

2nd International Symposium on Big Data and Cloud Computing (ISBCC'15) Virtualizing Electrical Appliances and Gadgets Input with Human Gestures

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Abstract

Natural User Interface [NUI] is the medium of interaction between a user and a machine through natural entity (Air) in the form of user's gesture, recognized by the machine using gesture recognition. Gesture Recognition is the detection of human's bodily motion and behavior. Encroachments have been made using advanced cameras, hardware devices like Kinect. Kinect is a motion-sensing device developed by Microsoft for gaming purpose, which now used in the paper to virtualize the input. The paper talks in detail about controlling Domestic Electrical appliances by simple human gestures using Microsoft Kinect. There are systems available to sense human motions for controlling electrical appliances but none of them provide user defined commands and gesture recognition techniques. This system is unique in finding and understanding human gestures.

Keywords: Virtualization, Natural User Interface, Gesture Recognition, Motion Sensing, Skeleton Tracking, Human Machine Interaction, Microsoft Kinect, Xbox 360 KINECT, IR sensor.

1. INTRODUCTION

Virtualization is the concept of performing an object's action yet in the absence of its actual source which can include hardware source, operating system, storage devices and computer networks. The project has the key notion as virtualization. Consider a human wants to switch a fan on, actually he/she should stroke the switch on but here this is achieved virtually just by waving hands (Human Gestures) in front of a sensor.

Application development in Human machine interaction and Natural user Interface has reached the crowning from the release of Microsoft's motion sensing gaming device Microsoft Kinect and its Software Development Kit [1] [6][7]. Humans however migrate towards technology advancements always expect flexibility in the way they use their system and machinery. At present lots of techniques and modulations are being introduced and are under research to minimize or simplify the human machine interaction [2]. The paper is been proposed in the aim of minimizing all those complexions and to attain maximum accuracy in controlling the electrical appliances with gestures. Human gestures are an important sign of human communication and an attribute of human actions informally known as the body language. A lot of methods are being in use to track human gestures [3]. To get maximum accuracy and to bring out the system unique a lot of methods are attempted and best case is user defined actions (gestures) to control the system. For example consider a person who can switch his lights on just by touching his head. Which will be variable according to the users requirement. The use of Microsoft Kinect in the system is to track the human joints and gestures; the stream of input data to the Kinect will be the live action of human's gestures. Once the human skeleton is identified the system keeps track on the gestures and matches with the user defined gestures. Once if both the gestures suits the switch is tripped on.

2. LITERATURE RESEARCH

MIT Media Lab is working on **SixthSense** [10] which is a gestural interface device comprising a neckworn pendant that contains both a data projector and camera. Headworn versions were also built at MIT Media Lab in 1997 that combined cameras and illumination systems for interactive photographic art, and also included gesture recognition (e.g. finger-tracking using colored tape on the fingers).

SixthSense is a name for extra information supplied by a wearable computer, such as the device called "WuW" (Wear yoUr World) by Pranav Mistry et al., building on the concept of the Telepointer, a neckworn projector and camera combination first proposed and reduced to practice by MIT Media Lab student Steve Mann [9]. One big limitation of this project is it is completely wearable and which is not flexible under all circumstances. This paper overcomes this wearable limitation that the user need not wear any sort of gadgets to stimulate the input stream.

3. MICROSOFT KINECT SENSOR

Kinect is a motion sensing device by Microsoft for the Xbox 360 video game console and Windows PCs. Based around a webcam-style add-on peripheral for the Xbox 360 console, it enables users to control and interact with the Xbox 360 without the need to touch a game controller, through a natural user interface using gestures and spoken commands [1] & [7].

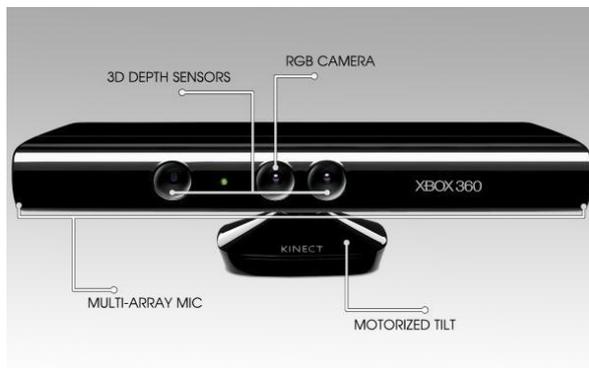


Figure 1: Microsoft Kinect (XBOX 360 gaming console sensor)

The basic parts of the Kinect are (Figure 1): RGB camera, 3D depth sensing system, Multi-array microphone, Motorized tilt. It interacts to the system by understanding human gestures.

- Software can use video, sound and gesture recognition driven interactions
- The Kinect sensor contains a high quality video camera which can provide up to 1280x1024 resolution at 30 frames a second
- The Kinect depth sensor uses an IR projector and an IR camera to measure the depth of objects in the scene in front of the sensor
- The Kinect sensor contains four microphones
 - These can perform background noise cancelling

Kinect is able to capture the surrounding world in 3D by combining the information from depth sensors and a standard RGB camera. The result of this combination is an RGBD image with 640x480 resolution, where each pixel is assigned color information and depth information (however some depth map pixels do not contain data, so the depth map is never complete). In ideal conditions the resolution of the depth information can be as high as 3 mm [4], using 11-bit resolution. Kinect works with the frequency 30 Hz for both RGB and depth cameras. On the left side of the Kinect is a laser infrared light source that generates electromagnetic waves with the frequency of 830 nm. Information is encoded in light patterns that are being deformed as the light reflects from objects in front of the Kinect. Based on these deformations captured by the sensor on the right side of RGB camera a depth map is created as shown in figure 2. According to Prime Sense this is not the time-of-flight method used in other 3D cameras [5].

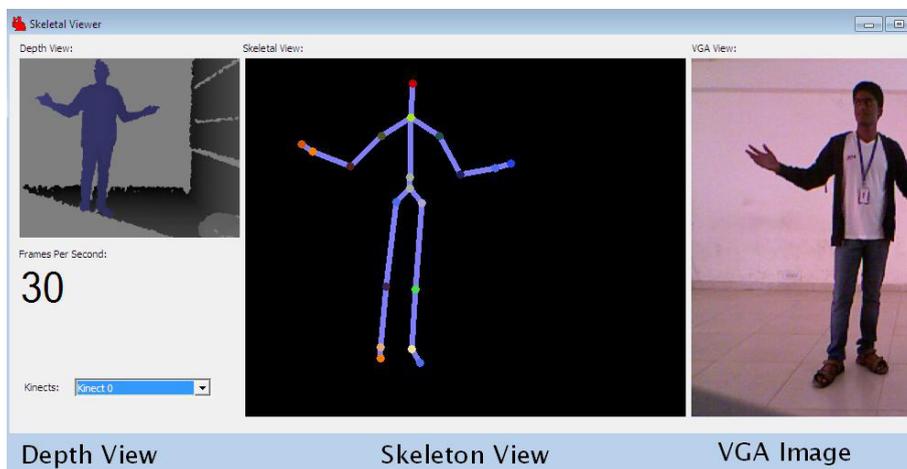


Figure 2: Depth, skeleton and VGA view

4. PROPOSED WORK

The proposed work is controlling electrical appliances with simple human gestures and motion sensing technology with the help of Microsoft's Kinect sensor. This paper started its initiations in the vision to successfully minimize the human machine interaction and to take up the Natural User Interface at the forefront. The initial phase of the project began in controlling a simple PowerPoint presentation with gestures like moving hands from left to right or moving from right to left to move between PowerPoint slides.

The system is already trained with the understanding of human gesture movements. Based on the body gestures the electric appliances are controlled.

The system is stably designed to identify 20 of human joints like (head, hand_right, hand_left and so on...) as shown in figure 3.

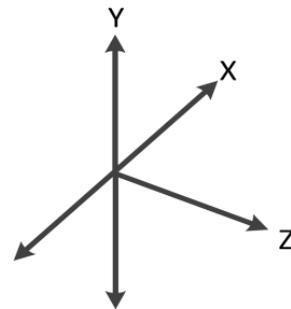
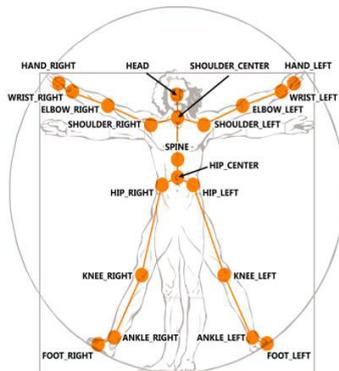


Figure 3: Skeleton Understanding by Kinect with its joints

Figure 4: Coordinate Axis

The position of each joint is given as an offset from the Kinect sensor as shown in figure 4.

X – Left, right

Y – Up, down

Z – Away from the sensor

The values are given in millimetre.

The electric devices are connected to a relay where the relay with four points (1, 2, 3, and 5) as shown in figure 5.

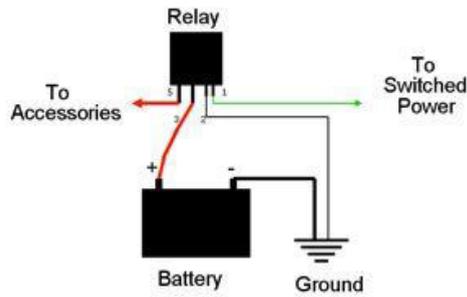


Figure 5: Relay connection

- Where 2 is grounded
- 1 is connected to switch
- 3 to power source
- 5 to the accessories or the appliances

Point 1 is connects to the switched power through the Microcontroller's output port, which is the Microcontroller of type AT Mega 8 from ATMEL products.

The micro controller switches the values to trip the accessories or the appliances ON or OFF where the microcontroller is connected to the computer by means of a serial port.

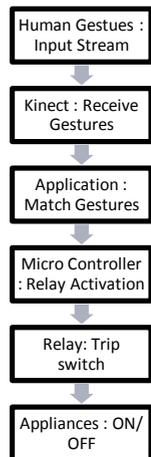


Figure 6: Sequential process flows.

The sequential process flow is as shown in figure 6. The Microcontroller gets input from a hyper terminal. The Kinect is connected to the central processing unit of the computer through a USB port and the program developed in .Net platform takes control of the Kinect and its input.

Once after a person steps in the room (i.e. once a skeleton frame is recognized the execution starts and the stream of input is continuously received from the Kinect to the program the human gestures are identified in time intervals and matched with the user defined gestures.

Once both the input streamed gesture and the User defined gesture matches there will be a unique code for each device which is represented in hexadecimal is sent to the microcontroller, the micro controller receives the input and connects to the respected relay and the specific appliance switches ON.

5. PERFORMANCE ANALYSIS

A series of experiments are being conducted to evaluate the system's returns and limitations.

In a test done for a sample of 100 spells for different electrical appliances. Accuracy up to 90 percent has been achieved. The below given tabular column shows a few random tests.

Table 1: Random Sample Test Particulars

| Name of Appliance | Users | Response time (Seconds) | Result |
|-------------------|-------|-------------------------|--------|
| Tube light | 1 | 1.2 | Pass |
| Fan | 1 | 1.3 | Pass |
| AC | 1 | 1.2 | Pass |
| Television | 1 | 1.1 | Pass |

Case Study-

1. Conference Hall

At certain times, during a conference, delegates wish to present PowerPoint slides. So, at every point while presenting, the delegate has to move each slide by clicking a keyboard button, rather he/she can signal with their hand (left or right) as desired before the device (Kinect) to move each slide.

2. Emergency Exit

Labs are dangerous at every unexpected spell. In an emergency one can't be at the right time in the area to operate and resolve. The device (Kinect) provides the way to operate from outside to solve issues by injecting right input signals via human gestures.

3. Physically Challenged

A physically disabled person in a room was trying to switch on the fan that merely is distant from him. Now, the device (Kinect) delivers a new platform for him to direct the fan.

6. Conclusion

This paper is not only aimed at minimizing the complexity of human machine interaction. Also one primary focus of the project is to benefit the physically challenged and old aged community. The system is well designed to understand human gesture behaviors and convert them in to procedural input stream. The user is given autonomy set his own gestures to trip the switches and also the system is capable of fault tolerance, it can identify maximum of two individual persons command.

It's also a revolution in the field of Natural User Interface to provide the users with the ultimate interface and a real time operating system that allows them to interact with their day-to-day usable machines naturally.

7. FUTURE WORK

The globe genuinely empathize the need for the development in field of Natural User Interface and Human Machine Interaction. The project will lead to its next gen development in rituals like

Controlling electrical appliance through remote procedures

Easy embedment of the device with household and business application

To track maximum individuals and to accept unique commands for each of them

Controlling Graphical User Interface through Natural User Interface

Speech recognition can be added to the system for better accuracy. The sensor has the capability of recognizing human voice which will be an added advantage to future works.

ACKNOWLEDGMENT

This project was selected by the University to display in Microsoft I spark project display and had been widely appreciated by Mr. Phani Kondupedi of Microsoft and Mr. Ramaprasanna chellamuthu (Former Microsoft employee, current founder and CEO of GotoPal Pvt. Ltd).

This project also gave us a First prize in the National Science Day – 2012 project display in the University and acquired us appreciations from Mr. Viswanathan.G (Chancellor, VIT University – India).

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