Gesture Based Management of Semi–Humanoid Robot

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Abstract

The mechanism for creating a chance for the user to control the humanoid robot remotely is proposed in this paper. In activities that are repetitive in nature, robotic manipulators are used commonly to replace human operators. There are, however, many activities that are unrepeatable, unpredictable or risky for human operators. Such tasks can also be done using robotic manipulators by tele-operation or remote control. With the aid of the Kinect sensor and a TCP connection between the transmitter and receiver, the application of the digital world of motion tracking to the real-world applications of humanoid robots is proposed. Communication in the working environment, apart from direct audio signals, greatly depends on body movements. Although verbal signals offer a brief idea of the work to be performed, it is the physical demonstration that appears to have the greatest effect. In the areas of gesture detection and application, a great deal of work has been performed gradually. Such human gestures are used to monitor the robot in in a 2-D path with exact accuracy.

Keywords: Teleoperation, Kinect Sensor, TCP Link; Gesture Control.

1. INTRODUCTION

A new research path in the robotics sector has now been an underactuated device for a few days. The control input of the underactuated robot is lower than the level of device independence [1]. A humanoid robot (HR) is characterized as an underactuated system since it comprises more DoFs than the number of its actuators. HRs are being deployed in public spaces including hospitals [2], banks [3] and airports [4]. HRs have the advantages of light weight, low energy consumption, excellent performance, and broad development prospects. Recently, the concept of Human-Robot Collaboration (HRC) has generated more interests. Literature suggested that human workers have unique problem-solving skills and sensory-motor capabilities, but are restricted in force and precision [5]. Time-separation or space-separation is dominant in HRC systems, which reduced productivity for both human workers and robots [6].

It becomes necessary in many applications in the field of robotics and computer vision, the ability to quickly acquire 2D models of the environment and estimate the pose according to those models. Gesture is one type of communication methods. Head nodding, hand movements and body postures in human-human cooperation are efficient communication networks [7]. Three types of gestures were mentioned in the literature. These are full body actions or motions, Hand arm poses, hand gestures, and nodding or shaking head, winking lips [8]. To identify body gestures, a detailed model of the human body is often useless. Different from the aforementioned approaches, skeleton model approach uses a human skeleton to discover human body poses [9]. Gesture recognition and control is an important function for any human-robot interface which gives an opportunity to the users to remotely operate the humanoid robot. The need to build such a humanoid robot stems from various socio-economic interests, such as day-to-day operations that are capable of lending a hand to the human race in places that are almost inaccessible, such as mines, areas exposed to radiation, war zones, etc [10].

Tele-operation of humanoid robots is ideal for a variety of applications, including complicated tasks where human presence is either impractical or risky, so such a device would be ideal. This type of study covers a wide range of topics, including interaction modalities. Recent innovations in the field of motion-controlled humanoid robot include the Xbox 360 gaming interface released by Microsoft for the player's intense involvement in gameplay, another notable area is deep image processing and skeletal tracking where the idea of motion tracking and motion mimic technology is widely developed. The Humanoid robot takes its inputs from the depth sensor in the form of image feed from the depth camera and outlines the gestures tracked by it. The time constraints of different workers make them grossly dependent on the processing and execution of real-time data. Then the system communicates wirelessly with the self-designed Semi- Humanoid which in-turn, imitates the operator with maximum accuracy which is connected through intranet.

In this project, we propose using the Kinect sensor and a TCP connection between the transmitter and receiver to apply the digital world of motion tracking to the real-world applications of humanoid robots. Humanoid robots seem to be the best alternative for human labour. Communication in the working environment, apart from direct audio signals, greatly depends on body movements. Although verbal signals offer a brief idea of the work to be performed, it is the physical demonstration that appears to have the greatest effect. A lot of work has been done increasingly in the fields of identification of gestures and implementation.

With the introduction of comparatively cheaper and easy-to-use depth imaging techniques like Microsoft Kinect, the accuracy of gesture recognition can be increased to a greater percentage. A perfect human impersonation by a robot necessitates massive calculations and the coordinated efforts of many different components of the system. A common type of mobile robot today is semi-autonomous, where the robot operates partly on its own, but via a connection, i.e., there is still a human in the control loop. There are no sensors on the bot in this technique, those it can use to take an option. One of the potential methods of managing such a bot is by combining the human operator's depth imaging and skeletal monitoring. It is wirelessly operated and fitted with fine manoeuvring techniques to broaden the bot's area of application.

2. MATERIALS AND METHODS

Communicating with machines by human contact by using gestures and movements is incredibly fascinating. There are many systems used to monitor the robot by gestures. Adaptive colour segmentation, hand finding and marking with blocking, morphological filtering, and then gesture behaviours are identified by matching the template and skeletonizing. Because of template matching, this does not have dynamicity for the gesture inputs. Another device uses computer interface equipment to provide the robot with real-time movements. Analog flex sensors are used to measure the finger bending on the hand glove, and ultrasonic measurement of hand position and orientation for gesture recognition is also used. And in another technique, the use of Microsoft Xbox 360 Kinect recognizes movements. Using an RGB and Infra-Red camera respectively, Kinect collects color and depth information.

Tools

A. Depth sensor:

Depth sensing is evolving very rapidly amongst many sensing technologies. This Kinect sensor is an inexpensive light-weight depth sensor that can capture 3-D images and therefore helps to identify patterns, monitor objects, plan long-term paths and improve processes. The ultimate aim of this job is to build a multi-agent robot system that can function independently in an outdoor environment. In addition, 3D depth information is the output of a depth sensor. 3D depth information simplifies the issue of gesture recognition compared to colour information [11] The ToF technology was used by Microsoft Kinect 2. The benefit of ToF technology is that the higher frame rate is. The drawback of the ToF technology is that its light power and reflection are highly dependent on camera resolution. [12] The depth sensor offers an inexpensive and quick gesture recognition solution. It is commonly used in entertainment, education, and science, which has led to a broad group of developers [13]. An idea was proposed to create a teleoperated humanoid robot capable of performing assigned tasks over a long distance based on human gestures [14].

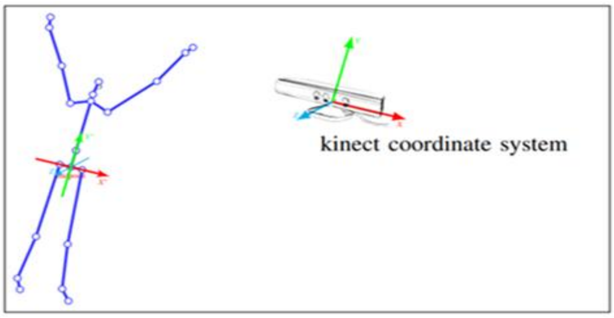


Figure.1. Kinect Coordinate System

B. Prime Sense: OpenNI and NITE

To access the Kinect data streams and skeleton/hand tracking features, OpenNI and NITE, so here's a bit more information about this platform. An API and high-level middleware called NITE is supported by the OpenNI framework to implement hand/skeleton tracking and gesture recognition. NITE The developer needs more than the 3D point cloud from Kinect to incorporate natural interaction. The most useful features come from the capabilities of skeleton and hand tracking. Not all developers, as they require sophisticated algorithms, have the expertise, time, or money to create these capabilities from scratch. PrimeSense wanted to incorporate and distribute these capabilities for commercial purposes, but kept the code closed, and NITE was therefore established.

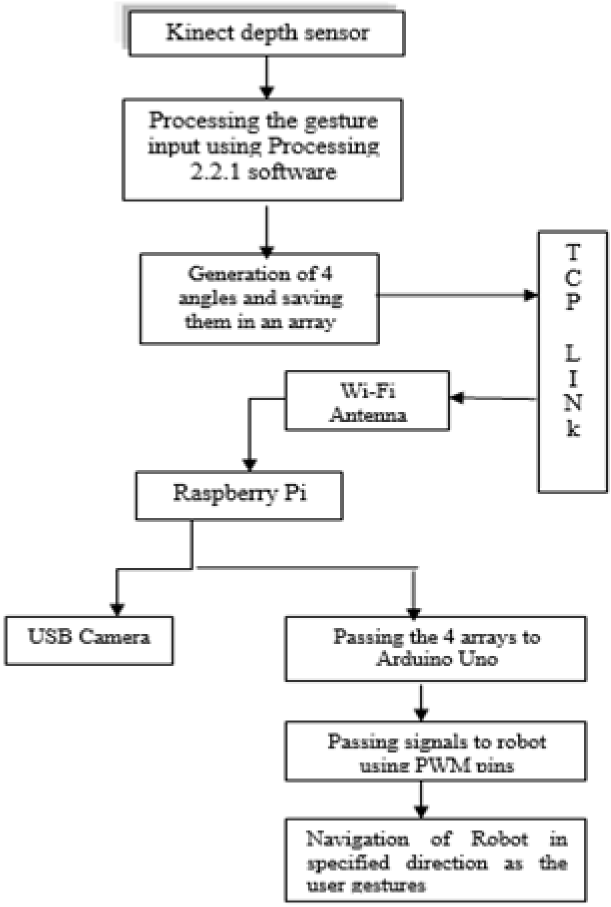
C. PuTTY:

PuTTY is a free and open-source terminal emulator, serial console and programme for transferring network data. It supports many protocols for the network, including SCP, SSH, Telnet, rlogin, and access to raw sockets. It is also capable of connecting to a serial port. There is no definite definition of the word 'PuTTY'. PuTTY was originally written for Microsoft Windows, but was ported to a variety of other operating systems. For certain Unix-like platforms, official ports are available, with work-in-progress ports for Classic Mac OS and Mac OS X, and unofficial ports for platforms such as Symbian, Windows Mobile and Windows Phone have been added.

The Kinect is developed specifically for Xbox 360, incorporating a standard RGB camera and a depth camera. By projecting extremely unstructured IR patterns from the IR projector, the depth data is acquired. Figure 3 displays the depth and the RGB pictures.

Figure. 2: Navigation of the robot as the user defines the direction

Gesture Building



3. RESULTS AND DISCUSSION

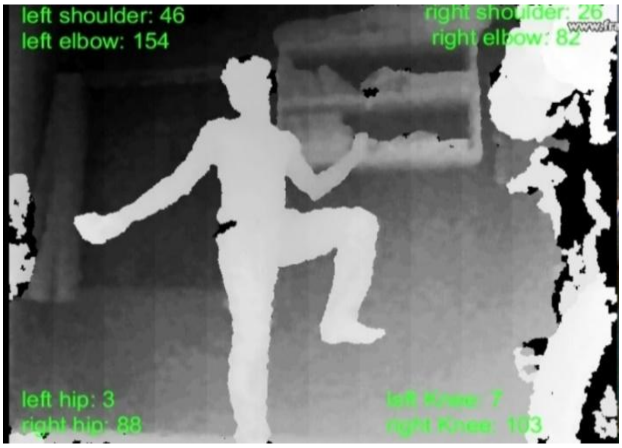


Figure. 3 3D depth mapping of human and gestures

A programme called Processing 2.2.1 performs the processing of the gesture input. The programme gathers and processes the movements sent by the Kinect console to detect angles between the skeletal lines.

Recording the joint angles in a file:

After tracking the skeleton of the human body and recording the joint angles with the help of Processing IDE. To transmit these angles through a TCP, link the captured joint angles are recorded into a file whenever a new set of values are generated. These strings of values are stored in a certain format such as:**[# 180, 180 + 180 $ 180 ~]**

The values are recorded in a text file successively.

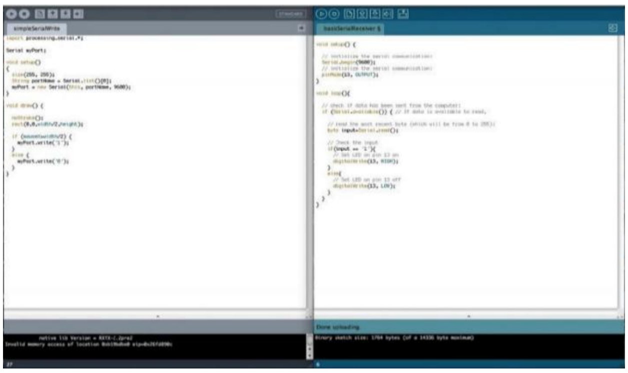


Figure. 4. Arduino IDE software coded blocks side by side on the screen.

A Client and Server is built using the Python language to transmit the joint angles via a TCP connection. The transmitter here serves as the server and the client acts as the receiver. Where the receiver consists of an internet-connected Raspberry pi, it produces an IP address. Both the transmitter and the receiver get paired up by entering the client IP (raspberry pi IP) and the device is ready to transmit information. This client and server pairing is achieved using Python IDLE (GUI). The connection is only formed if the Arduino is linked to the receiver's Raspberry Pi. After the pairing, for each new value given, the values in the file are transmitted successively and this information is received by the raspberry pi and sent to the audio through a serial port connection between the argument and the Raspberry Pi.

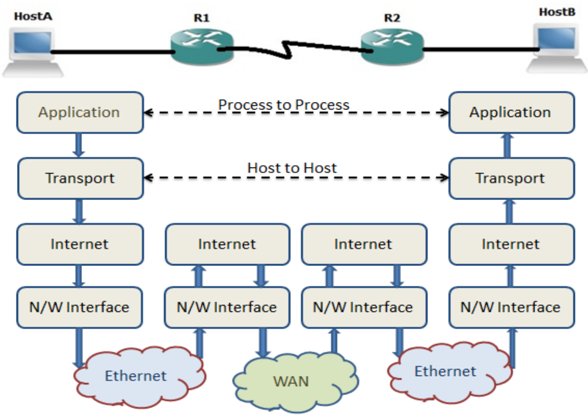


Figure. 5; basic flow chart of a TCP connection link

The Atmega328 processor that we are using in our project produces the command signals. The Atmega328 consists of 12 digital pins, 8 of which can be used via Rx/Tx for PWM signaling. In turn, each PWM pin is connected to a servo motor representing the angle between the corresponding skeletal lines.

Navigation of Robot in specified direction:

The angles obtained via the Pulse Width Modulation (PWM) signals by the servo motors represent the angle between the corresponding skeletal points. Eight separate data points in the user's body are tracked for real-time positions and orientations, namely: left shoulder, left elbow, right shoulder, right elbow, left hip, left knee, right hip, and right knee. A humanoid robot will be shaped by the combination of all body parts. These days, Virtual Reality research has been growing strongly.

We have several Virtual Reality applications. These applications cover different fields: defence: it has been adopted by the military and all three services are included: (army, navy and air force). It is used to train soldiers in fighting conditions or other hazardous circumstances in which they have to learn how to respond appropriately. Mining: It was adopted for mining for riskless human work where the robot begins working instead of a human where human harm or failure does not occur. Medical: Education by practical knowledge may be implemented for medical purposes, i.e., for the training of citizens. Gaming: It can be used for entertainment purposes, i.e., for children's gaming. Education: The value is that it helps large numbers of students to communicate within a three-dimensional environment as well as with each other. It is capable of presenting complicated data to students in an accessible way that is both enjoyable and easy to understand.

4. CONCLUSION

For controlling a semi-humanoid robot with human gestures, the implemented architecture suggests a simple, low cost and robust solution. The complete configuration includes software and hardware to be synchronised. The above-mentioned challenges were encountered to develop it. This manuscript will serve as a development platform for human and BOT interaction through movements that use virtual reality and can inculcate more complexity with the quality of product resources. Biped motion and holding mechanisms are currently being worked on in the hands. It is anticipated that the legged motion would allow the robot to easily navigate over uneven terrain than the wheels. The picking/holding mechanism will increase its applicability via manifolds in the industries. Thus, with perfection, the greater objective of achieving better man-machine teams for complex environments can be accomplished

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