Immersive Environment with Virtual Reality and Eyetracking in the Public Sector: Modernization of the TCE-GO Server onboarding and Training Process

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Abstract. *The combination of virtual reality (VR) and biofeedback technologies, such as eye tracking, offers new possibilities for measuring user presence and attentional focus in immersive environments. In the context of institutional training, this synergy proves particularly promising. This study presents a proposed VR-based onboarding and training platform for new employees of the Court of Accounts of the State of Goiás (TCE-GO), with a focus on visual attention measurement. By employing 3D modeling, integration with eye tracking technology, and data analysis through AI models, the project aims not only to familiarize new employees with the court's workflows but also to train technical skills and objectively assess their levels of engagement. The research is grounded in the Design Science Research (DSR) methodology, encompassing the design and development of the onboarding environment. Expected outcomes include increased efficiency and scalability in the training process, as well as a pioneering application of VR and biofeedback in employee training for Courts of Accounts.*

Keywords: *Virtual Reality, Eye Tracking, Employee Training, Public Sector*

1. Introduction

The integration of new government employees, particularly within organizationally complex institutions, constitutes a persistent challenge in the field of human resource management [Lamas et al. 2019]. Traditional onboarding and training practices—typically based on guided tours, document analysis, and face-to-face presentations—are often time-consuming, resource-intensive, and demonstrate limited efficacy in ensuring the assimilation of essential knowledge for initial job performance [**?**]. In institutions such as the Goiás State Court of Accounts (TCE-GO), characterized by a vast physical infrastructure and diverse operational workflows, this limitation becomes especially critical, directly

impacting the efficiency and productivity of newly appointed professionals, including outsourced and commissioned personnel.

In this context, Virtual Reality (VR) stands out as a promising technology capable of reshaping institutional onboarding processes by offering immersive, realistic, and secure environments. VR facilitates the simulation of real-world organizational scenarios, fostering experiential learning and enabling prior familiarization with physical spaces and institutional procedures before actual in-person engagement [Radianti et al. 2020]. The adoption of such technology is already evident in sectors like industry, healthcare, and public safety, with documented improvements in training efficacy, onboarding processes, and knowledge retention [Duchowski 2017].

The integration of biofeedback tools such as eye tracking enhances VR-based training by enabling objective measurement of user attention and engagement through metrics like fixations and saccades [Duchowski 2017]. These data support AI-driven personalization of learning and complement subjective evaluations [Clay et al. 2019]. This study proposes a VR onboarding platform for TCE-GO, based on the Design Science Research (DSR) framework [Hevner et al. 2004], incorporating 3D institutional models and AI attention analysis to improve training efficiency and reduce onboarding costs. .

2. Related Work

The application of Virtual Reality (VR) in professional training has been expanding, particularly in the industrial sector, with a focus on high-risk environments such as mining, occupational health, and workplace safety [Nasri 2025]. In these areas, VR enables realistic simulations that promote active learning without exposing users to real dangers. When combined with biofeedback data, such as heart rate, skin conductance, and eye tracking, the technology also allows for more precise assessments of participants' behavior [Ye 2024].

In Brazilian public institutions, consolidated examples are still scarce, although relevant cases are beginning to emerge. For instance, the Brazilian Federal Revenue Service developed an immersive environment to train agents in customs inspection operations, simulating scenarios involving smuggling and the identification of suspicious behavior [Receita Federal]. Similarly, the Rio Grande do Sul Civil Police used VR to simulate high-risk situations in police approaches, improving agents' reaction times and decision-making skills [Receita Federal].

Despite these initiatives, the systematic use of VR as a tool for institutional onboarding and administrative training remains underexplored. Thus, there is a gap to be filled regarding the application of VR in public institutions focused on management and oversight, such as courts of accounts and other entities of indirect public administration.

3. Theoretical Foundation

The sense of presence is essential for the effectiveness of training in Virtual Reality (VR), as immersive environments using head-mounted displays (HMDs) enhance the feeling of "being" within the virtual environment, thereby promoting greater user engagement. Studies have shown that a high sense of presence correlates with improved learning outcomes, particularly in tasks that require information retention and practical skill development [Clay et al. 2019]. For instance, [Grassini 2020] demonstrated that presence in

immersive virtual environments enhances memory performance and educational training outcomes, highlighting the importance of high-quality HMDs in maximizing immersion.

Complementary techniques such as biofeedback and eye tracking further enhance VR immersion and enable more accurate assessments of user experience. Biofeedback methods, including heart rate variability (HRV) and electrodermal activity (EDA), have been shown to foster self-regulation and reduce stress, with [**?**] demonstrating their effectiveness compared to conventional stress-reduction approaches. Eye tracking, using indicators like fixation duration and pupil diameter, offers insight into cognitive load and situational awareness [Nasri et al. 2024, Pastel]. However, challenges remain, including the need for constant recalibration due to HMD movement [Clay et al. 2019] and difficulty distinguishing between visual fatigue and mental effort, as pupil dilation can be influenced by both factors

4. Methods

Paradigm and Approach This research follows the Design Science Research (DSR) paradigm, which guides the development of technological tools aimed at solving real-world problems while contributing to new scientific knowledge [Hevner et al. 2004]. The nature of this study is applied and exploratory, with an emphasis on the creation and evaluation of an immersive training prototype, integrating biometric data collection and artificial intelligence models for public servants.

4.1. Problem Context

The training process for new public servants at the Court of Accounts of the State of Goiás (TCE-GO) includes, in its final phase, an in-person job rotation stage. In this phase, participants visit various departments of the institution to learn about workflows, routines, and the responsibilities of each organizational unit. At the end of each visit, the employee manually fills out an Individual Perception Report, recording their subjective impressions of the experience.

Although this model provides a broad overview of the organization, it has several significant limitations, including:

- Lack of standardization in the recorded perceptions, hindering comparative and quantitative analysis;
- Inability to measure actual engagement and attention of participants during visits;
- Difficulty in updating and replicating the process due to internal structural changes or administrative reorganizations

4.2. Solution Objective

To develop a virtual immersive training system, using Apple Vision Pro, focused on realistic simulation of institutional environments and the collection of objective visual engagement data through eye tracking, either replacing or complementing the current in-person job rotation model.

4.3. Design Science Research Stages

In the first stage, the current training process will be assessed, with emphasis on the in-person practices adopted by TCE-GO, especially the sector rotation model. The potential

limitations of the current perception reports will be analyzed to determine whether they lack standardization and objectivity in data collection.

The second stage will involve the technical mapping and planning of the solution, defining the departments to be virtually modeled, the metrics to be captured, the hardware devices, and the development tools. This phase will include the acquisition and study of the Apple Vision Head-Mounted Display (HMD) (Figure 1) and the possibilities offered by eye tracking, as well as the definition of parameters such as observation time, gaze focus, saccades, microsaccades, interaction, and the sequencing of simulated activities.

The third stage involves developing a VR prototype using Unity (2022.3.22f1) and Swift, emphasizing realistic interaction and environmental fidelity. The 3D modeling will cover key areas on the ground floor of the TCE-GO headquarters, such as the Atrium, Plenary Room, and HR Department, integrating interactive elements and documents. Apple Vision Pro will enable immersive navigation and precise visual data collection.

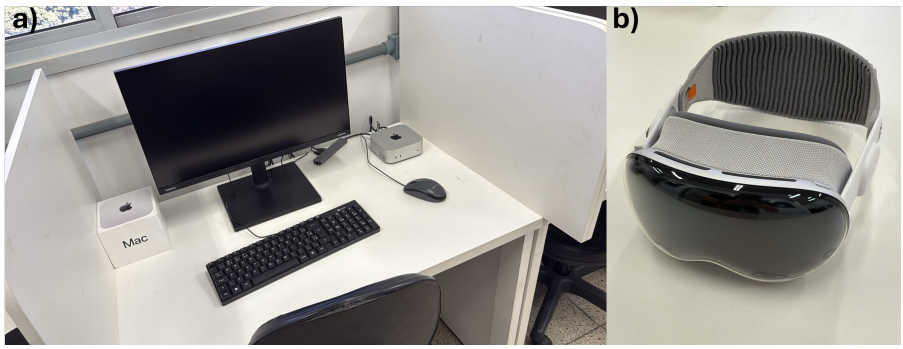

Figure 1. (a) Workstation setup with computer and peripherals. (b) Apple Vision Pro headset used for immersive VR interaction and eye tracking.

The fourth stage will involve demonstrating the prototype in experimental sessions with trainees. These tests will be conducted in a controlled environment, applying evaluation instruments such as the Igroup Presence Questionnaire (IPQ), the Immersion Scale, and the Technology Acceptance Model (TAM) to assess usability, perceived presence, and simulation effectiveness. During testing, real-time eye tracking metrics will also be collected to analyze participant engagement with each simulated environment.

The fifth stage will involve integrated analysis of qualitative and quantitative data, cross-referencing visual metrics and questionnaire responses to evaluate the prototype's performance. Among the variables considered will be simulation effectiveness, navigation clarity, the potential to replace or complement the current job rotation model, and improvement suggestions from participants. This stage will support technical and institutional adjustments, aiming for solution scalability within TCE-GO and possible replication in other courts or public institutions.

By combining immersive technologies, 3D modeling, and objective cognitive metrics, this approach aims to foster innovation in public training processes, with the potential to deliver more effective, standardized experiences aligned with the technological advances of contemporary public administration as demanded by society.

The results will be systematized and disseminated through scientific articles, tech-

nical presentations, and specialized events in virtual reality and public sector innovation, such as SVR (Symposium on Virtual and Augmented Reality).

4.4. Computational Methodology

This study leverages AI models previously trained on the VREED dataset [Tabbaa et al. 2021], which includes synchronized eye-tracking data collected during immersive 360° VR experiences. These models have shown strong potential in identifying emotional states and levels of presence based on users' visual attention.

In this phase, we aim to validate and refine these models by collecting new eye-tracking data using Apple Vision Pro devices during controlled VR experiments. The data will be preprocessed following the original pipeline and used to assess the performance of existing models.

Ultimately, this approach will support the analysis of attentional focus and presence in virtual onboarding experiences for government employees, offering data-driven insights through transparent and interpretable AI techniques such as SHAP.

5. preliminary results and discussion

The SHAP (SHapley Additive exPlanations) analysis revealed that eye-tracking data were the most relevant for predicting emotional states. Variables such as the variability of microsaccade peak velocity (SD-Microsac-Peak-Vel), the number of microsaccades (Num-of-Microsac), and the maximum saccade amplitude (Max-Saccade-Length) emerged as the most impactful features.

These findings suggest that oculomotor behavior, particularly microsaccades and voluntary saccades, is strongly associated with levels of attention and engagement, which are essential components in generating a strong sense of presence in virtual environments. For instance, microsaccades helped distinguish low arousal and negative valence states, while the amplitude of voluntary saccades was more useful in detecting high arousal and positive valence emotions.

Overall, the results confirm that eye-tracking is a dominant signal for modeling affective states in VR, offering objective insights into users cognitive and emotional states critical for real time adaptation of immersive environments using AI.

6. Conclusions and Future work

This study explores the use of eye-tracking technology as an effective means of evaluating user attention, presence, and cognitive engagement in immersive virtual training environments. By analyzing eye movement patterns, such as fixations, saccades, and microsaccades, it is possible to objectively assess user interaction and attentional focus, offering valuable insights for improving training quality, particularly in public sector onboarding scenarios.

The proposed system, implemented with Apple Vision Pro for enhanced realism and precision, will be tested in a virtual replica of the Plenary Room of the Court of Accounts of the State of Goiás (TCE-GO). Eye-tracking data will be analyzed alongside subjective presence measures, including the IPQ (Igroup Presence Questionnaire), to evaluate training effectiveness. The outcomes aim to inform the institutional adoption of immersive, evidence-based training strategies in public administration.

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