Prototyping A Digital Zen Garden

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Abstract. Since the start of the COVID-19 pandemic, the severity and prevalence of symptoms of psychological distress, fatigue, brain fog, and other conditions have increased considerably, including among people who have not been infected with SARS-CoV-2. Many studies summarize the effect of the pandemic on the availability of mental health services and how this has changed during the pandemic. Concerned that potential increases in mental health conditions, had already prompted 90% of countries surveyed to include mental health and psychosocial support in their post COVID-19 response plans, but major gaps and concerns remain. In this paper we developed a de-stress proposal through a digital zen garden by using an augmented reality sandbox. The system provides patients with flexible interaction and easy control of the scenario, while making real time data recording. An objective evaluation method is proposed to review the effectiveness of the therapy. According to the evaluation results of patients' training, the system is a low cost entertainment tool that augments patients' motivation, and helps to increase the effectiveness of therapy.

Keywords: COVID-19, Mental Health, Cognitive Disorders, Virtual Reality, Augmented Reality.

1 Introduction

In terms of pathophysiology, a closely related coronavirus (SARS-CoV) is reported to be neurotoxic and affect mental health. Furthermore, among the survivors of SARS infection, patients were reported to have persistent elevated stress, and over 64% of the survivors are reported to have a combination of stress, anxiety, and depression [1].

Only in the first year of the COVID-19 pandemic, global prevalence of anxiety and depression increased by a massive 25%, according to a scientific brief released by the World Health Organization (WHO). WHO Director-General, said that the information gathered about the impact of COVID-19 on the world's mental health is just the tip of an iceberg. As a consequence, this is a wake-up call to all countries to pay more attention to mental health and do a better job

of supporting their populations' mental health. One major explanation for the increase is the unprecedented stress caused by the social isolation resulting from the pandemic. Linked to this were constraints on people's ability to work, seek support from loved ones and engage in their communities. Loneliness, fear of infection, suffering and death for oneself and for loved ones, grief after bereavement and financial worries have also all been cited as stressors leading to anxiety and depression [2]. Among health workers, exhaustion has been a major trigger for suicidal thinking [3].

Some studies show that the pandemic has affected the mental health of young people and that they are disproportionally at risk of suicidal and self-harming behaviours. It also indicates that women have been more severely impacted than men and that people with pre-existing physical health conditions, such as asthma, cancer and heart disease, were more likely to develop symptoms of mental disorders [4].

Data suggests that people with pre-existing mental disorders do not appear to be disproportionately vulnerable to COVID-19 infection. Yet, when these people do become infected, they are more likely to suffer hospitalization, severe illness and death compared with people without mental disorders. People with more severe mental disorders, such as psychoses, and young people with mental disorders, are particularly at risk [5].

While the pandemic has generated interest in and concern for mental health, it has also revealed historical under-investment in mental health services. Countries must act urgently to ensure that mental health support is available to all. In this sense, there is an urgent need for tools to address diseases such as stress, anxiety, among others.

The aim of this paper is to propose a de-stress therapeutic tool by approximating the ancient method of Japanese Zen Garden through Augmented Reality (AR).

Section 2 gives a brief overview of Japanese Zen Garden. Section 3 describes the proposed Augmented Reality Sandbox Architecture System. Section 4 details the evaluation method to review the effectiveness of the therapy. Section 5 provides a small discussion and future guidelines.

2 Japanese Zen Garden

Japanese gardens create their own styles and one of the most famous are the so-called Zen gardens that seek to go beyond and create a place conducive to meditation and contemplation (See Figure 1).

The japanese zen garden creates a miniature stylized landscape through carefully composed arrangements of rocks, water features, moss, pruned trees and bushes, and uses gravel or sand that is raked to represent ripples in water. Zen gardens are commonly found at temples or monasteries. A zen garden is usually relatively small, surrounded by a wall or buildings, and is usually meant to be seen while seated from a single viewpoint outside the garden, such as the porch of the hojo, the residence of the chief monk of the temple or monastery. Many,

with gravel rather than grass, are only stepped into for maintenance. Classical zen gardens were created at temples of Zen Buddhism in Kyoto during the Muromachi period. They were intended to imitate the essence of nature, not its actual appearance, and to serve as an aid for meditation [6].

It is important to understand that the word zen means meditation. Monks used zen garden as an ideal place for meditation. They are areas that transmit tranquility, inner serenity and reduce stress through their beauty [7].

Sand represents the vastness of the ocean and rocks represent the mountains. One of the many benefits of zen gardens is to de-stress their owners by playing with the rake, creating shapes in the sand. We can give movement to our garden, for example by creating designs with "stacked stones" which signify stability.

Zen gardens bring us serenity and relaxation; they stimulate creativity and the best thing is that we do not need a large space to create one, we can assemble them in any corner of our home or office.

Fig. 1: Japanese Zen Garden.

3 Augmented Reality Sandbox

When referring to an augmented reality environment it talks about any real-world environment with elements augmented or supplemented by computer-generated input [8].

Since their conception in 2012 [9, 10], the AR sandbox system is used to teach geographical, geological, and hydrological concepts such as how to read topographic maps, the meaning of contour lines, watersheds, catchment areas, levees, etc. It is a tool that combines 3-dimensional visualization applications with a hands-on sandbox. Users can create topography models by shaping real sand, which is then augmented in real time by an elevation color map, topographic contour lines, and simulated water flow.

However, in many cases AR sandbox can be seen as a form of non-verbal therapeutic intervention [11–13]. Patients (often, children) can use sand to portray their experiences that they cannot express verbally. Moreover, many psychologists leverage this tool to treat psychic disorders due to its proven efficiency.

Given this background it would be interesting to evaluate how an AR sandbox can contribute to reducing stress resulting from everyday life problems and the well-known Covid-19 pandemic.

3.1 System Description

As mentioned in section 2, sand represents the vastness of the ocean and rocks represent the mountains. One of the many benefits of zen gardens is to de-stress their owners by playing with the rake, creating shapes in the sand. In relation to this, the sand in our sandbox is initially flattened and unrelieved, and the user has a set of tools such as trowel, rake and ruler. Using these tools, the user can perform different actions such as:

- to create indentations or mountains by the trowel,
- to create ripples that can represent water by the rake, and clean up and redraw them by a ruler,
- to clean and redraw the relief until the desired relief is achieved by a ruler.

It is expected that the user can visualize an analyze the projected textures in each sandbox section so they can determine and materialize the landscape appearance by means of the tools based on their observation.

3.2 Architecture System

Our AR sandbox prototype system comprises the following hardware components:

- A computer with a high-end graphics card, running Linux.
- A Microsoft Kinect 3D camera.
- A digital video short-throw projector with a digital video interface, such as HDMI or DVI.
- A mirror.
- A sandbox with a way to mount the Kinect camera, the mirror and the projector above the sandbox.
- Sand.

The architecture was designed for a medium sandbox of 120x100cm. These measurements determined that the depth sensor is suspended 2.2m above the sandbox. Having a regular projector, the ideal projection aperture is projecting to a screen located at a distance of more than 3 meters, that is, the projector position has to be higher than the position of the depth sensor. This feature gives a resulting sensor shadow on the sandbox. The sensor-projector height problem

can be solved by using a conveniently placed mirror to simplify the structure that supports all the devices. The mirror size results in 60x60cm.

The developed prototype used for this work is shown below (Figure 2). Figure 3 shows in detail the resulting visualized sand landscape.

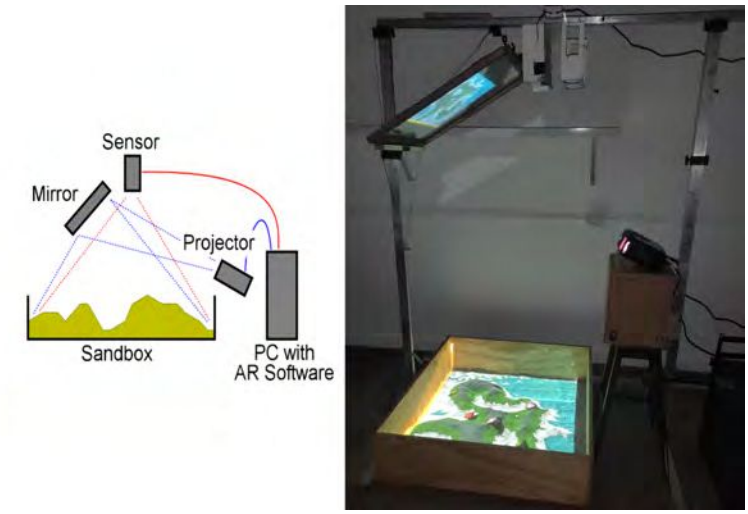

Fig. 2: Sandbox architecture system.

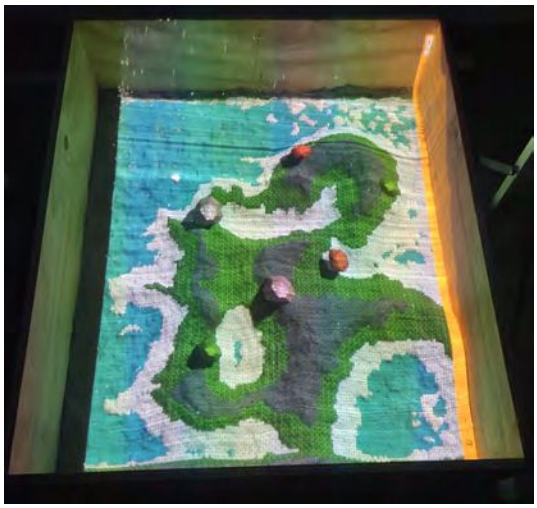

Fig. 3: Sandbox projected.

4 Experiences and Results

Representative stress assessment methods include psychological evaluation methods (questionnaire, etc.), biochemical evaluation method (blood test, etc.), and physiological evaluation methods (heart rate variability, etc.) [14, 15].

The present research carried out an experimental methodology using a group of participants. The user experience was developed with a group of 20 participants between 12 and 60 years old, all of them from San Luis, Argentina.

We performed an objective evaluation method to review the effectiveness of the therapy training. The training consisted of measuring the level of participants' stress before and after the experience with our sandbox prototype through 5-20 minutes user free actions. Actions were detailed in section 3.1.

Stress level monitoring enables to check how much stress the user has. For experimental data acquisition, a smart band was used [16]. The smart band measures the user's heart rate and determines the current stress level based on its variability according to Jachymek et al. work [17]. Ranges are suggested by the smart band application as shown in Table 1 [16].

Levels of stress			
Relaxed	Mild	Moderate	High
0-39	40-59	60-79	80-100

Table 1: Stress level description

Table 2 shows the stress level measured at two different time slices: before and after the sandbox experience (second, third, fifth and sixth columns from left to right).

# User	A Priori Level	A Posteriori Level	# User	A Priori Level	A Posteriori Level
1	35	24	11	43	26
2	29	21	12	47	29
3	34	25	13	44	35
4	29	23	14	42	31
5	40	31	15	30	24
6	64	34	16	41	28
7	38	28	17	35	27
8	27	22	18	44	35
9	38	28	19	49	38
10	59	33	20	42	28

Table 2: Stress level of participants before and after to the experience

5 Discussion and Conclusions

In this paper we developed a therapy system by using the augmented reality technique, a Kinect 3D camera and a sandbox. The system mimics a Japanese Zen Garden de-stress process by using a digital strategy through an augmented reality sandbox. The system provides users with flexible interaction and easy sand control, and also presents real time data recording.

From the objective evaluation method, results indicate that the level of stress after the experience decreases by 20 to 30 percent according to the measurements of the smartwatch used. Gathered data show that the system enables to provide an experience that reduces the participants' stress.

More over, the experiment provides a new insight into the relationship between these types of technologies and traditional mindfullness methods.

The experiences here considered gave users free will at the moment of actions' choice. Robust experiments should consider an actions' protocol to be followed by users. Additionally, real time digital sandbox elements interaction is beyond the scope of this work.

Future studies will take into account the development of a virtual reality Japanese Zen Garden including both headsets and gestural sensing devices. The system should immerse the user inside the virtual garden and give him the possibility to affect the scene through his avatar in the same way as it is done in a real zen garden.

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