Design and Development of Vehicle Inspection Routine Virtual Reality Application

Soon-Nyean Cheong(✉), Dendi Permadi, Nur Afshaa Mohd Ameeruddin, Raisa Musthofa, Siti Munirah Razaly, and Mazlan Bin Mahadzir

Faculty of Creative Multimedia, Multimedia University, Cyberjaya, Selangor, Malaysia
sncheong@mmu.edu.my

Abstract. This paper proposes a Vehicle Inspection Routine Virtual Reality simulation application that teaches students how to perform vehicle inspections, commonly known as "Rutin Pemeriksaan Kenderaan", which is a required module before obtaining a Malaysian driver's license. The module's goal is to ensure that the vehicle is safe on the road, and students currently learn the module in person and then review it through videos or books. The goal of producing the VR learning application is to give students a new approach to learning the vehicle inspection routine module in a more informative and entertaining manner, both during and after the pandemic, thanks to the evolution of virtual reality technologies. The VR learning application adopted the content from the Department of Road Transport's exact syllabus to create digital learning assets and immersive environment that are similar to driving schools. The VR learning application could potentially enhance or supplement the existing vehicle inspection routine module by giving students the opportunity to practice social distancing at home while learning it. Wearing a head mounted device like the Oculus Rift, students are immersed in a virtual driving school, where they are greeted and guided by an instructor. Students can learn and revise all of the vehicle inspection stages from the instructor, both in theory and hands-on, in a relaxed and engaging environment through the VR learning application.

Keywords: Vehicle Inspection Routine · Virtual Reality Simulation · Immersive Learning Environment

1 Introduction

The coronavirus disease (COVID-19) virus is highly contagious and has spread worldwide since December 2019. COVID-19 can be transmitted from person to person through normal breathing, sneezing, coughing, speaking, or even touching. As a result, in order to combat the disease, many countries have implemented social distancing policies. Malaysia implemented movement control orders (MCO) to combat the spread of COVID-19. As a result, many businesses are unable to operate during the MCO period. Because driving schools are no longer permitted to operate, the MCO has had a significant impact on students seeking a driver's licence. As a result, students are unable to enrol in driving lessons at nearby driving schools.

F. Mustaffa et al. (Eds.): ICCM 2022, ASSEHR 706, pp. 203–211, 2023.
https://doi.org/10.2991/978-2-494069-57-2_22

Because of the pandemic's unprecedented situation, everyone has had to adapt their lives, as evidenced by behavioural changes in their lifestyles such as sanitization, social distancing, and mask wearing. Traditionally, driving schools have focused on holding physical classes to teach and prepare students to take a driving test. For example, in order to teach the Vehicle Inspection Routines module, or "Rutin Pemeriksaan Kenderaan" [1], an official syllabus issued by the Malaysian Road Transport Department, driving instructor will physically demonstrate how to perform vehicle inspections on a real car. Students can refresh their knowledge of the vehicle inspection procedure by watching online videos or reading books. However, during the COVID-19 pandemic, the physical learning approach was no longer viable. The Vehicle Inspection Routines module is one of the most important topics to go over before getting a Malaysian driver's license with the purpose of ensuring that the vehicle is safe on the road.

Technological advancements such as Virtual Reality (VR) have prompted researchers to investigate ways to provide a better learning experience for students during the pandemic. This article presents the design and development of a VR Vehicle Inspection Routine (VIR) simulation application for students to learn the process of inspecting vehicle at home in a fun and informative way. VIR is developed based on the exact syllabus from the Department of Road Transport Malaysia to supplement and improve the existing vehicle routine module during and after the COVID-19 pandemic, by allowing students to practise social distancing at home while learning it with a head-mounted-device such as the Oculus Rift and HTC Vive.

2 Related Work

Researchers have employed VR in a range of sectors, including medicine [2], education [3, 4], training [5, 6], and museums [7], among others. In the education industry, VR is becoming more popular, notably during the COVID-19 pandemic. The capacity to operate with three-dimensional (3D) interactive learning objects, immersive virtual environments that resemble the actual world, safety through social distancing, cost-effectiveness, content comprehensiveness, and scalability are all compelling reasons for educators to use VR. In VR, students can learn at their own pace without the physical pressure of an instructor. They can practice until they get good at everything they need to do before they take the driver's license test.

The Vehicle Inspection Routine is an important part of the Malaysian driver's license test, which students must complete in front of an examiner officer. Table 1 summarises the sequence of activities for the vehicle inspection process. The objective of the Vehicle Inspection Routine module is to train students to properly inspect the vehicle before driving it to ensure that it is in good working condition. The module also teaches students to ensure that the car boot contains vital tools for changing a punctured tyre, a well-inflated replacement tyre, and an emergency triangle. Besides, the module covers the checking of the water level in the radiator, wiper reservoir, battery acid level, and the level of braking, power steering, and engine oil, all of which are maintained to avoid on-road automobile malfunctions.

Table 1. Activities of the Vehicle Inspection Routine

Step	Activities
1	Ensure that left side of the vehicle's windscreen has a valid road tax.
2	Ensure the vehicle's front and back windscreens are not cracked or shattered.
3	Ensure the front and/or rear windshield wipers are clean and that the rubber blades are in good condition.
4	Ensure the vehicle's headlights are in good working order and not broken or loose.
5	Ensure the brake lights and rear lights are in good working order.
6	Place your hand on the left and right signal lights to ensure they are secure and not cracked or loose.
7	Ensure both the front and back license plates are not broken and the numbers are clearly readable.
8	Ensure the car's front and rear bumpers are not broken or sagging.
9	Ensure the door mirrors on the left and right are securely mounted and that the mirror glass is not damaged or broken.
10	Ensure the door mirrors are securely mounted and the glass isn't cracked or broken. Inspect all tyres. Pay attention to ribs, treads, tread block, grooves, and shoulder contour.
11	Ensure the car's boot door and lifter are in good working order by opening it.
12	Ensure all the necessary tyre-replacement gear on hand, including a lug wrench, extension bar, jack, well-inflated spare tyre, and towing hook.
13	Ensure an emergency triangle is available. When you need to warn people to be cautious when passing your parked car, the triangle comes in handy.
14	Ensure the mechanical features of the automobile windows are working properly, fully open and close them.
15	Open the hood and check the engine oil while the car is warm. Remove the dipstick and clean it. Plunge the dipstick into the engine oil tank, remove it, and check the level. The oil should be between the two dipstick marks.
16	Ensure the water level in the storage tank is normal.
17	Ensure the water level of the coolant in the radiator after the engine has cooled is about full. Ensure the spring and the rubber gasket within the radiator are in good condition.
18	Ensure the car engine belt has the necessary level of tension.
19	Ensure the hose is securely fastened and not fractured.
20	Ensure the brake fluid level is approaching the reservoir's high mark.
21	Ensure the power steering oil level in the reservoir is approaching the high point.
22	Ensure you have the driver's license, identification card, and insurance paperwork when driving.

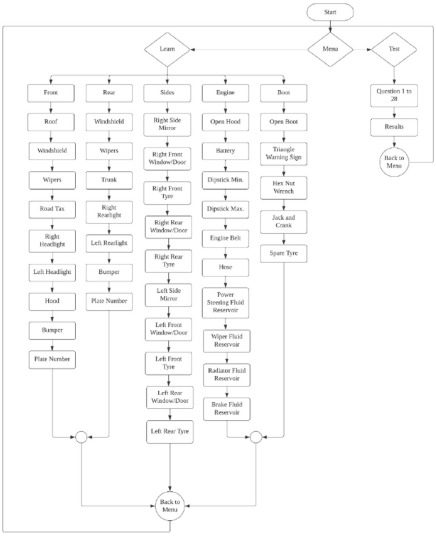

Fig. 1. Flowchart of the Vehicle Inspection Routine VR Application

3 Design of Vehicle Inspection Routine Application

Figure 1 depicts the overall flowchart of the VIR, in which users begin their VR learning journey by selecting the "start" option from the main menu. A virtual reality driving school environment, as well as the associated digital assets, will be loaded. The users are given a first-person 3D view of the office, allowing them to freely navigate around the office and garage using HMD's controller. An NPC resembling a driving school officer will greet and introduce the users to the learning outcome of the application. Throughout the VR learning experience, the officer will guide the user. The officer will walk users through the vehicle inspection step-by-step, through photos, videos, vocal explanations, and text descriptions through the UI dialogue box. The learning is divided into five sections, namely the front, rear, sides, engine, and boot of a car. Users are free to learn through the sections at their own pace. At the end of the course, users will be given a quiz to test their understanding, and their score will be displayed upon completion.

4 Development of Vehicle Inspection Routine Application

4.1 Software and Hardware Requirement

VIR application was created using Unity version 2021.1.17f1, a cross-platform game engine developed by Unity Technologies. Blender, Autodesk Maya, and Substance 3D Painter were used to develop the digital assets for VIR. Blender is a 3D computer graphics software toolkit for making animated films, visual effects, art, 3D-printed models, etc. Maya is 3D computer graphics software for creating characters and visual effects. Blender and Maya were used to model 3D assets such as car and non-player character

(NPC) design, rigging, and animation for VIR. Substance 3D Painter was used for texturing the digital assets. Meanwhile, the VIR user interface elements were created in Adobe Illustrator. VIR was deployed and tested using the Oculus Rift and the Windows 10 operating system on a standard PC.

4.2 Digital Car

For modelling the digital car used in VIR, an actual Perodua Axia car was used as a reference. Figure 2 depicts the digitally rendered Perodua Axia that is used throughout the application to teach users the inspection steps. Perodua Axia was chosen because it is used for driving tests and lessons by the vast majority of driving schools in Malaysia. Users are able to interact with different parts of the vehicle at a different level to ensure that they understand how to properly inspect a vehicle. During the learning phase, for example, users are guided by the orange outline of car parts such as windows, bonnets, trunks, and so on, which they must touch on to learn more about the parts, as illustrated in Fig. 3.

4.3 Non-player Character

An NPC in the shape of a humanoid was developed, rigged, and animated to behave as a driving school officer, guiding and assisting users throughout the learning process.

Fig. 2. Rendered Perodua Axia Car in VIR

Fig. 3. Orange Outlined Car Parts

Fig. 4. Rendered Driving School Officer

Figure 4 depicts the rendered driving officer, which is exported as FBX files and then imported into the Unity project. The NPC's narrations are recorded in mp3 format and then attached to the NPC in the Unity project. Thus, allowing users to communicate with the driving officer.

4.4 Virtual Learning Environments

The virtual driving school environments, namely the driving school office and garage were created in the style of an industrial loft, with a rusty and old feel. Figure 5 depicts the virtual office where users will first appear in VIR. The Unity XR Rig plug-in is used to allow users to navigate within VIR using an Oculus controller. The left controller is programmed to allow the user to move around the environment, whereas the right controller is programmed to rotate the camera's view. In addition, users can look around by rotating their heads through a VR headset. Figure 6 depicts the virtual garage, where users will learn all of the vehicle inspection steps from the virtual officer. Users begin their learning experience by selecting the section of interest, as shown in Fig. 7. As shown in Fig. 8, upon learning each of the inspection procedures, the virtual officer will explain the steps along with pop-up visuals demonstrating good and bad conditions for the part. The virtual officer will explain the reasoning behind the conditions and will walk user through the inspection process. Users are offered with a quiz after completing the learning session to test their grasp of the car inspection stages. Figure 9 prompts users, for example, to check the legality of the vehicle's road tax on the windscreen.

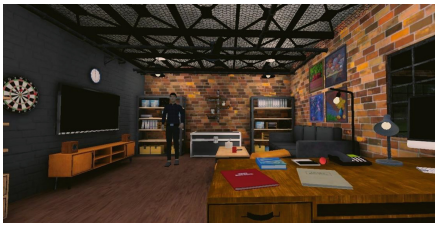

Fig. 5. Virtual Driving School Office

Fig. 6. Virtual Garage

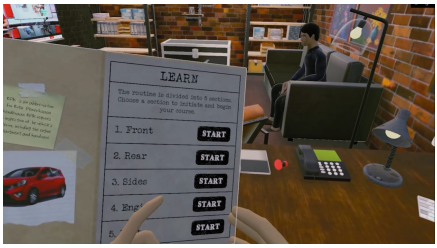

Fig. 7. Selection Menu

Fig. 8. Illustrations of Good and Bad conditions

Fig. 9. Quiz within VIR

5 Conclusion

This study presents an entertaining, instructive, and hands-on strategy for students to learn the Vehicle Inspection Routine by utilizing VR technologies, while also taking into account the social distance that is mandatory during the COVID-19 pandemic. The VIR application was installed and evaluated on the Oculus Rift, and it has the ability to improve or supplement the present vehicle inspection routine learning technique. The VIR prototype is still in its nascent stages, and additional System Usability Scale and Technology Acceptance Model evaluation studies will be conducted to determine the effectiveness of the VR learning application by putting it to the test.

Acknowledgments. The authors gratefully acknowledge the financial assistance and VR facilities provided by Multimedia University (Cyberjaya campus) to implement the project successfully.

Authors' Contributions. Nur Afshaa Binti Mohd Ameeruddin, Raisa Musthofa and Siti Munirah Binti Razaly: Formal Analysis, Methodology and Writing. Soon-Nyean: Supervision, Formulation Review and Writing, Dendi Permadi and Mazlan Bin Mahadzir: Supervision and Review.

References

1. Konsortium Villamaju Sdn Bhd, "Video Tutorial Ujian Memandu: Rutin Pemeriksaan Kenderaan (RPK)", Youtube, 23 Feb 2020 [Online]. Available: https://www.youtube.com/watch?v=M803eaL2rzY [Accessed: 30-Apr-2022]
2. Draganov, I. R., & Boumbarov, O. L., Investigating Oculus Rift virtual reality display applicability to medical assistive system for motor disabled patients, 2015 IEEE 8th international conference on intelligent data acquisition and advanced computing systems: technology and applications, IEEE, 2015, vol. 2, pp. 751-754. DOI: https://doi.org/10.1109/IDAACS.2015.7341403
3. Ortelt, T. R., & Ruider, E., Virtual lab for material testing using the Oculus Rift, 2017 4th Experiment@ International Conference, IEEE, 2017, pp. 145-146. DOI: https://doi.org/10.1109/EXPAT.2017.7984381
4. Remolar, I., Rebollo, C., & Fernández-Moyano, J. A., "Learning History Using Virtual and Augmented Reality", Computers, 10(11), (2021) 146.

5. V. T. Nguyen, K. Jung, and T. Dang, Vrescuer: A virtualreality application for disaster response training, 2019 IEEE international conference on artificial intelligence and virtual reality, IEEE, 2019, pp. 199–202.
6. Perez-C, H., Moscoso-Barrera, W. D., & Paipa-Galeano, L. A., Design and implementation of a cognitive ability virtual reality training tool, 2021 3rd International Congress on Human-Computer Interaction, Optimization and Robotic Applications, IEEE, 2021, pp. 1-6. DOI: https://doi.org/10.1109/HORA52670.2021.9461364
7. Zhou, Z., Si, Z., & He, R., Production and Experience of VR Roaming System in History Museum of Tianjin University of Science and Technology, Advanced Graphic Communication, Printing and Packaging Technology, Springer, Singapore, 2020, pp. 243-250. DOI: https://doi.org/10.1007/978-981-15-1864-5_33