center;">Undecided</td> <td style="text-align: center;">Disagree</td> <td style="text-align: center;">Strongly Disagree</td> </tr> <tr> <td style="text-align: center;"><i>Sangat Setuju</i></td> <td style="text-align: center;"><i>Setuju</i></td> <td style="text-align: center;"><i>Tidak Pasti</i></td> <td style="text-align: center;"><i>Tidak Setuju</i></td> <td style="text-align: center;"><i>Disagree Sangat Tidak Setuju</i></td> </tr> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> <td style="text-align: center;">4</td> <td style="text-align: center;">5</td> </tr> </table>		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	<i>Sangat Setuju</i>	<i>Setuju</i>	<i>Tidak Pasti</i>	<i>Tidak Setuju</i>	<i>Disagree Sangat Tidak Setuju</i>	1	2	3	4	5	/		Perlu translate semua
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree															
<i>Sangat Setuju</i>	<i>Setuju</i>	<i>Tidak Pasti</i>	<i>Tidak Setuju</i>	<i>Disagree Sangat Tidak Setuju</i>															
1	2	3	4	5															
<p><b>Adaptive Interaction Design Model Elements</b></p> <table border="1" data-bbox="304 1608 914 2020"> <tr> <td style="text-align: center;">1</td> <td>The available modalities are functional and useful for me to interact with MelakAR. / <i>Modaliti (kaedah) yang tersedia adalah berguna dan berfungsi untuk saya berinteraksi dengan MelakAR.</i></td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> <td style="text-align: center;">4</td> <td style="text-align: center;">5</td> </tr> <tr> <td style="text-align: center;">2</td> <td>Touch functions help me to</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> <td style="text-align: center;">4</td> <td style="text-align: center;">5</td> </tr> </table>		1	The available modalities are functional and useful for me to interact with MelakAR. / <i>Modaliti (kaedah) yang tersedia adalah berguna dan berfungsi untuk saya berinteraksi dengan MelakAR.</i>	1	2	3	4	5	2	Touch functions help me to	1	2	3	4	5	/			
1	The available modalities are functional and useful for me to interact with MelakAR. / <i>Modaliti (kaedah) yang tersedia adalah berguna dan berfungsi untuk saya berinteraksi dengan MelakAR.</i>	1	2	3	4	5													
2	Touch functions help me to	1	2	3	4	5													

	interact better with MelakAR. / <i>Fungsi sentuhan membantu saya untuk berinteraksi dengan MelakAR dengan lebih baik.</i>						/		
3	It was easy to tap the annotations on the screen. / <i>Mudah untuk saya untuk mengetik pilihan saya pada skrin.</i>	1	2	3	4	5	/		
4	It was easy to type in my preference on the screen. / <i>Mudah untuk saya untuk menaip pilihan saya pada skrin.</i>	1	2	3	4	5	/		“Butang kekunci”
5	The buttons are easy to tap and are functional. / <i>Butang Papan kekunci mudah digunakan dan berfungsi dengan baik.</i>	1	2	3	4	5	/		dengan
6	The keyboards are useful and responsive. / <i>Papan kekunci mudah digunakan dan berfungsi dengan baik.</i>	1	2	3	4	5	/		
7	Voice recognition functions help me to interact better with MelakAR. / <i>Fungsi pengecaman suara membantu saya untuk berinteraksi dengan MelakAR dengan lebih baik.</i>	1	2	3	4	5	/		Memasukkan
8	Speech function allowed me to use my voice as an input to put in my preference. / <i>Fungsi percakapan membantu saya untuk memasukkan pilihan saya menggunakan suara sebagai input.</i>	1	2	3	4	5	/		Dengan
9	Gesture functions help me to	1	2	3	4	5	/		Untuk



	<i>membantu saya untuk menetapkan sesebuah lokasi di Melaka.</i>											
15	I was able to view the locations based on my preference. / <i>Saya berupaya untuk nampak lokasi di sekeliling saya berdasarkan pilihan saya.</i>	1	2	3	4	5						
16	AR scene helps me to view the available points of interest around me. /	1	2	3	4	5						
17	I was able to read the information displayed in the annotation on the AR scene. / <i>Saya berupaya untuk membaca informasi yang tertera pada anotasi di skrin AR.</i>	1	2	3	4	5						
18	Having many interaction techniques (touch, gesture, and voice recognition) is better than having one interaction technique. / <i>Penyediaan teknik interaksi yang pelbagai adalah lebih baik daripada hanya menggunakan satu teknik interaksi sahaja.</i>	1	2	3	4	5						
<b>Ease of Use / Kemudahan Penggunaan</b>												
1	Learning to operate MelakAR is easy for me. / <i>Mempelajari untuk menggunakan MelakAR adalah mudah bagi saya.</i>	1	2	3	4	5						
2	MelakAR interface is clear and easy to navigate. / <i>Paparan antara muka MelakAR mudah untuk dikemudikan.</i>	1	2	3	4	5						
												Terdapat pada

3	I can read the information in MelakAR clearly. / <i>Saya dapat membaca informasi yang terdapat dalam aplikasi MelakAR dengan jelas.</i>	1	2	3	4	5	/		Aplikasi mudah alih realiti luasan
4	Location-based AR mobile app is easy to use. / <i>Aplikasi realiti maya berdasarkan lokasi mudah untuk digunakan.</i>	1	2	3	4	5	/		Aplikasi mudah alih realiti luasan
5	Location-based AR increases the process of exploring a specific location. / <i>Aplikasi realiti maya berdasarkan lokasi dapat meningkatkan proses penerokaan sebuah lokasi.</i>	1	2	3	4	5	/		Sesebuah
6	I find this LBAR MelakAR app is flexible and uncomplicated to interact with. / <i>Saya dapati aplikasi MelakAR ini fleksibel dan tidak sukar untuk berinteraksi dengannya.</i>	1	2	3	4	5	/		
<b>Perceived Usefulness / Kebergunaan</b>									
1	MelakAR is useful and functional to be used in Melaka. / <i>Aplikasi MelakAR berguna dan berfungsi untuk digunakan di Melaka.</i>	1	2	3	4	5	/		
2	The functions in MelakAR is adequate for me to interact with it. / <i>Fungsi-fungsi yang terdapat dalam MelakAR adalah cukup untuk saya berinteraksi dengannya.</i>	1	2	3	4	5	/		
3	The information in MelakAR is adequate to help my understanding about Melaka. /	1	2	3	4	5	/		Terdapat pada MelakAR



	MelakAR. <i>Saya berpuas hati dengan kemampuan dan fungsi plikasi MelakAR.</i>								
What are the improvements you would like to see on MelakAR? / <i>Apakah penambahbaikan yang ada mahu lihat pada aplikasi MelakAR?</i>							/		
<input data-bbox="300 465 911 517" type="text"/>									

Tanda Tangan Pakar :  \_\_\_\_\_

Nama: Ruzinor Che Mat

Pekerjaan: Pensyarah

Bidang: AR, VR, Mobile Apps, Games, Visualization and Computer Graphics



## Instrument Validation Sheet (2)

### SENARAI SEMAK PENGESAHAN INSTRUMEN SOALAN SOAL SELIDIK

Kajian kebolehpenggunaan pelancong terhadap Aplikasi Augmentasi Realiti Berasaskan LokasiPelancongan Warisan Budaya (MelakAR)

Tuan/Puan,

Tujuan kajian ini dilakukan adalah untuk memperoleh tindak balas anda terhadap aplikasi Augmentasi Realiti personalisasi berasaskan lokasi pelancongan barisan budaya (MelakAR). MelakAR merupakan aplikasi augmentasi realiti (AR) berasaskan lokasi pelancongan warisan budaya yang mempunyai ciri personalisasi berdasarkan pilihan dan minat pelancong.

Soalan–soalan ini adalah untuk mengkaji kebolehpenggunaan pelancong terhadap aplikasi MelakAR. Sila baca soalan kajian di bawah dan tanda (/) pada bahagian yang disediakan. Cadangan dan pandangan anda amat dihargai bagi membantu kami untuk mempertingkatkan kualiti aplikasi MelakAR. Terima kasih untuk kerjasama anda

			Semakan Pakar
BAHAGIAN A: DEMOGRAFI	Ya	Tidak	Catatan
1. Gender / <i>Jantina</i> <input type="radio"/> Male / <i>Lelaki</i> <input type="radio"/> Female / <i>Perempuan</i>			
2. Age Range / <i>Lingkungan Umur</i> <input type="radio"/> Below 19 / <i>Bawah 19</i> <input type="radio"/> 20 - 24 <input type="radio"/> 25 - 30 <input type="radio"/> Above 30 / <i>Lebih daripada 30</i>			
3. Nationality / <i>Warganegara</i> <input type="radio"/> Malaysian / <i>Rakyat Malaysia</i> <input type="radio"/> Non Malaysian / <i>Bukan Warganegara</i>			
4. Religion / <i>Agama</i> <input type="radio"/> Muslim <input type="radio"/> Non Muslim			

<p>5. Purpose of travelling to Melaka / <i>Sebab kunjangan ke Melaka.</i></p> <p><input type="radio"/> Working / Berkerja</p> <p><input type="radio"/> Holiday / Bercuti</p> <p>6. Channels used to learn about Melaka / <i>Saluranyang digunakan untuk mengetahui mengenai</i></p>		<p>Others is suggested to write : please specify :_____</p>
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<p>Melaka.</p> <p><input type="checkbox"/> Websites/Search Engines/Blogs</p> <p><input type="checkbox"/> Social Media</p> <p><input type="checkbox"/> Others</p>							
<p>7. Do you have prior experience in using location-based AR Mobile Apps? / Adakah anda mempunyai pengalaman menggunakan aplikasi realiti maya?</p> <p><input type="radio"/> Yes</p> <p><input type="radio"/> No</p>							
<p>8. If Yes in question 7, please state below the AR application that you have used. / Jika Jawapan ada ya pada soalan 7, sila nyatakan nama aplikasi tersebut.</p>							<p>My suggestion is - You can simply add this to the prior question with “if Yes please state the application:_____”</p> <p>And you might want to provide ample space if its required a lengthy answer</p>
<p><b>9. Section B: Usability of LBAR Mobile Apps</b></p> <p><b>MelakAR</b></p> <p>Please answer the following questions by circling the number in the provided space according to the scale below. / Sila jawab soalan berikut dengan membuat bulatan pada nombor di tempat yang disediakan berdasarkan skala di bawah.</p>							
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree			
Sangat Setuju	Setuju	Tidak Pasti	Tidak Setuju	Sangat Tidak Setuju			
1	2	3	4	5			
<p><b>Adaptive Interaction Design Model Elements</b></p>							
1	The available modalities are functional and useful for me to interact with MelakAR. / Modaliti (kaedah) yang tersedia adalah berguna dan	1	2	3	4	5	<p>These questions are sufficed for interactive design elements, However, question number 18 : “Having many interaction techniques (touch, gesture, and voice recognition) is better than having <b>ONLY</b> one interaction technique. / Penyediaan teknik interaksi yang pelbagai adalah lebih baik daripada hanya menggunakan satu teknik interaksi sahaja.</p>

	<i>berfungsi untuk saya berinteraksi dengan MelakAR.</i>								
2	Touch functions help me to interact better with MelakAR. / <i>Fungsi sentuhan membantu saya untuk berinteraksi dengan MelakAR dengan lebih baik.</i>	1	2	3	4	5			
3	It was easy to tap the annotations on the screen. / <i>Mudah untuk saya untuk mengetik pilihan saya pada skrin.</i>	1	2	3	4	5			
4	It was easy to type in my preference on the screen. / <i>Mudah untuk saya untuk menaip pilihan saya pada skrin.</i>	1	2	3	4	5			
5	The buttons are easy to tap and are functional. / <i>Butang Papan kekunci mudah digunakan dan berfungsi dengan baik.</i>	1	2	3	4	5			
6	The keyboards are useful and responsive. / <i>Papan kekunci mudah digunakan dan berfungsi dengan baik.</i>	1	2	3	4	5			
7	Voice recognition functions help me to interact better with MelakAR. / <i>Fungsi pengecaman suara membantu saya untuk berinteraksi dengan MelakAR dengan lebih baik.</i>	1	2	3	4	5			
8	Speech function allows	1	2	3	4	5			

	me to use my voice as an input to put in my preference. / <i>Fungsi percakapan membantu saya untuk memasukkan pilihan saya menggunakan suara sebagai input.</i>								
9	Gesture functions help me to interact better with MelakAR. / <i>Fungsi gerak isyarat membantu saya untuk berinteraksi dengan MelakAR dengan lebih baik.</i>	1	2	3	4	5			
10	Gesture functions helped me to tilt and pan to view the available POI around me. / <i>Fungsi gerak isyarat membantu saya untuk menggerakkan dan mencondongkan kamera untuk melihat POI di sekeliling saya.</i>	1	2	3	4	5			
11	I was able to tilt and pan the camera to view the POI available around me. / <i>Saya berupaya untuk menggerakkan dan mencondongkan kamera untuk melihat POI yang terdapat di sekeliling saya.</i>	1	2	3	4	5			
12	POI displayed on the screen changes every time I put my preference and I move around. / <i>POI yang berada di sekeliling saya</i>	1	2	3	4	5			

	<i>berubah-ubah setiap kali saya memasukkan pilihan yang berbeza dan setiap kali saya bergerak.</i>																			
13	Camera function helps me to locate an attraction at a specific location. / <i>Fungsi kamera membantu saya untuk mencari tarikan di sesebuah lokasi.</i>	1	2	3	4	5														
14	GPS functions helps me to pinpoint a location in Melaka. / <i>Fungsi GPS membantu saya untuk menetapkan sesebuah lokasi di Melaka.</i>	1	2	3	4	5														
15	I was able to view the locations based on my preference. / <i>Saya berupaya untuk nampak lokasi di sekeliling saya berdasarkan pilihan saya.</i>	1	2	3	4	5														
16	AR scene helps me to view the available points of interest around me. /	1	2	3	4	5														
17	I was able to read the information displayed in the annotation on the AR scene. / <i>Saya berupaya untuk membaca informasi yang tertera pada anotasi di skrin AR.</i>	1	2	3	4	5														
18	Having many interaction techniques (touch, gesture, and	1	2	3	4	5														



	<i>proses penerokaan sesbuah lokasi.</i>								
6	I find this LBAR MelakAR app is flexible and uncomplicated to interact with. / <i>Saya dapati aplikasi MelakAR ini fleksibel dah tidak sukar untuk berinteraksi dengannya.</i>	1	2	3	4	5			
<b>Perceived Usefulness / Kebergunaan</b>									
1	MelakAR is useful and functional to be used in Melaka. / <i>Aplikasi MelakAR berguna dan berfungsi untuk digunakan di Melaka.</i>	1	2	3	4	5			
2	The functions in MelakAR is adequate for me to interact with it. / <i>Fungsi-fungsi yang terdapat dalam MelakAR adalah cukup untuk saya berinteraksi dengannya.</i>	1	2	3	4	5			
3	The information in MelakAR is adequate to help my understanding about Melaka. / <i>Informasi yang terdapat dalam MelakAR adalah mencukupi untuk saya memahami mengenai Melaka</i>	1	2	3	4	5			
4	Using MelakAR would increase the productivity of my travel to Melaka. / <i>Menggunakan aplikasi MelakAR dapat meningkatkan</i>	1	2	3	4	5			
									<p>Question 5. It must be amended with as follows:</p> <p>Using MelakAR would make it easier to do my <del>travels</del> journey in Melaka. / <i>Menggunakan aplikasi MelakAR dapat memudahkan pergerakan perjalanan saya di Melaka.</i></p> <p>*Note: pergerakan is movement</p> <p>Suggestion: might consider to add other metrics such as time saving, effort saving, cost reducing, being fast/quick and overall usefulness. With these you be able to obtain the advantages of MelakAR from the tourists. And you can use this result to commercialize the app.</p>

	<i>produktiviti kunjungan saya ke Melaka.</i>										
5	Using MelakAR would make it easier to do my travels in Melaka. / <i>Menggunakan aplikasi MelakAR dapat memudahkan pergerakan saya di Melaka.</i>	1	2	3	4	5					
<b>Satisfaction / Kepuasanhati</b>											
1	I am satisfied with the touch function of MelakAR. / <i>Saya berpuas hati dengan fungsi sentuh aplikasi MelakAR.</i>	1	2	3	4	5					
2	I am satisfied with the gesture function of MelakAR. / <i>Saya berpuas hati dengan fungsi gerak isyarat aplikasi MelakAR.</i>	1	2	3	4	5					
3	I am satisfied with the voice recognition function of MelakAR. / <i>Saya berpuas hati dengan fungsi pengecaman suara aplikasi MelakAR.</i>	1	2	3	4	5					
4	I am satisfied with the amount of information that MelakAR has about the locations in Melaka. <i>Saya berpuas hati dengan</i>	1	2	3	4	5					
5	I am satisfied with the capability and functions in MelakAR. <i>Saya berpuas hati dengan</i>	1	2	3	4	5					
										Questions for satisfaction are all adequate to be asked. One suggestion: time on screen must be added to the question. It allows you to measure whether the app experiences leading to longer session or short session. Both have major differences related to the satisfaction metric.	

kemampuan dan fungsi aplikasi MelakAR.																					
What are the improvements you would like to see on MelakAR? / Apakah penambahbaikan yang ada mahu lihat pada aplikasi MelakAR?																					
For instrument expert comment. It would be glad if you could provide each row for each question-easy to do the comment for each question. All the best with your research.																					

Tanda Tangan Pakar 

Nama: Dr. Siti Salmi Jamali

Pekerjaan: Senior Lecturer/App. Developer

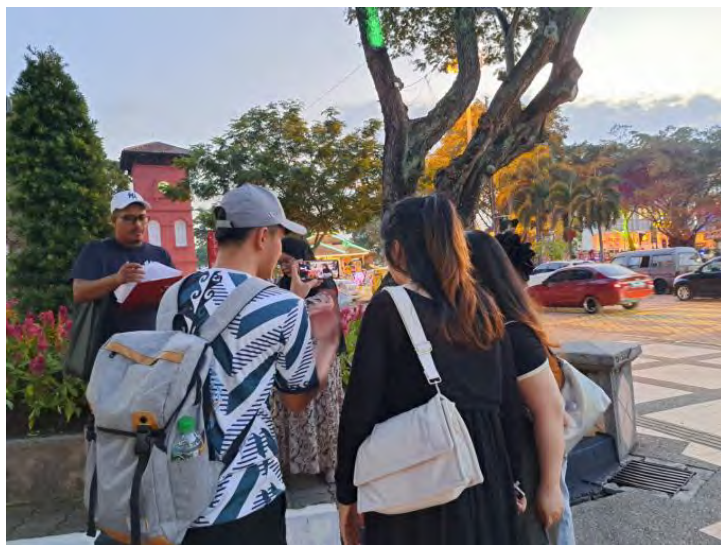
Bidang: Multimedia/Visual Communication & New Media/AR



## APPENDICES C

### Usability Testing in Melaka







## APPENDICES D

### Prototype development process



```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class TouchScript : MonoBehaviour
{
    public TouchScript PanelSta, PanelMCT;

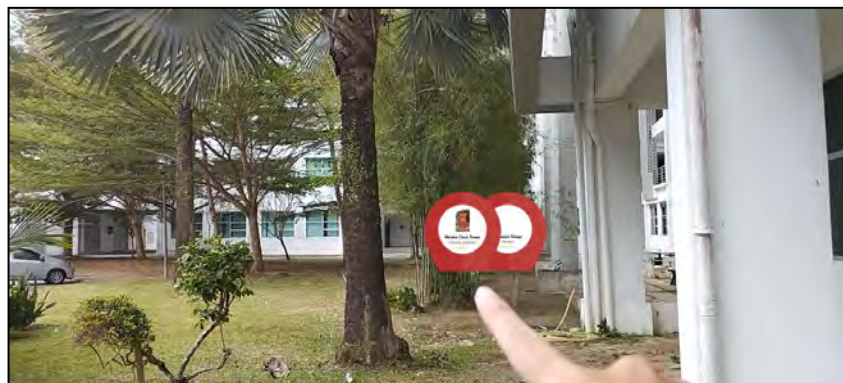
    void Start()
    {
        PanelSta = GetComponent<PanelSta>();
        PanelMCT = GetComponent<PanelMCT>();
    }

    void Update()
    {
        if (Input.GetKeyDown(KeyCode.S))
        {
            Ray ray = Camera.main.ScreenPointToRay(Input.mousePosition);
            RaycastHit hit;
            if (Physics.Raycast(ray, out hit))
            {
                if (hit.transform.name == "PanelSta")
                {
                    PanelSta.SetActive(true);
                    PanelMCT.SetActive(false);
                }
                else if (hit.transform.name == "PanelMCT")
                {
                    PanelMCT.SetActive(true);
                    PanelSta.SetActive(false);
                }
            }
        }
    }
}
```

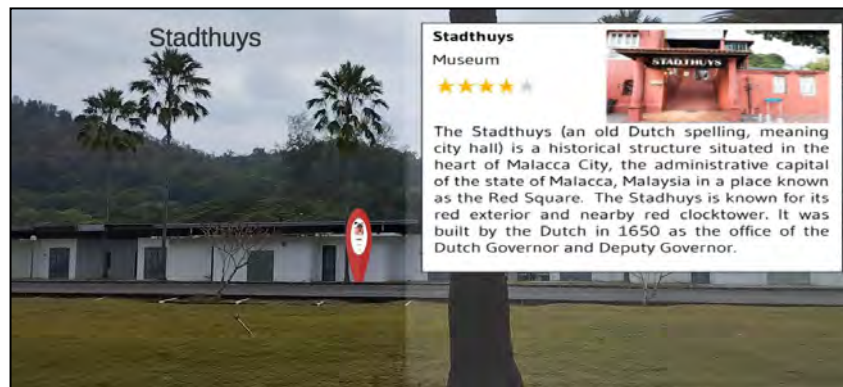
(a)



(b)



(c)



(d)

### Raycasting Script To Interact With POI

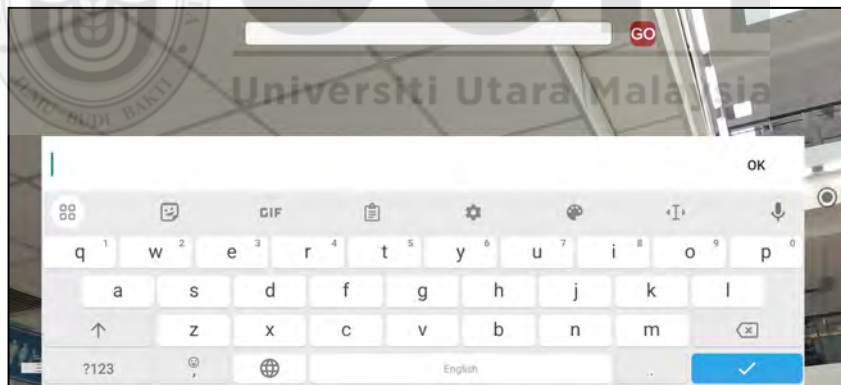
```
1 using System.Collections;
2 using System.Collections.Generic;
3 using UnityEngine;
4 using UnityEngine.SceneManagement;
5
6 public class ChangeS : MonoBehaviour
7 {
8     public void MoveToScene(int SceneID)
9     {
10         SceneManager.LoadScene(SceneID);
11     }
12 }
13
```

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Script For Changing Scenes

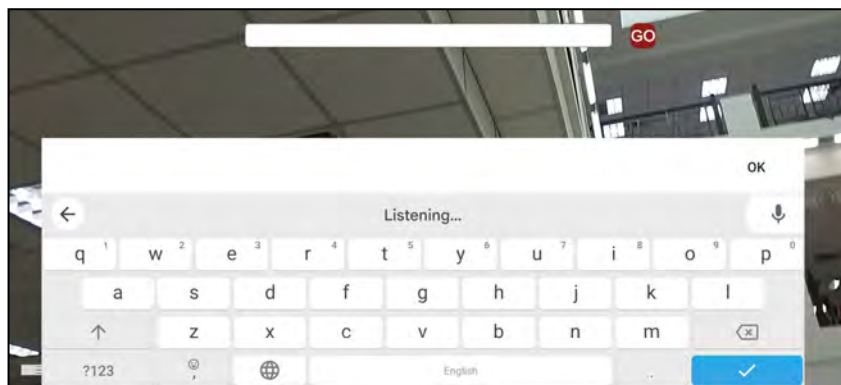
```
AndroidInput.cs
Miscellaneous Files
AndroidInput

1 using System.Collections;
2 using System.Collections.Generic;
3 using UnityEngine;
4 using UnityEngine.UI;
5
6 public class AndroidInput : MonoBehaviour
7 {
8     TouchScreenKeyboard keyboard;
9     public Text txt;
10
11     public void OpenKeyboard ()
12     {
13         keyboard = TouchScreenKeyboard.Open("", TouchScreenKeyboardType.Default);
14     }
15
16     // Update is called once per frame
17     void Update()
18     {
19     }
20
21 }
22
```

(a)



(b)

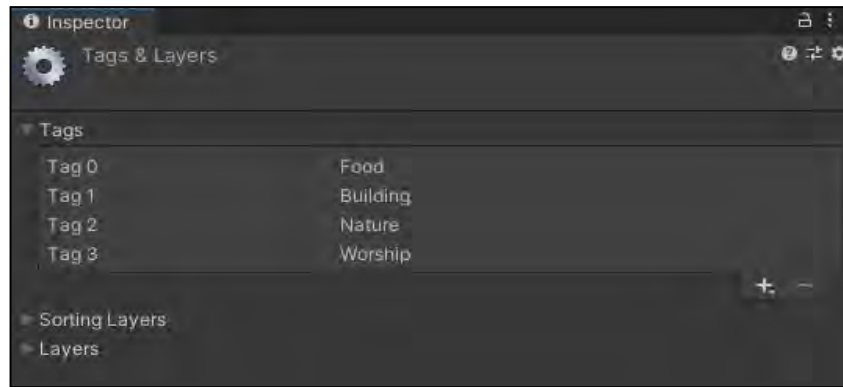


(c)

## C# Script For Typing and Voice Command Interaction

```
1 using System.Collections;
2 using System.Collections.Generic;
3 using UnityEngine;
4
5 public class SearchTag : MonoBehaviour
6 {
7     public List <GameObject> POIS;
8     public void CompareTag(string search)
9     {
10        if (search == "")
11        {
12            ClearFilter();
13            return;
14        }
15        foreach(GameObject POI in POIS)
16        {
17            if (POI.tag == search)
18            {
19                POI.SetActive(true);
20                Debug.Log(POI);
21            }
22            else
23            {
24                POI.SetActive(false);
25            }
26        }
27    }
28    // Start is called before the first frame update
29    void Start()
30    {
31        POIS = new List<GameObject>();
32        POIS.AddRange(GameObject.FindGameObjectsWithTag("Food"));
33        POIS.AddRange(GameObject.FindGameObjectsWithTag("Building"));
34        POIS.AddRange(GameObject.FindGameObjectsWithTag("Nature"));
35        POIS.AddRange(GameObject.FindGameObjectsWithTag("Worship"));
36    }
37
38    // Update is called once per frame
39    void Update()
40    {
41    }
42
43    public void ClearFilter()
44    {
45        foreach (GameObject POI in POIS)
46        {
47            POI.SetActive(true);
48        }
49    }
50 }
51
52
```

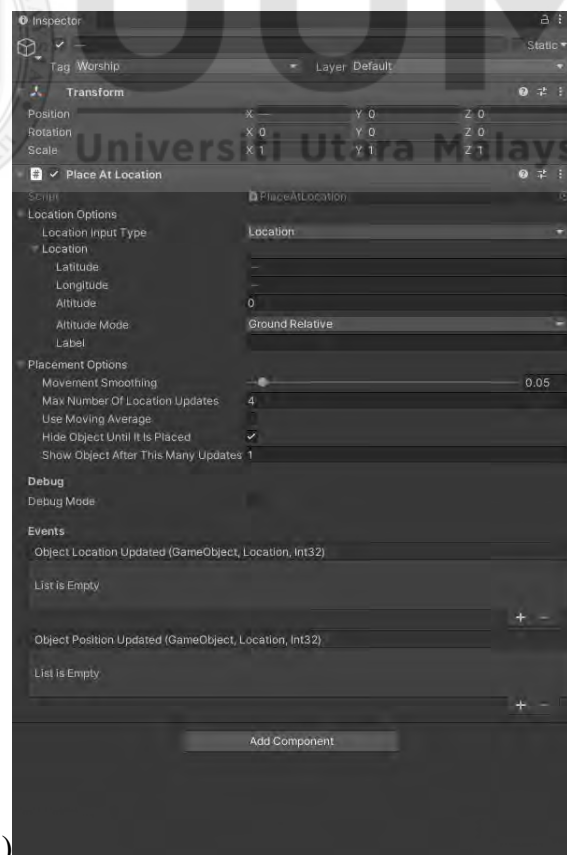
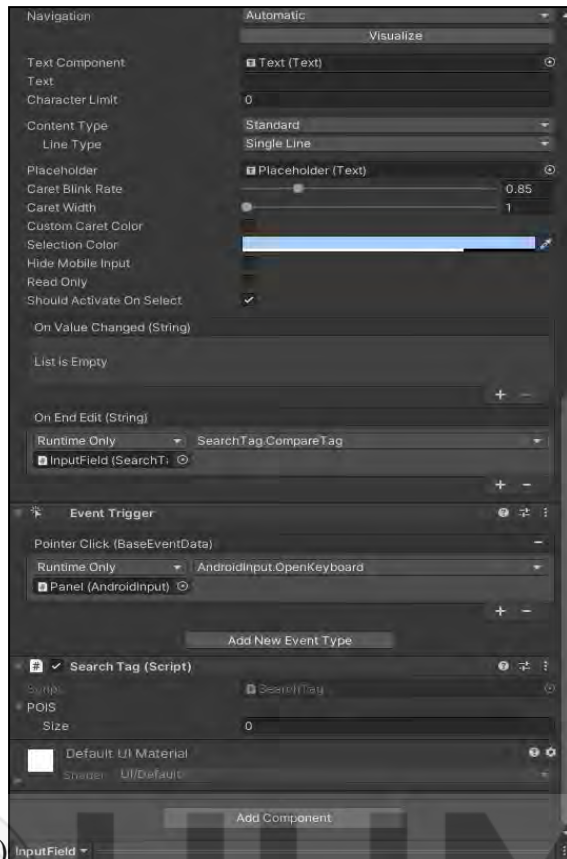
Script For Filtering Out POI Based Users' Preference



(a)



(b)



Elements In Section in Unity 3D Corresponding To The Script To Call Out POI