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Research paper

Virtual Reality Foot Reflexology (VRST): A New Alternative in Foot Reflexology

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Abstract

Virtual reality stress therapy (VRST) is an innovative and emerging concept that provides effective modality for relaxation and stress therapy by allowing users to be exposed to similar stimuli as their real-world counterparts using a computer-generated virtual environment. Foot reflexology has been widely used to improve quality of life and well-being, reflected in numerous benefits such as stress relief, distress, insomnia relief, potential diagnostic tool, sleeping disorder, and as a complementary treatment tool. This paper presents the varying alternatives in foot reflexology stress therapy applications and the opportunities VR offers the therapy. Virtual reality foot reflexology stress therapy application utilized VR technologies of visual and aural interactivity, coupled in a Head-Mounted-Display (HMD), alongside a reflexology artifact/device for haptic interaction for relaxation and stress relief. Implications and Future works were also discussed.

Keywords: *Virtual reality, Stress therapy, Foot reflexology, Virtual reality stress therapy (VRST),*

1. Introduction

Reflexology therapy as described by [1], is a natural healing art which is based on the foundation that in the feet and hands of the human body, there are reflex points that directly correspond to every part of the body. The study of [2] explored the traditional foot reflexology (TFR) therapy and identified the existence of multi-modal interactivity in the therapy that leads to relaxation and stress relief experienced from the users' perspective. From the previous study reflexology artifacts (RA) was revealed to be an alternative substitute for TFR, and compared RA against TFR to explore and compare the user experience from both perspectives [3]. This study hence presents the third alternative VR Foot Reflexology application to aid users in their relaxation and stress relief journey.

2. History of Reflexology

Literatures has revealed that reflexology is not a new therapy with countless evidences to imply its origin, effectiveness and use right from the early Egyptians, Chinese and Northern American Indian tribes for the purpose of healing [4], [5] even though that may not have been the name it was called. The modern history of reflexology started early in the 20th century by a US specialist, Dr. William Fitzgerald (1872-1942) (also regarded as the father of modern reflexology) and his team who observed that applying pressures to certain areas of the hands and feet resulted in an anaesthetizing effect on the corresponding body area [6]. Eunice D. Ingham (1879-1974), a physiotherapist, who was also a member of the team built further on this and went many steps ahead, and further developed the work into what is considered the "modern day reflexology". She argued that if hard pressure stops pain sensation being transmitted to the brain, reduced pressure might stimulate the nerve impulses, attaining therapeutic effects beyond pain reduction. While working on the hands, she discovered that there are also reflex points located on the feet and that working with them was more effective. Eunice Ingham worked together with Dr. Riley in 1930's, and their work greatly allowed people to understand reflexology [7]. Sharing the technique of reflexology with others by writing many books such as "Stories the Feet Can Tell, Stories the Feet Have Told, and Stories the Feet Are Telling"[6].

3. To Treat or Not to Treat

Studies have revealed that not all patients should take or is recommended to receive reflexology therapy. Therefore, practitioner must first determine whether or not the patient would benefit from the therapy. In other words, certain health or medical conditions require proper care and precautious handling by the reflexology therapist [8]–[10]. Certain conditions like early pregnancy, cardiovascular disorders, oedema, diabetes, recent surgery, arthritis, bleeding disorders or on anticoagulant therapy, where there is a tendency for easy bruising/bleeding or cancer as it may aggravate the spread of cancer cells. However, there are certain conditions where reflexology should not be performed on the patient:

- Localized skin diseases, inflammation or swelling of the massage areas (feet, hand and ear), as pressure exertion and movement during treatment may aggravate the condition.
- Pregnancy particularly during the first trimester, as this may lead to unfortunate miscarriages.
- Diarrhea and vomiting patients should also avoid treatment as this may over stimulate the body and aggravate the situation further.

- Patients experiencing fever or any infectious diseases should also avoid treatment, as this may also over-stimulate the already stressed body system trying to combat the infection.
- Patients experiencing a continuing extreme negative reaction to reflexology are advised against taking further treatment.
- Thrombosis and thrombophlebitis patients are also advised against reflexology as it may trigger blood clots lodging in or near the heart.

4. Reflexology and Complementary Therapy

Foot reflexology has been used widely for numerous benefits such as stress relief, distress, enhanced alertness, potential diagnostic tool, and as a complementary treatment tool which has been tested and proven effective in numerous studies [11]–[15] The relaxing characteristic of foot reflexology treatment makes it suitable for insomnia in antenatal inpatients, and hypertensive patients. The demands and desire of people wanting to be more in control of their own health have fuelled the increase in the practice of reflexology in health care [16].

Reflexology is a form of complementary and alternative medicine (CAM), used either as an adjunct to or instead of conventional medical care. Worldwide expenditure on complementary and alternative medicine surmounts to a minimal estimate of at least $40 billion per annum [17]. Ernst [18] highlighted that an estimate of £1.6 billion is spent in the UK alone per annum. There has been tremendous public investment on the therapy as reported from literature, particularly in Norway NIFAB, [19], Denmark ViFAB [20] and the UK as concurred by The House of Lords Select Committee for Science and Technology [18], [21], where it is in the top six CAM therapies purchased. Jones and Leslie [22]explained that the cost of a single reflexology session can cost from £15 (€18) (RM45) - £70 (€84) (RM210) per treatment and usually, to gain the optimal therapeutic outcomes, usually about 6-8 sessions are recommended by therapists [23], [24]. Implying the cost of an eight-week session would surmount to an estimate of £400 (€480) (RM1200) and about £1000 (€1195) (RM3000) annually for repeated blocks of treatment which are very likely for patient with chronic health issues [18]. Due to this public-driven investment, reflexology safety and product quality have become healthcare research priorities [25].

Applications of Reflexology

Traditional Foot Reflexology (TFR)

The traditional reflexology is the common form of reflexology conducted by a reflexology practitioner on a reflexology patients in areas of the feet, hands and ears [27]. This traditional form of the therapy is usually conducted in a control environment like the reflexology center or massage room, with both practitioner and therapy environment playing a significant role in the relaxation and stress relief perceive by the reflexology patients [27], [28]. The Malaysian Ministry of Health [27] documented a good practice guideline for traditional reflexology. They outlined the 'How-s', 'Do-s', and 'Don't-s' of reflexology practice and premises. Okere et al. [2], [28], [29] examined and identified from both the practitioner's and patient's perspectives, the multimodal interactive nature of TFR. The study revealed that several modal interactions exist in the therapy that play significant roles in the relaxation and overall therapeutic effects the patients perceive. In other words, what the patients see, hear, feel and touch all play significant role in the therapeutic experience as shown in Figure 1.

Reflexology Artifacts (RA)

Reflexology using artifacts / devices are the alternative substitute to the traditional form of reflexology. Several attempts have also been made in the replication and simulation of the haptic/touch interactivity in foot reflexology as can be seen from reflexology artifacts (RA) like reflexology slippers, reflexology mat, reflexology rollers, reflexology pebbles as can be seen in some parks/recreational centres [3] as shown in Table 1, or electronic foot devices like the robotic reflexology device or the Electro foot-reflexology stimulator [30], [31].

Okere and colleagues[3] revealed that despite the successful replication of only pressure exertion by the artifacts for foot reflexology therapy, users still enjoy and experience some certain degree of therapeutic experience which is considerably lower as compared to patients who undergo the therapy traditionally. RA as an alternative is somewhat effective for the purpose of its design and can

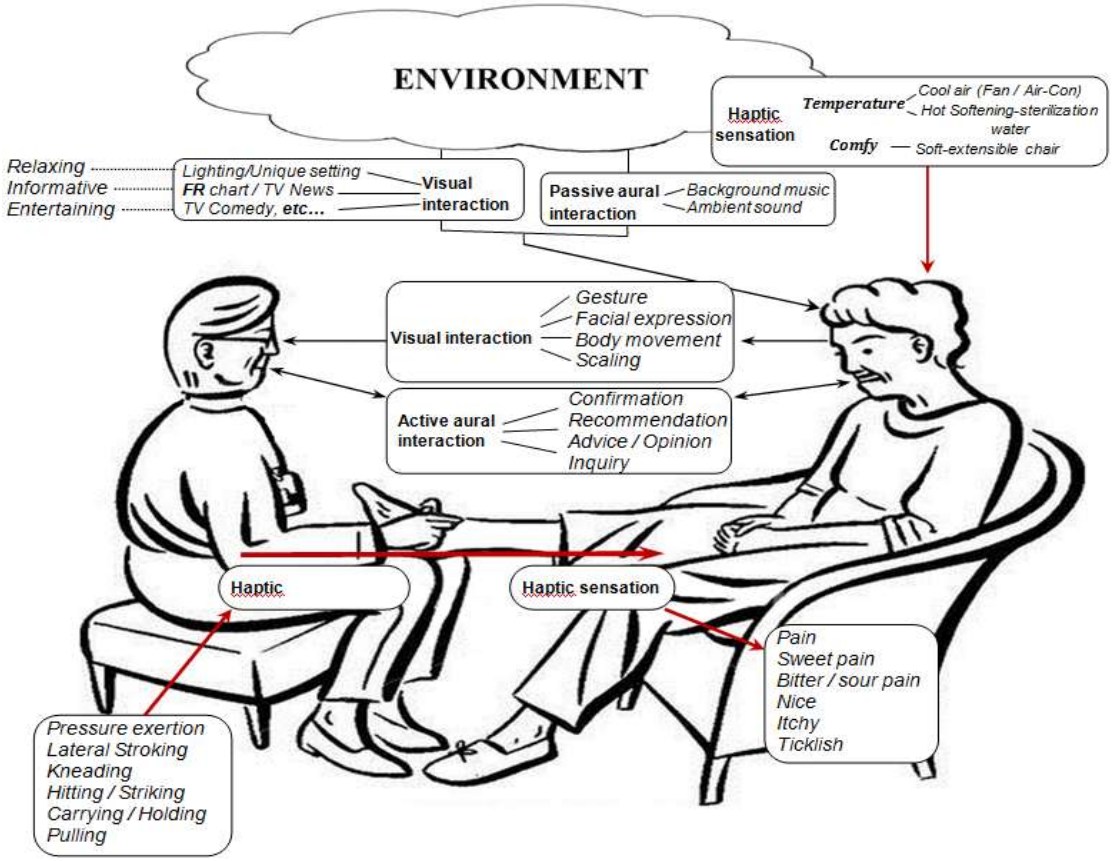


Figure 1: Graphical representation of the multi-modal interactivity in Traditional foot reflexology [26].

Figure 2: VR-Foot-ReST components of Mobile VR HMD with Bluetooth Gamepad Remote Controller, Reflexology Slipper (RA) and JBL Bluetooth wireless earphones

be used as an alternative in the absence of the traditional alternative. The aforementioned study also revealed that RA has expressed considerable strengths which include accessibility, time and cost saving, over its counterpart TFR. The study also portrayed RA to be faced with conspicuous limitations which includes sensation variety, pressure regulation, multi-modal interactive TFR environment, physical presence and required know-how to effectively use the artifacts. This leaves most users with very little knowledge on why they are using these artifacts, what benefits it actually offers, or how to properly use these artifacts without causing self-harm. As also highlighted earlier, not all patients are recommended to receive reflexology therapy. Certain health or medical conditions require proper care and precautious handling by the reflexologists [8]–[10]. In addition to that, [32] revealed that despite reflexology being a touch/haptic dominated domain, other modalities like visual and aural modalities also play vital roles in the relaxation and stress relief experienced by the patients. i.e., what the patients see, hear, feel and touch all play significant role in the therapeutic experience. Hence, using only RA in Table 1 for reflexology would not adequately cater for the aforementioned challenges. This exposes the opportunities where VR may be put to good use to overcome these challenges.

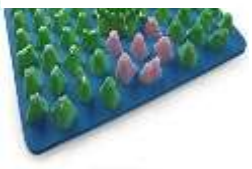
5. Virtual Reality and Stress Therapy

Both the benefits and reputation of reflexology motivated several attempts to simulate the interactivity of the therapy in the development of reflexology devices or artifacts [31]. The proliferation of VR technologies / applications as an area of research interest has motivated researchers to look into the utilization of VR technologies and applications to enhance, complement or support life, to treat phobias, for stress relief, relaxation and for complementary therapy tools [33]–[38].

VR technologies have been utilized by industries and researchers for relaxation and to combat stress of varying degree using the multimodal interactivity of visual/sight, aural/sound and haptic/touch amongst others. This can be seen from the work of in the design of [37] in the development of the VReST web based system, built based on the concept of guided image therapy to induce relaxation and stress relief on the patients/users utilizing visual and aural interactivity. Virtual Reality Stress Therapy VRST technologies / applications that allow users to utilize or explore virtual environments and interacting with it through touch, sound and/or sight to combat stress [37], [39], [40].

VR Foot Reflexology

Table 1: Some foot reflexology artifacts/devices

	
Electronic Reflexology Foot Massager  **Foot Reflexology Mat**	**Reflexology Slipper**  **Foot Reflexology Roller**

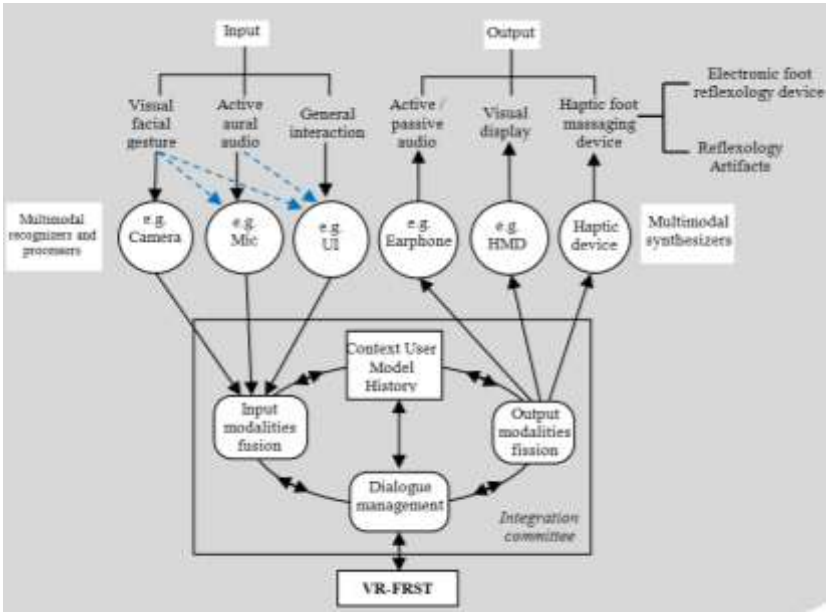


Figure 3: The architecture of a multimodal VR-FRST system, with the czentral integration committee and its major software components.

Virtual Reality Foot Reflexology Stress Therapy utilizes VR technology of visual, aural, and haptic technology to aid users in their relaxation and stress relief journey, using the design guidelines presented in [41]. The user is required to wear the Android HMD and reflexology artifact or device as the system takes the users through a guided progressive relaxation and foot reflexology session. The guided progressive relaxation and foot reflexology activities is a combination of guided progressive relaxation activities and instructions given to the users to perform during the therapy session to enable users relax and relieve stress. The user being immersed in a virtual world would visually and aurally interact with VR-Foot-ReST while wearing the RA or foot reflexology device as shown in Figure 2.

Interaction Architecture

Multimodal interaction from the machine side and the major software components that every multimodal system should contain is presented in this section. Dumas and colleagues [42] lead the frontier of interaction architecture. The author highlighted the generic components for handling multimodal integration which will include: a fusion engine, a fission module, a dialog manager and a context manager, will together form what is called the "integration committee" as shown in Figure 3, illustrates the processing flow between these components, the input and output modalities, with the potential client applications. As shown in the figure, input modalities are first perceived though various multimodal recognizers and processors, outputing their results to the fusion engine, in charge of giving a common interpretation of the inputs. The fusion engine interprets the input, then communicates it to the dialog manager, in charge of identifying the dialog state, the transition to perform, the action to communicate to a given application, and/or the message to return through the fission component. The fission engine is finally in charge of returning a message to the user through the most adequate modality or combination of modalities, depending on the user profile and context of use. For this reason, the context manager, in charge of tracking the location, context and user profile, closely communicates any changes in the environment to the three other components, so that they can adapt their interpretations. This is then transmitted back to the users through the several output synthesizers or methods available and chosen by the machine. This interaction is then perceived by the user visually, aurally, haptically or so as shown in Figure 3.

5. Conclusion and Future works

In this paper, the author presented various applications of foot reflexology: Traditional foot reflexology (TFR), Reflexology artifacts (RA), and VR foot reflexology stress therapy (VR-FRST). The paper presented the use of virtual reality's multimodal interactivity of visual, aural and haptic components, designed into the VR-FRST application to assist users in their relaxation and stress relief journey. VR-FRST applications are not intended to replace the existing approaches of traditional foot reflexology but instead as complementary tool through the utilization of VR, RA and Smartphone technology. Future works should conduct a comparative study to explore how VR-FRST compares to TFR and the conventional use of RA. Future works should also provide empirical justifications using appropriate measures, to evaluate the effectiveness of VR-FRST on relaxation and stress relief.

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