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Kinect Gaming And Physiotherapy

Sachin.V.Singh , Akshay.S.Sonawane , Prajakta Kshirsagar , Yogesh Mahajan

Department Of Computer Engineering
Shatabdi College Of Engineering And Research
Agaskhind. Pincode - 422502
Pune University

Abstract – In this paper we have proposed the system prototype which combines two applications of kinect which are kinect gaming and application of kinect for physiotherapy. The proposed system performs task depending upon some crucial capabilities like Gesture Recognition, Skeletal Tracking, Depth Recognition. All these operations are implemented through kinect camera. Gesture recognition includes tracking the human movements through kinect and identifying the particular part of human body. Skeletal tracking implemented to track the movement of human body by considering human body as skeleton and identifying certain points on skeleton. Depth recognition is implemented to segment the background and foreground of the image and separates person from the background depending upon the pixel color. To perform all these operation we require kinect which is capable to produce depth and RGB streams at cheaper cost than traditional sensors. Kinect consist a time of flight camera which is capable to evaluate the distance of any given point form the kinect sensor. We are implementing open kinect driver framework for kinect which generates 640x480 RGB and depth images at 30 fps(frames per pixel)[1]. Generally kinect is used with console device for per- forming applications. In this proposed system, we are trying to attempt to tackle the problem of skeletal tracking of human body using Microsoft kinect sensor, as console device is expensive hence trying to optimize the hardware by eliminating the use of console device. It is our attempt to optimize the hardware and instead of console device we perform operation by collaborating the kinect with developed system program to perform the specified operations. The final project implementation can be explored and use further to develop specific real time applications.

Keywords – Kinect, Skeletal tracking, Gesture Recognition, Depth Recognition.

1. INTRODUCTION

Kinect is used with console device for applications. In this proposed project work, we are trying to attempt to tackle the problem of skeletal tracking of a human body using the Microsoft kinect sensor, as the console device is expensive hence trying to optimize hardware by eliminating use of console device. The image processing based human recognition is yet a challenging task because of series of complications such as variations in pose, lighting conditions and complexity of background in the tracking environment. This study introduces a methodology to track Human gestures using image processing techniques and depth information generated from the Microsoft Kinect sensor [3]. The main vision behind this system is to optimize the hard- ware. Kinect device is interfaced with system to detect the human body when human body is detected the images are captured by the kinect device then the image is converted into gray scale image i.e. we get RGB (Red, Green, Blue) image and depth image [2]. Images are used to form the skeletal model of the body, in the skeleton model joints of the body are to be recognized by using stick skeletal model algorithm. Movements are performed and these body movements are used in application [6].In this proposed system it is our attempt to collaborate two applications of kinect with one another. Implementation of our proposed system enable user to implement gaming and physiotherapy applications. The core element of our proposed system prototype is kinect Sensor. Kinect sensor is a device which is introduced by Microsoft in November 2010.Generally kinect cam- era is used for gaming purpose in collaboration with the hardware console, which is very expensive. In the pro- posed system it is our attempt to eliminate the expensive hardware and making application work by collaborating with kinect sensor with our application. In our proposed system user can able to play game and the same application can be implemented by user for physiotherapy purpose.

Human computer interaction need to be as natural as possible. The interaction of user or human with the machine should be simple with the use of some simple devices which can be easily operated by users [2].

By the introduction of Kinect camera it is possible to interact with the machine .Kinect implement particular strategies for detection of human features. Kinect sensors implement gesture recognition to detect the body expressions of user [4]. For detecting motion of the body kinect implements a skeletal tracking algorithm by implementation of which motion of human body parts are recognized by Kinect sensors present in kinect camera [6]. Distance of object or human from the kinect camera is evaluated using depth of image. Our proposed system allows user to implement two applications of which are gaming using kinect and implementation of physiotherapy. Gaming application using kinect can be performed by installing a game and kinect camera is interfaced with screen so while playing the game user have to stand in front of the kinect camera and by recognizing the movement of the user, Kinect camera senses the movement and relate with the person in the game.

Physiotherapy is another application which is included in our developed system prototype by which our application gives direction to the user by detecting the motion of the person in front of the Kinect camera. Further future scope of this application can be done by maintaining the log of the poses of the user which can be sent online to the

physiotherapist which then guide the user instructing him to perform in correct manner. Our system include various crucial elements Kinect, Depth Data. Human Skeleton tracking, Gesture recognition,

1.1. KINECT

Kinect is a hardware device which was introduced by Microsoft in 2010 [5]. Kinect is able to generate depth and RGB streams at much lower price. Kinect is device which contains depth sensors color camera and set of microphones kinect is connected to a small mo- tor that make device to be tilted in horizontal direction [1]. Kinect sensor also contains Infrared (IR)emitter ,IR depth sensors, LED [1].

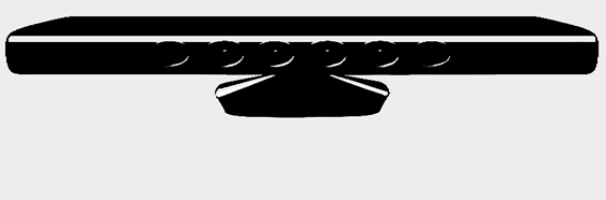

Figure 1. Kinect camera

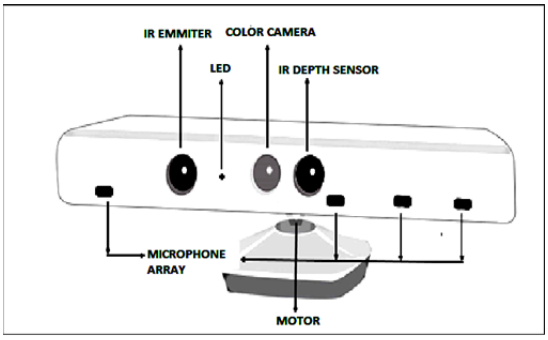

Figure 2. Parts of kinect

1.1.1. COLOR CAMERA

The color camera is responsible for capturing and streaming color data. Function of color camera is to detect red , blue, green from the source. Viewable range of Kinect is 43 degrees vertical by 57 degrees horizontal [1].

1.1.2. IR DEPTH SENSORS

Kinect depth sensor contains IR emitter and IR depth sensor, which works in collaboration with each other to perform a task. IR emitter emits infrared light in a pseudo-random dot pat- tern over everything at the front. Dots are not visible to us but it is possible to capture their depth information using IR depth sensor. The dotted light reflects from different objects which is then read by IR depth sensor- sand converts them into depth information by evaluating the distance between the sensor and the object from where IR dot was read [1].

1.1.3. DEPTH AND DATA PROCESSING

Kinect camera able to capture 3D view of objects which is at its front, despite of lighting condition of room . Kinect camera implements IR emitter and IR depth sensor that is a monochrome CMOS sensor [1].

1.1.4. TILT MOTOR

Kinect camera is interfaced with the motor which enable the camera to move to capture the[every aspect of object in front the camera [1].

1.1.5. MICROPHONE ARRAY

Microphone arrays let the kinect camera to capture sound and also locate the direction of audio wave [1].

1.2. DEPTH RECOGNITION

In Our proposed system object detection is carry out depending upon the depth information captured from kinect camera in a suitable conditions like in- door environments[3]. Here our objects are detected de- pending on 2-stage head detection process , which con- tributes 2D edge detector and 3D shape detector to use edge and relational depth change information in depth image [3]. Our system also implements segmentation method to segment persons from the background objects and extract over all contour of subject accurately

1.3. HUMAN SKELETON TRACKING

In our proposed system to track the movement of human body parts human skeleton is represented by 7 body parts which include 8 points. Head and neck is considered at the cancroids and midpoint of base line of the detection rectangle. Shoulders points are fixed halfway between the face detection and torso detection rectangle base lines with shoulder width set as twice the face width [6].

1.4. GESTURE RECOGNITION

In the proposed system the data collected from kinect camera is use to identify the feasibility of gesture recognition. To recognize full body action we implement full body tracker to identify the location of per- sons hand and recognize patterns in hands movement over time [4]. It includes identification of pixels of image which constitute the hand then extracting the features from those pixels to match pixel of hand to predefined poses the recognize occurrence of specific pose as gesture [4].

2. WHAT OUR SYSTEM INCLUDES

2.1. IMPLEMENTATION OF GAMING USING KINECT

We are implementing the game control system using kinect where a specific game can be played. By capturing the images from kinect camera we will be able to achieve the control over the game. We can play the game by doing various actions (gestures). Consider an example of car racing. In this game by tilting towards
left the car will also move towards left of the track and with more inclination it will take left turn. Similar is with right tilt. When we incline forward the car will accelerate where as backward tilt will indicate the slow- down of the car and more advanced backward inclination will result in car halt stage. Next module proposed in this system is the interaction with computer system where we are going to interact with the computer.

2.2. KINECT HOME BASED PHYSIOTHERAPY

Another but the most important module of our pro- posed system is Kinect based system for home based Physiotherapy (KHPT). In this module we are achieving the goal for assistance for patients to perform exercises at home in absence of a physiotherapist. This is implemented so that even if the therapist is absent patient can do exercises without any side effects. In this system the physiotherapist

will create a log of exercise which is to be performed by patient. Patient will have look at the images sent by physician and try to perform the exercise. These exercise positions will be captured by kinect and will compare it with the images saved in the log by the physician. Matching images indicate that patients are performing the exercises correctly. If the match is not found to be appropriate then a message indicating incorrect posture will pop up. In case the physician need to add or change the steps of exercise for a particular patient can be done as there is a dynamic module designed to adding, removing or changing the steps. Once all the changes are done and saved in the log registry patients implement those exercises and all the results of the patient are also saved in separate logs which are forwarded to the physiotherapist so know the improvement in the patient's health. That is all the postures of patients, correct or incorrect are automatically saved in the independent log register. This log is then evaluated by the physician and concludes the health of related patients and also decides the medication needed to be given. This all is done without the physician being around the patient. The advantage of this module is that physiotherapist can give attention to large number of patients within minimum time. The ultimate goal is to offer assistance for patients to conduct exercise at home in absence of a physician to avoid side effects.

3. Technologies Implemented In Proposed System

3.1. Gesture Recognition

In the application which has human machine inter- action, gesture recognition has the capability to provide a way for communication between human and machines [4].This technology available for the public and real world computer vision. The typical domain of this trade is gaming industry and Microsoft launch new camera for it called as Kinect, we know the another known examples or domains where gesture recognition is needed like sign language, virtual reality environment, smart homes. The challenge for such real time application is that complex picture, untidy background, moving objects and possibility of changing in lightening condition. In our proposed methods that overcome such challenges by detecting the hand movement using object depth information capture through Kinect [4]. On the upper side of our detector we implement a dynamic programming method called as Dynamic Time Wrapping (DTW)[4].The interaction between human- machine must be as natural as possible. The human interact with machines directly without intervention of input devices such as Mouse, Keyboard, Remote controls by using hand gestures we tackle this situation and provide ease to the user for the communication with the machine. We can found much hand gesturing application in researcher and industry such as game con- trolling, human-robot interaction, virtual environments, sign languages, smart homes. We introduce a method for building a tough, long lasting hand detector that captures hand gestures in scene by using motion detection depends on frame differencing and depth segmentation. When we capture a data using kinect camera the depth values for each pixel is calculated [4].

Main features of our method are:

- It performs very well and tackles the challenges in environments within the presence of multiple disturbance like moving objects and skin colored objects.
- It is tough to handle overlap between hand gesturing and face.
- Our method can recognize a wide range of gestures other than sign of digits.

3.2. Skeletal Tracking

This is also another method of tracking the gesture of human beings. In this method we create a skeleton like image which can be easily used to capture the movements of the object (specifically humans). Here in this method a mid point is taken into consideration which acts as reference point for calculation of distance. We are using spinal cord and shoulders as reference points. By using spinal cord as reference point it be- comes easy to identify the movements. If the hands move in forward direction the distance is measured from spinal cord to the actual position of the hand which is displayed on the terminal in form of image. Similar is with the backward hand movement. Here the distance is measured in negative numbers which is depicted in the display. Spinal cord is used for gesture reorganization of hands and legs. To recognize the gesture of neck movements shoulders are used as reference point. If neck move towards left the distance between left shoulder and head is measured which is distinguished as left side gesture. Right side, forward and backward movements are also calculated in similar manner.

3.2.1. Stick Skeletal Model.

In the proposed system if object is human then it can be detected and its motion can be captured by considering the human body in the form of skeleton. By implementing the stick skeletal approach the human body is modeled by 7 body parts which includes 8 points [6]. While tracking human through kinect, it consider human body as a skeleton made of match sticks which simplifies the human body detection. During skeletal view of human body a person is detected with parts like Head, R-shoulder, L- shoulder , Neck ,R-Elbow ,L-Elbow, R-Wrist, L-wrist , Spine, Hip Center-Hip Right-,Hip Left,-Knee Right-,Knee Left-,Ankle Right-Ankle Left-Foot Right-Foot Left [1].

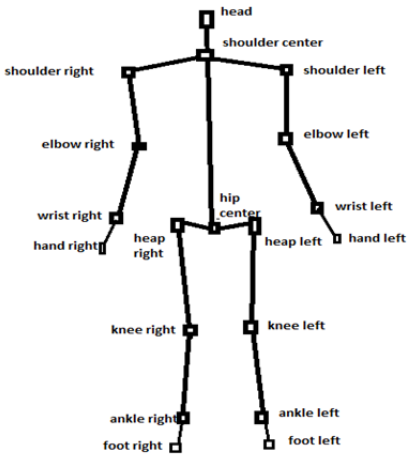

Figure 3. Stick skeletal model

3.3. Depth Recognition

In our Proposed System the information which is in the form of depth array is considered and every interference within the array are eliminated to get accurate depth information. Edge information present in depth array is implemented to recognize the users region which comprises the appearance of peoples. Algorithm implemented is 2D chamfer distance matching. Stated algorithm scans the overall image which is taken for examining and generates the regions which represent the presence of peoples [3].

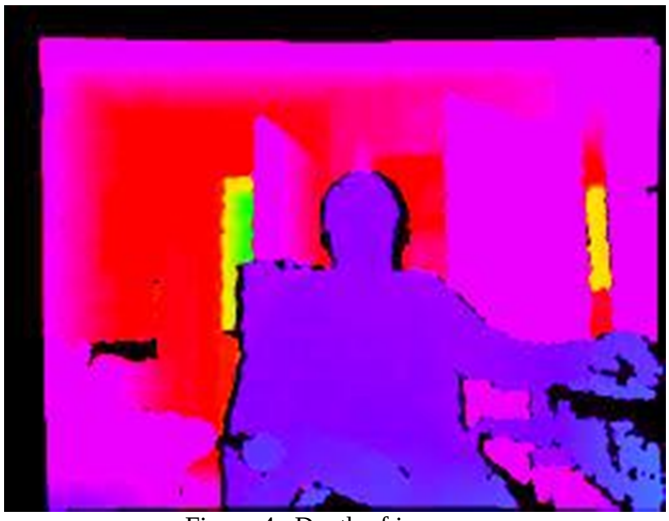

Figure 4 . Depth of image.

3.3.1. 2D CHAMFER DISTANCE MATCHING.

Here the boundary information which are examined and generated from the depth array is used. Here Canny edge detector is implemented to discover the edges of particular scenario. To minimize the disturbance from the surrounding asymmetrical objects, we eliminate particular edges which are having size smaller then certain threshold [3].

4. CONCLUSION

By implementing the required technologies mentioned in this paper we are able to accomplish the task of human and object detection. Depth Recognition, Skeletal Tracking and Gesture Recognition are the key technologies through which kinect camera able to identify the peoples and their motion with utmost precision. By implementing which we are able to accomplish our proposed system which is kinect Gaming and Physiotherapy which is single application having the capability of performing two application related to kinect. By using our proposed system prototype user can play game and same system can be implemented for guidance system for physiotherapy.

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