International Journal of Trend in Scientific Research and Development (IJTSRD)
International Open Access Journal | www.ijtsrd.com

ISSN No: 2456 - 6470 | Volume - 2 | Issue – 6 | Sep – Oct 2018

To Design and Develop Intelligent Exercise System

Nitu Sharma[1], Nitin Janwe[2]
[1]Student, [2]Head of Department
Rajiv Gandhi College of Engineering Research and Technology, Chandrapur, Maharashtra, India

ABSTRACT

As the population increases result in rise in the occurrences of accident .The person need a physical exercise as followed by doctor to overcome the injury happed during accident. The every individual also required proper physical exercise. This paper explains the automatic intelligent exercise system. The system is implemented with the help of kinet sensor. The camera is very efficient it will track a person at a distance of 10 to 15 foot. The framework forms profundity data to overcome the deficiencies of a formerly introduced 2D vision framework for a similar application. A review literature on human motion recognition techniques used in Kinet applications. We provide a classification of motion recognition techniques to highlight the different approaches used in human motion recognition.

Keyword: *Kinet, skeleton tracking, depth sensor.*

I. INTRODUCTION

Microsoft Kinect is a device originally designed for sensing human motion and developed as an controller for Xbox game console that is being sold since 2010. It did not take too long for researchers to notice that its applicability goes beyond playing video games, but to be used as a depth sensor that facilitates interaction using gestures and body motion. In 2013, a new Kinect device is introduced with the new game console called as Kinect v2 or Kinect for Xbox One. The new Kinect replaced the older technologies and brought much advancement to the quality and performance of the system. The older Kinect named as Kinect v1 or Kinect for Xbox 360 after new Kinect's arrival.

A. Kinect Hardware Specifications

The Kinect for Xbox 360 has a RGB camera as the color sensor, and a depth sensor comprised of an infrared (IR) light source emitter and an IR depth sensor. The later Kinect brings out new technologies with an IR illuminator and an IR Time-Of-Flight (TOF) depth sensor. Both Kinects and a detailed comparison of their specifications are shown in Fig. 1 [1, 2, 3, and 4].

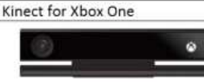
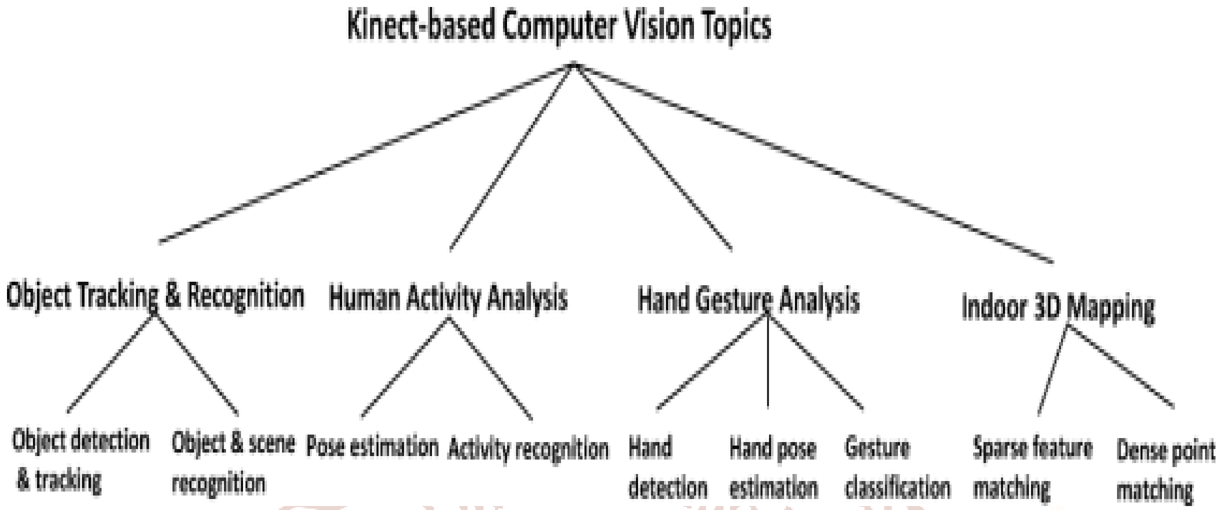
Device	Kinect for Xbox 360	Kinect for Xbox One
Photo		
Color Camera	640 x 480 @30 FPS	1920 x 1080 @30 FPS
Depth Camera	320 x 240	512 x 424
Min / Max Depth Distance	40 cm / 4.5 m	50 cm / 8 m
Horizontal Field Of View	57 degrees	70 degrees
Vertical Field of View	43 degrees	60 degrees
Tilt Motor	Yes	No
Number of Skeleton Joints Identified	20	25
Number of Full Skeletons Tracked	2	6
USB Standard	2.0	3.0
Minimum Latency (Lag)	102 ms	20 ms
Active IR (able to use in dark/low light)	No	Yes

Fig.1. A comparison of specifications for Kinect versions

B. Computer Vision Capabilities of Kinect

Although it is categorized as a depth camera, the Kinect sensor is more than that. It has several advanced sensing hardware containing a color camera, a depth sensor, and a four-microphone array. These sensors ensure different opportunities at 3D motion capture, face and voice recognition areas [5]. While Kinect for Xbox 360 uses a structured light model to get a depth map of a scene, Kinect for Xbox One uses a faster and more accurate TOF sensor. After the arrival of Kinect, it did not take long that the computer vision community discovered the potential of Kinect that could extend far beyond gaming. Kinect costs much lower than traditional 3-D cameras (such as stereo cameras and time- of-flight (TOF) cameras) [6]. Not only indoor 3-D mapping, Kinect may be used for many other Computer Vision topics including object tracking and recognition, human activity analysis, and hand gesture recognition. A tree-structured classification in Fig.2 shows what kind of vision problems can be addressed or enhanced by means of the Kinect sensor. Taking account of these topics, we can say that Kinect shows a great potential for academic studies in many areas



C. Kinect Skeletal Tracking

The key to the innovation behind Kinect is its advanced skeletal tracking ability. In skeletal tracking, RGB and depth streams are processed by the software to create a visual stick skeleton to represent the human body. Skeleton is constructed by a number of joints representing body parts such as head, neck, shoulders, and arms. After calculating 3D coordinates of all joints, Kinect succeeds at determining all the 3D parameters of these joints in real time to allow fluent interactivity [5]. Fig. 3 shows all the joints and their labels supported by Kinect for Xbox One sensor and the constructed skeleton map [7].

II. LITERATURE SURVEY

Shoulder injuries are very regular in sports and certain labour concentrated occupations. While some injuries are minor and full recovery is within 1-2 weeks, some major injuries requires the person to consult a physiotherapist and follow an exercise plan. Hidden Markov Models (HMM) for recognition and a histogram-based comparison for computing the accuracy score. The Microsoft Kinect sensor is used to obtain 3D coordinates of human joints. Important features are extracted from the skeletal coordinates which are then quantized into 16 intermediate upper-body poses. It intends to help the patient by keeping track of daily exercise routine, advising for improvements and maintaining records for doctor to access. [1]

The difficulty of vision-based posture estimation is really decreased with the aid of profitable depth camera, such as Microsoft Kinect. Yet, there is still much to do to bridge the results of human posture estimation and the understanding of human movements. The experiments are conducted on the videos of ten action types, and the results show that the proposed human action descriptor is representative for action video retrieval and the tutor system can successfully help the user while learning action movements [2]

The design and implementation of a Kinect-based system for rehabilitation exercises monitoring and guidance has been developed in this paper. The Unity framework frame work has been used to implement system because it enables to use virtual reality techniques to demonstrate detailed movements to the patient and to facilitate examination of the quality and quantity of the patient sessions by the clinician. A set of basic rule elements has been developed that can be used to express the correctness rules for common rehabilitation exercises [3].

III. HUMAN MOTION AT JOINT LEVEL

Fig. 2 illustrates the range of motion allowed by human joints [16]. For the elbow (Fig. 2a), only the flexion and extension will be measured, therefore a single degree of freedom (DoF) is allowed. The angles are reported with respect to the horizontal and vertical direction. The rotation of the forearm (supination and pronation) cannot be captured due to the fact that only one sensor is used in the current platform. For the shoulder and the hip (Fig. 2b and

2c), three different motions are allowed: extension and flexion, abduction and adduction and rotation. The rotation cannot be measured, therefore at the level of these joints 2 DoF are allowed. Similarly, at the level of the knee (Fig. 2d), one DoF can be quantified. Due to the sensitivity of the sensor, for the moment the quantification is not performed at the level of the neck and ankles.

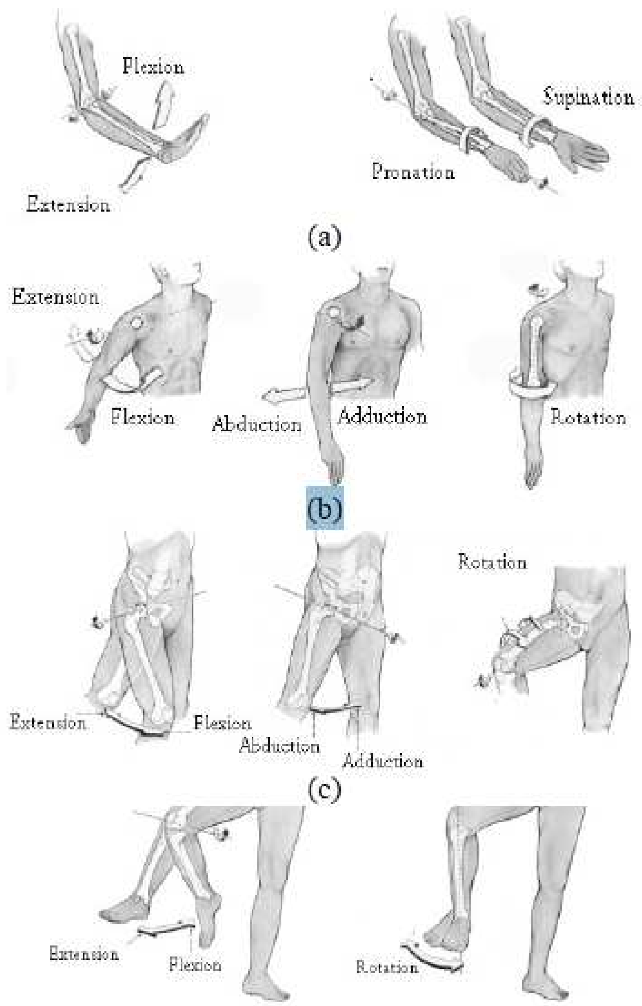


Fig.2. Human motion characterization at joints: (a) elbow, (b) shoulder, (c) hip and (d) knee [16]

D. Movement Quantification at Joints

Using Kinect Several measures of an exercise sequence are monitored in real-time. Some are reported online, for example the angles at joints, while others are presented at the end of the sequence, namely the evolution of the position and velocity of each joint, the working envelope, and the rate of fatigue. *Position of joints:* The evolution in time of each joint can be measured in time by tracking its corresponding marker, shown as a red dot in Fig. 3. Graphs of this evolution are presented for each joint at the end of the exercise sequence. *Angles at joints:* In order to calculate the angles, the scalar product is computed between the corresponding segments that connect at a given joint. For example, to compute the angle at the level of the elbow, the scalar product is calculated between the normalized forearm and upper arm vectors as:

$$\theta = \cos^{-1}\left(\frac{a \cdot b}{\|a\|\,\|b\|}\right)$$

Where a and b are the two vectors,. Represents the norm of a vector and θ the angle between them. The values of all angles are presented in real-time in the user interface along with the tracked skeleton and a color image of the subject executing the exercise as shown in

Fig. 3.Functional working envelope: In clinical practice, the range of motion assessment is a quantitative method that allows evaluating the movement and the functional status of an impaired extremity [17]. The functional working envelope is closely related to the range of motion and defines the volume generated by every possible point touched by a given body part. The functional reaching volume is the space within which a person can interact with the environment around them. A larger volume likely correlates with an increase in the functional ability. This volume is obtained in the current application as the alpha-shape of all points that the body part contacts in space [17, 18]. An alpha-shape is a generalization of the convex hull and a sub-graph of the Delaunay triangulation. It therefore consists on an approximation of a concave surface containing a set of points [18], points that represent the tracked joints of the skeleton in the current work.

Velocity of joints:
The evolution of velocity, computed as the distance travelled by the joint of interest in the time interval, is monitored for each joint during the exercise sequence.

Rate of fatigue:
One final component essential for the quantification procedure is the ability to sustain the movement. The rate by which a person fatigues, or the rate by which the velocity of his/her movements declines, is directly related to the amount of functional work that can be performed. The rate of fatigue is the average difference in the movement velocity in the first versus the last half of an exercise sequence, as in [6]. A decline in velocity is associated with fatigue. By reporting fatigue as a decrease in velocity over the

first and second part of the exercise sequence, the application does not penalize a subject who moves slowly in general, but does not show a decrease in velocity from the beginning to the end.

IV. SYSTEM ARCHITECTURE

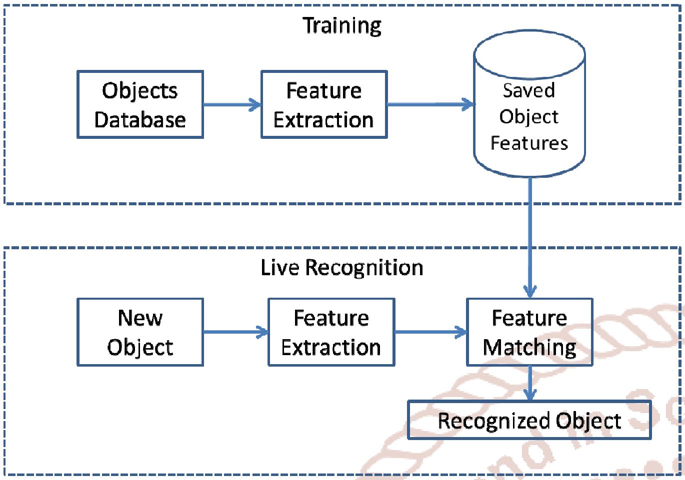


Fig.2. Kinet based Physical Rehabilitation system

A Kinect-based rehabilitation system is shown in Fig2. Kinect sensor was utilized to record their movements. These movements are captured by color image, depth image and skeleton. The image is tracked. Performed by the coaches are considered as standard movement, and the skeleton of these movements are used as a feature and trained by Support vector machine. During recognition process the new feature are extracted and then compared with the database trained by SVM. The classification is done by multisvm. When a person uses this rehabilitation system, the system first displays standard movements on the screen. Then person follows the information on screen to perform compared to the movements of coaches by comparing the skeletons. The results will show on screen to inform the user.

Result Analysis

Sr. No	Exercise	No. Of Attempts	Correct/ Incorrect Detection	Accuracy (%)
1	Pos. 1	10	10	100
2	Pos. 2	10	10	100
3	Pos. 3	10	10	100
Total Accuracy			100%	

CONCLUSION

Thus, the paper proposes to develop a home training system which allows users to perform exercises under supervision anywhere, thereby, reducing the need for users to travel to the gym to perform basic routine exercises. This system promotes health and fitness amongst the youth and elderly alike. If used regularly, it serves as a guide and mentor to perform certain compound movements accurately, eliminating the possibility of injuries that may be caused due to incorrect form.

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