A new Framework for Gaining Emotional Health Knowledge Through Virtual Reality-IoT Technology

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Abstract: This work presents a new framework for studying the emotional and physical conditions of workers in Virtual Reality (VR) environments. The framework collects data from simulated virtual environments and helps develop adaptable models for different contexts. It introduces an architecture based on immersion in virtual reality (IVR), focusing on sensory perception, natural actions, narrative engagement, and social features. The author proposes categories to assess the impact of each concept on IVR applications, supported by an artificial intelligence module for data analysis and feedback. The framework also enables the collection of physiological parameters using VR glasses with storage and processing capacity. This facilitates control, performance, and integration with IoT contexts. The primary objective is to identify behavioral patterns for decision-making and employee emotional health management.

Keywords: Knowledge management, Artificial intelligence, Emotional intelligence,Virtual reality,Information management, IoT technology

1. Introduction

The discipline of knowledge management has gained prominence worldwide in recent years. Focused on the business area, it addresses technical concepts about the processes that govern the creation, dissemination, and use of knowledge to meet organizational objectives (Zyngier, S. (2011)). In principle, most organizations face numerous challenges, which limit the efficiency of a knowledge management system, to name a few:

- Not using a significant amount of structured data.
- High complexity of analysis and organization of these data.
- The lack of technological systems capable of extracting and distributing useful information from unstructured content.

Thus, emerging technologies, such as *artificial intelligence*, play an important role in the protection and management of information, breaking down the obstacles that prevent the use of knowledge originating internally in organizations (An, X. and Wang, W. (2010); Albena, A, and Elissaveta, G. (2006).

The human factor is the fundamental slabon in the knowledge management chain and in recent years companies have highly valued their emotional health. Computational emotional intelligence (Sherer, K. R. (2005)) will be useful in all areas of human collaboration with AI, including entertainment, medicine, social work, education, and more. Modern intelligent agents, however, are below the human level in their ability to decide how to behave socially appropriately in a given situation involving others, how to respond to human emotions, or how to guide the climate of interaction with a partner. In order to bridge this gap between natural intelligence and AI, many attempts have been made in recent decades (de Melo, C. M. et al, 2013) to develop a universal approach. Still, a general model of human-compatible socially emotional behavior is needed to guide the design of intelligent agents. Currently, there are two main approaches used in the development of such models. One of them – statistical – relies primarily on deep learning in popular neural network models (e.g., Balan, O. (2019)) and requires large volumes of data annotated for training that are not normally available for high-level real-life moral and ethical decision-making. Therefore, this approach is primarily used for the recognition and expression of emotions (e.g., Reed, R. et al(2019)), rather than for the implementation of emotional intelligence itself.

The use of a virtual reality (VR) test may be a future solution to accurately and sensitively measure emotion regulation in experimental behavioral paradigms with social situations. Virtual reality tasks allow the simulation of naturalistic, multimodal, and complex cognitive challenges that are like real-life situations, maintaining a controlled environment and minimizing confounding variables (Nurn-berger et al., 2011).

VR simulations create a digital psychological sense of being immersed in a synthetic computer-generated virtual world as if it were a real-life place. This evokes a feeling of "being there," or as Witmer and Singer (1998) have defined it, a "sense of presence." As such, these unique immersive characteristics can increase students' affective arousal and boost their cognitive processing (Guan, Wang, Chen, Jin & Hwang, 2021; Parong & Mayer, 2021). Building on VR as a highly emotional and cognitively stimulating learning environment. With the increasing accessibility and representational fidelity of IVR technology, the number of researchers investigating the educational possibilities of IVR technology is increasing dramatically (From, J. et al (2020); Dubovi, I.,(2022)). Armourgun, A. et al (2019) analyze the effect of the cognitive load of train travelers in real-life situations by taking the VR model. Freeman, D. et al, (2019) conduct a review on the potential of VR technology for mental health. Yen, H. E and Chiu, H.-L. (2019) explore the effectiveness of VR exercises in improving cognition in older adults and improving depressive outcomes through a systematic review, meta-analysis, subgroup analysis, and meta-regression. Tawil, N. et al (2021) explore solutions for assessing psychological well-being and mental health in response to interiors presented in virtual reality. Despite the increased interest of researchers in the development of the study of mental health, there are still solutions that can be optimized and challenges to be solved.

Even the knowledge of the authors of this study was not found in the literature, a proposal that considers a management system that allows knowing all levels of detail of the structure of an organization in the area of emotional health or emotional intelligence. The purpose of this work is to create a framework that helps companies identify and manage information associated with emotional health using the integration of virtual reality immersion technologies and artificial intelligence.

2. Methodology

We discuss a new methodology to create a framework that assists in the management of information about the user subjected to a process of emotional analysis. The study was segmented into four areas based on the literature (Won, M et al (2023); Dede(2009)). Figure 1 represents the integration of the active and passive modules that make up the method infrastructure. The following are described as their functions.

The external *social feature* is classified as an active function in relation to the execution models of the proposed framework. The authors highlight a different function to the methods presented in other works (Won, M et al (2023)). Considering the function as a source of acquisition and knowledge management of our method. In this process, three important characteristics were highlighted:

- *Building an emotional questionnaire* is the basic pillar in emotional assessment through questions validated by protocols, instruments, and solid organizations in the area of emotional health studies (Watson, D. et al(1988)). These questionnaires are selected by health professionals for the purpose strongly related to the objectives of using our solution, an example, to help detect possible cases of depression and stress.
- The *Development of interaction environments* aims to construct virtual reality (VR) environments. These environments are created using the concepts discussed in the previous process. Each question of the questionnaire is associated with a virtual location, allowing for the identification and evaluation of emotions.
- *VR/IoT information collection planning*, the data collection process involves gathering information from the questionnaire and capturing all interactions within the virtual reality environment. Additionally, hardware devices are utilized to collect external data, including heartbeats, that are not directly part of the VR environment.

Narrative has two processes:

- *Gamification the* initial step aims to enhance the overall execution of subsequent processes by creating a more enjoyable and engaging experience. Its purpose is to motivate users to participate in all tests and interactions presented in the VR environment and questionnaires, ensuring a smoother and more seamless engagement.
- The *Elaboration of scripts* is aligned with *Gamification* to create a user-friendly VR environment that enhances the overall experience. Regarding the Sensory/Actional/Inner social feature, once the previous steps have been executed, information from the internal VR and physiological environment is collected using IoT devices.

- *VR/IoT information collection*, enables the system to collect the data through the questionnaire carried out in the virtual environment (Tawil, N. et al (2021)) and through the integration of hardware devices are obtained the associated physiological parameters HVR (Morales, J. M. et al (2020)).

The *AI Model* analyzes the collected data and performs various functions during this stage. These functions include data processing to prepare and format the data according to the required standard for the next phase. Additionally, the data is classified based on a pre-trained pattern using machine learning (ML) techniques. Finally, the data is specifically studied to identify any divergent or unique results that may need to be communicated to the registered models within the AI Model. This phase emphasizes the continuous updating of information and transforms the system into an evolving model of knowledge.

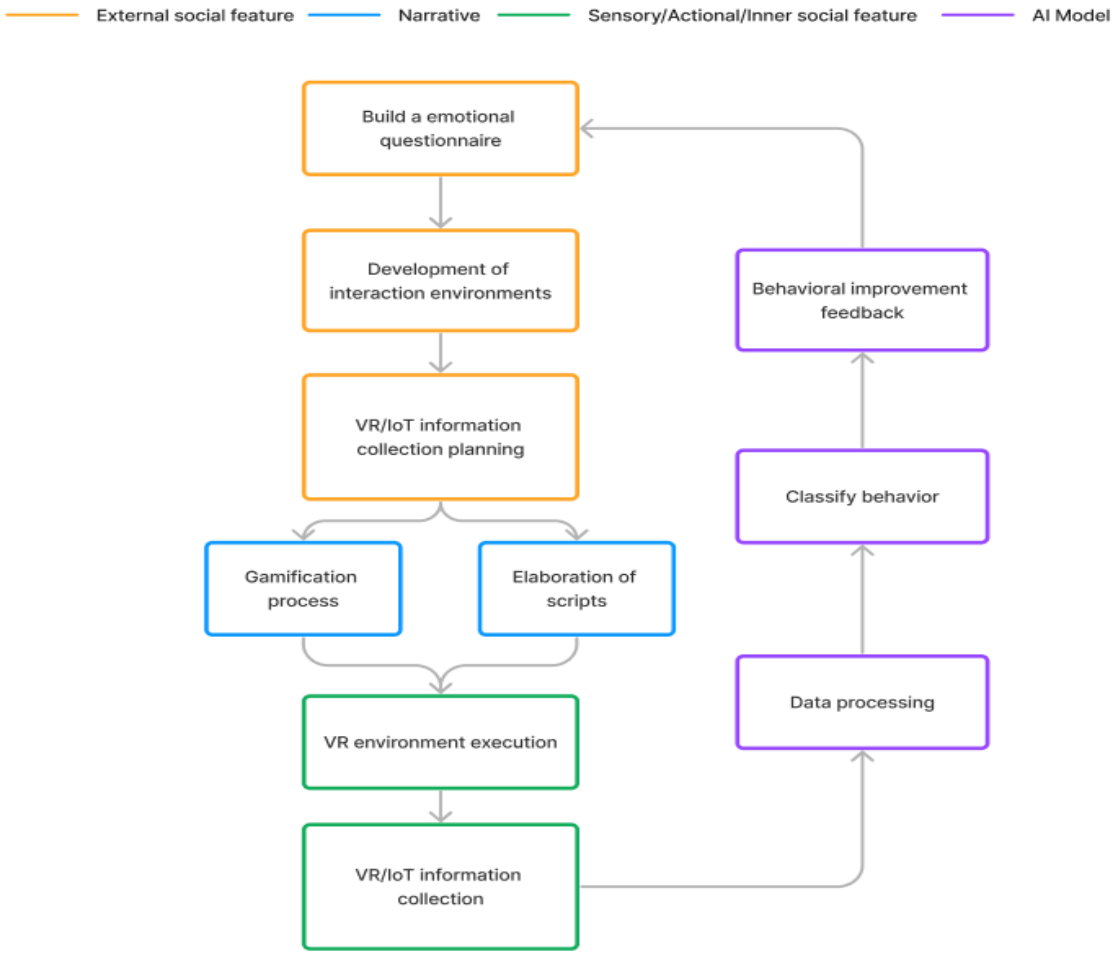

Figure 1: Operational Functions of the Information Technology Model

The *External social feature* consists of three processes, starting with the creation of an emotional questionnaire. This involves using validated emotional assessment questions from reputable instruments and organizations specializing in emotional health studies. Healthcare professionals carefully select these questionnaires to support our solution's objectives, such as detecting potential cases of depression.

The *development of interaction environments* aims to create immersive virtual reality (VR) environments that align with the selected questions from the previous process. For example, if there are ten questions in a questionnaire aimed at assessing depression, an environment is constructed for each question with the specific objective of capturing the essence required by the instrument. This ensures that the VR environments effectively meet the intended purpose.

VR/IoT information collection planning collects the data related to the questionnaire being applied as well as all the interactions with the applied virtual reality environment. In addition, hardware is used to collect data external to the VR environment, such as heart rate.

The narrative has two processes, *Gamification* is the first of them, with the purpose of making the execution of all other processes lighter and more fun as far as possible, motivating the user to perform all the tests and interactions proposed in the VR environment and with the questionnaires in a more fluid way. It follows the process of *Elaboration of scripts*, which aligned with Gamification produces a user-friendly VR environment to be observed.

Sensory/Actional/Inner social feature, with the execution of the previous processes we run the VR environment and collect all information from the internal VR and external IoT environment. The data is processed in the *AI Model*, where we process the data collected in the previous steps and classify the information according to the instruments adopted.

Our framework operates cyclically, meaning that if the results are not deemed acceptable in the initial cycle, we continue to iterate until the solution becomes suitable and aligned with the health instrument being utilized, as well as the aspects of virtual reality (VR) and the Internet of Things (IoT) in the interactive process. This iterative approach allows for continuous improvement and ensures that the framework evolves to meet the desired standards and objectives.

3. Results

Our work aims to achieve a comprehensive framework that facilitates the identification of emotions through the use of standardized emotional health tools. Figure 2 visually depicts the relationship between the operational model and the user. Each component of the framework serves two primary functions: enabling immersive experiences within a virtual reality (VR) environment and gathering physiological parameters through the Internet of Things (IoT). The results of our efforts culminate in a well-defined structure that enhances emotion identification processes.

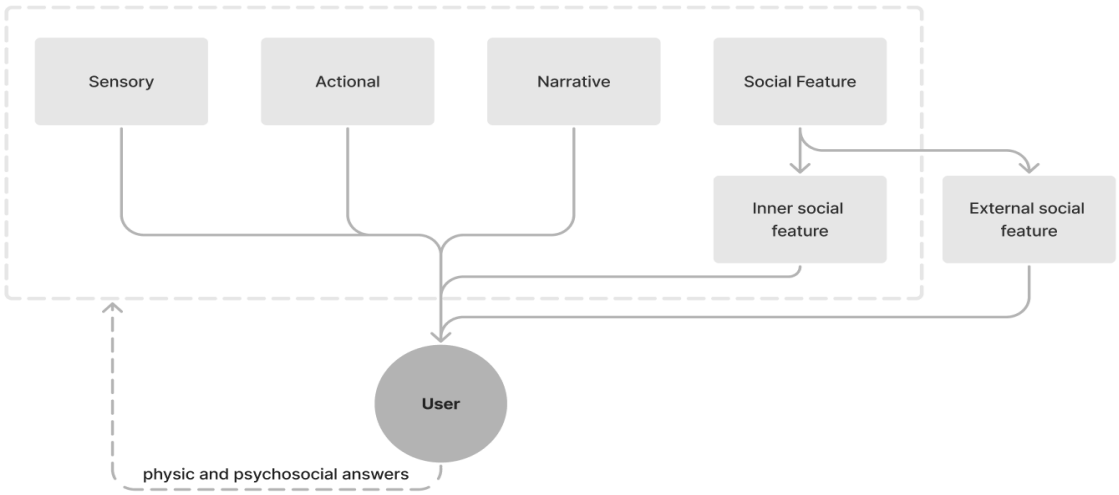

Figure 2: Diagram of the Interaction Between the *Framework and the User*

Immersion in the VR environment

During the immersion process, we begin by utilizing standard questionnaire models recommended by the literature. The user's responses to each scenario are then compared to predefined outcomes facilitated by the AI Model. The Sensory, Actional, and Narrative blocks collaborate with the Inner Social Feature, forming part of the Social Feature layer. This allows for periodic updates to the Social Feature, emphasizing its dynamic nature as the system evolves. The External Social Feature serves as a temporary validation mechanism for the generated information, emphasizing the model's robustness as a fundamental aspect. Consequently, it acquires sufficient data to directly engage with the user and enhance their social well-being.

IoT Technology

In Figure 3, an IoT technology was *designed,* being an extension of the *framework* to monitor the physiological parameters of *HVR.* As the figure shows, the data travels in one direction and is integrated into the overall system solution. The architecture helps to perform measurements through sensors that are connected to a processor to determine the values associated with stress and relaxation before an activity and finally the data is transferred

to a platform that will archive and analyze the data. The correlation of physiological and psychosocial data helps in the identification of the emotional state with greater precision.

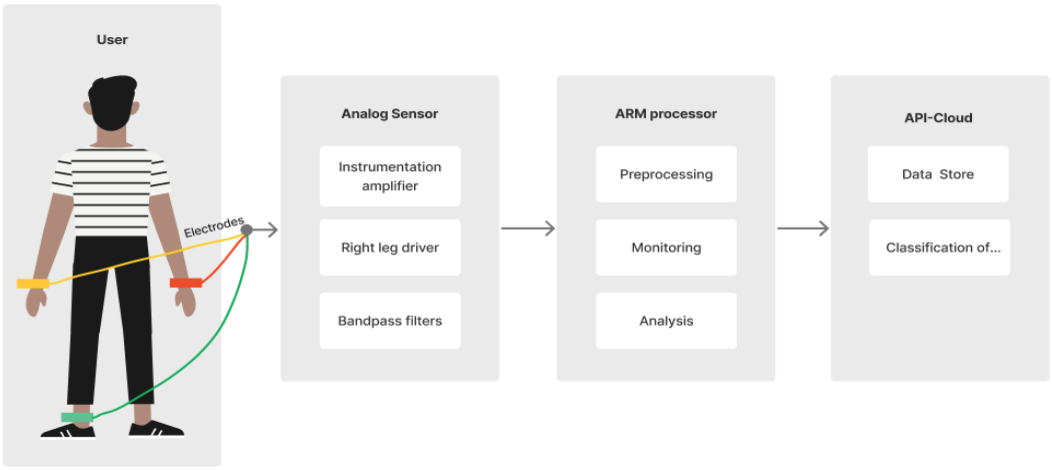

Figure 3: Representation of the IoT Diagram in the Collection of Physiological Parameters

The techniques employed synergistically contribute to the development of a comprehensive solution that encompasses a multidisciplinary evaluation of employees. A manager in a company or industry requires insights into the emotional well-being of their workforce to facilitate effective administrative supervision. Hence, our framework provides a means to acquire knowledge about various emotional aspects of employees, thereby enabling informed decision-making.

4. Conclusion

Our study introduces an innovative and comprehensive framework designed to develop virtual reality environments that assess emotional health characteristics. By combining advanced technologies, including medical instruments and IoT equipment, our framework offers a diverse range of tools to evaluate both external and internal aspects of emotional well-being.

The utilization of interactive virtual environments provides several advantages over traditional methods of assessing emotional health. Through immersive experiences, patients can engage with scenarios that elicit specific emotions, replicating situations relevant to their emotional challenges. This exposure allows patients to confront and address difficult circumstances within safe and controlled settings, offering a unique therapeutic approach for emotional disorders.

The integration of IoT equipment with virtual environments brings further benefits by enabling real-time monitoring of physical and emotional data. Wearable sensors, for instance, can track a patient's heart rate and brain activity during therapy sessions, granting healthcare professionals a comprehensive understanding of the patient's emotional state.

Moreover, our framework can be tailored to individual patients, accommodating their specific needs. Virtual environments can be customized to align with their emotional requirements, providing a personalized therapeutic experience that promotes more effective treatment.

Furthermore, our solution can contribute to the development of knowledge regarding the mental health aspects of employees in industries or companies. This empowers managers with insights to make informed decisions aimed at preserving and preventing issues related to the emotional well-being of their workforce.

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