Musical Exercise as Physiotherapy

Ridwan Ahmed Khan

Graduate Student, Computer Science

Michigan Technological University

1400 Townsend Drive, Houghton

MI, 49931, USA.

ridwank@mtu.edues

ABSTRACT

Physical exercise is necessary to one's good health. But it is not enough to keep up one's motivation to do exercise regularly. Also there are cases when physiotherapy in the shape of exercise is a must. Still then, doing exercise regularly is hard for anyone. Sometimes even if people do exercise, they cannot be certain that, they are doing it in the right way. These types of problems are addressed in this paper and we have discussed different solutions using technologies. This technical solutions have adopted different ways to motivate people to do exercise and also give feedback about its proper form of exercises. Our proposal is one of these solution. But its novelty lies in uses of gesture based devices for exercising and music to motivate and give feedback to people. Discussion of our proposed system and its comparisons with other techniques is main theme of this research paper.

Author Keywords

Auditory feedback, Human Computer Interaction, Physical exercise, Virtual Reality, Kinect.

INTRODUCTION

Physical exercise is essential for good health. Doing exercise is not only beneficial for physical health [1] but also for mental health [2]. Yet people are usually reluctant to physical exercise. The reasons are many. The benefits of physical exercise can be gotten instantly where people want quick result. To be physically fit, a person need to do exercise regularly. It seems boring and monotonous to the people. In today's busy world going to outside needs time and motivation. Also some people need to do physical exercise to keep moving their limbs. Due to some accidents or physical disability they have lost the normal functionality of their limbs. They need to do some precise exercise as physiotherapy for a long time to recover their health. They need to go the physiotherapy center and do the exercise. A doctor or a nurse will observe the exercise and fix the patient's exercise form if needed. But this effort need lots of manpower and money. If these patients can do these prescribed exercise by themselves in their home environment then it would

been great for them. It will save them time and money. They will feel comfortable in their home environment. Moreover, if there is a way they can know about the correctness of their exercise then it will save another person's effort of constant watching the exercise to figure out whether it is in the right way or not. Therefore in this new age of technological advancement, people are integrating technology in doing physical exercise without other's help and making it more fun, enjoyable. Many researchers are proposing different technologies to do the task. Different wearable tracking devices like Fitbit [3] are invented to keep track of physical activities. Some 3D tracking devices like Kinect, Nintendo Wii have been used to track people's physical movements. All these devices are used to make users aware of their physical activities in various ways and these can used by the users themselves without going to physiotherapy center or gym. Many software specially smartphone applications are developed with the purpose to making physical exercise fun and informed for people like an application developed for obese people [4]. In this paper, we are going to propose our system design using Kinect which is developed by Microsoft. Our proposed system will keep track of the movements of the user and at the same time it will update the user in real time about how they are doing in the exercise. It will help them correct their exercise posture and their movements. Our proposed system is novel in a way that it will make the physical exercise fun again by adding music. Music alleviates boredom and fatigue [5] while doing repetitive work like physical exercise. Moreover, in our proposed system design, we plan to use music to provide auditory feedback to the user about their exercise in addition to visual real time feedback.

BACKGROUND AND RELATED WORKS

Use of technology to elevate physical exercise into a more fun and motivating chore is not new idea. Many researchers have invested their time into finding the appropriate use of technology in making people do their exercise. Also there are some research on how to make the exercise easy for people with some disabilities. One such research [6] uses Kinect which combines the aspect of virtual reality and natural user interface in a game for patients having Parkinson's Disease (PD). The patients use the developed system for motor rehabilitation exercises by playing the game. In the author's field study with patients, they found improvements in condition of the patients. Another study [7] also uses Kinect based game for people who has to use wheel chair. The authors developed a game that required full body motion while sitting in a wheel chair to play the game. This game can be used for people who cannot walk to support their physical exercise to some extents. Similar research [8] which also based on Kinect is used for rehabilitation purpose of movement disorders in patients. The authors have used Tai Chi movement as the exercise for the patient. They proposed an exercise program and if patient can be rated on how well they have done in the list of exercises. This system provides a way for the patients with movement disabilities to do their exercises in an interactive way. Another research [9] also uses Kinect based system for older adults to motivate them to exercise. The authors built a prototype system where they have arm raising to touch a point virtually as an exercise. They experimented with their prototype system and found out integrating social network feature in the system and more visually animated system can motivate people to do exercise. Another interesting system developed [10] which also utilizes Kinect to do some cycling. The system is called PaperDude which is a game where a player will mount on a real fixed bike, paddle it and deliver newspapers from door to door in the virtual world. The fixed cycle has power trainer which records the speed and Kinect is used to detect the hand movements for throwing the newspaper. User wears an Occulas Rift VR to see the virtual world

where he/she has to deliver newspaper. In the process of this game, user get cycling exercise in an entertaining and challenging way. An application named "MOPET" is proposed by Buttusi and et al [11] which uses GPS sensor of smartphone and track user's running in a fitness trail. The application has a virtual character which shows user how to do the exercise with 3D animation which can motivate them to do the exercise. A system with auditory feedback was developed by Singh and et al [12] to support exercise for people with chronic pain. The researchers found that auditory feedback in different phases of exercise is very useful and informative to patients. And if the audio is tailored to one's personality then the exercise become psychologically motivating. Another system [13] works as a game to aid upper extremities rehabilitation developed by Huang and et al. The authors have used a wearable glove and Kinect to play a game which will help patients to improve their upper extremities rehabilitation exercises. Another research uses Nintendo Wii Balance Board to play a game which can be helpful for patients with Parkinson's Disease [14]. This system is called ABAR which is developed by Albiol-Perez and et al. This system incorporates a game which can be played by the patient using the Wii board keeping their balance in both sitting and standing position. This training system works as balance rehabilitation exercise for patients with Parkinson's Disease. Another interesting study [15] shows us that multimodal feedback can be helpful to older adults for performance gain while doing an activity. There are other similar studies where virtual reality devices have been used to aid people in exercising or rehabilitating. Next we are going to discuss our proposed system.

OUR PROPOSED SYSTEM

Our proposed system is based on two usability concepts. First concept is, we will use unobtrusive technology to record the physical exercise for therapy. Using unobtrusive technology give us flexibility that user can behave properly like in a normal scenario. Users can exercise in a relaxed way without any handicap. The second concept is we will use musical sounds to provide feedback about how well the user is doing exercise. Another secondary effect of using musical sound is that, people feel motivated when they listen music while doing monotonous work like exercise. We are going to use Kinect as our unobtrusive technology to build our proposed system. Kinect hardware is developed by Microsoft. It can track body and limb movements easily with the help of camera and IR sensor (Infrared sensor) from a distant place. So users do not need to wear anything for the purpose of tracking their movements. User will do the exercise and Kinect will monitor the movements. We will develop a system software which will fetch the skeleton data provided by the Kinect and analyze it. Our software will store these user's movement data. Ideal movement data will also be stored in the software. Then our software system will compare the ideal movement data with the user's real time movement data. If user's movement data is greater than a range of flexible error margins, our software system will produce warning sound. Otherwise if user does the movements properly and in the prescribed way, sound music will play rhythmically. The music will be happy instrumental music so that user remains happy and motivated. Deviations from the prescribed movement will increase the pitch of the sound. So if the deviation is high, then a warning sound will be played by the software. In this way, user will get auditory feedback. Using Kinect, we will record the skeletal movement data of the user. So if error occurs, user can easily play the recordings and see the deviations from the ideal movement. User will also see the real

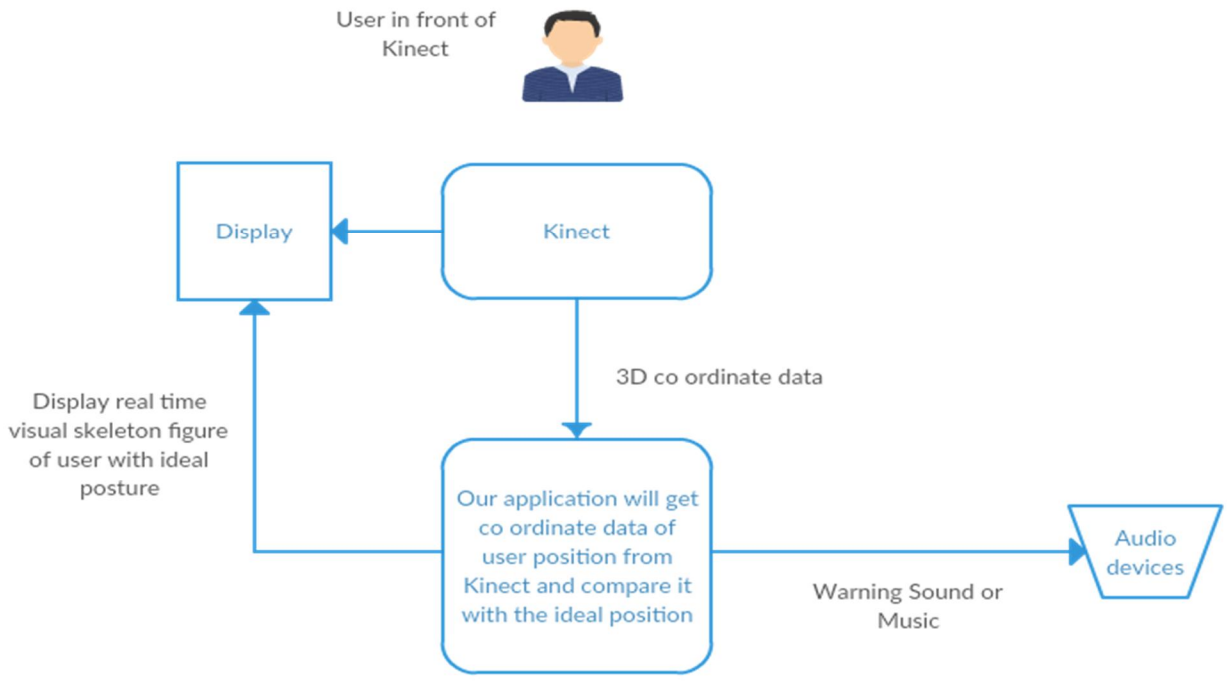

Figure 1: Our proposed system in a block diagram

time movement in a graphical skeleton form by the software which will work as a mirror. This will make user aware how to move and align their movements to the prescribed paths. Both visual and auditory feedback make user fully aware of how the user is doing the exercise. We will add ranking system among users based on points. Specific badges will be provided if certain amount of points are accumulated by the user. This will increase the motivation level of the users. A user will compete with other users and see where the user stands in the ranking. We also plan to integrate social platforms in our system so that users can publish their achievements like virtual badges in the social networks. In this way, they will have the proper motivation of doing the exercise for their physiotherapy. User can maintain their ideal form of exercise with the aid audio and visual feedback. At the same time, listening to music while exercising make this monotonous work enjoyable for users. They can have feel of their achievements by collecting virtual badges of accomplishments and sharing those in the social network. It will create a healthy competition between peers to do exercise. So not only the people who need to do exercise for their physiotherapy gets benefitted, but also the people who is doing exercise to keep good health can rejuvenate their motivation using our proposed system.

COMPARISION AND ADVANTAGES OF OUR PROPOSED SYSTEM

In this section, we are going to describe similar systems like ours and compare with these systems. The first system, as described in [8] uses Tai Chi movements to make patients exercise. That system is also using Kinect to track the movements and based on the form of the patients, it divided the rating of the movement into four criteria. This system only provides visual feedback in text form. There is no audio feedback or real time feedback. This system first determines a baseline for the patient specific movement and on that it scores the practice movement. The aim of that project

is also the same as ours – to provide rehabilitation system at low cost in the home environment. But our system provides real time audio feedback to the user. So user can easily understand whether they are moving in the right way while moving their limbs. Also our system works for keeping up user's motivation to do exercise regularly. But the system [8] developed by Ting-Yang Lin and et al has no such provision. Our system use peer ranking system, social acknowledgement and music for motivation. Our system will act as an entertaining game by playing which people will accomplish the goal of good physical health.

Another similar system is developed by Samyukta Ganesan and Lisa Anthony [9] which also uses Kinect to make older people to do exercise. It is a prototype system where the authors used arm raising as an exercise. They consulted with a Wellness manager who works with the older people to motivate them to exercise and concluded that arm raising is a good starting exercise for older adults. Then they experimented with users where they need to raise their arms to certain position to touch a virtual object. They found that, using Kinect to track the movement is an efficient way. Their system show real time visual feedback of how the user is moving but there is no audio feedback. Also they experimented for short term period. For long term period to do exercise, motivation is essential. The authors did not consider this but their future works include adding audio feedback and ranking system into the prototype. Compare to their system design, our proposed system if developed with all the features can serve the purpose of their designed system. Moreover our system's aim to keep user motivated to do the exercise which makes our system different than others.

CHALLENGES

We need to develop our proposed system in a robust way so that multiple modules of the applications like displaying skeletal images and playing the sound accordingly works in harmony. After developing this audio visual feedback system, we plan to integrate haptic displays in our system so that users who have disabilities in the area of hearing or visual can perfectly use our system and get benefitted from it. But at the same time we have to find out a haptic display which can serve our purpose and go with the developed system as well as it will unobtrusive to the minimum while doing the exercise. We also plan to include physicians in our system in future so that they can easily prescribe patients about the movements. The physicians will also record videos of physical exercise or therapy and send it to the patients to do it. Our future system will also keep track of the patient's progress given a prescribed program schedule by the physicians. Also there will be some playlist videos for new users to follow. These playlists will have some basic movements. Developing the system, to recognize different kinds of movement is also a challenge. Machine learning techniques can help develop this feature of recognizing new and various movements. So integrating machine learning technique in our system is a big challenge as there are plethora of features to consider while developing a machine learning technique. Which features like time of movement, position of body limbs etc. are important is a matter of concerns. To resolve this, we need to do a pilot study once our system is developed involving people who need physiotherapy, people who do exercise to maintain good health and also the physicians who can point out important factors in an exercise. Also for some exercises front view of the body is not enough, so we need to provide side view of the body with another Kinect as well. So synchronizing two Kinect devices at the same time also another challenge we need to handle after we develop our system. Also we have to experiment with out sounds. Which type of sound are good for

feedback or giving users to customize the sound can also be an option. We need to take opinion of the psychologists and sound designers in this regard to design sounds for our users. The challenges of this project are endless. We have to develop our system at first. Then in an iterative process, we can solve the challenges one by one which will make our system more useful and robust.

CONCLUSION

Technology is continuously shaping our life. Using technology in the field of physical exercise or physiotherapy can benefit us a lot. To use technology to its potential, we need explore different new ways of using it and its usability. Our proposed system is one of those ideas. We need to develop our system at first. Then we need to test it in real life and see its implications. But the idea is promising. It is unique in way of using two forms of feedback models in the shape of audio and visual. Then again real time feedback is essential to the users so that they can instantly correct their posture. Sound is a unique part of our system. We will use sound for both as feedback medium and as entertainment. Integrating all of these ideas into our single system make it novel and useful but we need to test it in the real life to see the results. We hope that our system will play a major role in the field of using technology for the benefit of good health.

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