Real – Time Hand Gesture Tracking for Network Centric Application

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Abstract

This paper focuses on the Real – Time Gesture Tracking for Network Centric Application. In it, human hand gesture was acquired using Kinect depth camera. The user posed in front of the camera about 2 meters away from the camera mounted about 80 cm above ground level. The acquired image is processed to extract the right hand joints vertical and horizontal coordinates, which is transmitted over a network medium. The received information is then classified and assigned to a sub routine that is meant to perform a defined task.

Keywords: Real – Time; Gesture; Network; Tracking; Human machine Interaction (HMI)

1. Introduction

Human Machine Interface (HMI) is a growing technology. The technology supports the interaction of human and machine for effective communication operation and control. According to Sanjay (2011), some achievements of this technology are in the areas of voice synthesis, face recognition, computer vision, gesture recognition, etc.

Sanjay stated that Gestures are the non-verbally form of communication. The author added that multiple gestures are possible with a person at a time and that since human gestures are perceived through vision, it is a subject of great interest for computer vision researchers.

Dong-Iko et al. (2012), noted that over the past few years, gesture recognition has been largely used in the gaming and entertainment market. Now, gesture recognition is becoming a commonplace technology, enabling humans and machines to interface more easily in the home, the automobile and at work. The author added that gesture are already applied in some TV and light controls.

Before the advent of intensive research in the area of non - verbal human - machine interaction and computer vision (Sanjay, 2011), network applications has been with some form of hardwired or wireless technologies. Today's technology of networks and the internet can be exploited in the application of certain human machine interaction.

2. Related Works

The related works are not limited to:

a. A Gesture Based Interface for Human – Robot Interaction (Waldherr, Romero & Thrun, 2000). This paper is aimed at developing and evaluating a vision – based interface that is capable of recognizing both pose and motion gestures. The robot could identify a person and follow his hand gesture. It could recognize and interpret the following gesture commands made by hand: Follow, Stop, Pick and Drop. The robot could follow a human guide, stop, pick up rubbish and drop it in a refuse bin at a known spot in the map already designed for the robot to follow. The robot could distinguish between static and motion gestures.

b. Real – Time Robotic Hand Control Using Hand Gesture (Raheja, Shyam, Rajsekhar & Prasad 2012). This research paper is aimed at Detecting Hand Gesture for Real – Time Control of Robot Hand, in which they were able to detect hand gesture with an accuracy of 95% when the hand was kept in from of the camera for one second.

c. Application for Gesture Based Control of the Pioneer Robot with Manipulator Lapuskin (2012). With an aim to create a system that would allow a human to use gesture to control a robot, the author, Lapuskin, in his master's degree thesis presented a work that was able to use Java to develop GUI that achieved gesture recognition and encoding of gesture information into wifi signal for transition. The implication shows that the gesture could detect and interpret Ok signal made by hand gesture, Go there signal made by pointing the index finger, Come here signal made by hand gesture an Turn around signal made by drawing a circle I the air. The robot could also respond to all these gestures by driving its manipulator.

d. Gesture Recognition and Mimicking in a Humanoid Robot (Begley, 2008). Here, Begley, was able to reprogram ISAC (Intelligent Soft Arm Control), resident at Vanderbilt's Featheringill University to repeat any hand gesture made in front of it. The robot is fitted with two Sony XC-999 color CCD (Charged Coupled Device) cameras as the robot eye.

e. Gesture Based PC Interface with Kinect Sensor (Samet, 2012). This is a master's thesis by Samet ERAP with an aim to use abilities of Kinect XBOX 360 sensor to develop an application which allows operating windows 7 operating system in touch-less and clicking-less manner. The thesis was able to achieve a software system that could switch from one slide to another during presentation, control a pioneer robot and reliably collect information about position of human body in real time.

f. Hand Gesture Recognition Using Computer Vision (Lockton). Lockton in his thesis worked towards interpreting American one-handed sign language alphabet and numbers using hand gesture captured by camera. He was able to make the computer to display the alphabets and number as he made the gestures in front of the camera. A stereographic system with 3D Depth camera and good lightning system for different skin color and background color were used. The human hand is identified by a color marker won on the hand. RGB color of the hand captured was celebrated using the following model:

g. Gesture Interface for Robot Control (Florian, N., Ken, & Sumudu 2010). Florian in this paper presented an innovative way to control a robot arm by using a gesture interface. Their aim was to offer a different control method that needs only one hand and is a simple alternative to joystick for direct control of an arm that can move in 3D. The result of comparative study of hand gesture, haptic and gamepad control of robot showed that gesture interface performed better than gamepad (joystick) because it free up the hand for other task and cost less.

In the field of human machine interface, computer vision, and in particular, hand gesture recognition has been greatly exploited. Noting the fact that this area of research is still very new, numerous effects have been deployed by many researchers and a lot have been achieved so far, though the exploit remains inexhaustible.

The review presented here show a hug application area hand gesture recognition in the control of robot. Raheja et al. presented a work bordering on the real-time tracking of gesture information for robotic control. This work and others dwell on standalone application of hand gesture tracking. The aspect of network application of the tracked information seems not to be considered by any author. This paper therefore will focus on this aspect, tracking human hand gesture information in real time and deploying the tracked data over network for certain application.

3. Methodology

In the development of this system, the modular methodology was adopted. Figure 1 shows the block depicting the system being implemented. The figure shows the point where the hand gesture is captured using depth camera (Kinect), connected to the Personal computer (PC) through an interface. Gesture processing software running on the PC detect and process the gesture information by encryption. The encrypted information transmitted over a network medium to receiving PC, where it is decrypted and classified for a classified action or control. This block diagram typifies the Real – Time Hand Gesture Tracking for Network Centric Application.

From this block diagram, the following major modules can be identified:

a. Gesture Recognition module

b. Network module

c. Application module

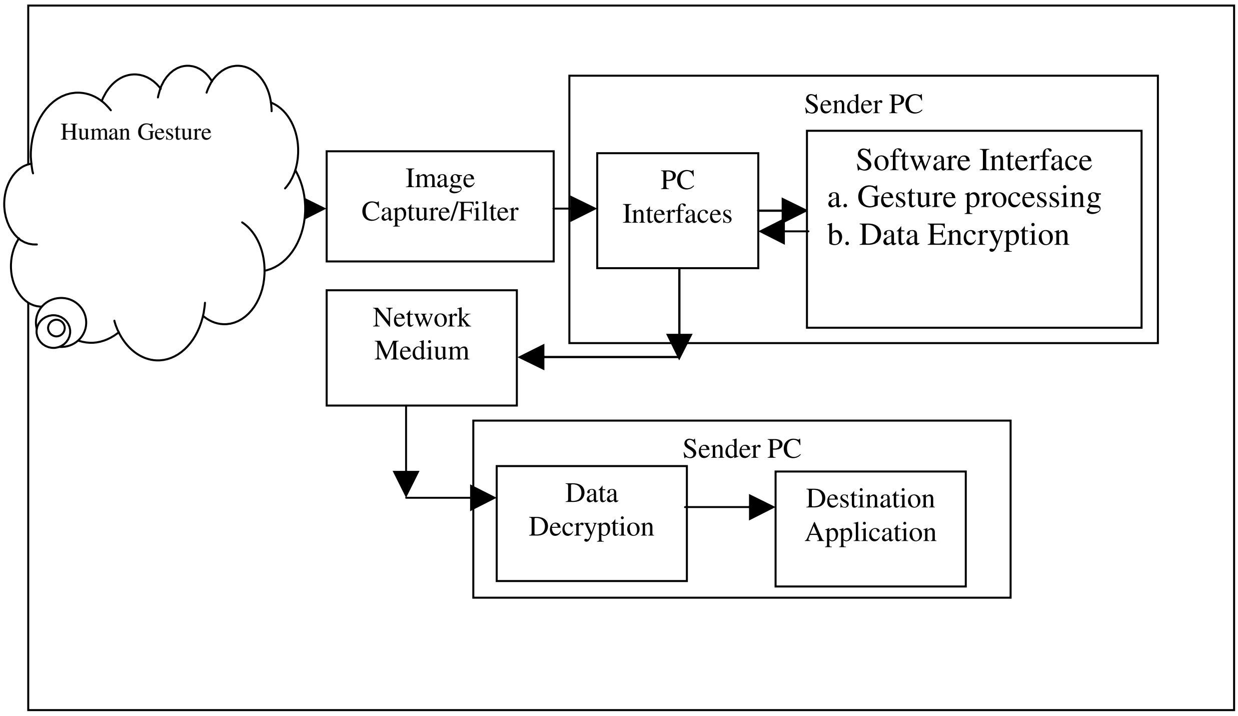

Figure 1 System Block Diagram

3.1 Development of Gesture Recognition Module

To design the gesture detection software, the basic gesture algorithm was adopted. The flow chart in figure 2 represents the algorithm.

The following steps are involved the gesture detection application

The image of the user in front of the camera was detected;

X, y coordinates each of twenty (20) skeletal joints of the user was identified;

If any change in joint location was noticed, the new location of the joint would be tracked and computed using Pythagoras theorem;

$$d = \sqrt{(distance\ of\ A,C)^2 + (distance\ of\ B,C)^2}$$

$$d = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2} \quad (1)$$

Where d is the distance between two joints

The value that was computed was assigned a predefined task, according to the required angular movement of the robotic arm.

The flow chart below implements the Kinect algorithm:

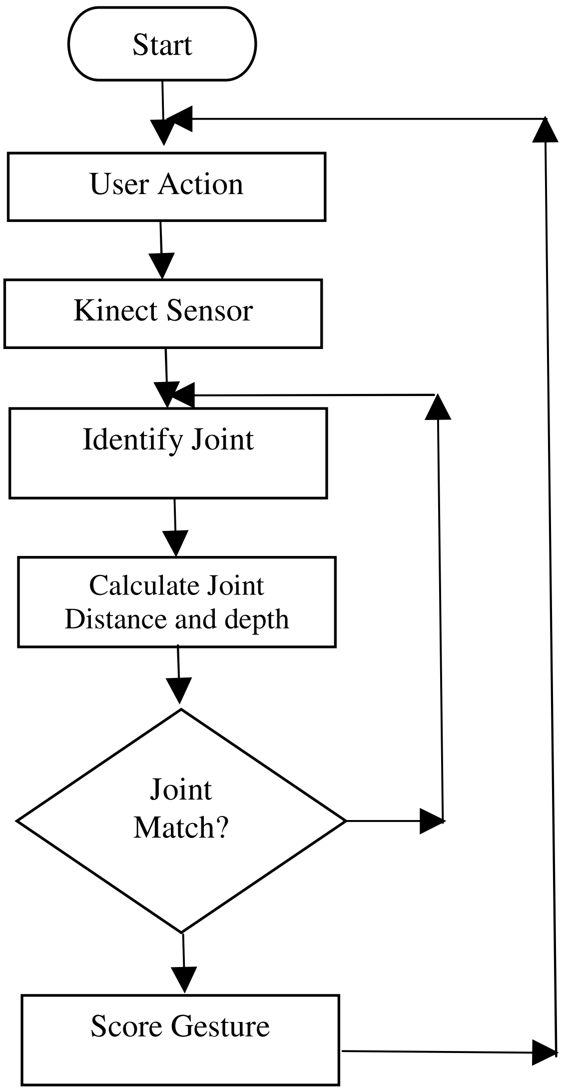

Figure 2 Flow Chart of Gesture Recognition sub system

3.2 Development of the Network Module

In developing this module, socket programming using TCP/IP was implemented in C#. There are two parts of this implementation, the server and the second is the client applications. Figure 3 shows the representation of the flow sequence of the implementation. The flow chart describes the following algorithm.

Step 1: Server and client create a stream socket s with the socket () call.

Step 2: (Optional for client) Sever bind socket s to a local address with the bind() call.

Step 3: Server uses the listen() call to alert the TCP/IP machine of the willingness to accept connections.

Step 4: Client connects socket s to a foreign host with the connect() call.

Step 5: Server accepts the connection and receives a second socket,

Step 6 and 7: Server reads and writes data on socket ns, client reads and writes data on socket s, by using send() and recv() calls, until all data has been exchanged.

Step 8: Sever closes socket ns with the close)) call. Client closes socket and end the TCP/IP session with the closed call. Go to step 5.

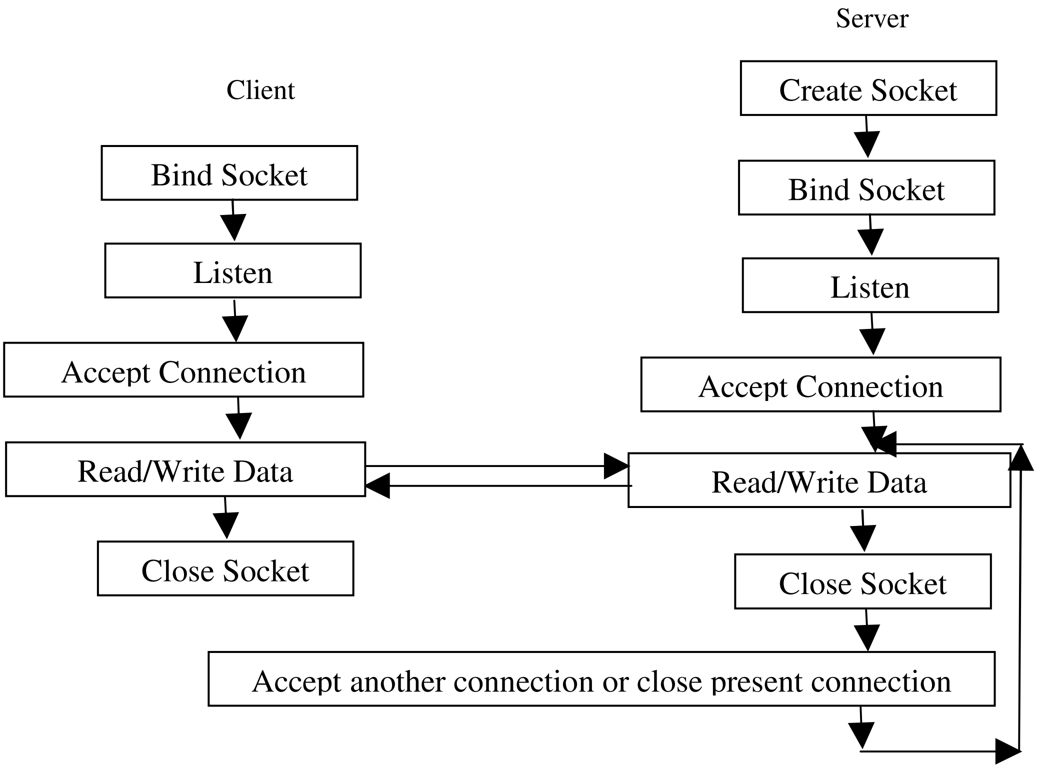

Figure 3 Flow Sequence of Client Server Interaction

3.3 Implementation of Feedback or Voltage monitor circuit

The application module was the part that was used for the scoring and classification of the actions that would be controlled by the gesture. This was achieved by converting all the joints coordinate locations into values. The controlled action is such that when a particular joint value is received, a sub routine defining an action is triggered.

4. *Results and Discussions*

Each module defined above was implemented, tested and integrated. The received information over the network shows the following result:

The gesture sub system was implemented in C#, using visual studio 2010. During this test, the Kinect sensor was connected id a PC running the visual studio 2010 and the Kinect SDK. The code was able to track the dynamic positions of the following joints in the x y plane: shoulder, elbow, wrist and the palm. Figure 4 shows the software interface.

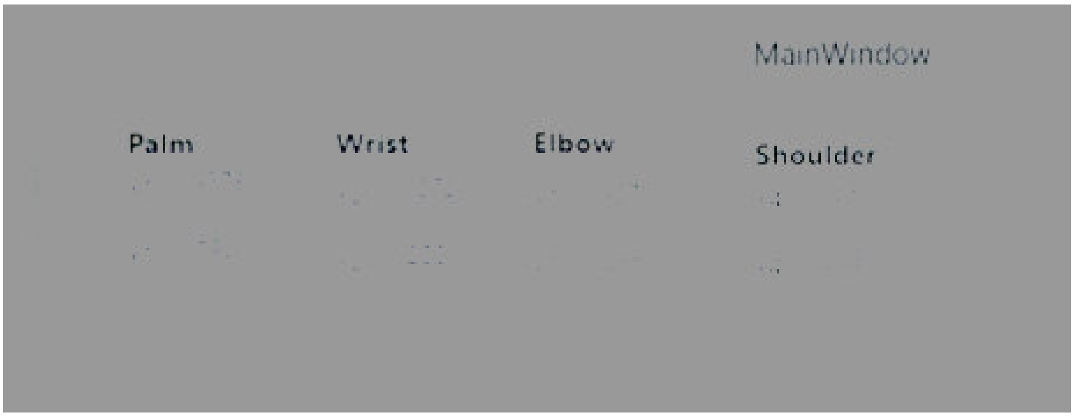

Fig. 4.1 Joint Tracking Results

These results were only for the right hand. Other joints were not tracked. Different positions of these joints presented different results. At rest position of the right hand, the joints values were as follows:

Table 1 Pixel values of joints at rest position

Joint	Value (Pixel)	
	X	Y
Palm	420	400
Wrist	420	360
Elbow	420	300
Shoulder	420	217

All x values are the same while y values change from joint to joint.

5. Conclusion

This paper looked at how hand gesture information can be tracked in real time and transmitted over a network medium for the remote control of any task. The system used Kinect camera to extract the hand gesture of a person that poses a few inches away from the camera. The result show that gesture information was extracted as the x, y coordinate of the joints of the hand. These values are stored and assigned desired task when needed. Hand gesture recognition can therefore be effectively used for remote control of certain operation as the need arises.

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