A VIRTUAL REALITY BASED FITNESS PLATFORM ON SMART TV FOR ELDERLY LIFE WELL-BEING PROMOTION

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Abstract- Both domestic and international research shows that the elderly lack of exercise seriously affect their life quality as well as physical and mental health. Therefore, with the integration of new technology in developing applications in life, we could promote the well-being of the elderly. It is expected that in the near future, smart TV is to the elderly what smartphone is to mankind, which is inseparable from daily life. With the advance of cloud computing, smart TV will become the next generation‘s "home media center". This study is aimed to introduce the integration of hardware and software motion sensing (MS-Kinect) to detect facial features, as well as the establishment of joints-coordinating module and the virtual coach module of aerobic exercises for the elderly. The platform is accomplished by Unity 3D that senses the body gestures, moreover designs gesture manipulation interface in motion sensing interaction. As a result, through a fitness program combining smart TV with motion sensing interaction and cloud services of cable TV, the elderly can take at-home aerobics exercises and do acupressure by themselves accurately to improve life wellbeing. In addition, the function modules can be the service platforms which the elderly could enjoy instant massages, share experiences, and connect with others.

Index terms- The Elderly Well-being, Health-related quality of life, Smart TV with Motion Sensing, Acupressure, Virtual Reality.

I. INTRODUCTION

The world has a trend of aging, Taiwan is deteriorating aging and low-birth rate issues. However, in order to solve the problem and get the shallow effect quickly, Taiwan's government manipulates the resources and policy thinking, when faces this social state, who emphasizes on the needs of the elderly in the solution of health care decisions or disability subsidies. For example, in the application of information technology practice on the issue of successful aging, the past for the care of the elderly planning, mostly to establish such as telemedicine, home telehealth, as well as support thinking and measures of community health care. The whole country also does not focus on the establishment of aging industry, when developing the elderly gerontechnology. However, when we study the development experience of Japanese, the increase in the elderly population brought about the silver-haired market, in fact, vibrant and unlimited business opportunities [1]. So, in the face of the challenges of the elderly society, we must implement the use of science and technology for nurturing innovative silver-haired services, as well as the development of smart products and services that can satisfy the needs of the aging society. Thereby, it has opportunity to bred the new gerontechnology industry, and drive another wave of economic development.

This study is aimed to elicit the common issues of life well-being and then is expected to implement the new technology for improving the elderly’s life quality. In recent years, governments of countries in Asia such as China, India, and Indonesia, view increasing the IPTV-using proportion in poverty-stricken families or households in remote districts as one of the goals in enhancing the nation’s competitiveness. It is expected that in the near future, smart TV is to the elderly what smartphone is to mankind, which is inseparable from daily life. With the advance of cloud computing, smart TV will become the next generation‘s "home media center". A fitness platform with multi-user virtual situations on smart TV named FMVSTV for the elderly’s health promotion has been created by integrating the hardware and software of motion sensing kit (ex. MS-Kinect 2) with smart TV connecting cloud services.

It can be used synchronously to do the elderly fitness in multi-users virtual environment which is established to manipulate the joints-coordinating module and the virtual coach of aerobic exercises. Besides, the acupoint and acupressure module can detect personal facial features that the elderly can press the acupuncture point correctly and improve sleep quality. The function modules of FMVSTV are accomplished by the Android based program with 3D VR engine-Unity 3D, which can sense the body gestures, joint coordinates and the feature positions of surface, moreover can drive gesture manipulation interface in motion sensing interaction.

As a result, through a fitness program combining smart TV with motion sensing interaction and cloud services of cable TV, the elderly can take the at-home aerobics and ascertain the acupoint to do acupressure by themselves accurately to improve sleep quality. In addition, the social link function modules can be the service platforms which the elderly could enjoy instant massages, share experiences, and connect with others.

II. RELATED WORK

A. Life well-being of the elderly

Life well-being is a feeling interpreter for the elderly to represent personal overall life perception. Three aspects of psychological wellbeing can be distinguished: evaluative wellbeing (or life satisfaction), hedonic wellbeing (feelings of happiness, sadness, etc), and eudemonic wellbeing (sense of purpose and meaning in life) [2]. Life satisfaction is generally assumed and expected to decline in older age, most notably as health conditions deteriorate. In reality, the general finding of the large body of gerontological literature on the relationship between age and life satisfaction is that there is no age-related decline in life satisfaction [3], [4] .

However, the relation between physical health and subjective wellbeing is bidirectional. Older people with illnesses such as coronary heart disease, arthritis, and chronic lung disease show both increased levels of depressed mood and impaired hedonic and eudemonic wellbeing. Likewise, drawing on data from the Survey of Health and Living Status of the Elderly in Taiwan, Chen's (2001) study of the aging process and life satisfaction concludes that not only the age effect but also cohort experiences have an impact on life satisfaction [5].

Moreover, other research results indicated that some significant factors have an effect on the elders who satisfied with their lives and their perception of life. It consist of education level, perceived happiness, participated on volunteer work, and economic level which are the major factors influencing feelings of well-being, hope, and depression. In addition, there are significant correlation between positive attitudes toward death and feelings of well-being and hope. Studies also mentioned there are closely relationship among spiritual well-being, symptoms disturbance, mental health and physical function [6]-[8].

B. Positioning Standardized Acupuncture Points on facial features

The traditional Chinese medical acupuncture has been used for thousands of years in East Asia, and accepts of this modality have spread all over the world [9]-[10]. According to the traditional Chinese medicine regards disease as a result of an imbalance state in the body's energy field. Doctors stimulate acupuncture points to give a force, so that the body energy field will be balanced to achieve the purpose of treatment. The acupuncture treatment apply principle of salt bridge, electrical conduction by more than two power metal pins, so that the cell activity, and stimulate the meridians to normalize physiology and function of human body [12]. In order to achieve the effect of acupressure, the operator must be able to accurately identify the specific acupuncture points over the human body. Recent advances in technology having modernized imaging tools for precise positioning of acupuncture points where the traditional therapeutic method is applied is essential. For example, Kim, & Kang, suggested a more systematic positioning method that uses X-ray computer tomographic images to precisely position acupoints. Depending on the method used to pinpoint the positions of the acupoints, every acupoint was classified into one of three types: anatomical points, proportional points, and morphological points. A computational algorithm and procedure were developed for partial automation of the positioning. The anatomical points were selected by using the structural characteristics of the skin surface and skull. The proportional points were calculated from the positions of the anatomical points. The morphological points were also calculated by using some control points related to the connections between the source and the specific positions of body surface. This method can help for developing more accurate experimental designs and for providing more quantitative volumetric methods for performing treatments in acupuncture-related research [13], [14].

For that reason, we proposed a imagine recognition solution which integrated Microsoft Kinect kit with depth camera sensor, RGB camera and infrared camera with imaging processing program for precise positioning of acupuncture points (Fig. 1). The function module is used to capture the instantaneous image of the acupressure of the human body. The reference points or the landmarks were positioned based on the database of standard descriptions of the acupoints, and the formulae for the proportionalities between the acupoints and the reference points were presented. The spatial coordinates of the points obtained by specific local area, which are compared with the fixed human acupoints database. In the error threshold, the green point appears at the display shows the precise positioning of acupuncture point, otherwise it will be showed red. So, the elderly can do the acupressure accurate to improve the sleep quality by following the real time interactive function module on FMVSTV.

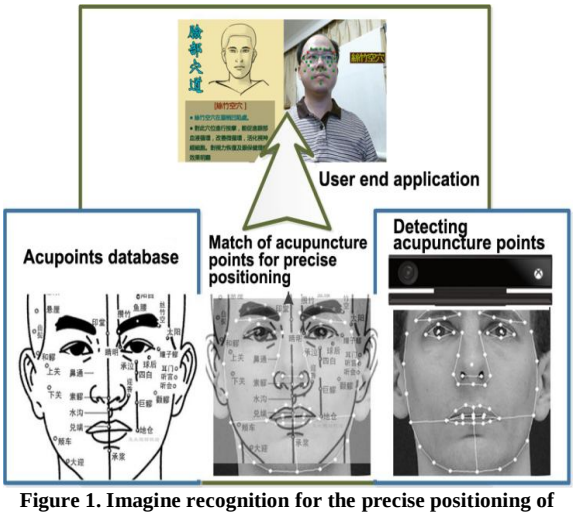


Figure 1. Imagine recognition for the precise positioning of acupuncture points

C. User Interface Design for Elderly

By the year 2025, one in five of the Taiwanese population will be aged over 65, and meanwhile Asian countries will have most elderly population and will be the fastest growing in the world [9]. Nowadays, the population imbalance between the elderly who require daily care and caregivers is being one of global social issues since the population aging advances. In order to avoid the negative effects of population aging, people believe that the information and communication technology can support the daily lives of the elderly persons at the early stage for increasing active aging [10]. Accordingly, designer must develop handy interface for use by elderly to enable them to educate or entertain themselves, interact with the society, challenge themselves by completing task achievements and increase their changes of doing productive jobs such as writing, using emails, network communications and other computer manipulation.

There are three major barriers encountered by the elderly in their using of computer technologies which include the eyesight degeneration, memory degradation and cognition. Eyesight problems, such as prone to feel tired, are one of the major factors causing physiological burden of the elderly. Memory degradation causes them to become unable to quicken the paces at which they learn new things, resulting in their efficiency in handling difficult tasks being lower than those of groups of younger age. These frustrating and negative emotions will further affect their cognition and become the psychological factors preventing them from learning computer knowledge as they feel old and unfit for high-tech products or fear they are going to cause damage to such products during their learning process [11]. It is fortunate that the restrictions caused by degradation in eyesight and memory can be ameliorated by user interface design to enhance the positive feelings of the elderly for their acceptability and cognitive ability [12]. As mentioned above, a certain number of studies about user interface design for elderly in smart home have been conducted. Thus, this study was issued at the usability of interactive content service on smart TV for indoor use. It was presented with GUI based on contactless display and 3D virtual situation applications as an example of a practical use of the system.

III. PLATFORM IMPLEMENTATION FOR ELDERLY LIFE WELL-BEING PROMOTION

This article shows the project results: to integrate hardware and software of motion sensing (MS Kinect 2) for detecting body movements and establish joints coordinates processing module; to establish home aerobics virtual coach module for the elderly; to build up a virtual coach module by Unity 3D for guiding the acupressure; to design gesture manipulation interface of motion sensing interaction; to develop social interaction modules with virtual reality technology.

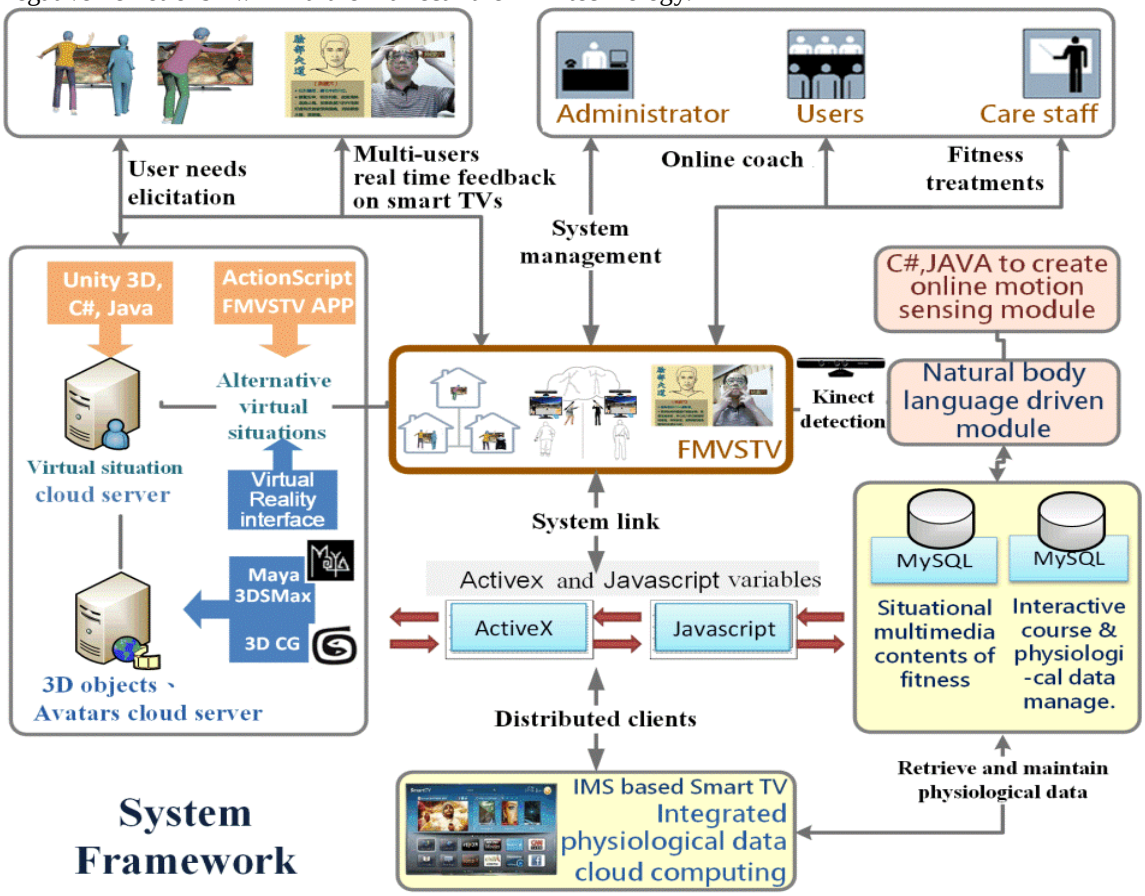


Figure 2. The modular architecture of FMVSTV

A. The System Framework of FMVSTV

In order to implement the functionalities of FMVSTV, the system goals are formulated as following:

1) developing the fitness treatment for elderly at home,
2) conducting distributed elderly users to their interaction by the implementation of avatars driven by motion sensing technology,
3) implementing the virtual reality application by Unity 3D program on protocol of Apps for Android TV to construct the real time feedback mechanism and data management of the system,
4) integrating all of the requirements that were elicited from the subjects of elderly and care staff to develop the UI-UX and communication feedback modules.

Accordingly, the analysis approach of service experience engineering was manipulated to establish the system framework of fitness service with motion sensing technology on smart TV [7,8]. It was integrated and implemented with 2D/3D computer graphics technology, contactless and intuitive user interface design, multimedia database, motion sensing interaction by Microsoft Kinect sensor, synchronous/asynchronous fitness treatments, virtual reality app for smart TV by Unity 3D, and protocol of Apps for Android TV. Fig. 2 illustrates the modular architecture of FMVSTV. There are six modules namely: System manipulation module for content editor to manage the service elements and materials; Alternative virtual situations module for presenting the immersive multiple scenes; Avatars and interactive objects module for users to choice the alternative avatar in fitness and social communication; Natural body language driven module for processing joints coordinates data from Microsoft Kinect sensor immediately; Virtual reality interface module for users to control and manipulate the service contents in intuition; and physiological data management module for
user and medical staff to maintain the detected data.

B. Acupressure improves sleep quality

Many studies have shown that the correct acupressure can improve the total number of sleep and sleep quality [15], [16]. In addition, the practice also indicated that the operation experience of acupressure is very important. It will affect the operator how to choose acupuncture points, massage techniques, massage intensity, massage frequency and duration. Therefore, in the system development process developers must identify the related knowledge and skills, and then consulted by the expert for assessment and ensured the reliability and validity of system implementation. The virtual coach of the program will guide the user to take a finger or massage-stick to work acupressure. Practically, a massage-stick works more accurately than with the finger to press acupuncture point.

Figure 3 shows the developed results of acupoint and acupressure module on FMVSTV.

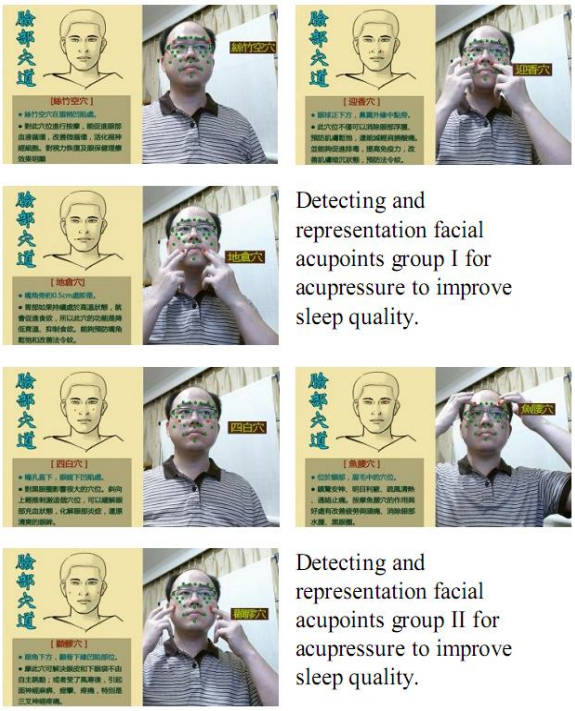
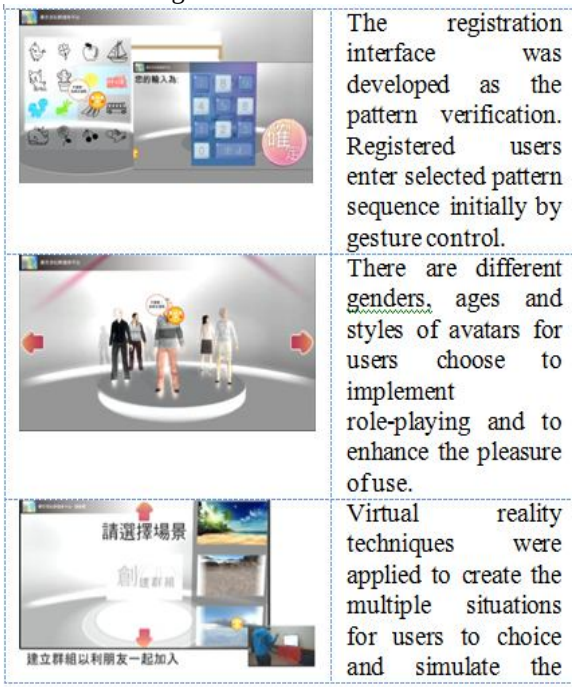


Figure 3. The acupoint and acupressure module on FMVSTV

CONCLUSIONS

FMVSTV is developed to apply the VR program with skeletal tracking function of Kinect kit and to combine with the home based exercise for the elderly healthy living by smart TV. There are 10 sets of aerobic exercises and 2 groups of acupoints for acupressure in the virtual reality interface module, which were developed by professional medical staffs and hoped to help the elderly to boost metabolism, combat stress, improve memory and slim waistline. The design characteristics of functions and contents are described and shown in Figure 4.





10 sets of aerobic exercises in the virtual reality interface module, which will auto-demo movies content after chosen and help the elderly to use.



A virtual coach at the center of the screen and shows the briefing of the aerobics at the upper right corner. The lower right corner is the user's avatar.



The avatars and interactive objects module offers visual and vocal social networking function also link wink FB and Twitter.



User's health data are collected by the smart wristband, such as blood pressure can be keyed in by gesture control.



The developed acupoint and acupressure module can detect and represent facial acupoints groups for acupressure to improve sleep quality.

Figure 4. Working function modules of FMVSTV

It is believed that continued use the service of FMVSTV will help maintain healthy and improve sleep quality for the elderly. Obviously, the FMVSTV has been found during the experimental process that most of the elders show their greatest interest in the contactless and gesture interface manipulation not only by giving it positive remarks but also taking great pleasure in trying it. Therefore some subsequent modifications will be made to enhance the usability of FMVSTV on the basis of the suggestions which obtained from the interview with the depth users.

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