

Evaluating Interactivity in VR Healthcare Applications Using Analytics

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Abstract. Currently, Virtual Reality-based 3D applications are more and more in use. Education is a field that makes use of this technology providing the users with a pleasant way of learning. Thus, the human-computer/smart phone interactivity increases. To measure the human-computer interactivity in a Virtual Reality-based 3D application, certain metrics may be considered (e.g.: application usage time, speed of execution of certain tasks). In this paper we use Google Analytics to observe and measure the interactivity in a medical application created for educational purposes. The application is based on Virtual Reality, and the user may observe and handle the bones of the human skeleton. The main actions monitored via Google Analytics to observe interactivity are: skeleton parts selection, zooming in/zooming out, rotation. An 80% usage percentage (measure of interaction) was achieved for the skeleton selection (foot bones), while for the other actions and selections the achieved percentage was of 100%.

Keywords. Google Analytics, Virtual Reality, interaction, 3D applications, healthcare, education

1. Introduction

Virtual Reality-based (VR) 3D applications are more and more present in medical academic education or for healthcare staff continuous education. Such applications, either for educational or medical purposes or for serious gaming, have an advantage over the usual applications. Virtual Reality may be defined as an artificial three-dimensional environment created by man on a computer, simulating reality so well that the users experience the impression of physical presence when using it. Virtual Reality, is experienced with the aid of hardware and software that enable the 3D visualization of the objects. Amongst the most frequently used equipment is the VR headset in conjunction with an app (a smart phone application). The purchase price of the headset is very low, therefore any user can afford this piece of equipment. There are also other devices that allow exploration/visualization of the 3D virtual space such as: Oculus Rift, HTC Vive, Microsoft HoloLens. The advantage of using such equipment is that they allow a detailed visualization of the 3D virtual space, with higher clarity than the VR headset. The purchase price of such devices is much higher than the VR headset's price. In both cases, using either the VR headset or other devices, the human-computer or smart phone interactivity increases. We may define VR-based 3D application

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interactivity as the process of visualization and action/handling between humans and 3D virtual objects within a certain time duration and with the aid of peripheral devices.

To measure the interactivity in a VR-based 3D application various metrics can be created: the application usage time duration, the manner of usage or of accessing certain 3D objects of the specific application and the speed of execution of certain actions within the 3D virtual space. An alternative to measure interactivity in a 3D application is the traditional one, i.e. using a test plan. In the test plan, answers to various questions related to the way the user perceives interactivity within the application are important for evaluation of the application. In this paper we use Google Analytics (GA) to observe and measure the interactivity in a VR-based educational application [1]. This VR-based application was developed for educational purposes, for medical students or any users passionate about exploring human anatomical systems. Using GA allows the automated detection of the actions performed by the user in the 3D application. The integration of such service into our app is modular and may be used to detect the interaction in other 3D applications as well.

2. Related Work and Tools

Interaction in a 3D application is presented in a system based on extended or experimental reality (XR) [2]. The main interactions within the 3D virtual space being studied are: the selection, translation and rotation of a 3D object. The metrics proposed for measuring the interactivity in this system are: time of usage of each user option, speed and precision of execution of the actions.

Using VR to explore and analyze data allows the users to visualize them in 3D and consider another perspective on them. The data analysis is presented in a 3D application developed in Unity [3]. The data presented in the application refers to the geospatial coordinates in the Massachusetts Institute of Technology (MIT) campus, made available by Twitter. The data is presented in a VR environment. The application allows the user to apply various filters such as: time intervals, searching for certain Twitter data type. In addition, it uses Leap Motion to allow the users to use their hands to select certain Twitter data. The data analysis in the early stages of their exploration is proposed in another system [4]. It allows the users to evaluate the VR-based analytics advantages. It proposed 2 data analysis methods: star coordinates and star plots. Another technology used in data analysis is mixed reality (MR). An MR-based 3D system measures both the time-related performance of the users, the errors, and the movement patterns [5]. To measure the users' performance, they had to perform several tasks: detection of previously visualized objects (memory-based detection) and cluster recognition. The users' performances improved when using this new technology as compared to the traditional one, i.e. using 2D applications.

Certain data web analysis services may be used to analyze data sets which should reflect interactivity in an application. GA provides this service [6], allowing the users to visualize certain data: audience data, acquisition data, and behavior data. This service may be used to understand online learning and the manner of use of certain learning platforms [7]. This paper will present the integration of such service in a VR-based educational application developed in Unity. The purpose of the integration of such service is to observe and measure the interactivity in the application.

3. Methods

GA was integrated into the VR application developed in Unity. The Unity editor allows its integration with the project activating a GA option.

For our research we created 8 GA type events: 5 events for the control panel and 3 for the skeleton representation. Such events are called *analytics trackers* and are predefined C# scripts. Their role is to detect when an interaction takes place between the object they are attached to and an external object (in our case a virtual point). Thus, events may be created, activated in various cases such as: when starting the application, when stopping the application or they may be activated via external events such as pressing a button. The first 5 events will activate when the user executes a zoom in/zoom out movement, right/left rotation of the skeleton or when resetting its position and scale, respectively. The rest of GA-type events activate when the user selects skull bones, pelvic bones, respectively foot bones representations.



Figure 1. Main scene of the SkeduVR Application.

The control panel has five objects (Figure 1) each showing its role. By placing the pointer on one of them the user will zoom in or zoom out of the skeleton and will rotate the skeleton to the left or to the right on the y axis. The 3D skeleton will increase in size on all the 3 axes by 0.1 measurement units in the Unity virtual space, each time the user places the point on the object meant for zooming in or zooming out. The rotation to the left or to the right on the y axis is performed by 30 degrees on each selection of the object ensuring the rotation. When the user places the point on the “Reset” object the scene will reset, and the skeleton will get back to the initial position and scale. When placing the point on one of the bones, the user will receive information on it, the name and type of the selected bone (wide, short or long). The users are informed on the possibility of their activity being monitored from the start of the application. They get a message informing them that their interaction in the application is monitored. Thus, if the users agree to it, the main scene is displayed where they may visualize and handle the skeleton; then their consent is sent to GA’s API (Application Programming Interface). Their timing is also started in order to see how long they used the application. This function is also performed with the aid of GA. In this application, the administrators (the application developers) may observe the inactivity of each user in relation to the application usage time and to the actions performed in the application. The actions observed are only the functions which integrated the analytics tracker part with them (Table 1).

Table 1. Actions observed in the application through GA (usage percentage)

Action	Zoom	Zoom	Rotation_left	Rotation_right	Reset	Bone selection		
	in	out				skull	pelvic	foot
Percentage	100%	100%	100%	100%	100%	100%	100%	80%

Automatically detecting the user’s actions results in a major advantage since it eliminates the users’ subjectivity when testing 3D applications. For instance, one of the questions often raised within a test plan is: “How easy was it to access certain functions (e.g.: buttons, information texts) in the application?”. Such type of question is

eliminated when using GA. In educational applications, the information visualization and accessing in certain positions within the virtual 3D space are detected automatically via this service. Thus, in the new versions of the app the information may be concentrated under another mode/position, in order for the user to be able to read/use it.

4. Conclusions

Using GA we measured interactivity from a usage time perspective and related actions. Currently, we obtained an average of 3.5 minutes of usage per day and the zooming in/out, rotation, and respectively resetting actions were performed by all (Table 1) the users (10 active users). The activation of the GA trackers is triggered by selecting every single bone. It was noticed that some users activated most of the time only the trackers for the upper part (skull bones) and middle part of the skeleton (pelvic bones). The lower part (foot bones) was not selected by all the users, only 80% of them managed to select it (Table 1). The foot bones of the skeleton was selected only by 80% of users, because the users' gaze is not oriented at the bottom in the 3D space. To develop a successful VR-based application its interactivity must be measured. With the aid of GA in our application the interactivity may be increased by observing the most frequently and the less frequently used parts. The application deficiencies as far as the use of certain functions is concerned may be remedied by detecting of the causes thereof. One of the causes is the positioning and the color of the 3D objects that the user must observe in the 3D virtual space. GA also offers the opportunity to increase the usage time of a 3D application by keeping track of the initial time spent with the application as well as of its most frequently used areas. Therefore, the application may be personalized to focus more on each individual user's specific needs.

In the future we intend to generate more reports to reflect the application usage on a larger sample of active users. By detecting the interaction in our education application, automated tests may be generated when the user has completed more than 90% of the application, observing all the skeleton bones within a predefined time duration.

References

- [1] Nicola S, Virag I, Stoicu-Tivadar L, VR Medical Gamification for Training and Education, 11th Annual Conference on Health Informatics Meets eHealth (eHealth), Austria, May 2017.
- [2] Casarin J, Ladrech A, Tchilinguirian T, Bechmann D, A UMI3D-based Interactions Analytics System for XR Devices and Interaction Techniques, 2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), Japan, Mar. 2019.
- [3] Moran A, Gadepally V, Hubbell M, Kepner J, Improving Big Data Visual Analytics with Interactive Virtual Reality, 2015 IEEE High Performance Extreme Computing Conference (HPEC), Sept. 2015.
- [4] Nguyen H, Ward B, Engelke U, Thomas B, Bednarz T, Collaborative Data Analytics Using Virtual Reality, 2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), Japan, Mar. 2019.
- [5] Hoppenstedt B, Probst T, Reichert M, Schlee W, Kammerer K, Spiliopoulou M, Schobel J, Winter M, Felnhofner A, Kothgassner OD, Pryss R, Applicability of Immersive Analytics in Mixed Reality: Usability Study, IEEE Access 7 (2019), 71921 – 71932.
- [6] Clark D, Nicholas D, Jamali H, Evaluating information seeking and use in the changing virtual world: the emerging role of Google Analytics, Learn. Pub. 27(3) (2014), 185-194.
- [7] Luo H, Rocco S, Schaad C, Using Google Analytics to understand online learning: A case study of a graduate-level online course, 2015 International Conference of Educational Innovation through Technology (EITT), China, Oct. 2015.