

Capacitive 3D Tracking

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Abstract: In this project, we'll take a very simple idea -- the length of time it takes a capacitor to charge -- and make something rather amazing with it: a 3D interface that can track the position of your hand. The original implementation of this project comes from media artist.

1. Introduction

A capacitor (originally known as a condenser) is a passive two-terminal electrical component used to store electrical energy temporarily in an electric field. The forms of practical capacitors vary widely, but all contain at least two electrical conductors (plates) separated by a dielectric (i.e. an insulator that can store energy by becoming polarized). The conductors can be thin films, foils or sintered beads of metal or conductive electrolyte, etc. The non conducting dielectric acts to increase the capacitor's charge capacity. Materials commonly used as dielectrics include glass, ceramic, plastic film, air, vacuum, paper, mica, and oxide layers. Capacitors are widely used as parts of electrical circuits in many common electrical devices. Unlike a resistor, an ideal capacitor does not dissipate energy. Instead, a capacitor stores energy in the form of an electrostatic field between its plates

This project, we'll take a very simple idea — the length of time it takes a capacitor to charge — and make something rather amazing with it. A 3D interface that can track the position of our hand. Main objective is to create a 3D computer interface using little more than an Arduino, six resistors, and some aluminium foil.

2. Block diagram

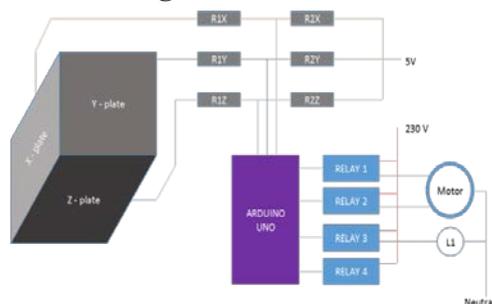


Figure 1. Block diagram

The block diagram of a Touchless 3D Tracking Interface consists of the following blocks. They are:-

2.1. Plates X,Y,Z

The three plates acts as 3 coordinates x,y and z.Each plate acts like a capacitor that can store charge when a voltage applied to it.each plate is attached with arduino which provides the voltage entry to charge the plate.

2.2. Power supply

Power supply given to the three plates from arduino.

2.3. Capacitive sensing

Nearly all sensing of this kind depends upon how long it takes a capacitor to charge (known as the time constant).

2.4. Arduino

The Genuino UNO R3 is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, 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 (not included) or power it with a AC-to-DC adapter or battery to get started. The UNO differs from all preceding boards because it does not use the FTDI USB-to-serial driver chip.

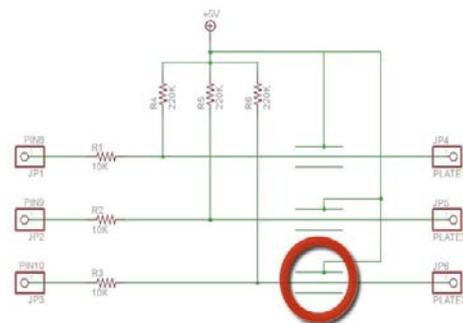


Figure 2. Circuit diagram

$$R1X=R1Y=R1Z=5\Omega;R2X=R2Y=R2Z=220\Omega$$

3. Experimental work



Figure 3. Experimental setup.

For this project we'll need some cardboard squares (mine are approximately 12" square, but anything from about 8-12" is fine), alligator clips, an Arduino, shielded wire, aluminium foil, spray glue, and some wide tape. (3) 10K Ω and (3) 220K Ω resistors are also required. Additionally, we'll need a soldering iron to connect the resistors to the cable. Spray the glue onto the cardboard and smooth the foil onto one side. Work slowly and try to leave a small gap around the edge of the foil. It is important that the foil plates do not touch each other when we tape the three sides together. In a pinch you can use a glue stick. I cut a small notch in the inside edge of the rightmost plate to make it easier to connect the alligator clips later on. Using tape, assemble the plates to form one half of a cube. Next we need to prepare the wiring. I bought a 6' shielded audio cable for this. It is important to use shielded wire so that the cable itself doesn't act as an antenna and skew the sensor readings. Cut the wire into 3 pieces of equal length (2' or so) and strip off the outer and inner insulation. On one end, trim off the shielding wire and connect just the inner signal wire to an alligator clip

Download the Arduino sketch and Processing sketch from GitHub. If you haven't previously installed Processing, get it here. From the Arduino IDE, upload the sketch to the Arduino. Keep the USB cable connected to the Arduino, then install and load the Processing sketch. It is important that your computer is plugged into the wall for this to work properly. If the circuit isn't connected to earth ground (at least indirectly through your computer) you may find that your computer itself will affect the circuit. The next thing to be done is calibrate the software. With the Processing sketch running, hold down the left mouse button. Then move your hand from the far outer diagonal corner (i.e., the invisible corner of the cube closest to you) to the inner corner.

Don't touch the foil, just move your hand through the space defined by the cube. Now release the mouse button. The path your hand traveled gives the software a chance to detect the range of motion your hand will make inside the cube. Now move your hand around inside of the cube. There should be a sphere on the screen through which you can control and move to touch all 27 cubes inside the computer model. Pressing tab will change the color of the cubes. This is the simplest form of capacitive sensing available. In the final section, we'll look at some alternative solutions and options to improve the system.

4. Output

The 220K Ω resistors form part of the RC network and it's worth experimenting with different values. Typical values are 200K Ω to 500K Ω . The responsiveness of the system will be affected by these values. You can also tweak the values in the "Normalize" tab of the Processing sketch to calibrate your particular configuration. The computer is connected to the wall socket ground, this is generally good enough to provide a consistent reference to ground. If you have a house ground connection available you might want to connect this to the Arduino ground pin and see if that improves the response. A good earth ground would be a water pipe. Includes some good information on configuring capacitive sensing circuits.) put together a neat "vision" system for robotics called Theremin Vision. It uses tuned oscillators and heterodyning to implement a therein circuit.

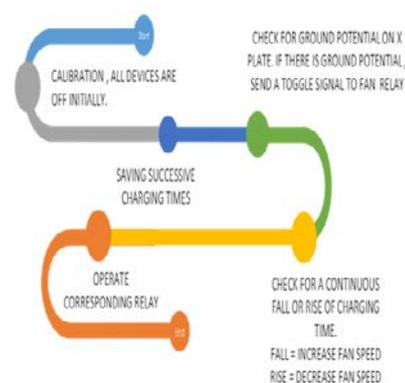


Figure1. Fan control of single cycle

5. Conclusion

In this project, we introduced the concept of capacitive sensing. Nearly all sensing of this kind depends upon how long it takes a capacitor to charge (known as the time constant). Placing an

object within the electric field of a capacitor will affect the value and the corresponding time constant capacitance.

6. References

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