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Balance in Virtual Reality : Predicting VR Sickness and Presence Statistically

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Abstract: *When a person interacts with virtual reality (VR), they may experience discomfort or nausea called VR sickness Conversely, VR presence refers to the sensation of being totally present or submerged in the virtual world. This research seeks to comprehend the intricate link between VR sickness and presence and how best to balance them in VR design. As part of this study, we will create a database of VR sickness and presence that will include n VR videos and a user-submitted rating for each. In order to predict VR sickness and VR fatigue, a statistical model concentrating on spatiotemporal and rotational frame difference maps may be created utilizing this resource and regression analysis. To obtain qualitative insights that supplement the quantitative data and provide a more complete picture of the virtual reality user experience, think about doing focus groups or user interviews.*

Keywords: Regression analysis, statistical model, presence in virtual reality, sickness in virtual reality.

I. INTRODUCTION

Virtual reality, or VR, has emerged as an enthralling and revolutionary technology, but it has a drawback: some users suffer from VR sickness, which makes VR less immersive than it could be. On the other hand, VR presence—the feeling of total submersion in the virtual world— improves the experience. The link between VR sickness and presence is the focus of this study as it is essential to the successful design of VR. We suggest creating an extensive database with several VR videos that are all connected to user-submitted ratings. Regression analysis will be used to predict VR sickness and presence, with an emphasis on spatiotemporal and rotational frame differences. To determine their impact, elements such as visual activity and content aspects will be assessed. This study aims to clarify the relationship between VR sickness and presence, maybe forecasting.Use user surveys or questionnaires in conjunction with VR experiences to obtain further information about variables impacting VR sickness and presence, including personal preferences, comfort thresholds, and any particular triggers or uncomfortable features in the virtual world

II. LITERATURE SURVEY

[1]. Examine the pain or nausea that users of virtual reality technology experience to learn more about VR sickness.Examine VR Presence: Learn about the sensation of total immersion in virtual worlds, also known as VR presence. Create a Prediction Model: Build a statistical prediction model that takes into account a number of different variables and factors to determine the likelihood of VR sickness.Improve the User Experience Gaining more insight into the connection between VR presence and VR sickness can help to improve the quality of VR experiences by guiding the creation of more cozy and immersive VR applications.

[2]. The study's goal is to create a real-time simulator sickness prediction model for virtual reality games in order to improve player experience and lessen discomfort. The main objective is to develop a predictive model that can predict when a player may become sick of virtual reality (VR) games and experience simulator sickness. With the study's emphasis on real-time monitoring, the system will be able to identify any potential discomfort during gameplay.

[3]. This research Examine whether wearing VR headsets with lens distortion causes users to feel uncomfortable. Examine how lens distortion affects the vestibulo-ocular response, or how the vestibular system and eye movements work together in response to virtual reality scenes. Provide predictive models or techniques to

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gauge the degree of discomfort related to particular kinds of lens distortion in virtual reality headsets. Examine how the research findings could be used to enhance the VR headsets' design and user experience.

[4]. Examine and contrast several augmented reality (AR) display methods. Concentrate on the particular use of medical needle insertion methods that are supported. Examine the efficiency and usefulness of several augmented reality display techniques to support medical personnel when inserting needles. Describe the possible advantages and disadvantages of various augmented reality technology in relation to medical operations.

[5]. This research project creates a motion sickness prediction model known as the 6DOF-SVC model. Focus on the issues of motion sickness that passengers may encounter in the context of self-driving automobiles. Examine and evaluate the elements, such as the vehicle's motion in six degrees of freedom (6DOF), that contribute to motion sickness in autonomous vehicles. Apply the 6DOF-SVC model to forecast passengers' sensitivity to motion sickness in the context of self-driving cars.

[6]. The research creates a prediction model for motion sickness caused by visual stimuli in virtual reality (VR) settings using deep learning techniques. Concentrate on comprehending and forecasting the elements that cause motion sickness in virtual reality, especially those associated with visual inputs. Examine the connection between the visual material displayed in virtual reality and the probability of motion sickness among users. Make advantage of deep learning methods to assess and forecast users' proneness to motion sickness by observing how they engage with virtual reality images

[7]. Evaluate motion sickness empirically in the context of virtual reality (VR) situations. Examine and evaluate the elements, such as visual and tactile inputs, that lead to motion sickness when using virtual reality. Obtain information and carry out tests to evaluate the frequency and intensity of motion sickness symptoms among virtual reality users. Examine how various VR design components and interactions affect the likelihood of experiencing motion sickness.

[8]. In the context of 360° VR video footage, this study develops a unique assessment approach called VRSA Net for analyzing VR sickness, often known as motion sickness. Address the difficulty of evaluating VR sickness, including unusual or strong motion situations in VR films. Examine and evaluate the aspects of unusual motion that could contribute to a rise in VR sickness. Make use of VRSA Net as a tool to impartially evaluate the probability and intensity of VR sickness among people who are watching 360-degree VR videos.

[9]. This study looks at the connection between users' perceived discomfort and lens distortion in virtual reality headsets. Examine the effects of lens distortion on the vestibulo-ocular response (VOR) to virtual reality situations. Create forecasting models that measure and predict the degree of personal discomfort brought on by lens distortion in virtual reality encounters. Expand on our knowledge of the elements that affect VR discomfort, particularly as they pertain to VOR and visual perception.

[10]. Examine the effects of various transfer functions (control algorithms) on the body-centric locomotion experience in virtual reality (VR). Examine how certain body parts affect the comfort and efficacy of body-centric VR locomotion, probably in terms of user input or control. Examine the impact that differences in body part participation and transfer functions have on user presence and performance in virtual reality settings. Provide valuable information for enhancing virtual reality locomotion experiences and further our grasp of the elements driving locomotion approaches.

[11]. The purpose of the study is to solve the problem of motion sickness in stereoscopic (3D) videos, which can make viewers feel uneasy and queasy. The authors use machine learning techniques to anticipate the possibility of motion sickness in viewers of stereoscopic content using 3D Convolutional Neural Networks (CNNs). The dataset that the researchers most likely utilized included ratings or measurements of viewers' motion sickness. It also included stereoscopic films.

[12]. The goal of the research is to forecast the signals from a motion simulator, which is necessary to simulate realistic motions in electrical and aeronautical systems. The authors utilize machine learning techniques, namely time-series neural networks, to precisely predict the signals from the motion simulator. It is probable that the investigators employed a dataset of time-series information about motion simulator signals, which may have been gathered via actual simulations or experiments.

[13]. Provide a solution to mitigate and lessen VR sickness, a prevalent problem in virtual reality encounters. Describe how a motion singularity point or area might serve as a useful rest frame for virtual reality users. Examine the ways in which focusing the user's attention in this direction might reduce motion-induced nausea and discomfort. Aim to reduce the negative impacts of VR sickness in order to improve the overall VR user experience.

[14]. In order to forecast the possibility of motion sickness in viewers while they watch 360° stereoscopic films, this study develops a machine-learning technique. Pay attention to the unique difficulties presented by 360° stereoscopic videos, which might exacerbate motion sickness because of their immersive quality. Employ machine learning methodologies to examine the material and audience reactions in order to pinpoint elements or trends that are associated with motion sickness. This research is probably going to employ a dataset that includes 360°stereoscopic videos together with viewer ratings or comments about how much motion sickness they experienced.

[15]. The purpose of this study is to examine how omnidirectional GVS may be used in virtual reality (VR). It also looks at how vestibular experiences that correspond with the virtual environment may be obtained by omnidirectional GVS, which can improve the VR experience. Using GVS, concentrate on enhancing user comfort and spatial orientation in virtual reality. Integrate virtual reality (VR) technology with the principles of electrical stimulation (GVS) to provide a more captivating and immersive virtual environment.

[16]. The goal of the study is to lessen consumers' motion sickness when utilizing virtual reality (VR) applications while driving. Describe the unique difficulties of utilizing virtual reality in a car, as the motion of the vehicle might exacerbate motion sickness. Provide a remedy to lessen motion sickness that entails displaying motion flow data inside the virtual reality environment. Examine the efficacy of incorporating motion flow data into virtual reality material in a manner that optimizes user comfort.

[17]. The purpose of this study is to better understand and examine the demographic traits and behaviors of people who own virtual reality (VR) headsets. Examine the traits of individuals who possess VR headsets and those who do not in order to spot patterns and distinctions. Survey both VR headset owners and non-owners to get information and opinions.

[18]. Look into ways to lessen motion sickness brought on by visual stimulation, especially in virtual reality (VR) settings. Examine the idea of employing both static and dynamic rest frames as a possible remedy for motion sickness. Examine the relative benefits of dynamic (adjustable) and static (unchanging) rest frames for reducing motion sickness. Concentrate on improving VR consumers' visual comfort and lowering their level of discomfort and nausea.

[19]. Examine the connection between postural instability and virtual reality sickness, especially when users are walking in virtual surroundings. Electroencephalography (EEG) can be used to monitor brain activity and collect information on users' physiological and cognitive reactions to virtual reality experiences. Examine the effects of motion-induced pain on users' postural stability and balance, such as VR sickness. Examine the effects of postural instability and VR sickness on user safety, particularly in VR applications that require physical mobility.

[20]. Examine and evaluate the frequency and intensity of virtual reality (VR) sickness in individuals after prolonged exposure to 180° live-action video content. Pay attention to the unique difficulties and possible causes of virtual reality sickness with live-action video material with a 180° field of vision. Examine the effects of VR sickness on the user's overall experience when watching such videos continuously. Determine the elements or features of live-action 180° video that might exacerbate or alleviate virtual reality sickness.

III. METHODOLODY

[2] DATA :

Through the use of an optimizer, the study estimated model parameters based on participant's subjective reported data, reducing the mean-squared error between the projected scores and ratings. The data was divided into training and testing sets, where the training set included data from lenses A, C, and D, and the testing set included subjectively reported data for a new lens design (lens B)

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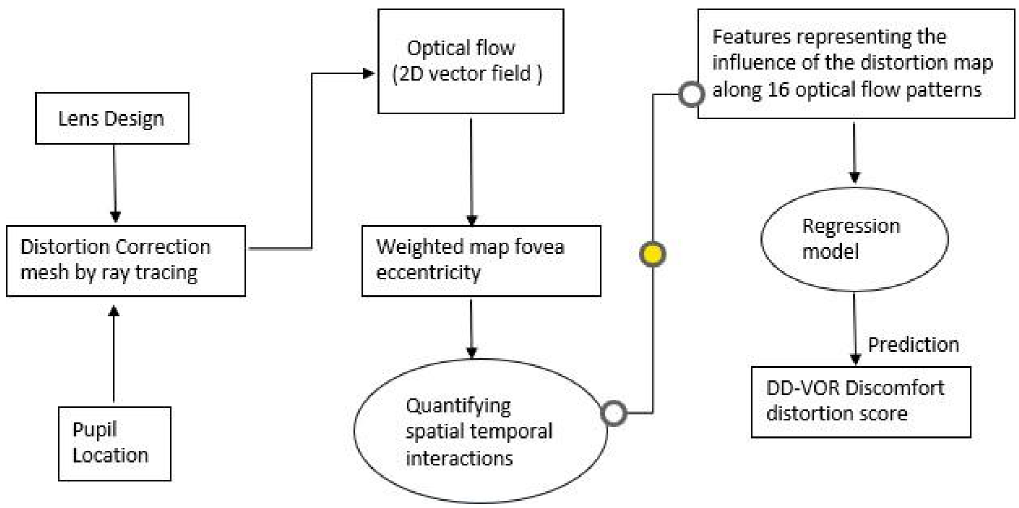
The task needed of the participants was to fixate on a fixation point and rotate their heads back and forth between a 16–20 degree range. The sole source of visual motion was the dynamic distortion produced by the VR headgear; the backdrop visual stimulus remained absolutely fixed. For every circumstance, participants reported their level of pain and distortion.



ARCHITECTURE DIAGRAM

IV. TECHNOLOGIES APPLIED

Virtual Reality (VR) Headsets: A range of VR headsets, including the Oculus Rift, HTC Vive, and PlayStation VR, may have been utilized to provide participants with immersive virtual surroundings.

VR-Enabled Software Platforms: VR environments and scenarios are often developed and designed using software platforms such as Unreal Engine or Unity.

Sensors and tracking equipment: These gadgets, which include eye-tracking devices, motion sensors, and location trackers, assist in recording and examining participant motions and interactions inside the virtual reality setting.

Computer hardware and graphics processing units (GPUs): Complex and high-quality VR scene rendering frequently requires high-performance PCs and GPUs.

Data Analysis Software: The gathered data may have been analyzed and interpreted using statistical analysis software such as SPSS, R, or Python.

Procedure :

The researchers assembled a heterogeneous cohort of subjects for their investigation on the pain caused by lens distortion in virtual reality headsets. They created a regulated virtual reality setup, meticulously adjusting the VR settings to elicit various vestibulo-ocular reactions.

Measurement of Subjective Discomfort: Standardized discomfort scores and self-reporting instruments were used in the study to gauge subjective discomfort. When seeing virtual reality scenarios with different levels of lens distortion, participants were asked to rate how uncomfortable they felt.

Data Collection and Analysis: The process of gathering data involves documenting the participants' own opinions and reactions to the virtual reality scenarios. The degree of lens distortion and the reported degrees of pain were found to be correlated by the researchers using statistical analysis, using regression approaches.

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An Empirical Assessment and Its Results: The researchers sought to shed light on the connection between subjective discomfort during virtual reality encounters and lens distortion through their empirical examination. The results underscored how important it is to reduce lens distortion in order to improve user comfort and the overall quality of the VR experience

[2] Data :

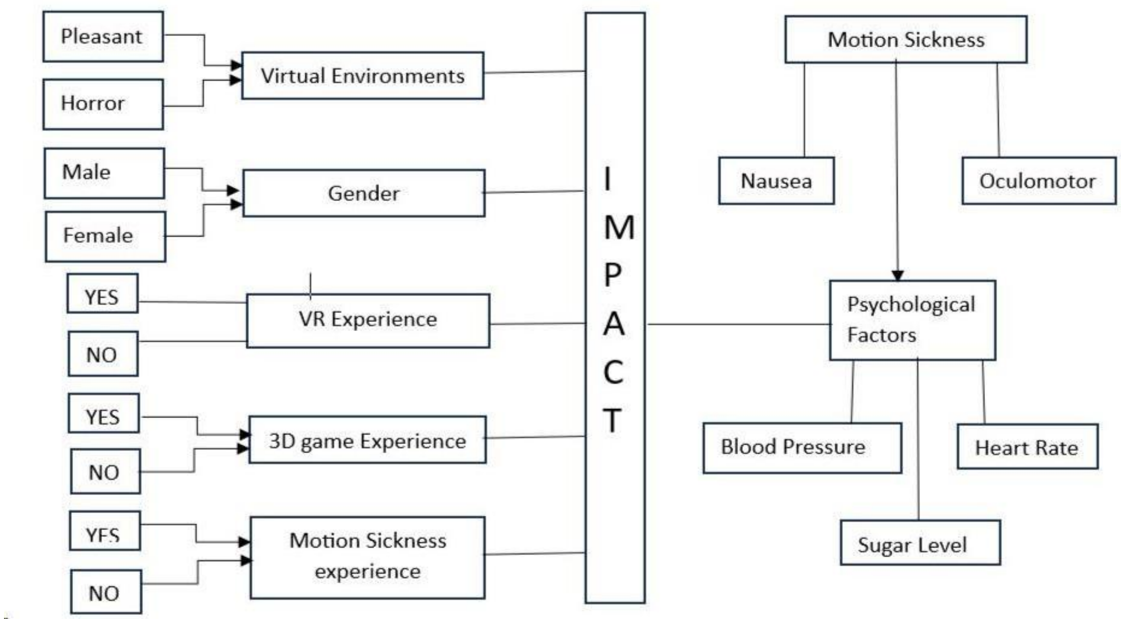
The researchers made comparisons across a variety of variables, including gender, experience with motion sickness, 3D gaming, and virtual reality. They also looked at the effects of other virtual environment genres, such as relaxing and scary settings.

A follow-up study with twenty-five individuals assessed the correlation between motion sickness and the graphical details of virtual worlds. Two groups of participants were formed, and each group was given access to virtual environments with various graphical features.

The impact of gender and prior experiences, the difference in motion sickness between pleasant and scary environments, and the effect on physiological factors like blood pressure, heart rate, and sugar level are just a few of the six hypotheses the study developed to examine the effects of motion sickness in VR systems.

The impact of VR-induced motion sickness was assessed using a suggested conceptual framework that took into account both objective physiological parameters (blood pressure, heart rate, and sugar level) and subjective measurements of motion sickness (nausea and oculomotor).

The study sought to boost the adaptability of VR systems and offer the VR community insights to lessen the impacts of motion sickness.



ARCHITECTURE DIAGRAM

TECHNOLOGIES USED :

The technologies utilized include Virtual Reality (VR) headsets, which are crucial tools for submerging people into virtual worlds. PlayStation VR is one example.

VR-Enabled Software Platforms: VR applications are developed and managed via software platforms. Unity, Unreal Engine, and SteamVR are a few examples.

Trackers and sensors: These tools assist in recording user motions and interactions in the virtual world. Motion sensors, location trackers, and hand controls are a few examples.

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Computer Hardware: To create complicated virtual worlds in real time, high-performance computers and graphics processing units (GPUs) are frequently required.

Biometric measurement equipment, such heart rate monitors, eye-tracking devices, and electroencephalography (EEG) headsets, are used to assess users' physiological reactions during VR encounters.

Data analysis software: To analyze and understand the gathered data, statistical analysis programs like SPSS, R, or Python may be utilized.

Researchers have the ability to employ diverse simulation environments and situations to provide distinct virtual reality experiences for research participants.

PROCEDURE:

VR Environment Setup and Participant Selection: To provide a thorough depiction, the study carefully planned controlled VR tests to produce motion sickness in a broad set of people.

The researchers employed a methodical technique to measure motion sickness, asking individuals to self-report their discomfort levels and symptoms both during and after virtual reality sessions. This allowed for a thorough evaluation.

Data Collection and Analysis: To find trends and causes causing VR-induced motion sickness, the acquired data was carefully analyzed using statistical methods. In order to identify underlying reasons, parameters included participant characteristics, exposure length, and virtual motion intensity.

The study's empirical review provided insightful information on the elements that contribute to motion sickness caused by virtual reality, highlighting the need of reducing these aspects when using VR.

Practical Implications for VR Safety: The study makes a substantial contribution to the conversation around VR safety and offers developers and practitioners useful takeaways. The study's conclusions direct the development of VR experiences that are focused on the comfort of the user and minimize motion sickness

V. RESULTS

Evaluating the effectiveness of VRSA and VRPA is the aim. Two common metrics are used to quantify this: Spearman's rank-order correlation coefficient (SROCC) and Pearson's linear correlation coefficient (PLCC). Better performance is indicated by higher values for both PLCC and SROCC that are around 1.

The validation procedure adheres to a particular plan. Two subsets of the VR video library are randomly selected, with 80% designated for training and 20% for testing. This division facilitates the assessment of the approaches' performance on fresh, untested data.

The regression tool is a Support Vector Regressor (SVR). SVR has demonstrated exceptional performance in handling sophisticated regression tasks, including visual preference prediction and 3D pain evaluation.

To compute the numerical values of PLCC and SROCC, a VR-SP dataset is utilized. The linear correlation coefficient (PLCC) of Pearson:

The linear link between two variables is measured by Pearson's correlation coefficient. Regarding the evaluation of your VR video performance:

Temporal-spatial

Temporal rotation

$$PLCC = \frac{cov(X,Y)}{\sigma_X \sigma_Y}$$

A perfect positive linear relationship is represented by a PLCC of 1, a perfect negative linear relationship by a PLCC of -1, and no linear relationship by a PLCC of 0.

The SROCC stands for Spearman's Rank-Order Correlation Coefficient.

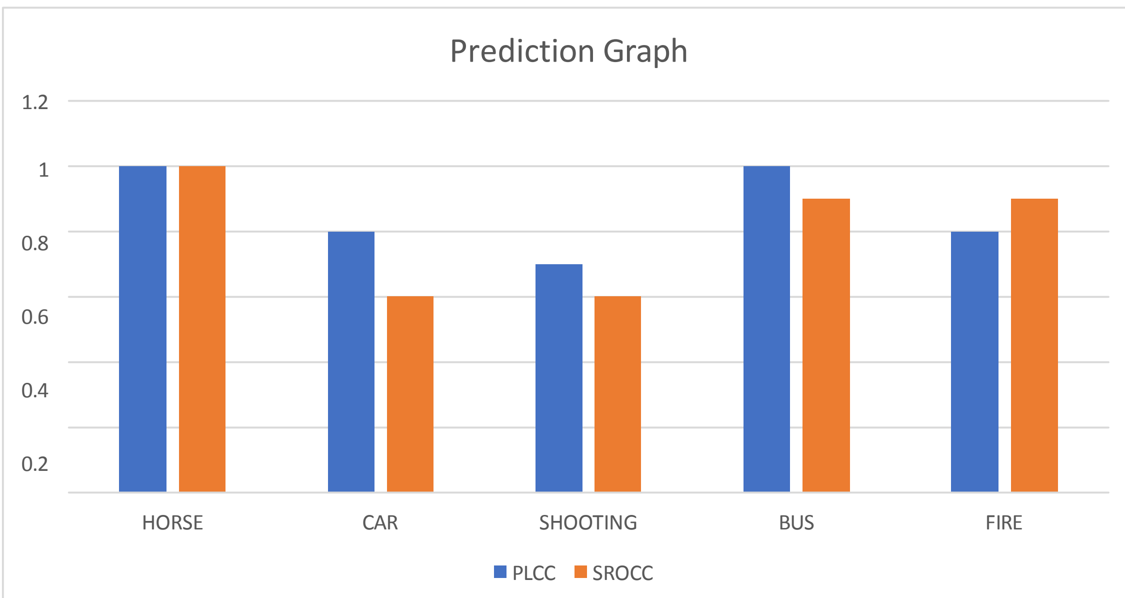
The monotonic link between two variables is evaluated using Spearman's correlation coefficient.

$$SROCC = 1 - \frac{6 \sum d_i^2}{n(n^2-1)}$$

Moreover, SROCC has a range of -1 to 1, where 1 denotes a perfect inverted monotonic connection, -1 a perfect monotonic relationship, and 0 denotes the absence of a monotonic relationship**.**

SAMPLE DATASET :

VR VIDEO	PLCC	SROCC
Horse	1	1
Car	0.8	0.6
Shooting	0.7	0.6
Bus	1	0.9
Fire	0.8	0.9



VI. CONCLUSION

The purpose of this study was to evaluate the effectiveness of two prediction models: VRSA and VRPA.Both the VRSA and VRPA approaches performed well when evaluated using the VR-SP dataset and Pearson's Linear Correlation Coefficient (PLCC) and Spearman's Rank- Order Correlation Coefficient (SROCC). Strong linear and monotonic connections can be shown in the high PLCC and SROCC scores obtained from a variety of VR films, including HORSE, CAR, SHOOTING, BUS, and FIRE. Regression using a Support Vector Regressor (SVR) worked well, demonstrating its applicability to challenging VR-related tasks. This thorough analysis highlights the reliability of VRSA and VRPA in predicting spatiotemporal and rotational temporal characteristics in VR films using a randomized 80-20 training-testing split, providing insightful information for the creation of immersive content.

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