

Gesticulation Controlled Robot with Augmented Reality Based Acuity

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Abstract: A combination of Robotics and Augmented Reality is the proposal here. The two major and fast growing fields are combined to reach an optimal perception. The control operation of the robot is by gestures using the skeletal tracking of human fingers. Thus the robot control is free of buttons and switches; it requires only air space and our gestures to be controlled. The robot holds a camera, which performs the object tracking. Predetermined objects are loaded to the AR SDK, when the vision of the robot comes into the objects; a computer generated layer is imposed on the object. This can be a 3D view of the object or some information about the object in the form of images, texts or videos.

Keywords: Gesture, Augmented Reality, Skeletal Tracking, Metaio Toolkit

1. INTRODUCTION

Augmented reality is a fast growing trend finding its application in many domains starting from real estate to any consumer product interaction. Robotics is another vast field, a combination of both would result in new applications. In many application of controlling robotic gadget it becomes quite hard and complicated when there comes the part of controlling it with remote or many different switches. Mostly in military application, industrial robotics, construction vehicles in civil side, medical application for surgery. In this field it is quite complicated to control the robot or particular machine with remote or switches, sometime the operator may get confused in the switches and button, so a gesture control concept is introduced to control the machine with the movement of hand which will simultaneously control the movement of robot. Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data. Predetermined models are loaded in to a computer, and a camera is fixed to the robot, whenever the loaded objects come to the vision of the robot, there emerges augmented information about the object.

2. GESTURE CONTROL

The way of interaction with a system or a machine has to be easy and convenient for the user. The method of interaction is chosen depending on the type of system and user. There are various interfaces in controlling a robot, such as buttons, voice commands, etc. While gesture control is a handy interface as the robot can be made to perform a task on the basis of our gesture. This control method avoids the time lag and the minute delay in the user's thinking time and the input time that would be consumed to press button. Whereas, here the user performs the gesture at the same moment when he thinks of an action. Gesture recognition enables humans to communicate with the machine (HMI) and interact naturally without any mechanical devices. Using the concept of gesture recognition, it is possible to point a finger at the computer screen so that the cursor will move accordingly. This could potentially make conventional input devices such as mouse, keyboards and even touch-screens redundant. Gesture Recognition and Control and serve very conveniently in controlling Robots.

The ability to track a person's movements and determine what gestures they may be performing can be achieved through various tools. Some of them are wired gloves, depth-aware cameras, Stereo cameras, Controller-based gestures, Single camera. The component used here to capture gesture is Leap Motion Controller.

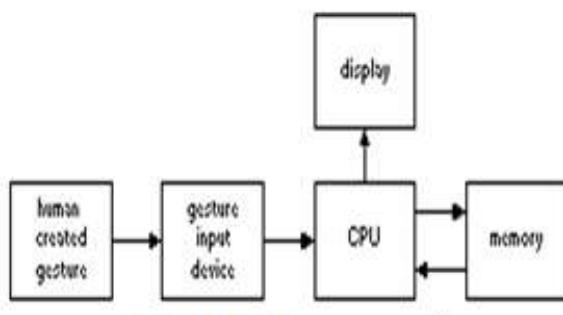
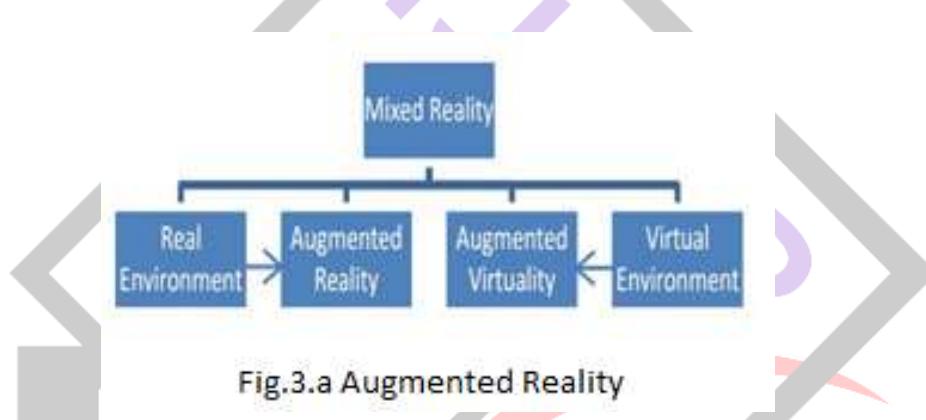


Fig.1.a Gesture Control

I. Augmented Reality

The process of superimposing digitally rendered images onto our real-world surroundings, giving a sense of an illusion or virtual reality. Recent developments have made this technology accessible using a smart phone or a computer. Augmented reality is hidden content, most commonly hidden behind marker images, that can be included in printed and film media, as long as the marker is displayed for a suitable length of time, in a steady position for an application to identify and analyze it. Depending on the content, the marker may have to remain visible. It is used more recently by advertisers where it popular to create a 3D render of a product, such as a car, or football boot, and trigger this as an overlay to a marker. This allows the user to see a 360 degree image (more or less, sometimes the base of the item can be tricky to view) of the product. Depending on the quality of the augmentation, this can go as far as indicating the approximate size of the item, and allow the consumer to 'wear' the item, as viewed through their phone. Alternative setups include printing out a marker and holding it before a webcam attached to a computer. The image of the marker and the background as seen by the webcam is shown on screen, enabling the consumer to place the marker on places such as the forehead (to create a mask) or move the marker to control a character in a game. In some cases, a marker is not required at all to display augmented reality. Augmented reality has been proven very useful on a day to day basis when tied with location based technology. Several apps are available that will show consumers their nearest food outlets or subway transport stations when they raise the app and view their surroundings through the camera.

Their use in marketing is particularly appealing, as not only can additional, detailed content be put within a traditional 2D advert; the results are interactive, cool, engaging and due to the initial novelty - have high viral potential. Consumers react positively to fun, clever marketing, and brands become memorable. The potential audience varies depending on the application of AR. Through a Smartphone, it is limited to an audience with suitable handsets, and those willing to download an app. With printing a marker for use with a webcam, it is limited to those willing to follow through these steps, though often opens a wide demographic including children (printing an AR code on a cereal box to play a game for instance). As long as the resulting augmented content remains engaging and innovative, consumers will certainly adopt augmented reality as a new and fun twist to conventional marketing and services.



II. LEAP Motion SDK

Once the image data is streamed to your computer, it's time for some heavy mathematical lifting. Despite popular misconceptions, the Leap Motion Controller doesn't generate a depth map – instead it applies advanced algorithms to the raw sensor data. The Leap Motion Service is the software on your computer that processes the images. After compensating for background objects (such as heads) and ambient environmental lighting, the images are analyzed to reconstruct a 3D representation of what the device sees. Next, the tracking layer matches the data to extract tracking information such as fingers and tools. Our tracking algorithms interpret the 3D data and infer the positions of occluded objects. Filtering techniques are applied to ensure smooth temporal coherence of the data. The Leap Motion Service then feeds the results – expressed as a series of frames, or snapshots, containing all of the tracking data – into a transport protocol. Through this protocol, the service communicates with the Leap Motion Control Panel, as well as native and web client libraries, through a local socket connection (TCP for native, WebSocket for web). The client library organizes the data into an object-oriented API structure, manages frame history, and provides helper functions and classes. From there, the application logic ties into the Leap Motion input, allowing a motion-controlled interactive experience.

III. METAIO Creator / SDK

Metaio is a privately held Augmented Reality (AR) company that develops software technology and provides augmented reality solutions. Metaio provides a software development kit (SDK) for programming PC, web, mobile and custom offline augmented reality applications. Additionally, Metaio is the creator of Junaio, a free mobile AR browser available for Android and iOS devices.

IV. About the Arduino Ide

The Arduino integrated development environment (IDE) is across-platform application written in Java, and derives from the IDE for the Processing programming language and the wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. A program or code written for Arduino is called a sketch. Arduino programs are written in C or C++. The Arduino IDE comes with

a software library called "Wiring" from the original Wiring project, which makes many common input/output operations much easier. Users only need define two functions to make a runnable cyclic executive program:

- `setup()` : a function run once at the start of a program that can initialize settings
- `loop()` : a function called repeatedly until the board powers off

3. ARDUINO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

I. Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

a. Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

b. External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attachInterrupt()` function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the `analogWrite()` function.

c. SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

d. LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though it is possible to change the upper end of their range using the AREF pin and the `analogReference()` function.

Additionally, some pins have specialized functionality:

e. TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

There are a couple of other pins on the board:

f. AREF: Reference voltage for the analog inputs. Used with `analogReference()`.

Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

II. Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the Uno's digital pins.

The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

The Arduino Uno can be programmed with the Arduino software. By selecting "Arduino Uno" from the Tools > Board menu (according to the microcontroller on your board). For details, see the reference and tutorials. The ATmega328 on the Arduino Uno comes pre burned with a boot loader that allows us to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar.

The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU bootloader, which can be activated by:

On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2.

On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

V. Motor Driver

It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor. In a single L293D chip there are two H-Bridge circuit inside the IC which can rotate two DC motor independently. Due to its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L293D motor controller.

There are two Enable pins on L293D. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to

high. If anyone of the either pin1 or pin9 goes low then the motor in the corresponding section will suspend working. It's like a switch.

4. IP/WIFI CAMERA

IP cameras are very popular in video data capture and processing. IP stands for Internet Protocol, but these electronic devices are more popular as network cameras, webcams, or CCTV cameras. They are used in homes, offices, vehicles, and public places. IP cameras come in basic units, right up to complex multi-channel security systems with advanced built-in software. In order to understand how IP cameras work, consumers should consider the applications for the devices, as well as video data capture and resolution.

I. Applications for IP Cameras

Unlike USB web cameras that run only when plugged into a computer on the network with the required software, IP cameras connect directly to the network with no dependence on any other device. Some models even get their power supply through the network using Power over Ethernet (PoE) chargers. Built-in software, such as motion alert notification via SMS or email, makes these devices much more advanced than regular video cameras.

IP cameras offer two-way audio, so the user can interact with the video footage. Store owners can supervise what is happening in their absence. With a home surveillance IP camera, parents can keep an eye on their kids from outside the home. IP cameras enable remote viewing to anyone connected to the network, without compromising on security. Smartphone users can monitor multiple camera feeds while on the go. Area review camera for cars helps drivers to park vehicles easily and safely.

II. Process of Data Capture and Transmission

IP cameras connect to a network of electronic devices, which could be the local area network (LAN) at home, the wide area network (WAN) at the office, or the Internet at large. IP cameras have either a wired or wireless connection, with the latter preferred for flexibility and convenience. The camera functions properly from any location, as long as the device stays within the network's range. Most IP cameras have a dedicated memory source to store the video data captured, but it may store memory by connecting directly to the network or live web streaming over the Internet. IP cameras capture digital video data like a regular video camera, and then send it to other devices on the network.

5. LEAP MOTION CONTROLLER

The Leap Motion controller is a small device that is plugged into a computer using a USB cable. The box which holds the controller comes with a long and a short cable. The controller is about 3 inches long, 1-inch wide, and 1/2-inch thick and has a nonskid rubber bottom. It has three cameras and infrared sensors that detect the motion of ten fingers up to 1/100th of a millimeter and has a 150° range of view. With detection that precise, it is able to create accurate paintings and drawings on a computer screen. The 150° range of view allows users to move their hands in 3D. By 3D it means that they are able to use Leap Motion apps to grab and move objects as if in real life. There is an eight cubic feet of space above the controller that is used to control the computer. The controller also moves when you move because it tracks movement at a rate of over 200 frames per second.

6. CONCLUSION AND FUTURE WORK

The combination of AR and robotics technologies are becoming successful in various applications such as wirelessly monitoring a remote area via gestures and perceiving the environment in a more understandable manner from the information generated by AR. This method is used to track and detect objects that are in the perceiving environment. Object detection and tracking along with environment tracking and be used in rescue management systems. The growth of the combination of these technologies has its application in almost every field.

In addition to the works done in this project further enhancement are planned to be made by loading the trackable objects in a cloud application. This will enable every user to access the cloud and benefit. There are existence of AR using GPS systems, with operates on Global Positioning, while a cloud application with a user interaction portal will allow user to detect any object in the cloud and benefit from the information about the object or environment. Route maps to tread paths with in a building can also be made and uploaded to the cloud.

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