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Measurement of Velocity and Acceleration of Human Movement for Analysis of Body Dynamics

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Abstract

Human posture recognition is gaining increasing attention in the field of computer vision as well as image processing, due to its promising applications in the areas of personal health care, environmental awareness, human-computer-interaction and surveillance systems. Human posture recognition in video sequences is a highly challenging task which is part of the more general problem of video sequence interpretation. In this paper a non-contact view-based approach for measurement of velocity and acceleration of human movement for analysis of body dynamics using kinect camera is introduced. In the first step, twenty body-joint points of skeletal structure of the human body are extracted. Then, Array of joint points is stored. Finally Using obtained Array of joint points calculates the velocity.

Keywords

Human Joint Analysis, Human Motion, Kinect, Depth Images, Human Skeletal Joints Model.

I. Introduction

An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows. Human motions are colourful, different motions often represent different meanings. In many application cases, such as behaviour monitoring and motion analysis, human motions hope to be presented comprehensively, but it is difficult in 2D space. However, if we can recognize human postures in real-time and display recognition results in 3D space, we can restore human postures more accurately and vividly which is convenient for people to observe and learn human motions. For this objective, it is necessary to find a method to recognize human postures in 3D space.

The process to capture human movement and motions patterns on camera to make them Computer readable has been steadily developing and advancing for the last two decades. From bio-mechanical research to life-like movie and videogame character animations, the technology to track complex human movements and translate them into three-dimensional models in software has had an immense impact on many different areas.

The process of this so-called 'motion capturing' (or 'Mo-cap' for short) is usually a very time-consuming and resource-intensive process. Actors have to wear specialized suits equipped with infrared reflectors, performing on a specifically rigged stage that is captured by a multitude of cameras from different angles. The movement data is then captured by recording the special markers on the actor, and fed to the computer using specialized software to combine all camera angles into a single, unified capture frame. This data can then be used to animate a character in a videogame or movie, or further processed for research and other purposes. The amount of time, effort and financial resources required to realize this are substantial and usually not very feasible on a large scale. Lowering the cost and effort for accurate motion capturing has been a big focus in related research. The need for a very Meticulous setup was mainly hamstrung by the absence of a feasible depth-sensing technology that allows for the translation of three-dimensional space to the computer in real-time. Further research was also trying to remove the need for a multiple camera setup and the necessity for specialized markers on actors.

Fig.1 : Microsoft Kinect sensor

It was not until the release of Microsoft's Kinect technology in 2010, when basic motion capturing technology became commercialised and affordable. The dual-camera sensor allowed for three dimensional body tracking without the need for multiple cameras or a meticulous marker setup for the users. Initially designed to work with Microsoft's Xbox 360console, it was developed as an alternative way to interact with games without the need to hold a controller. It was designed to work in a lot of different environments and distances. Its functionality was later expanded to work with any Windows PC; enabling access to the sensor's data using a specifically designed Kinect Software Development Kit (SDK). This step made it economically feasible for developers, gamers, researchers and hobbyists alike to tap into a fully new way of interacting with computers and applications, as well as gathering data and conducting research. The unique functionality of the Kinect sensor, coupled with a fast and uncomplicated setup, an easy development framework, and access to a large amount of online learning resources made a huge impact in the research community. Many different applications for its technology were found, ranging from physiotherapeutic enhancements to remote UAV controls utilizing Kinect.

Microsoft unveiled its Kinect sensor for the Xbox 360 in November 2010. The technology, coming from Israeli-based tech company Prime Sense, was bundled with Microsoft's successful console to attract a new segment of gamers and allow for a new way of interacting with software and games.

Due to the availability of a depth image, this approach greatly cuts down on the computational effort to estimate joint positions, but also allows circumventing the downsides of other, colour-based recognition approaches. The latter were usually influenced by a huge variety of differences in colours of clothing, hair and backgrounds, which hampered usability and robustness (Shotton, et al., 2013). However, correctly proposing joint positions using depth images still has to deal with differences in shapes and sizes. This issue was solved by creating a large training set for the algorithm consisting of both real and synthetic motion capture data across many different poses, body shapes and camera angles. Synthetic poses in this context consist of algorithmically created body shapes, postures and angles to mimic real data and was made to enhance the training sets. They then use a randomized decision forest for each pixel of a depth image to assign a final classification of which body part it belongs to, based on the training set consisting of real and synthetic frames.

A. Purpose of the Project

Human posture recognition in video sequences is a highly challenging task which is part of the more general problem of video sequence interpretation. Human posture recognition is gaining increasing attention in the field of computer vision as well as image processing. Purpose of this project is to measure the velocity and acceleration of human movement using kinect camera is introduced.

B. Scope of the Project

Human body position in physical coordinates is measured and 3D human postures are recognised accurately. Moreover, human features can be extracted according to depth image and human skeletal joints model. This project can be implemented in the self-healthcare application and in the field of sports. This project will also make a significant change in applications such as robotics, medicine etc.

C. Proposed System

This project is to measure the velocity and acceleration of human movement using kinect camera is introduced. In the first step, twenty body-joint points of skeletal structure of the human body are extracted. Then, Array of joint points is stored. Finally Using obtained Array of joint points calculates the velocity and Acceleration.

II. Methodology

The work started with literature survey for detecting human in the real time. Human posture recognition in video sequences is a highly challenging task which is part of the more general problem of video sequence interpretation. Microsoft unveiled its Kinect sensor for the Xbox 360 in November 2010. The technology, coming from Israeli-based tech company Prime Sense, was bundled with Microsoft's successful console to attract a new segment of gamers and allow for a new way of interacting with software and games.

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Initialization of the kinect and obtaining data

Kinect should be initialized by the user and skeletal data should be retrieved from the kinect.

Store in array

Skeletal data from the kinect for required frames are stored in an array

Calculate velocity

Extracted array consists of displacement value with respect to time of particular points. And velocity is calculated using differentiation method for every joint point.

Calculate Acceleration

Rate of change of velocity with respect to time is calculated using differentiation for every joint point.

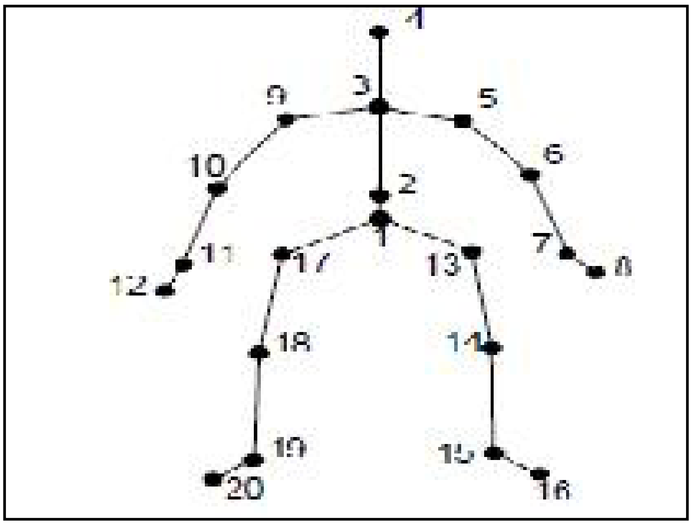

Fig.2 : Skeleton with 20 joint points

Table.1. Skeleton Points

Joint Number	Joint Name	Joint Number	Joint Name
1	Hip Centre	11	Wrist Left
2	Spine	12	Hand left
3	Shoulder Centre	13	Hip Left
4	Head	14	Knee Left
5	Shoulder Left	15	Ankle Left
6	Elbow Left	16	Foot Left
7	Wrist Left	17	Hip Right
8	Hand left	18	Knee Right
9	Shoulder Right	19	Ankle Right
10	Elbow Right	20	Foot Right

III. System Design

The system design refers to plan the solution for a problem analyzed in analysis phase where analysis is the first step in moving from problem to the solution domain. Design generally incur to the overall development maintenance and up gradation of the system under process of development. Here discussion on the high level design and detailed design of the project is done. The various issues that need to be taken care of while designing are also dealt with. Here Problem Partition design principle is used.

In this system, mainly concentrates a non-contact view-based approach for measurement of velocity and acceleration of human movement for analysis of body dynamics using kinect camera is introduced. In the first step, twenty body-joint points of skeletal structure of the human body are extracted. Then, Array of joint points is stored. Finally Using obtained Array of joint points calculates the velocity and Acceleration.

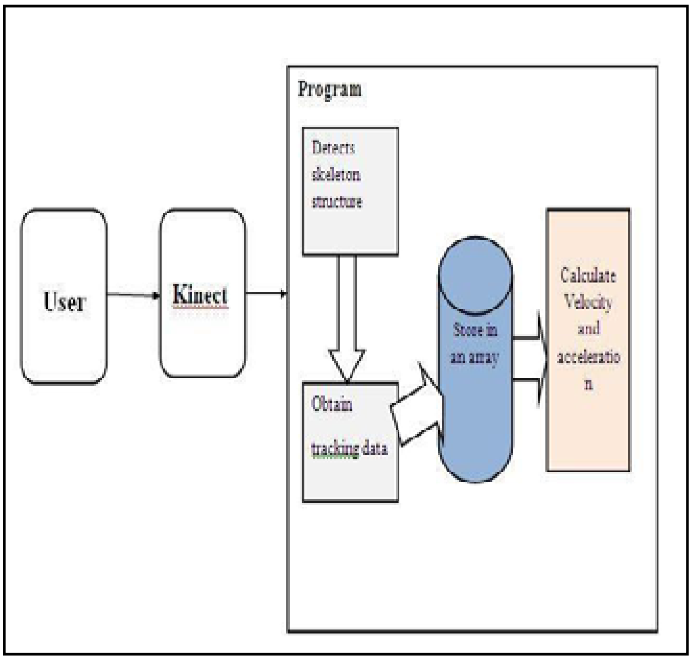

Fig.3 : System Overview

Block diagram of the system is shown in Fig 4. The user first initializes the kinect. Then skeleton data is obtained from the kinect and required data frames are stored in an array. From the obtained array of skeleton data of all joint points extract the data of every joint point separately and store it in an respective array and apply differentiation method and display the velocity and Acceleration.

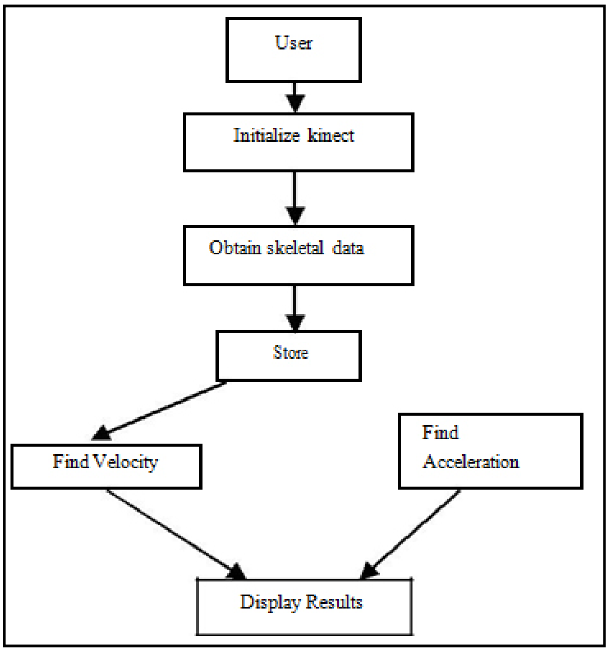

Fig.4 : Block Diagram

IV. Results

From our lab setup, we were able to detect the human very accurately. Even when the human was in different postures. The accuracy for human detection, when human was in FOV of kinect was near to 100%.and velocity and acceleration values of human movement of each joint point displaying correctly as expected. The whole system was implemented in real time and the results were very encouraging.

V. Conclusion

In the proposed a method, 3D human postures are recognized and human joint points are analysed by using Kinect. This method can measure human body position in physical coordinates and recognize 3D human postures accurately. Moreover, human features can be extracted according to depth image and human skeletal joints model. This project has been implemented in the self-healthcare application called self-yoga. This project will also make a significant change in applications such as robotics, medicine etc

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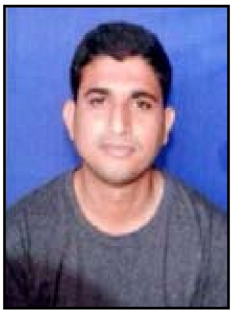
Author's Profile



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