

UTILIZING VIRTUAL REALITY TECHNOLOGY TO ENHANCE CARDIO EXERCISE EXPERIENCE

Adam Linoby¹, Najib Bahaman², Akma Faris³, Fariz Izzudin⁴, Faiz Nawawi⁵

^{1,2,3,4,5}*Faculty of Sports Science and Recreation, UiTM Negeri Sembilan, Kampus Seremban, Malaysia
linoby@uitm.edu.my*

ABSTRACT:

The aerobics, or also known as cardiovascular exercise, produces numerous desirable metabolic and cardiovascular effects. A widely acknowledged benefits of aerobic exercise include managing body composition, reducing serum cholesterol, controlling blood glucose level, attenuating of body triglycerides, lowering of blood pressure indices, which ultimately reduce cardiovascular disease risk profile. However, despite its numerous benefits, cardiovascular activities are heavily criticized as people claim them to be burdensome and boring due to conventionally monotonous, lengthy and repetitive movements of the exercise. To address this limitation, the present invention responds by providing a high-fidelity virtual reality (VR) headset and a mobile application with visually stunning interactive trails (in Malaysia and around the world), designed to motivate users to continue the cardio exercise while touring in virtual reality environment. VRtual Cardio system, with a built-in sensor in the VR headset and the user's smartphone sensor, continuously detects the motion of the user's head to correspondingly sync with the movement/speed of VR trails footage. Our preliminary data suggests a higher rate of enjoyment and self-efficacy in the participants using VRtual Cardio system compared to exercising using only the traditional ergometer system. The invention of such a practical cardio-based exercise system could potentially help sedentary individuals, people who want to age healthily, clinical population as well as health professionals to implement a more effective, motivating and enjoyable exercise regime.

Keywords: virtual reality, cardio, exercise, sensor, motivation

INTRODUCTION

Exercise ergometer has now been developed with increasingly sophisticated built-in components, providing a better guidance to the exercising individuals. However, cardiovascular exercise is still perceived as a burden for large segments of the population due to its lengthy duration and repetitive nature, despite the ever increasing added features in modern exercise ergometer. Several equipment manufacturers respond to this issue by offering built-in multimedia entertainment assets into their products. However, bicycling (on or off road and through countryside) is, for many people, more interesting than listening and/or watching the conventional multimedia throughout their exercise training (Boulanger et al. 2017). There is clearly a need for an easily accessible exercise system that could provide users with an immersive experience to encourage them to perform lengthy exercises. Our objectives for this study embark on 1. to fabricate a prototype of a sensor-equipped virtual reality headset with visually stunning interactive trails, designed to motivate users to continue the cardio exercise while touring in virtual reality environment and, 2. to investigate the feasibility and usability of the exercise system on psychological outcomes compared with a traditional stationary exercise bike in healthy adults.

METHODS

Several patents were awarded and designs for virtual reality exercise system have been proposed in the literature and industry, but none described specifically the proposed system (Fisher et al., 2007 and Nusbaum et al., 2005).

A. Proposed System

Fig. 1 presents the user head motion-sensor configuration. The system consists of a sensor fusion system which uses a combination of a gyro-sensor in the user's smartphone (to measure the miniscule movement changes of the user's head while exercising) and a magnetometer (to assess direction/magnitude of true magnetic north orientation that could avoid the user from falling during exercising while in VR environment). All communications between the VR headset and VR trails visual rendered in VRtual Cardio smart phone application are possible using optional Wi-Fi or Bluetooth protocol.

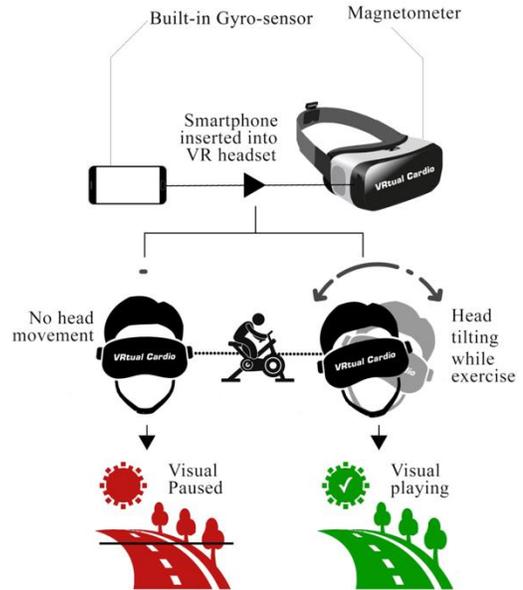


Fig. 1. Proposed ActiVRide System Flow

B. Prototype Technical Performance

A test was conducted to determine the data accuracy of the visual display of VRtual Cardio prototype. Percentage of error occurs in time delay between the user's commencement/termination of exercise and movement of the visual VR footage as a measure of sensor performance.

C. Psychological measures

A small pilot trial (comparing VRtual Cardio system vs. traditional stationary exercise) was conducted to measure the psychological aspect of the proposed prototype. Participants responded to self-efficacy and enjoyment survey after each exercise session using point Likert-type scale (1: strongly disagree to 5: strongly agree). The item mean was calculated and used as a measure of participants' respective self-efficacy and enjoyment toward the two exercise conditions. GraphPad Prism version 7.00a for MacOS (GraphPad Software, San Diego, CA, USA) was used for descriptive statistics and paired t-tests were used to evaluate differences in self-efficacy and enjoyment between the two exercise sessions for each participant. The significance level was set at $P < 0.05$. Finally, Cohen's d was determined and an effect size of 0.2 was considered small, 0.5 medium, and 0.8 large.

RESULTS AND DISCUSSIONS

A. Prototype Performance

The VRtual Cardio prototype showed an excellent performance in transmitting data from the headset to its dedicated mobile phone application. The application also displayed an acceptable percentage of error in time delay between the user's commencement-termination of exercise and movement of the visual VR footage.

B. Self-efficacy and Enjoyment

Participants (mean \pm SD, age 22 ± 7 yr, height 1.78 ± 0.03 m, body mass 75 ± 3 kg, $n = 11$ subjects) had significantly higher self-efficacy ($P < 0.05$, Cohen's $d = -0.89$) and enjoyment ($p < 0.05$, Cohen's $d = -0.84$) during the exercise using VRtual Cardio compared to conventional stationary cycle ergometer exercise. From the usability survey, over 94% of the users of VRtual Cardio were very impressed by its performance and would certainly like to use it if such device is available in their home.

CONCLUSION

In conclusion, the VRtual Cardio prototype system is designed to give users an enjoyment while performing the cardiovascular/aerobic type workout and helps to counter boredom due to the conventionally lengthy and repetitive movements required by such exercise. By providing sensor-equipped VR headset, users do not have to purchase specialized equipment to start using the VR exercise system. This, in turn, will likely reduce the cost of the proposed device compared to the high cost of relatively similar system in the market. The VRtual Cardio exercise system could prove to be beneficial in a range of population including sedentary individuals, people who want to age healthily, clinical population as well as health professionals to implement a more effective, motivating and enjoyable exercise regime.

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