Metachron: A framework for time perception research in VR

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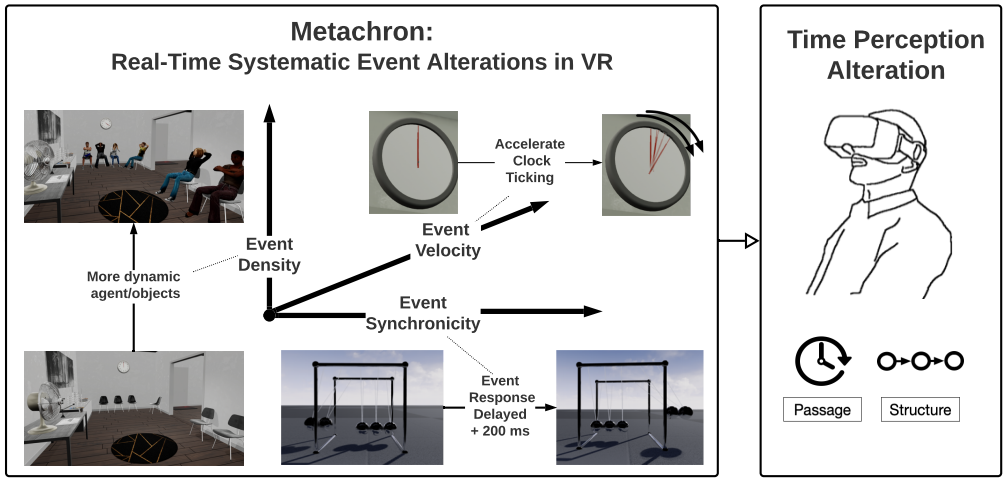

Figure 1: Metachron Framework Principles.

ABSTRACT

The perception of time is closely related to our well-being. Psychopathological conditions such as depression, schizophrenia and autism are often linked to a disturbed sense of time. In this paper we present a novel framework called *Metachron*, which is intended to support research in the field of time perception and manipulation in Virtual Reality (VR). Our system allows the systematic modification of events in real time along the three main event axes i) *Velocity*, ii) *Syncronicity* and iii) *Density*. Our future work will investigate the influence of each dimension on the passage of time (varying velocity of time flow) and the structure of time (varying synchronicity of events), which should provide insights for the design of VR diagnostic and therapeutic tools.

CCS CONCEPTS

• **XR applications**; • **Multi-disciplinary research projects involving innovative use of XR**;

KEYWORDS

time perception manipulation, virtual reality, therapy, framework

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1 INTRODUCTION

The sense of time is an important aspect as well as an indicator of our well-being. Psycho-pathological conditions such as depression, schizophrenia and autism are often accompanied by a disturbed sense of time, which can manifest itself in a slowing down or acceleration of the experienced passage of time [5]. A disturbance in the structure of time is reflected in asynchronisms and temporal disorders [6]. Persons affected by such disturbances are severely handicapped since the feeling of time contributes to our well-being [3, 8, 15]. Although these psycho-pathological conditions can be detected, therapies targeting a distorted perception of time are difficult to realize. In the meantime, the ability to actually change and control the perception of time in VR in a consistent and accurate manner is still an important question that needs to be answered.

In this paper we propose a framework built on top of a game engine and allows a systematic manipulation of the event flow in VR. These manipulations can be performed in real-time to further investigate their effects on the passage and structure of time. As described in the following sections, the current version of the framework allows the modification of events (i.e. state changes) in terms of three orthogonal dimensions: i) *Velocity*, ii) *Synchronicity* and iii) *Density*. Our main objective is to know how we can systematically influence the time perceived in VR, either its passage or its structure. This is a fundamental preparatory work for the development of a therapeutic VR application that might be able to correct psycho-pathological distortions of time.

2 RELATED WORK

For specific psychological disorders, e.g. specific anxieties or post-traumatic stress disorders, virtual reality (VR) seems to be a promising therapeutic tool [1, 9, 11]. Typically, VR environments tend to have a distracting capacity. They usually trigger an elapsed time compression effect, whereby the perceived amount of time spent in VR is less than the actual elapsed time. For instance, this effect was reported by Schneider et al. [13]. They observed that being immersed in a VR simulation (deep sea diving, walking through an art museum or solving a mystery) can make chemotherapy treatment appear up to 10 minutes faster. In addition, a *Time Travel* illusion can be created in VR by allowing user to relive and modify previous situations [4, 10].

However, there has been a limited amount of research on the possible impact of VR on the perception of time and its manipulation. One recent study in an immersive VR scene showed an interesting effect where the absence of continuous sun movement led to significantly longer estimates of time spent in VR, but only when participants were not given a distracting cognitive task [12]. Van der Ham et al.[14] measured no significant difference in the estimation of time duration when letting people watch video clips in VR and in the physical world. Bruder and Steinicke [2] also observed no significant difference in time distortion when walking in VR. More recently, Lugrin et al. [7] found a significant difference in retrospective time duration estimates of a waiting task between a real room and a virtual room. They manipulated the visual quality of a virtual room replicating a real one (360°-picture vs. 3D-model) and with and without avatar embodiment (no-avatar vs. avatar). Without an avatar, the participants estimated the waiting time to be longer, but paradoxically closer to the actually measured time. Therefore, the presence of an avatar in VR is suggested in order not to significantly disturb the perception of time and to develop reliable diagnostic and therapeutic tools.

3 SYSTEM OVERVIEW

The framework was implemented for the Unreal Engine 4 (UE4)®, a high-end game engine for video game creation. The Figure 2 shows the core architecture and the content of the libraries. Time influencers (zeitgebers) support the manipulation of states in the event modification domains velocity, density and synchronicity. The influencers can be placed in various environments to meet different experimental needs. The framework is designed to automatically collect the available time influencers in the loaded scene and make them available for modifications before and during the simulation. With Metachron it is for example possible to set up a waiting room scene containing several zeitgebers that are manipulated in different dimensions. More or less agents, an accelerated wall clock, a slowed down fan movement and an accelerated sun movement (Figure 3) can create a scenario which is rich in perceptible distractions and possible influences on the users' perception of time. For example, if the state changes from synchronicity to asynchronicity, a reaction to a physical impact event can be delayed. See for example Figure 1. We ask ourselves how these modifications influence time perception and whether the interplay between the different modifiable dimensions is important for further investigation.

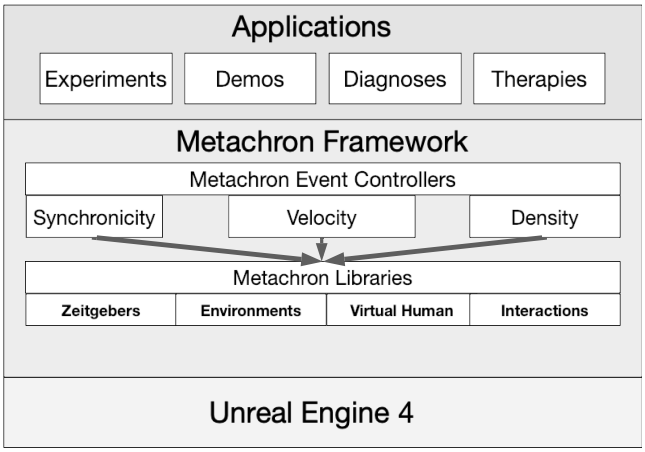

Figure 2: System architecture overview.

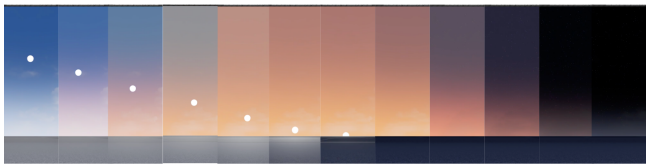

Figure 3: A change of the velocity state of the sun will lead to an increased or decreased sun movement.

4 CONCLUSION

We presented a high-level tool that will help researchers to create VR experiments that focus on time perception and manipulation. The goal of the Metachron framework is to find important time-affecting event modifications and their interaction in order to enable the manipulation of time perception in VR. Future work will focus on the evaluation of the usability, performance and further development of time-related manipulation features. In addition, further experiments will be developed to investigate whether these factors also influence psycho-pathological states and thus reveal a potential for designing useful applications for diagnosis and therapy.

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