Leap Motion Sensor-based Learning-aid Tool using Hand Gesture Interfacing

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Abstract. This paper presents a free-hand gesture-based human computer interfacing system for developing a learning aid tool in a virtual reality environment. A device known as the leap motion controller, which tracks hand movements optically, is used for hand interaction. Various virtual objects are created using Unity 3D platform. By using our system, we have been able to control multiple virtual objects such as the globe, box, cylinder, etc. with our hand system. This tool can be utilized as a learning-aid for school students.

Keywords: Human-computer interaction, Natural user interface, Leap Motion controller, Virtual reality, virtual objects.

1 Introduction

Nowadays augmented and virtual reality platforms are used for various visualization purposes. With the increasing number of computer applications in everyday life and the rapid progress of vision techniques, Human-Computer Interaction (HCI) has an important role in the modern world.Comparing our hands to the rest of our body, the hand is the most comfortable and simple way to convey our feelings [1]. For gesture recognition and movement, Leap Motion Controller (LMC) gives a useful portrayal. We apply the information through the API of LMC to see hand movements and motions [2]. In real-world environments, Virtual Reality (VR) is primarily utilized as a mechanism in order to see 3D information [3]. With the help of LMC, it is possible to implement virtual jobs like virtual games, selections, controls, and other applications based on virtual environments [4].

1.1 Previous works

Various research works have been reported for the application of LMC for HCI in Augmented and Virtual reality environments. Jia et al. [6], proposed an application that employed the use of AR to improve consumers' experiences with electronic medical records (EMR). In- depth views of their 3D innards and previous medical records are made available to patients. Leap motion device incorporation allows for hand gesture management of the 3D organs. Three 3D

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versions of the kidney, heart, and liver were created to show the viability of using augmented reality as a substitute for traditional storage of user medical data. Ashraf et al. [7], proposed a Virtual-Physical Interaction System (VPIS), a system for HCI: firstly they were offering a realistic product experience process in a Virtual Reality (VR) environment. Secondly, the corresponding process was controlled by manipulating a tangible product model in a physical world. Thus, the VPIS with a Virtual-Physical combination enhances user experience in HCI field, which can be applied in several application scenarios (Aided Design). In their article, Ribeiro et al. [3] introduced a free-hand interface for representing simulated terrains in an AR world. The additional aspect of this research is the investigation of a set of suitable motions for the interactive manipulation of virtual landscapes with LMC and AR markers. An application that enables users to engage with the virtual landscape with their bare hands directly was created to showcase the research. Min et al. [8] in their paper, designed a numeral gesture recognition system using Leap Motion. Sharma et al. [9] in their paper, proposed a model to transform dynamic hand gestures into text by employing Leap Motion. Rehman et al. [11], developed a new technique for recognising gestures. This system is composed of static and dynamic gestures. For static motions, they used features extracted based on the length, angle, and degree of twisting of the fingertip, and then trained a support vector machine to identify them. Rehman et al. [13] in their paper, there is a new idea for a directional tool that combines visual assistance with gestural action. The suggested aids offer users in the VE two different types of guidance: they help them choose the right path and pose the right gestures.

In this paper we have suggested a simple finger pointing based gestures for manipulation of virtual objects like globe, sphere, capsule, box, cylinder etc. in VEs. The remaining part of the paper is organised as follows: Section 2 discusses the proposed system design, Section 3 describes the experimental results and finally Section 4 concludes the paper with final direction.

2 Proposed System Design

A system built on the Unity platform and the Leap Motion Controller is utilised to perform free-hand manipulation of the 3d virtual objects. In Fig. 1, the suggested system's block diagram is displayed. Firstly the hand gestures are captured using the LMC and then converted to Virtual hands using a package of the LMC interaction engine. Then this virtual hand interacts with the virtual objects created using Unity. For the visualization and augmentation of virtual objects such as sphere, box, capsule, cylinder, earth globe etc., we used UNITY 5.6.7f1, which allows the creation of different shape structures that can be moved with the hands of the user when handling a virtual object. The suggested system was developed on a Windows system utilizing the MS Visual Studio 2019 framework and the Leap Motion SDK, version 3.2.0. To create the layout, we used different 3D gaming objects such as sphere, capsule, cylinder, box, UI sidebar etc. These objects were incorporated with Unity asset.

We downloaded the driver file from the device's official page to run LMC on the computer, in our project we use version 3.2.0. For the interaction of the Unity program with its environment, two asset packages are required for the project folder, these files are: "Leap Motion Core Assets 4.4.0.unitypackage" and "Leap Motion Interaction Engine 1.2.0.unitypackage".After that,the target object is detected and with the help of virtual hand, the object can be hit or released.

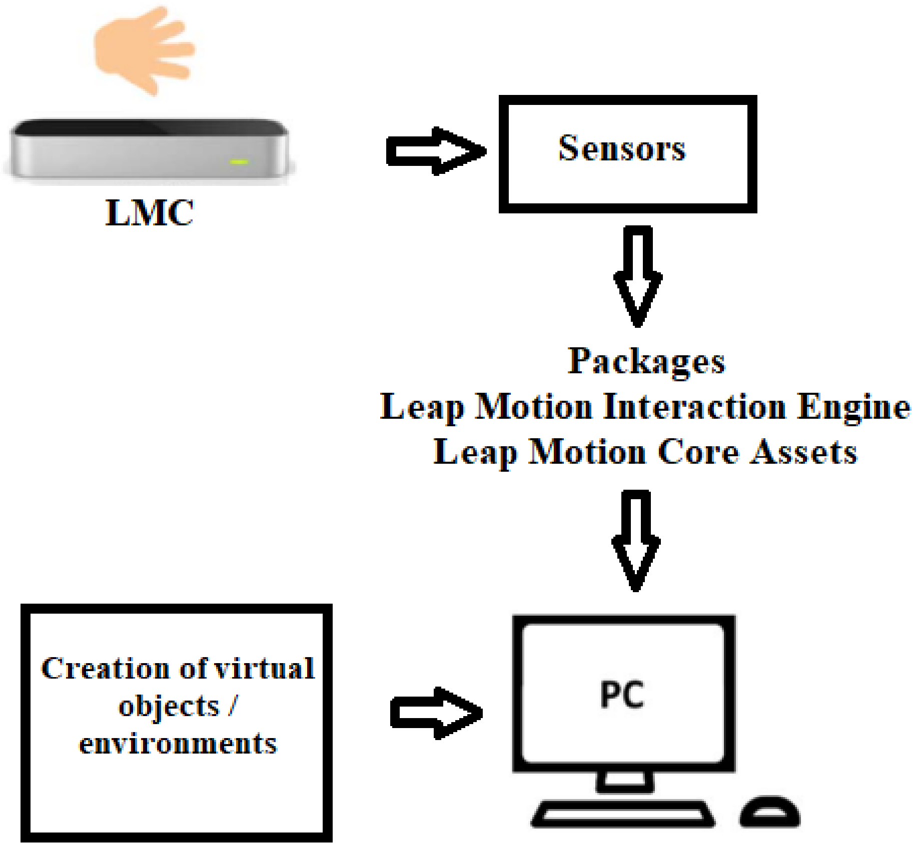


Fig. 1. System design- Interaction with leap motion in a Virtual environment [12].

The computer used in our experiments featured an Intel Core i5 3.20 GHz, 8.0 GB of memory RAM and a GeForce GTX 1650 graphics card.

2.1 Leap Motion Controller

In this study, we employ a little gadget called a Leap Motion Controller for hand motions and motion tracking. A tiny gadget measuring around 6.2 mm thick, 25 mm broad, and 75 mm long, the Leap Motion Controller has sub- millimeter accuracy for detecting hands, fingers, and movements. (Fig. 2).

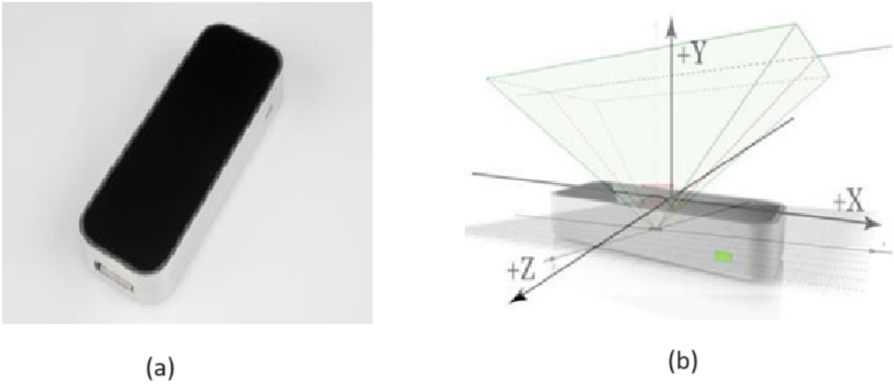


Fig. 2. (a)leap motion device,(b)LMC and coordinate

The interaction space is 8 cubic feet in size and is shaped like an inverted pyramid, [3] rising around sixty centimeters above the gadget. Leap Motion has an approximately 8 cubic foot interactive 3D area with a 150 degree perspective and uses infrared cameras for tracking the user's hands at a maximum of 200 frames each second (Fig. 2). It uses three infrared LEDs and two cameras to take the capture. They capture that information and transfer it via USB to the associated detecting software, where it is then evaluated along with the stereo grayscale images taken by the two cameras to reconstruct whatever the device views in 3D. The Unity platform will now display the 3D information and interfere with the location of the fingers and hands, along with any occluded areas.

2.2 Creation of virtual 3D object

In this project, we have built seven 3D objects viz globe, box, slide bar, capsule, cylinder, resistor, capacitor. All 3D objects were constructed with the help of gaming objects present in the unity app. Each 3D model can be dealt with free hand gestures, by using LMC. To create the globe we import an earth map and develop it in a scene with a resolution of 1280 x 720. The visual effects of the rotating globe were obtained using the C#. In a similar way we have created a box, resistor, and capacitor as shown in Fig. 3.

2.3 Interaction with virtual 3D object

Designing and creating virtual things falls under numerous study categories, including simulation and human- machine interaction. The key challenge with a human- machine interaction strategy is figuring out how to represent, interact

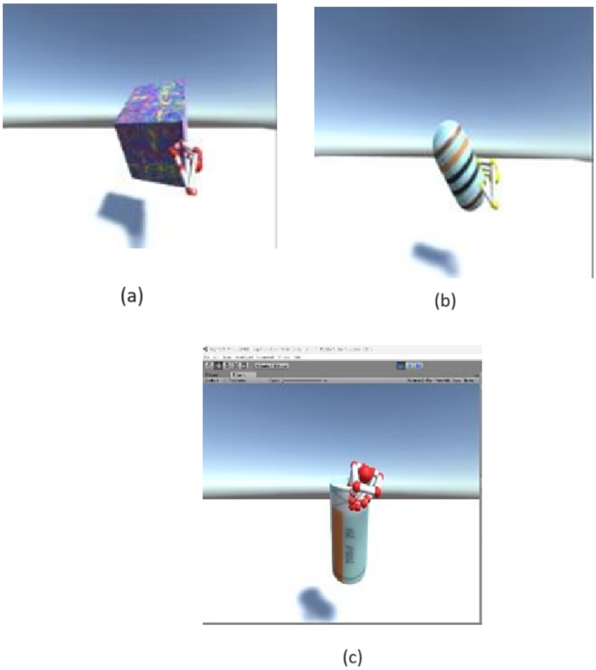


Fig. 3. Virtual objects (a) Virtual box (b) virtual resistor (c) virtual capacitor

with, and see virtual objects. In the unity 3D system, virtual objects interactions use the adjustment of objects like spheres, capsules, cylinders, and globes by external systems or directly by users to engage with them without the usage of a mouse or keyboard.

As seen in Fig. 4, LMC provides 3D coordinate data and direction formulation for significant spots in the hand.

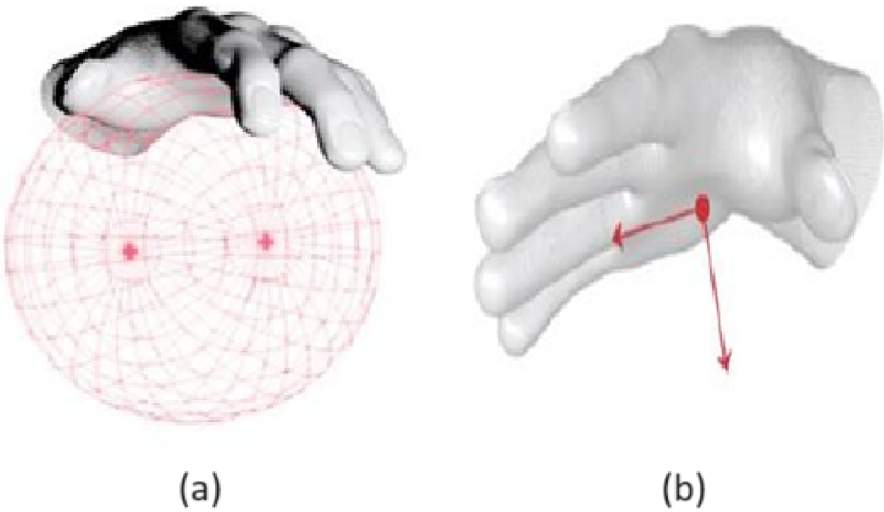


Fig. 4. Hand modelling

2.4 Experimental results

Some of the system's outcomes are presented in this section.

All the aforementioned experiments were made using a Leap Motion Controller. The C# programming language was used to implement the entire project. As shown in Fig. 6, a globe is created in a constant position and rotated in VEs controlled with finger point-based gestures.

The adjustments shown in Fig. 6 were made using our method on a virtual map with a resolution of 1280×720 and a fixed gravity and time step constant of 4.905 and 0.01111, respectively. Using this technique, more intricate virtual things can be produced. Here along with the creation of objects, zoom-in and zoom-out is done with the box and UI slider as shown in Fig. 7.

Rotation of objects such as capsule, cylinder, resistor and capacitor is done with free hand finger pointing based gesture as shown in Fig. 8,Fig. 9.

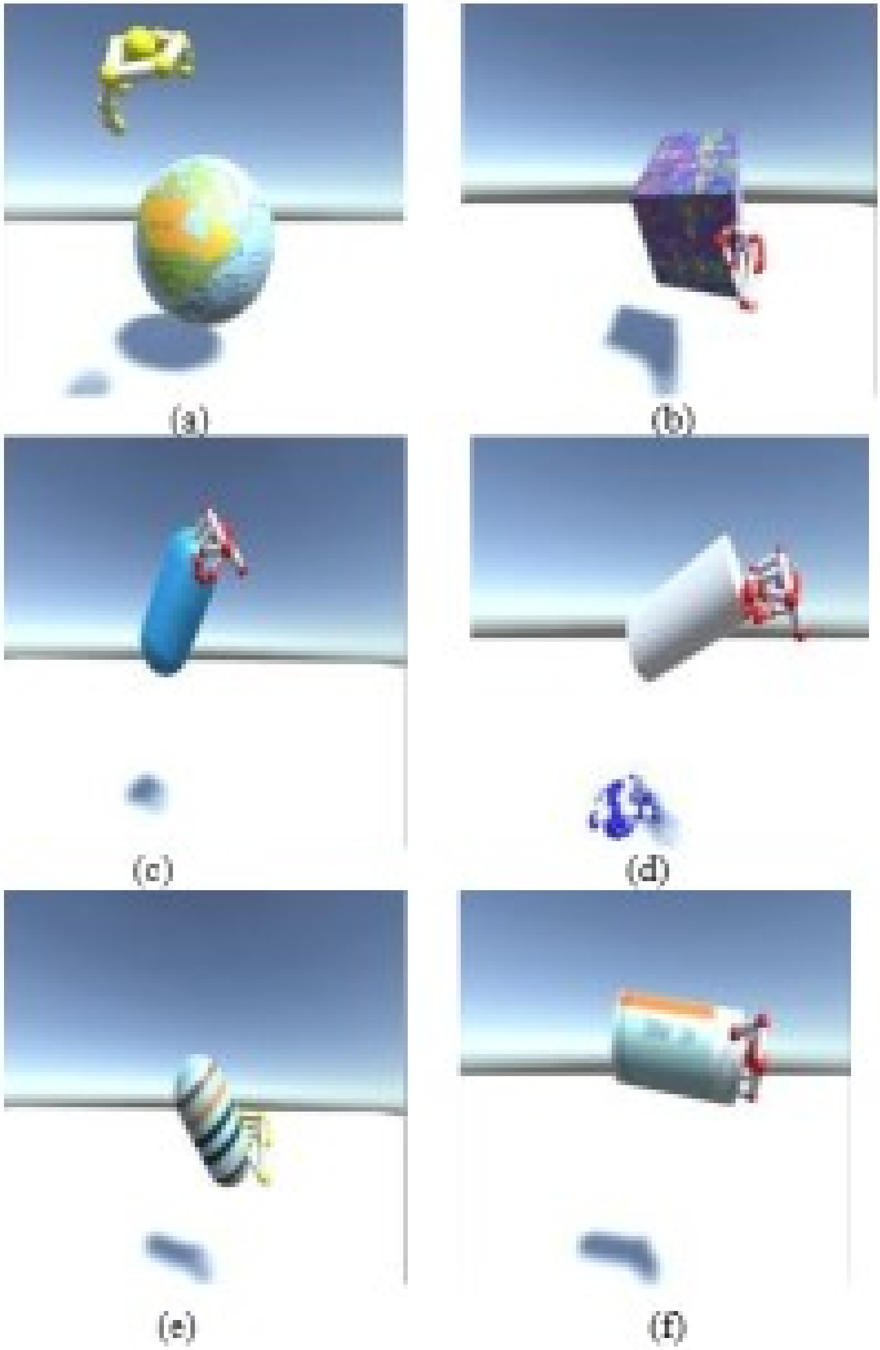
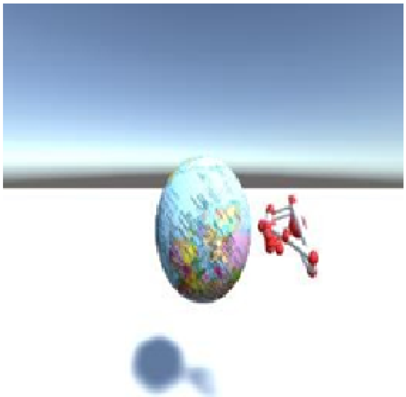


Fig. 5. Object created in a virtual reality environment

(a)



(b)

(c)

Fig. 6. Creation of (a) static globe and (b) rotating globe and interact with leap motion in unity 3D (c) interaction of the user with a virtual globe

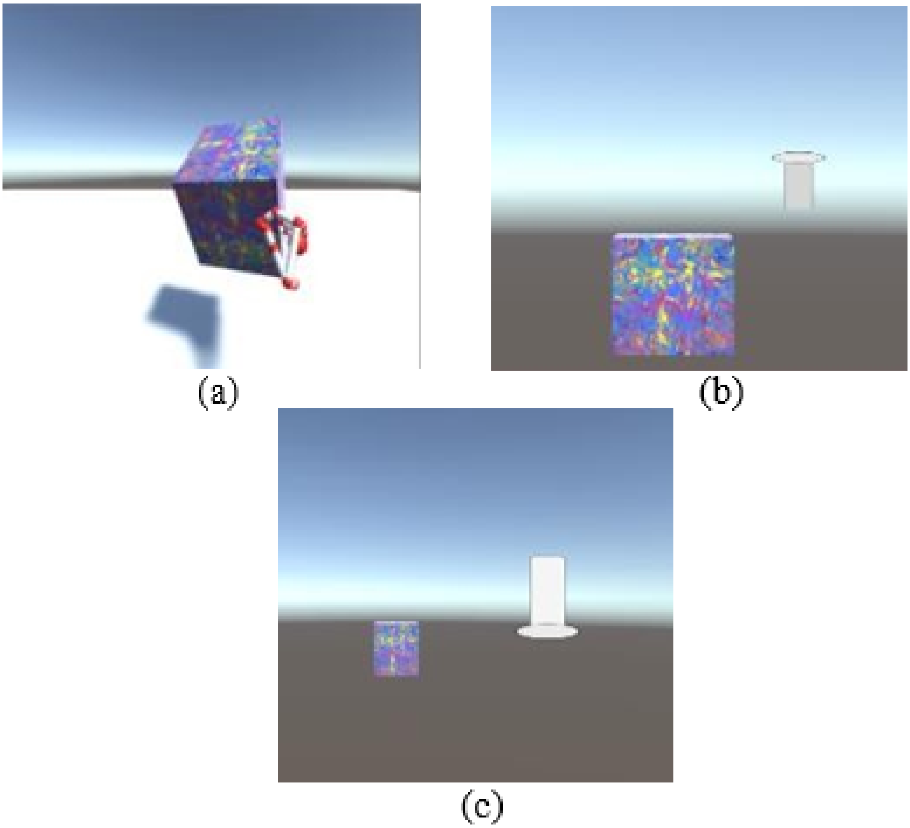


Fig. 7. (a) Control of virtual box in unity (b) zoom-in (c) zoom-out

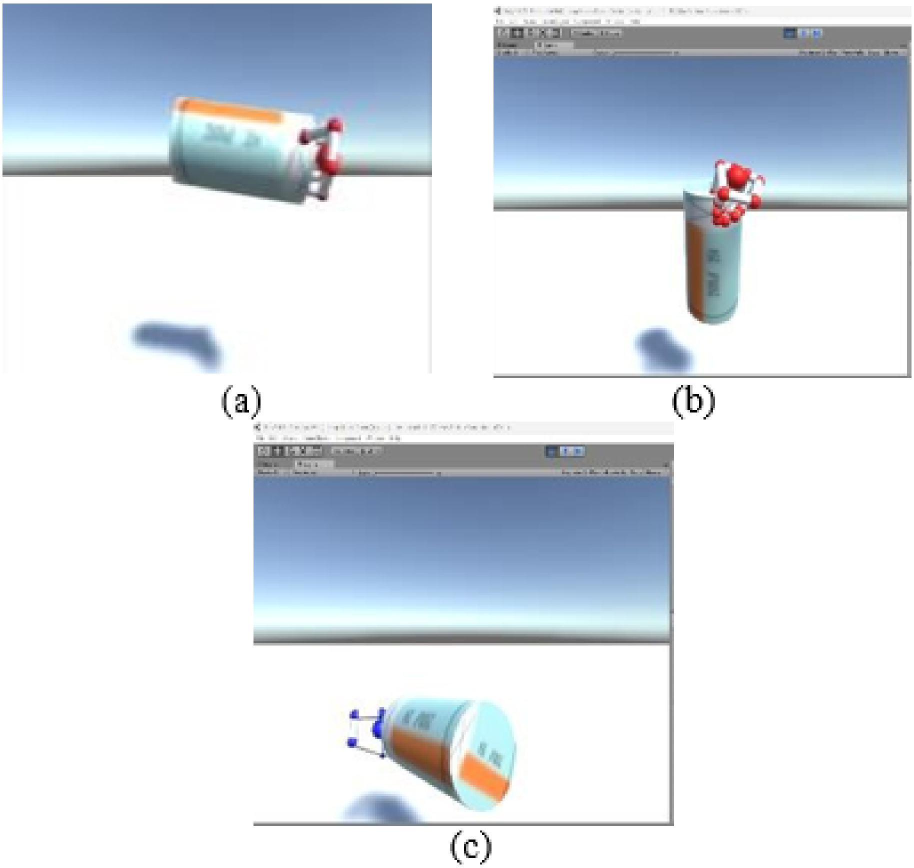


Fig. 8. Rotation of some virtual capacitor (a) capacitor (b) capacitor rotated (b) capacitor rotated (zoom-in view)

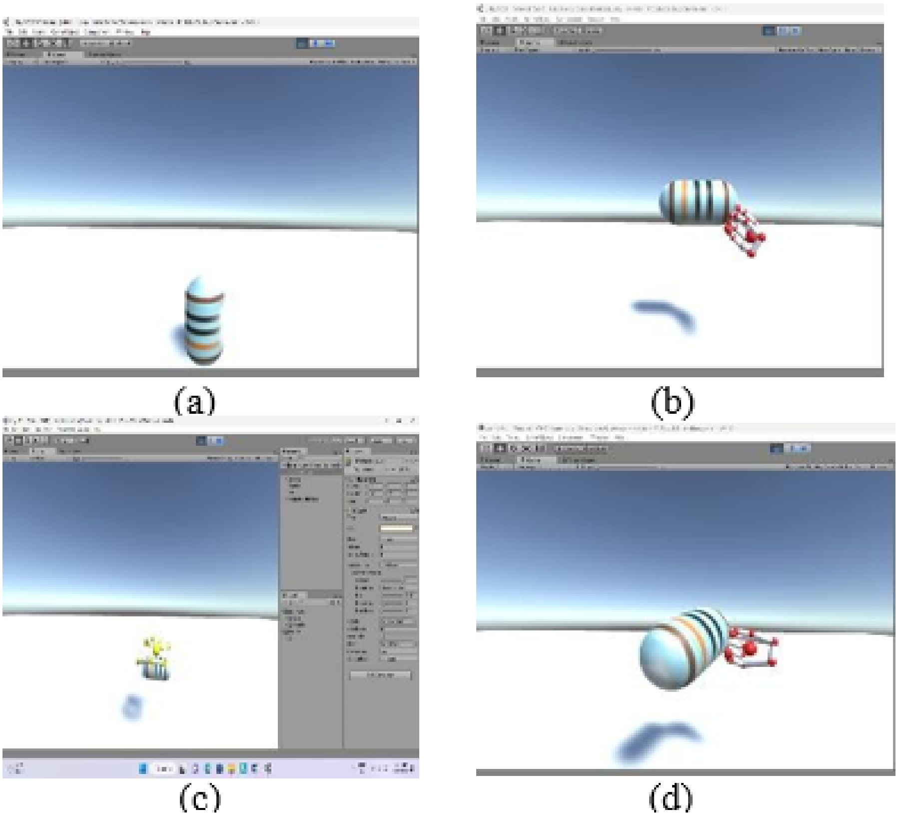


Fig. 9. (a) A virtual Resistor (b) Resistor rotated (c) Resistor zoomed out (d) Resistor zoomed in.

3 Conclusion and future work

In this research, we have proposed a virtual reality environment with a free hand interface for manipulation of virtual structures. The manipulation of the virtual objects are done by using various hand gestures. The suggested framework can be used by students as a teaching aid. The Leap Motion Device's view angle is a noticeable restriction of this research. Rendering the virtual volume that the device generates is one approach to get around this restriction.

Our future work will be focused on the scope to include the segmentation and the classification of hand gestures. It will also include capturing of dynamic hand gesture sequences for more manipulation tasks. Furthermore, in an augmented reality setting, we are also concentrating on developing a new learning assist tool. The development of the learning aid tool can be done for students by developing some electronic components and objects in a virtual environment which could be much easier than practical lab classroom. This will help the teacher to explain characteristic of the component to the students using this system.

References

1. Chen, Y., Ding, Z., Chen, Y. L., et al.: Rapid recognition of dynamic hand gestures using leap motion. In: 2015 IEEE International Conference on Information and Automation. IEEE, 2015: 1419–1424
2. Sharma, A., Yadav, A., Srivastava, S., Gupta, R.: Analysis of movement and gesture recognition using Leap Motion Controller. In: Procedia Computer Science. vol. 132, pp. 551–556. Elsevier B.V. (2018). https://doi.org/10.1016/j.procs.2018.05.008.
3. Ribeiro, A. A., de Oliveira, D. C. B., da Silva, R. L. D. S.: Gesture-based manipulation of virtual terrains on an augmented reality environment. In: 19th Symposium on Virtual and Augmented Reality (SVR), pp. 1–7. IEEE, 2017. https://doi.org/10.1109/SVR.2017.9.
4. Satheeshkumar, R., Arivoli, R.: Real Time Virtual Human Hand Using Leap Motion Controller. International Journal of Electronics and Telecommunications, **67**(3),(2021).
5. Jiang, H., Duerstock, B.S., Wachs, J.P.: A machine vision-based gestural interface for people with upper extremity physical impairments. IEEE Trans. Syst. Man Cybern. Syst. **44**(5), 630–641 (2014). https://doi.org/10.1109/TSMC.2013.2270226
6. Jia, J., Tu, G., Deng, X., Zhao, C., Yi, W.: Real-time hand gestures system based on leap motion. Concurrency and Computation: Practice and Experience, **31**(10), e4898(2018).
7. M. A. S. Selleh and A. Saudi,: Augmented Reality with Hand Gestures Control for Electronic Medical Record. In:2019 IEEE 10th Control and System Graduate Research Colloquium (ICSGRC), Shah Alam, Malaysia, 2019, pp. 146-151, https://doi.org/10.1109/ICSGRC.2019.8837061 .
8. Min, X., Sun, S., Zhang, W., Chao, C. (2018).: Virtual-Physical Interaction System. In: 2018 International Conference on Virtual Reality and Visualization (ICVRV),pp. 158-159. IEEE, Qingdao, China. https://doi.org/10.1109/ICVRV.2018.00056.
9. Sharma, J., Gupta, R., Pathak, V.: Numeral gesture recognition using leap motion sensor, pp. 411–414. https://doi.org/10.1109/cicn.2015.86

10. Jamaludin, N.A.N., Huey, O.: Dynamic hand gesture to text using leap motion. IJACSA **10**(11), 199—204 (2019)
11. Rehman IU, Ullah S, Khan D, Khalid S, Alam A, Jabeen G, Rabbi I, Rahman HU, Ali N, Azher M et al (2020) Fingertip gestures recognition using leap motion and camera for interaction with virtual environment. Electronics **9**(12):1986 https://doi.org/10.3390/electronics9121986
12. Hidalgo, J.C.C., Bykbaev, Y.R., Delgado, J.D.A., Coyago, T.P., Bykbaev, V.R.: Serious game to improve fine motor skills using leap motion. In: 2018 Congreso Argentino de Ciencias de la Informática y Desarrollos de Investigación (CACIDI), pp. 1—5. IEEE (2018).https://doi.org/10.1109/CACIDI.2018.8584370
13. Rehman, I.U., Ullah, S., Ali, N. et al.: Gesture-based guidance for navigation in virtual environments. J Multimodal User Interfaces 16, 371–383 (2022). https://doi.org/10.1007/s12193-022-00395-1