New Kinect Desktop Application for Enhancing Physiotherapy Exercises Result

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Abstract

The Kinect is one of the most successful systems developed for recording and sensing the natural and intuitive gestures of users. It is a type of motion sensing device that enables the detection and tracking of the movement (rotation, position and velocity) of an individual or objects. The movement tracking may be in real or near-real time. The target users of proposed application are two major groups. The first group is patients. The patients can do exercises in front of Kinect tool which is connected to the application for more result notifications. The second target is specialists who creates the exercise data and manage patients for their digestion and their exercises. They can monitor patient’s activity and make feedbacks for them to improve their exercises. According to the problem, lack of the knowledge of the patient and the importance of home exercise for patient, this research and fulfill the gap between the specialist and patient. Moreover the monitoring exercise system can enhance the quality of the exercise. Therefore the proposed application can increase the specialist and patient satisfaction during the exercise and the result would improve the patient issues.

1. Introduction

Research and development in recent years has made the inclusion of individuals with a physical or cognitive disability into society much easier, helping them in the realization of their daily activities, thus increasing their autonomy and self-confidence (Avola et al., 2013). Particularly, research in the fields of computer vision, virtual reality, and augmented reality has given rise to applications in the educational, working, domestic, and leisure environments, with the potential for significant impact on the life of individuals with a disability. For instance, they use computers due to the development of vision-based human–computer interfaces.

Generally, physical and cognitive rehabilitation is a complex and long-term process that requires clinician experts and appropriate tools. Although some clinical decision-support systems are based on computer vision to help health professionals (Zhang, 2012), there are few medical centers with rehabilitation professionals and programs that currently utilize such systems. Therefore, a system that can successfully support the rehabilitation of individuals with a disability would be of great interest.

Zhou (2008) conducted a review of the human motion tracking systems for rehabilitation. Six issues were considered to assess systems: cost, size, weight function, operation, and automation. Marker-free visual systems were highlighted because they have reduced restrictions, robust performance, and low cost (Zhou, 2008).

Non-compliance is traditionally defined as a failure by patients to follow advice. Attempts have been made to reduce the proportion of non-compliers, but with little apparent effect on levels of compliance (Liu, 2013). More recent interest has focused on patient perspectives of medication advice. Sociological research suggests patients make reasoned and rational decisions about medication taking, depending on their own beliefs about drug therapies, personal experiences and the information they have available (Soares et al., 2013). In this research, it will be explored compliance with physiotherapy from the patient’s perspective, using Kinect application to find out how the exercises failed because of non-compliance or lack of the knowledge during exercises (Oikonomidis et al., 2011).

Literature Review

2. Similar Systems from Previous Researchers
Wang et al. (2004) proposed a virtual reality application for brain injury rehabilitation. Lin et al. (2004) demonstrated the effectiveness of an eye-tracking device to play a computer game in the rehabilitation of eye movement dysfunction. Da Costa and de Carvalho (2004) showed that positive results of a virtual reality device for stroke and cognitive rehabilitation, respectively. Rand et al. (2004) studied there habilitation potential with the low-cost video game con-sole Sony@ PS2TM and a camera. It was stated as a useful intervention tools during the rehabilitation of stroke patients and those with other neurological disorders, leaving a side it is limited motion monitoring and recording. Lin et al. (2004) developed a rehabilitation system with a double-CCD camera to exercise hand grasp-and-place movements, so that their upper limb movement and trigger trunk control and balance can be improved. Vousdoukas et al. (2012) presented a stereo vision motion tracking system for the detection and assessment of human motor reactivity elicited by sensory stimulation. The system achieved robust performance with low cost. Broeren et al. (2008) investigated the effects of virtual reality technology for stroke rehabilitation. They provided evidence that virtual reality rehabilitation can increase stroke subjects’ motor and cognitive skills and showed that virtual reality can achieve a real-time quantitative 3D task analysis. Pyk et al. (2008) presented a virtual reality-based therapy system for arm and hand rehabilitation in children. They stated that the system can reduce staff therapy cost, increase patient motivation, and evaluate objectively patient progress. Cho et al. (2013) developed and tested a rehabilitation system based on virtual reality proprioceptive feedback training. It improved the motor control of stroke patients. Some researchers have worked on applications to develop customized virtual reality-based rehabilitation exercises. Avola et al. (2013) described an open gesture recognition framework, which is supported within a virtual environment creator, for fast prototyping of customized rehabilitation exercises in virtual scenarios. Badesa et al. (2013) presented a classification method to automatically adapt the therapy and real-time displays of a virtual reality system to the specific needs and demands on the patient. Having said, that many issues need further research; for instance, vision-based motion analysis for epilepsy diagnosis and rehabilitation (Zhou 2008).

3. Kinect

Devices have also arisen outside of the field of rehabilitation research that can be very useful. Such is the case of the Microsoft® Kinect device, which achieves 3D body motion capture. Following its appearance in 2010, a great number of applications of different nature have been developed, which use the motion tracking that the Kinect device provides. Among these applications, some focus on rehabilitation tasks. Chang et al. (2011) applied the Kinect for the rehabilitation of two people with motor disabilities. Human body motion capture was used to determine the correct and incorrect performance of exercises in physical rehabilitation. They concluded that the Kinect device can motivate physical rehabilitation. The patient can carry out the rehabilitation prescribed by the therapist autonomously. Lange et al. (2011) developed a game to train reaching and weight shift to improve balance in adults with neurological injury using the Kinect device. They also stated the potential of the Kinect device as a rehabilitation tool.

Kinect for Windows gives computers eyes, ears, and the capacity to use those (Kinect for Windows, 2013). Kinect sensor gets the information stream (such as video, depth, and audio stream) and delivers to Natural User Interface (NUI) library.

4. Kinect Application

Human body part detection and tracking has a wide range of applications. In the past, camera-based motion capture systems that required cumbersome markers or suits were used. Recent research has focused on marker-free camera-based systems. The complexity of such systems regarding image processing depends largely on how the scene is captured. When 2D cameras are used, problems such as the variety of human motions, occlusions between limbs or with other body parts, and the sensitivity to illumination changes are difficult to cope with.

These problems can be faced with capture system that provides depth information. To that end, multi-camera systems or binocular cameras can be used (Avola et al., 2013; Broeren et al., 2008; Musen et al., 2001). Another type of depth cameras are Time of Flight (TOF) cameras. They use an
infrared light beam to illuminate the scene and then they measure the phase lag between the waves sent by the transmitter to the receiver device. TOF cameras are very precise but require complex hardware, are expensive and provide a low resolution, e.g. depth image can have a resolution of 176 × 144. As a low-cost alternative, the Kinect sensor adds on for the Microsoft Xbox 360 TM video game platform came out at the end of 2010. It includes a structured light camera with a conventional RGB camera that can be calibrated to the same reference frame. The Kinect device interprets the 3D information of the scene obtained through infrared structured light that is read by a standard CMOS sensor. It was designed to allow users to interact with the gaming system without the need for a traditional hand held controller. Instead, the sensor recognizes the user’s gestures.

Although the Kinect device was developed as an add-on for the Xbox 360 platform, it can be connected to a PC via a USB port. Initially, Microsoft did not launch official drivers to use the Kinect device with a PC. Some libraries were developed to make the most of the functionalities of Kinect shortly after. Eventually, Microsoft launched a Kinect software development kit in June 2011. Since its commercial launch, many developers and researchers have used the Kinect device in their work, in different areas, e.g. head pose and facial expression tracking, hand gesture recognition, human activity recognition, and health care applications. Schwarz et al. (2012) presented a method for human body pose estimation using depth data extracted from TOF cameras and the Kinect device. The Kinect depth images lead to higher stability in landmark locations and more robustness to noise. The use of an off-the-shelf device such as the Kinect device in diverse computer vision-based systems can make life easier to many people, particularly the individuals with a disability. For instance, Dutta (2012) studied the validity of the Kinect device to assess the postural control and concluded that it may provide comparable data to a 3D motion analysis system for performing ergonomics assessment.

Hu et al. (2012) presented a tracking system that estimates the 3D pose of a wheeled walker user’s lower limbs with Kinect. The tracker showed robustness against partial occlusions and missing observations. Chang et al. (2011) used Kinect in a system to facilitate task prompts needed by people with cognitive impairments. Their system uses the Kinect device to achieve human body joint tracking and facial feature detection (nose, eyes, ad ears) so that psychomotor exercises which consist of touching a facial feature with a hand or raising a hand can be monitored and the correct and incorrect realization of the exercise can be determined.

5. Kinect in Learning Process
Over the last few years, with a purpose to entertain the users, the companies have launched in the market several new platforms. However, using these platforms properly, some of them can even be used in the educational process. A typical example is the platform of Microsoft Kinect for Xbox 360.

5.1 How does Kinect function?
“The identity of technology behind Microsoft’s Kinect for the Xbox 360 provides enhanced gaming and entertainment experiences by combining multiple technologies based on the use of RGB cameras, depth-sensing, and careful user interaction design” (Zhang 2012).

“Kinect’s system tracks users’ identity based on three techniques: face recognition, clothing color tracking, and height estimation” (Xia et al., 2011). Each time a user attempts to connect, the system goes back to the database to check out if the user has been reconnected before. If they have played in the past, it pulls the old profile and the users continue with this one. If it is about a new user, then the system creates a new personal profile. Of course, as the aforementioned criteria can be modified, such as the color of clothes, Kinect puts more emphasis on the biometric characteristics of each user to create a more complete profile.

As every other typical computer game, so Kinect relies on the interaction that exists between the user and the computer. “Human-computer interaction (HCI) is a fundamental pillar in the Information Technology discipline.

Any interactive computing system involves one or more interfaces with which a user can provide commands and get results. The development of graphical user interfaces has provided users with varying levels of computer skills in order to use a wide variety of software applications. The development of natural user interfaces provides more intuitive ways of interacting with the computing
device. The development of natural user interfaces is expected to make it easy for users. It is about to learn how to use the interface in the quickest possible way (Chang et al., 2011).

“HCI design should consider many aspects of human behaviors and needs to be useful” (Lange et al., 2011). “The complexity of the degree of the involvement of a human in interaction with a machine is sometimes invisible compared to the simplicity of the interaction method itself. The existing interfaces differ in the degree of complexity. Those are because of degree of functionality/usability and the financial and economical aspect of the machine in market” (Lange et al., 2011).

“With the rise of portable devices, e.g. tablets and smart-phones, and motion-sensing controller such as the Microsoft Kinect, Nintendo WiiMote and the Playstation Move, people have shown huge interest and motivation to develop new and interactive methods or teaching” (Oikonomidis et al., 2011).

6. Software Methodology

6.1 RUP
IBM Rational Unified Process, RUP, is an exhaustive methodology schema that gives industry tried practices for programming and frameworks conveyance and usage and viable task administration (Kruchten, 2003). It is one of numerous techniques held inside the Rational Process Library which offers best practices direction suited to your specific advancement or undertaking need. IBM Rational Method Composer permits you to effectively alter RUP to help your undertaking. It empowers you to select and convey just the procedure segments you need, and afterward distribute it through your intranet (IBM, 2010). The RUP process structure with IBM Rational Method Composer gives:

Methodologies focused around the best practices received in many ventures around the world. Abstain from developing everything without any preparation and reuse forms that have been fruitful for different associations.

Ability designs that permit venture directors to quickly include or evacuate reusable pieces of methods tending to regular issues. Since no two activities are apparently equivalent, venture administrators can quickly adjust the methodology to address particular extend needs.

Out-of-the-case conveyance techniques to give the task administrator a snappy beginning stage for planning and initiating a venture. A conveyance procedure will give a starting undertaking layout, recognize what sort points of reference to have in the task, what work items to convey by every development, and what assets are required for each one stage. RUP advertises iterative advancement and comprises the improvement of programming and frameworks into four stages, each one comprising of one or more executable emphases of the product at that phase of development (Kruchten, 2003).

The RUP has four project life cycle phases such as listed below:
1) Inception phase
2) Elaboration phase
3) Construction phase
4) Transition phase

According to the inception phase, all software requirements would be analysis by many meeting business analyzer and customer. In meeting durations, the developer can understand every detail requirements. The result of the analysis would be tabulated and graphed based on UML tools in elaboration phase. Then in construction phase the analysis transform into the code and development. The finalized code would be tested, documented and released at transition phase.

5. Conclusion
In this research, the proposed system was presented from scratch. Every software development has difficulties such as project management, selecting best software methodology to manage codes and implementations. It is leant that the wrong software methodology provides negative effects on requirement analysis. The researcher found that the requirement analysis is very significant step of software development. The chains of between steps make management difficulty to monitor the code
quality. Other difficulty was found in implementation plan. The effect of software methodology always can make worst planning which the finalized product could not meet the high quality software. In order to reduce project difficulty, more specific researches are done to find better knowledge; those knowledge support researcher to find better decision to choose software methodology and better research methodology for enhancing proposed system software quality. The good software methodology can enhance the quality of implementation and increase the customer satisfaction according to the finalized software. Researcher found that the only software methodology which could increase the chance of success of current proposed system is RUP.

References


