Comparing the Workload of Joysticks and Buttons in a Virtual Reality Environment

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1 Introduction

The purpose of this study is to determine whether the perceived workload of users is influenced by the interaction technique. To do this, we will administer a task using 2 different input modalities. Our findings will contribute to the development of user-friendly multimodal interfaces in Virtual Reality environments.

This study will compare the NASA Task Load Index (NASA-TLX) [1, 2] for two different input methods in a Virtual Reality environment. The NASA Task Load Index is a standard way to measure the perceived workload of a technical solution. This is calculated by administering a questionnaire to capture the user's perspective on each solution's mental demand, physical demand, pace, success, difficulty, and distress.

In this paper, we will discuss related literature on how virtual reality interaction techniques can affect perceived workload. We will then describe the methodology, including participant selection, the materials used in this study, the data collection procedure, and the design of this experiment.

2 Related Works

Rupp et al. [4] compared the Xbox controller and the joystick using both the NASA Task Load Index and the system usability scale.

Neumann and Durlach [3] found that joysticks provided smoother users interaction and lower workload ratings in high-precisions taks, whereas button-based controls required more user attention and induced higher cognitive strain. Additionally, prior experience with gaming controllers significantly influenced performance, as seen in studies that examined familiarity effects on task efficiency [3].

Sandra G. Hart's research on NASA-TLX [1] provides an extensive insights on how workload is measured across different human-computer interactions, which also includes virtual reality environments. The NASA-TLX has been widely used across various fields. This includes aviation and remote vehicle operation, to asses mental and physical workload differences between interface design.

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This research builds upon previous findings by comparing the usability and workload impact of joystick-based and button-based interaction in a VR task, unlike prior studies which focused on 2D tasks. This study investigates VR navigation, where understanding perception and spatial reasoning may introduce new workload considerations.

3 Methodology

3.1 Participants

We will select a total of eight participants on a volunteer basis. To ensure ethical compliance and informed consent, all individuals will be at least 18 years of age at the time of enrollment. The participant pool will consist of individuals with varying degrees of prior experience using virtual reality (VR) technology. This diversity in experience will allow for a more encompassing assessment of user interaction experience.

3.2 Apparatus

Using Unity, we will develop software to deliver the virtual reality experience. The software will be composed of three separate scenes. Each scene contains the same objective conveyed to the users by text on screen. The users control a ball that they need to navigate a simple path into a box on the other side of the room. For hardware, a Meta Quest 3 will be used. This includes the Virtual Reality headset and controllers. The two controllers have a joystick and two buttons each. We will use a computer to mirror the virtual reality content so we can monitor user interaction and activity.

3.3 Procedure

The participants will be given instructions via text on screen to navigate three different scenes.

The first scene is the control where we measure the user's baseline in Virtual Reality. In this scene, the ball will move on its own into the box so the users can get a visual of the objective, and we can measure how they feel in Virtual Reality environments generally. This will help us filter out potential outliers that may have discomfort or disorientation in Virtual Reality independently of the interaction techniques.

In the second scene, the users will have access to the A, B, and X, Y buttons on the left and right controllers to move the ball. X and Y will control up and down, and the A and B buttons will control left and right. Similarly, in the third scene, the users will use the right and left joysticks to navigate the path and get the ball into the box.

After each of the three scenes, we will survey the user's experience with each of the tasks. To do this, we will administer a questionnaire to assess the NASA Task Load Index. This will measure user perspectives by comparing the mental demand, physical demand, pace, success, difficulty, and distress. Additionally, we will also measure the amount of time each task takes the user.

3.4 Design

The independent variable is the input method used to interact with the content. We chose to test two input methods for this, which were the usage of either the joysticks or buttons. The buttons represent 4 discrete movement choices to move the ball, whereas the joysticks allow for continuous 360-degree movement. The dependent variable is the perceived workload, as measured by the NASA Task Load Index. We will use the NASA Task Load Index measured after the first scene as our baseline control.

The total number of trials will be 24 (=8 participants x 3 input methods).

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