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A Proposed Hybridized Model for Image-Based Virtual Reality in Technology-Driven Self-Therapy

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ABSTRACT

Stress is one of the issues in mental health among the societies. Self-therapy has been an alternative to provide relaxation and to reduce stress that includes the use of guided imagery therapy (GIT). It could also take advantages of technologies that support the sense of presence. In this technology-driven era, Spatial Presence Model (SPM) has been applied in existing studies to develop virtual reality (VR) tools, while Guided Imagery Therapy (GIT) has been used as a treatment tool for potential psychological problems. Currently, no study has utilized both SPM and GIT in supporting the practice of self-therapy to reduce stress. Hence, this study aims to propose a hybridized model for Image-based VR (IBVR) that incorporates SPM and GIT for the purpose of technology-driven self-therapy. The Design science research methodology (DSRM) is used as the basis for conducting the study. The proposed model is expected to benefit the application designers as a reference in developing IBVR tools for self-therapy.

1. Introduction

Virtual reality (VR) is created for generating user experience features in which users are expected to feel present and immersed when using with the application [1,2]. The concept of presence in VR, which allows users to feel of "being there" in a virtual environment provides a wide variety of potential applications in various fields [3,4]. In medical and health, VR has been used as a tool for the treatment of psychological disorders through VR exposure therapy in a safe and controlled environment with less cost.

Stress is considered as a psychological and physiological response that could affects people's health and performance [5-7]. Traditionally, Guided imagery therapy (GIT) is known as one of the approaches to treat stress, in which client is guided by the therapist to imagine a relaxing scene or series of experiences [8]. But in some cases, the patient tends to misunderstand the instructions and cause the patient to imagine a scenario that will negatively affect them [9]. In this case, VR can be utilized as an alternative by providing calming scenario in a virtual environment, rather than using

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imagination and memory. The VR mediated environment can assist users in practicing relaxation techniques in the therapy to overcome stress.

Hence, this paper proposes an approach for self-therapy by using Image-based VR (IBVR) that applies spatial presence theory and GIT technique. With this approach, users with mild and moderate stress levels can undergo the therapy on their own, without direct intervention from a real therapist. Users are expected to feel calm hence reduce stress as they navigate through the images in the virtual environment provided in the IBVR. However, currently, spatial presence and GIT are two different concepts that have been applied independently in exclusive contexts and no study has utilized both SPM and GIT in supporting the practice of self-therapy to reduce stress. In this study, the potential of both will be optimized in a wider and heterogeneous context. Accordingly, this study attempts to bridge the gap by hybridizing the Spatial Presence model and GIT technique for the application of IBVR in self-therapy. The proposed model in this study that utilizes both SPM and GIT is expected to benefit the application designers as a reference in developing the IBVR tools. The following sub-topics briefly elaborate some background, methodology, result, discussion and conclusion of the study.

2. Background

2.1 Virtual Reality and Presence

VR refers to a computer-generated digital environment that seems like a real environment, which can be experienced and interacted with [10]. The advances of VR have expanded across various domains including education, entertainment and health [11]. Particularly, in mental health, VR has been utilized as a therapy tool in managing stress and proven to be able to decrease stress level and increase task performance [12,13].

In VR, it is important for users to feel being physically present in the mediated environment and to feel being able to act in the environment [14]. Geometry-based virtual reality (GBVR) is one type of VR application that has been the focus of most research on presence due to its capabilities of providing deep sense of presence through high interaction functions [15,16]. But the development of realistic synthetic environment in GBVR is time-consuming and requires high computing performance as it uses 3D computer graphics [15,17].

On the contrary, IBVR is a type of VR application that is developed using real photos, stitched together to develop a high quality and realistic virtual environment. It is less time consuming and requires only low computing performance [5,9,18]. IBVR has also demonstrated its capability in psychotherapy through several existing studies [5,9]. Despite the limitations of its interaction function, it is important to ensure that there is a sense of spatial presence in the IBVR to enhance its effectiveness.

2.2 Spatial Presence Theories

Nicovich [19] developed a spatial presence theory for high interactivity application, which is not suitable for IBVR that has low interactivity. Presence theories by Riva *et al.,* [20] and Lee *et al.,* [21] focus on the factors of application, but do not provide detail explanation on the directions or relationships between the variables in their theories. Spatial presence theory by Draper *et al.,* [22], Steuer [23], Slater and Usoh [24], and Schubert *et al.,* [25] are more on human psychology as opposed to this study that focuses on media factors that can produce spatial presence, instead of human factors.

On the other hand, Wirth *et al.,* [14] produced a spatial presence theoretical model that comprises both media and human factors in creating spatial presence. The model contains two-level process and claimed to be appropriate for inducing spatial presence in any kind of media. In line with that, Nadia [26] enhanced the model by Wirth *et al.,* [14] and proposed a spatial presence model that is specifically tailored for IBVR. Nadia's model only focuses on the media factors that can induce spatial presence, excluding the human factors as in the Wirth's model. It is a general model that comprises components for generating spatial presence in IBVR. Despite the fact that the model was not developed specifically for use in self-therapy, the components and elements of Nadia's spatial presence model can be further explored to suit the objectives of this study.

2.3 Guided Imagery Therapy

GIT is the technique where elements of the unconscious mind are provoked to appear in the conscious mind through variety of techniques including simple visualization and imagery, metaphor and story-telling, fantasy exploration and game playing, dream interpretation, drawing, and active imagination. It is proven to be an effective intervention for reducing stress and anxiety [27,28]. Normally, the process involve a therapist guiding the patient to imagine 'being in' a relaxing scene, preferably a favourite location [9], thus giving the sensation of relaxation. However, there are possibilities that the patient misunderstand the therapist instructions and consequently imagine scenarios that could affect them negatively.

This study proposes a technology-based solution using IBVR as a self-therapy tool, based on GIT technique. Through the IBVR, users can view the scenario or environment instead on using their own imagination.

3. Methodology

This study was conducted based on the design science research methodology (DSRM) [29]. The methodology is appropriate for the development of working artifacts that may include constructs, models, methods, and instantiations [30]. It comprises five phases namely (i) awareness of the problem, (ii) suggestion, (iii) construction, (iv) evaluation and (v) conclusion.

In awareness of the problem phase, research problem, research questions and objectives, as well as the scope of the study are identified through literature analysis and preliminary study. In suggestion phase, potential solution is proposed by applying content analysis and comparative analysis of existing theories and models. This results in the identification of the components and elements for the proposed model in this study. The components and elements are then consulted with the experts to get their recommendations and verification. Once confirmed, the components and elements are integrated in the construction phase of the proposed model. A completed model will be validated again by experts before it is translated into a working prototype for the purpose of user experience testing in the evaluation phase. Finally, in the conclusion phase, the results will be concluded by referring back to the research questions and objectives of the study.

4. Results and Discussion

The hybridized model for IBVR in self-therapy as proposed in this study is designed and constructed based on the most relevant existing models of spatial presence, GIT and VR system. These models have been selected through content analysis. Based on the analysis, the spatial presence model for IBVR (SPM4IBVR) by Nadia [26] is selected as the basis as it is specifically

constructed for creating spatial presence in IBVR. This study adapted SPM4IBVR by taking into consideration all the components and elements in the model. It comprises three main components namely (i) calmness, (ii) interactivity and (iii) perceptual realism. Table 1 shows the elements for each of these components, which have been adapted to the hybridized model proposed in this study.

Table 1
Components and elements of SPM4IBVR

Components	Elements/Features
Calmness	Calm panoramic view
	Calm sound
Interactivity	Hotspot activity
	Panning function
	Standardized menu
	Comfort navigation
Perceptual Realism	Storyline
	Additional object
	Natural sound
	Animation

The proposed model is further enhanced by integrating the GIT technique as the selected approach of psychotherapy, to develop a model for IBVR that is tailored for self-therapy. As a complement, a model for VR system is also included as part of the hybridized model. Several existing studies with relevant models were identified for inclusion in the comparative analysis. The purpose is to look at the similarities and differences of the generic components of the models in order to determine the most suitable components and elements for the proposed hybridized model. Selection of models for the comparative analysis was based on several criteria: (i) highly relevant to this study, (ii) covers fundamental principles and (iii) contains adequate descriptions. Whereas, selection of components and elements was based on the conditioning rules (Table 2) that serve to classify whether it is compulsory or recommended to be applied in the proposed model.

Table 2
Indicator for classification of components

Indicator	Description	Condition
©	Compulsory to be applied	The component is compulsory to be applied when All or Majority models apply
®	Recommended to be applied	The component is recommended to be applied when Few or No models apply

Table 3 shows the comparative analysis of generic components in selected models for GIT. While Table 4 shows the classification of the components based on the conditioning rules.

According to the classification in Table 4, five of the generic components are compulsory, while the others are recommended to be applied in the proposed hybridized model. It also generates the Structure components for the proposed model which classified into opening, content and closing section. It represents the activities that will happen in every section of the IBVR self-therapy.

Table 3
Comparative analysis of generic components for GIT in selected models

Generic Components	1	2	3	4	5	6	7	8	9	10	Total Occurrences
Therapist Guide	/	/	/	/	/		/	/			7
Deep breathing	/	/	/	/	/	/	/	/		/	8
Relaxation exercise	/	/	/	/				/			5
Multiple senses	/	/	/	/	/		/	/		/	8
Natural/Ambient sounds		/	/		/		/				4
Images of peaceful nature	/	/			/	/	/		/	/	7
Image variation		/		/			/	/			4
Specific details of images		/			/	/	/	/	/		6
Client-based	/		/						/		3
Coping strategies									/	/	3

Note: Number 1-10 is referring to selected models/studies

Table 4
Classification of generic components for GIT

Generic Components	Classification
Therapist Guide	©
Deep breathing	©
Relaxation exercise	®
Multiple senses	©
Natural/Ambient sounds	®
Images of peaceful nature	©
Image variation	®
Specific details of images	©
Client-based	®
Coping strategies	®

Description of symbols:
© - Compulsory to apply
® - Recommended to apply

On the other hand, Table 5 shows the comparative analysis of generic components in selected models for VR system. It is followed by Table 6 that shows the classification of the components in VR system, based on the conditioning rules.

Results of the classification as shown in Table 6 indicates that all generic components for a VR system are compulsory to be applied in the proposed model, except for one component that is the database. For this study, no database is required as there will be no user data records. Therefore, it is decided that database components are excluded in the proposed hybridized model.

Table 5
Comparative analysis of generic components for VR system in selected models

Generic Components	1	2	3	4	5	6	7	8	9	10	Total Occurrences
VR engine	/	/		/	/	/	/	/	/		9
Software	/	/	/	/	/	/	/	/	/	/	10
Database	/				/			/	/		3
Input	/	/	/	/	/	/	/	/	/	/	10
Output	/	/	/	/	/	/	/	/	/	/	10
User		/	/	/	/	/	/	/	/		9
Task	/	/	/		/	/	/		/		7

Note: Number 1-10 is referring to the selected models/studies

Table 6
Classification of generic components for VR system

Generic Components	Classification
VR engine	©
Software	©
Database	®
Input	©
Output	©
User	©
Task	©

Description of symbols:
© - Compulsory to be applied
® - Recommended to be applied

Based on the components and elements described previously, the proposed hybridized model for IBVR in self-therapy is constructed as in Figure 1.

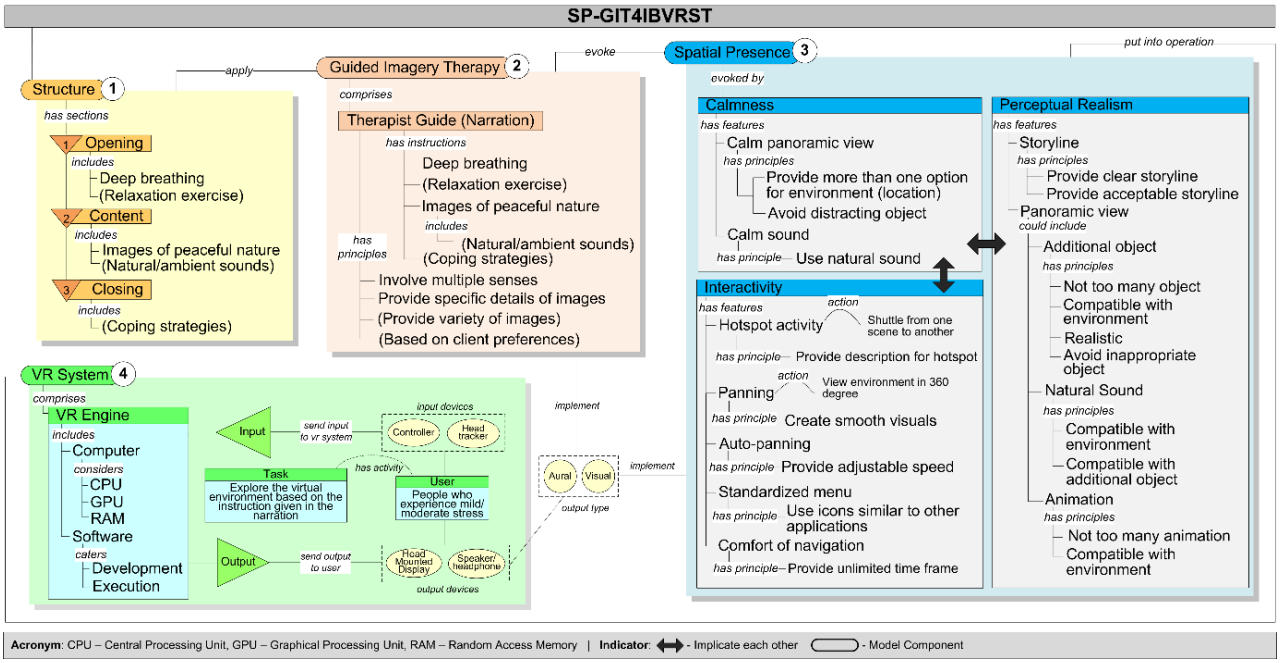

Fig. 1. The proposed hybridized model for IBVR in self-therapy

As illustrated in Figure 1, the proposed hybridized model consists of four main components which are (1) Structure, (2) GIT, (3) Spatial Presence and (4) VR system. The structure component shows that the IBVR for self-therapy must be divided into three sections which are opening, content and closing that apply all the elements in GIT throughout the IBVR self-therapy tool. While the GIT component indicates that the IBVR self-therapy should include therapist guide in the form of recorded voice. It provides instructions to users on deep breathing and imagery of peaceful nature. It must also involve users' multiple senses and variety of images with specific details. For the spatial presence component, it illustrates that the IBVR for self-therapy should be able to evoke spatial presence through calmness of the panoramic view and the natural sound. In terms of interactivity, it must provide hotspot activity, panning function, standardized menu and comfort of navigation. For creating perceptual realism in the IBVR, it should has clear and acceptable storyline. Among others, the panoramic view could also include additional object, natural sound and animation to increase perceptual realism. Finally, the VR system component shows the hardware and software that should be taken into consideration in the development of the IBVR. It includes the computer, software, input and output devices.

5. Conclusions

This study aims at developing a model for the development of IBVR in self-therapy, specifically for the condition of stress. The model applies spatial presence theory and GIT technique as the foundation for achieving the objectives of the study. This paper discusses about the initial model that has been designed and constructed based on existing models. It will be validated through expert review to evaluate the relevancies of the components and readability of the model. A prototype will be developed based on the proposed model for user experience evaluation to measure the effectiveness of the model. Based on the results, final refinement will be made before the model is ready for utilization. This will involve an iterative process. The model would be beneficial to application designers in developing IBVR tool for self-therapy. It would also provide alternatives to the mental health experts in overcoming stress issues among the societies.

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