

Web Audio Visualizer Part II

1) Doing pixel manipulations to the entire canvas.

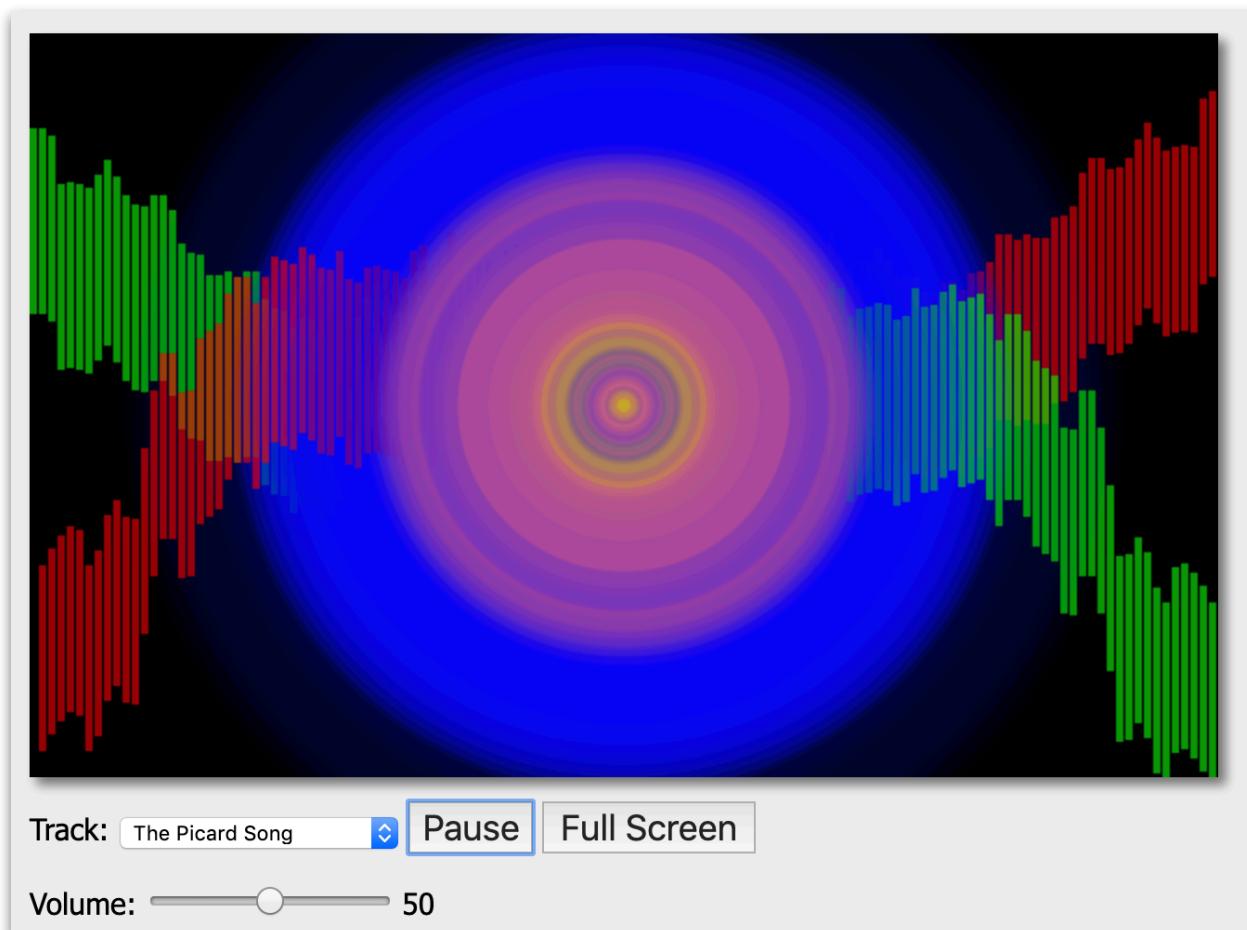
We can grab the RGBA (red, green, blue, alpha) data for the entire canvas, manipulate it, and then copy the modified data back to the canvas. This allows (for example) Photoshop style filters, chroma key effects, edge detection for motion and object recognition applications, and more.

The methods we'll use here:

`ctx.getImageData(x,y,width,height)` - returns an `ImageData` object for the specified `x,y,width height`. This `ImageData` object has a `.data` property that is an 8-bit typed array of the `rgba` values of each pixel of the canvas.

`ctx.putImageData(imageData,x,y)` - copies an `ImageData` object onto the canvas at the specified `x,y`

The starting state of our visualization (yours is supposed to be somewhat different)



- A) Grab the Web Audio Visualizer-I done file (the one with the circles, or another working version you've customized) and add 2 *script-scoped variables* at the top of the file (where your drawCtx and canvasElement variables are):

```
// 26 - these will help with our pixel effects
let invert = true, tintRed = true, noise = true, sepia = true;
```

- B) At the very end of the update() method (NOT inside the for loop), add a call to a function (that we are going to write next) called manipulatePixels(drawCtx).

- C) Make manipulatePixels() look like this, and put it in the // III. - HELPER FUNCTIONS area:

```
// III. HELPER FUNCTIONS

function manipulatePixels(ctx){
    // 28 - Get all of the rgba pixel data of the canvas by grabbing the ImageData Object
    // https://developer.mozilla.org/en-US/docs/Web/API/ImageData
    let imageData = ctx.getImageData(0, 0, ctx.canvas.width, ctx.canvas.height);

    // 29 - imageData.data is an 8-bit typed array - values range from 0-255
    // imageData.data contains 4 values per pixel: 4 x canvas.width x canvas.height = 1,024,000 values!
    // we're looping through this 60 FPS - wow!
    let data = imageData.data;
    let length = data.length;
    let width = imageData.width;

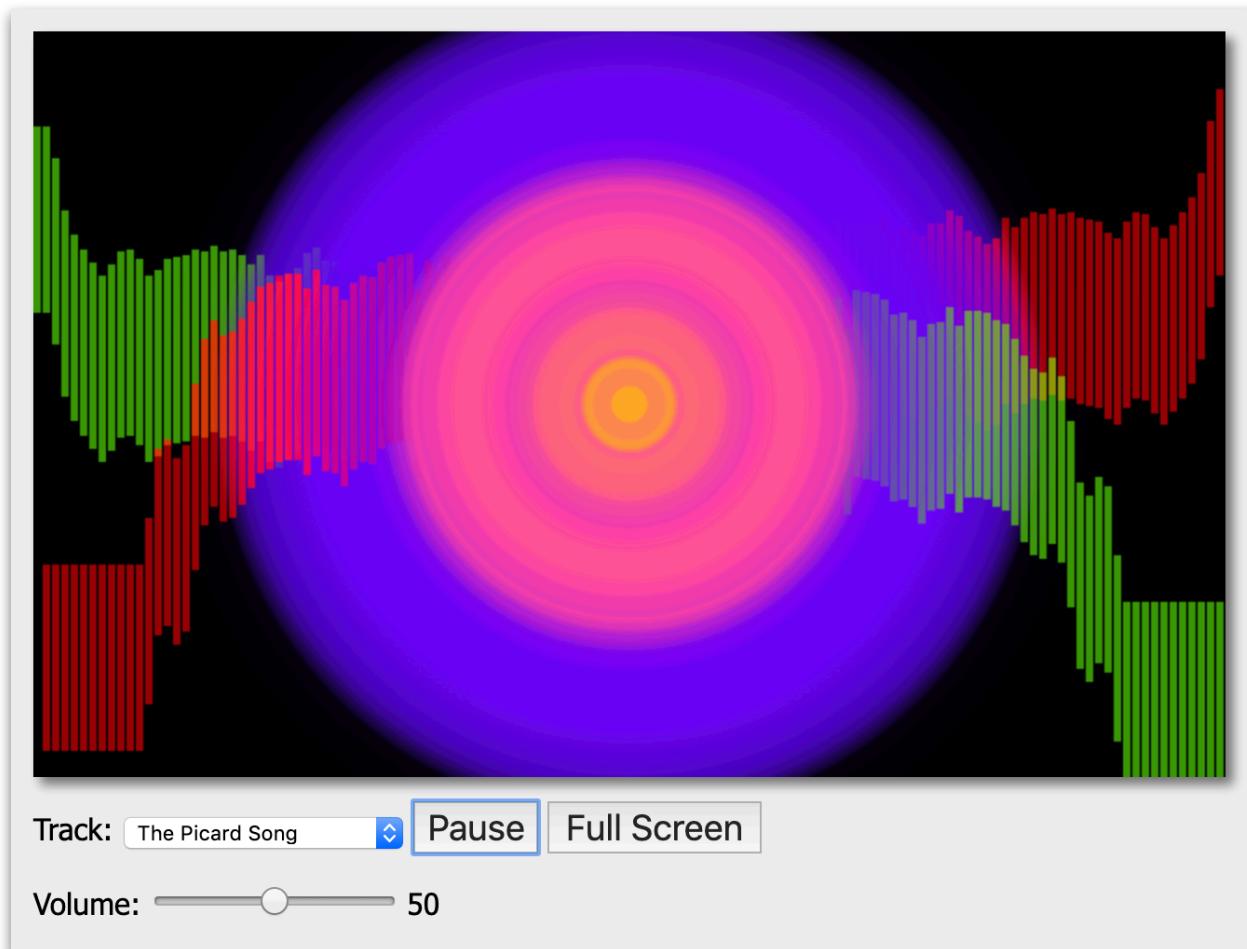
    // 30 - Iterate through each pixel
    // we step by 4 so that we can manipulate 1 pixel per iteration
    // data[i] is the red value
    // data[i+1] is the green value
    // data[i+2] is the blue value
    // data[i+3] is the alpha value

    let i; // declaring `i` outside loop is an optimization
    for (i = 0; i < length; i +=4){
        // 31 - increase red value only
        if(tintRed){
            // just the red channel this time
            data[i] = data[i] + 100;
        }
    }

    // 32 - put the modified data back on the canvas
    ctx.putImageData(imageData, 0, 0);
}
```

Outside of the comments, there's not much code here - and be sure you understand what's going on.

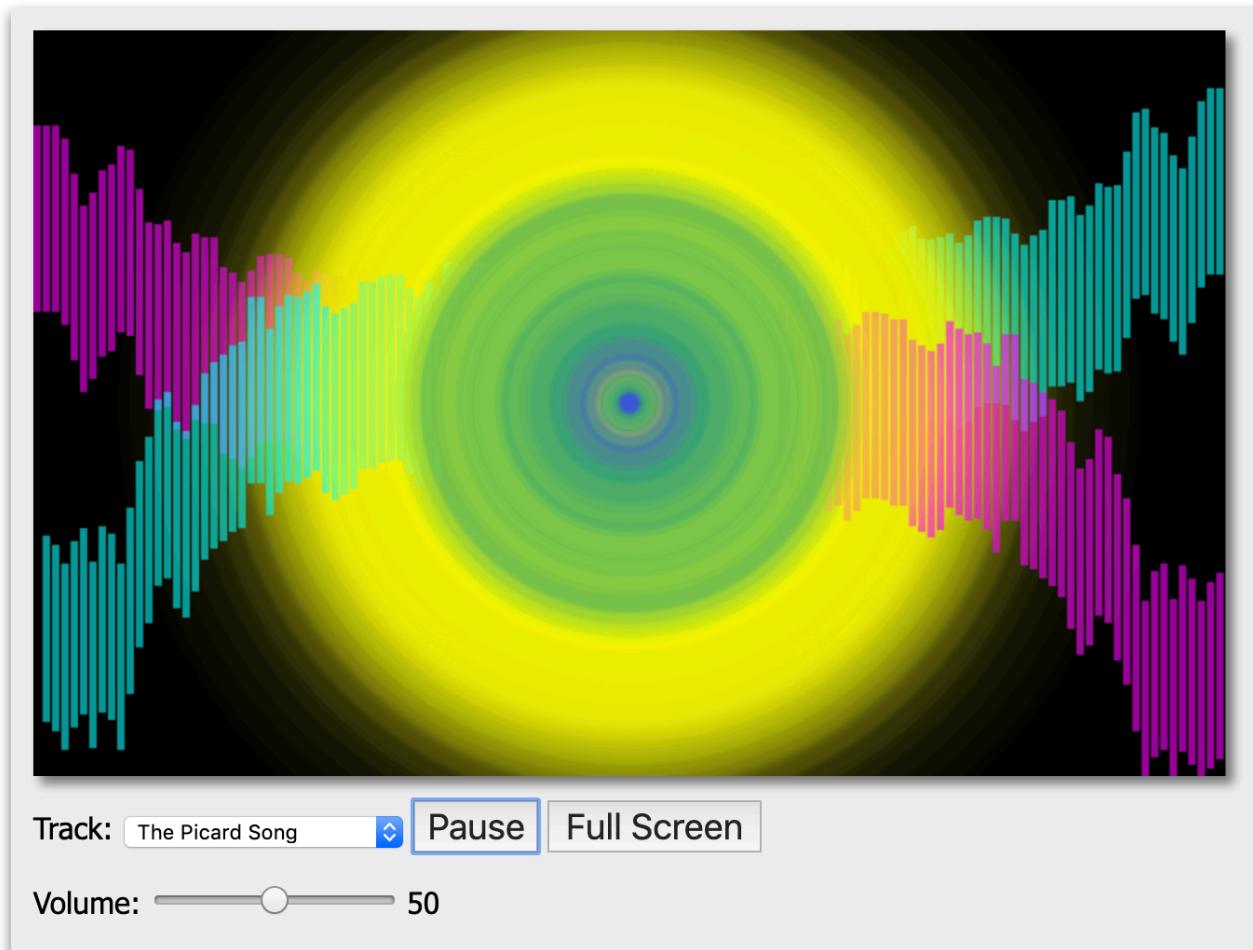
Run this in Chrome, you should get a red tint on the circle pixels:



D) Next we will invert the colors. Add the following right after the `tintRed` code (and inside of the loop):

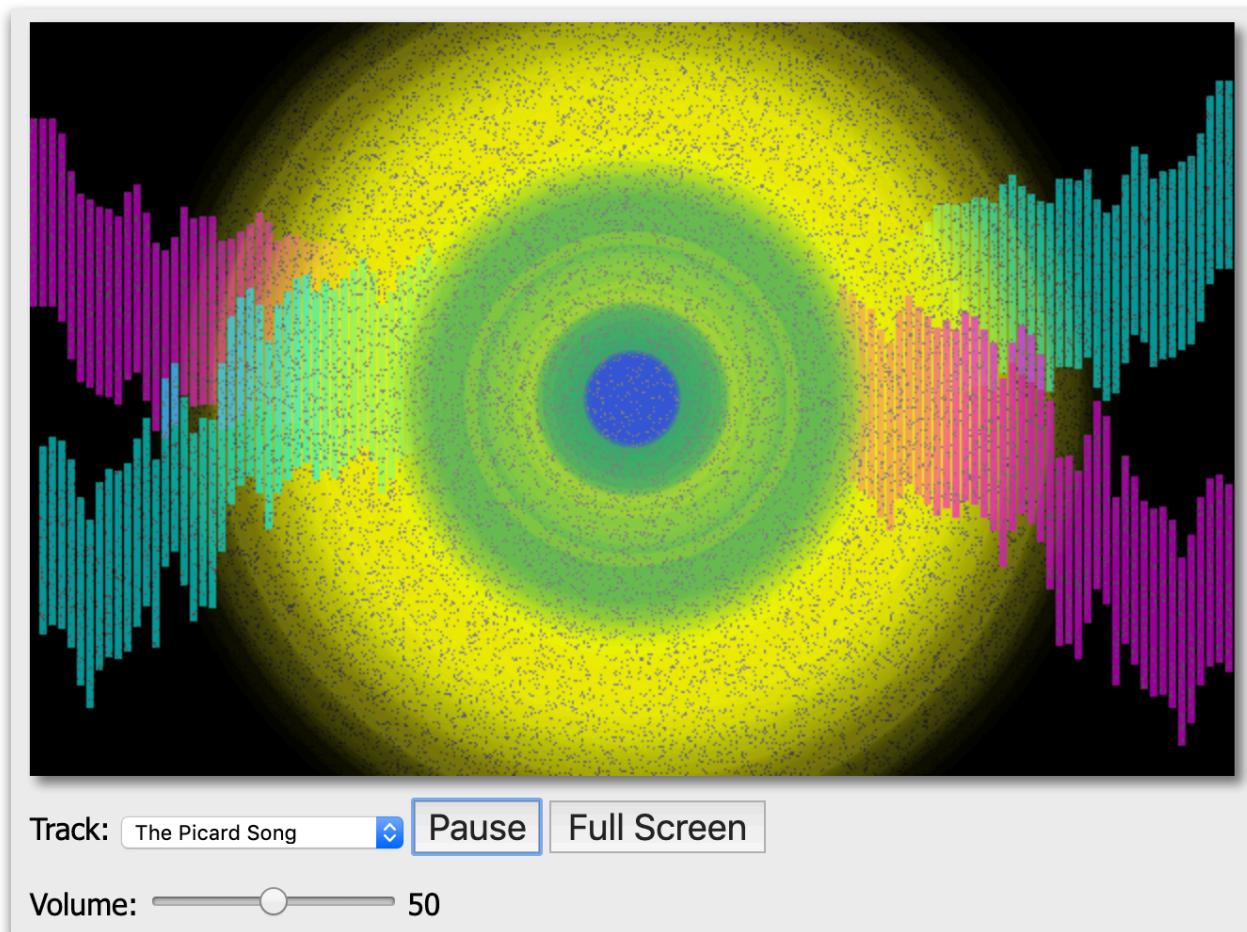
```
// 32 - invert every color channel
if(invert){
    let red = data[i], green = data[i+1], blue = data[i+2];
    data[i] = 255 - red;      // set red value
    data[i+1] = 255 - green; // set blue value
    data[i+2] = 255 - blue; // set green value
    // data[i+3] is the alpha but we're leaving that alone
}
```

Set your `tintRed` script variable to `false` before you run this. You should see something like the following:



E) How about some noise?

```
// 33 - noise
if (noise && Math.random() < .10){
    data[i] = data[i +1] = data[i+2] = 128; // gray noise
    //data[i] = data[i +1] = data[i+2] = 255; // or white noise
    //data[i] = data[i +1] = data[i+2] = 0; // or black noise
    data[i+3] = 255; // alpha
}
```

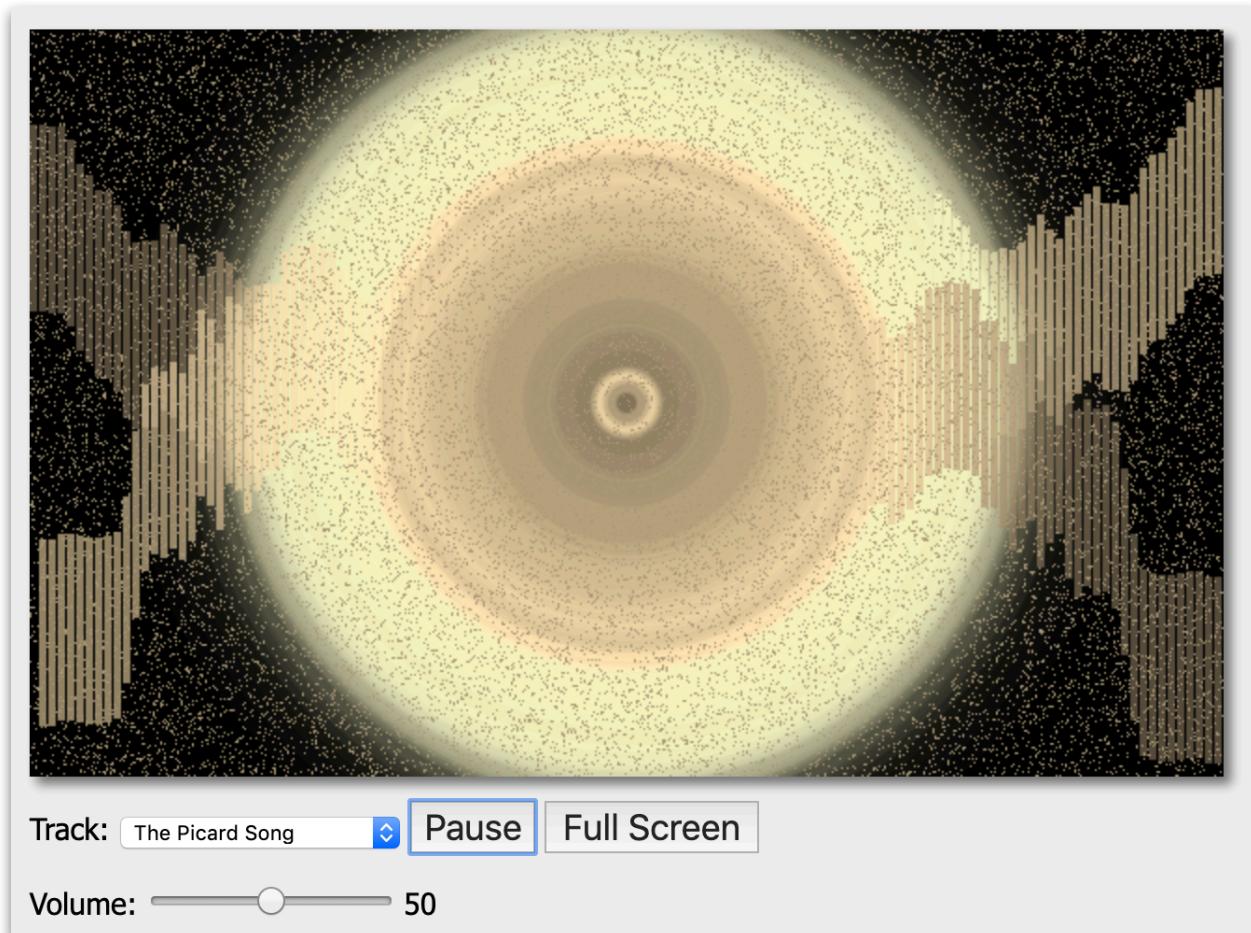


To see noise even on the black areas we haven't drawn to, add this:

```
data[i+3] = 255; // alpha
```

F) How about sepia tone?

```
// 34 - sepia
if (sepia){
    // You write this!
    // https://stackoverflow.com/questions/1061093/how-is-a-sepia-
    tone-created
}
```



That's enough for now. These effects often work well if animated, under user control (mouse, keyboard etc), and especially on bitmapped images like photographs and video feeds.

2) Image Processing Links

Image processing is a large field of study - here are some links you might find handy:

<http://www.techrepublic.com/blog/how-do-i/how-do-i-convert-images-to-grayscale-and-sepia-tone-using-c/#>

<http://stackoverflow.com/questions/1061093/how-is-a-sepia-tone-created>

<http://html5doctor.com/video-canvas-magic/>

https://archive.org/details/Lectures_on_Image_Processing

<http://stackoverflow.com/questions/13932855/canvas-flip-half-the-image>

<http://www.html5rocks.com/en/tutorials/canvas/imagefilters/#toc-setup>

<http://lodev.org/cgtutor/filtering.html>

Another application of this (when combined with the webcam) is edge detection, which lets us detect, recognize and track objects and motion, which leads to making a webcam controller that acts like the Kinect. There are JS libraries available that can do this.

<https://github.com/mtschiirs/js-objectdetect>

<http://trackingjs.com/docs.html>

3) A few demos - fun with Canvas and Video

So far our Audio Visualizer is performing pixel effects on procedurally generated drawings - but what if we wanted to do this on still images or even video?

It's easy - just copy the image or video frame to the canvas, then grab the canvas image data, manipulate it, and then copy it back to the canvas.

A) The screenshot below is from:

<https://igm.rit.edu/~acjvks/courses/2014-spring/450/code/getImageData-putImageData-demo-video-image-data-demo-3.html>



Here we see some additional effects applied to a video, such as *Desaturate*, *Sepia*, and *Shift RGB* (I made that one up). Feel free to “view source” to check out the code.

The above effects look at only one pixel at a time. More interestingly, the *Emboss* effect looks at neighboring pixels .

Here's the code for the emboss effect for the above app:

```
// emboss
if (emboss){
    // Loop through the subpixels, convoluting each using an edge-detection matrix.
    for(var i = 0; i < length; i++) {
        if( i%4 == 3 ) continue;
        data[i] = 127 + 2*data[i] - data[i + 4] - data[i + width*4];
    }
}
```

And here's a good explanation of how the emboss effect is accomplished from:
<http://html5doctor.com/video-canvas-magic/>

Then I just loop through the pixels, like I did before. If the pixel happens to be for the alpha channel (every fourth number in the array), I can just skip it — I don't want to change the transparency. Otherwise, I'll do a little math to find the difference between the current pixel's color channel and the similar channels of the pixels below and to the right, then just combine that difference with the "average" gray value of 127. This has the effect of making areas where the pixels are the same color a flat medium gray, but edges where the color suddenly changes will turn either bright or dark.

B) Turns out we can do this with webcam video too:

<https://igm.rit.edu/~acjvks/courses/2014-spring/450/code/video/webcam-image-data-demo.html>

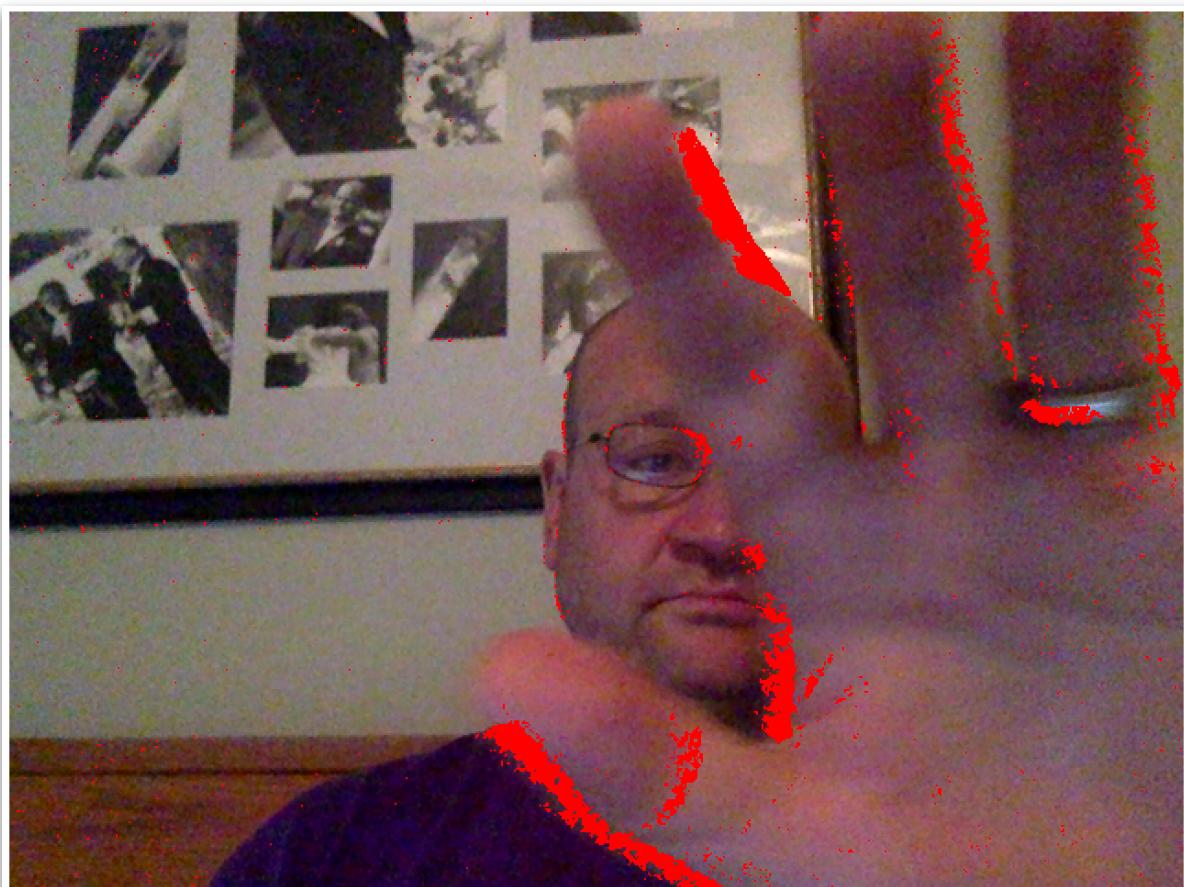


The screenshot shows a grayscale video frame with a prominent embossed effect applied. The image is heavily textured, with raised edges and shadows creating a 3D-like appearance. At the bottom of the screen, there is a toolbar with several filter options:

- Invert
- Desaturate
- Sepia
- Tint (Green dropdown menu)
- Noise
- Shift RGB
- Emboss

C) We can also use pixel data for motion detection.

<https://igm.rit.edu/~acjvks/courses/2014-spring/450/code/video/webcam-image-data-demo-2.html>



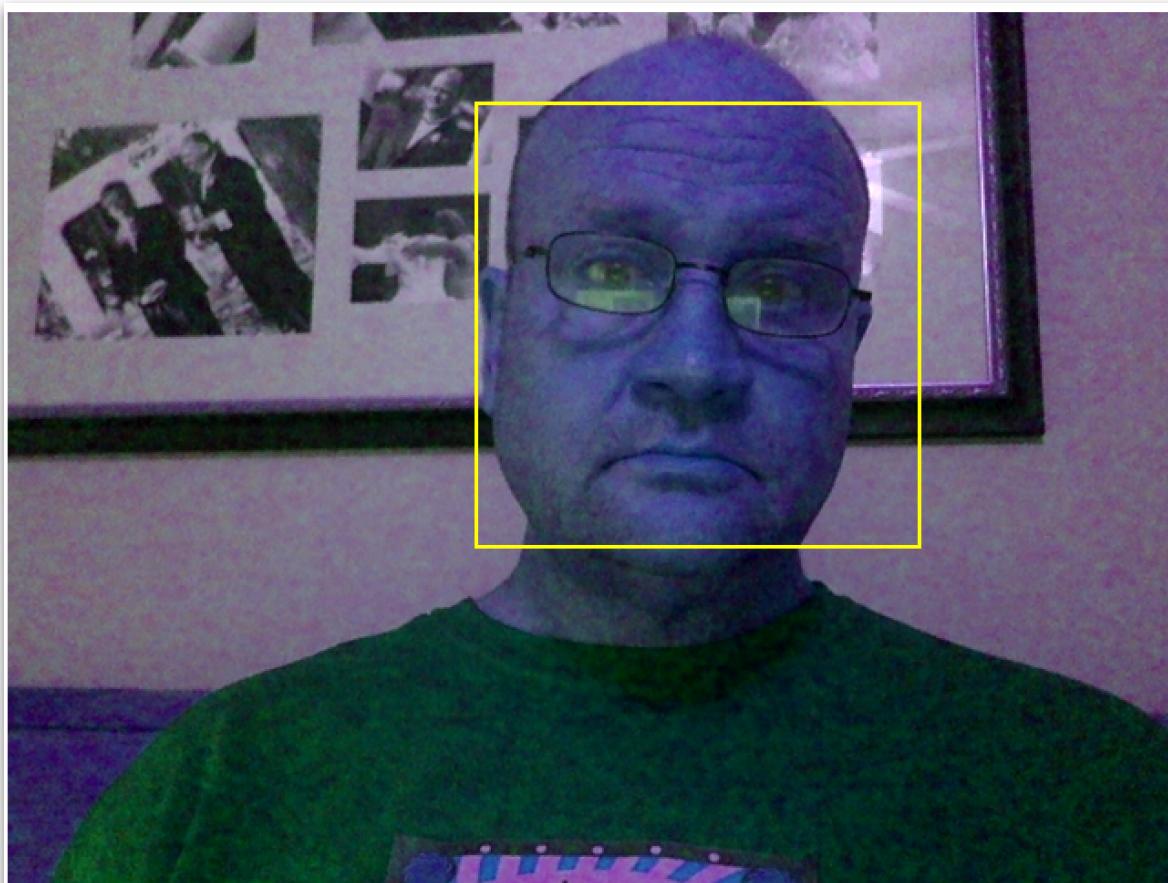
- Invert Desaturate Sepia
- Tint Green Noise Shift RGB
- Emboss
- Detect Motion

Feel free to view the source code. Here we just look at the current and previous `ImageData` captures and compare the pixel data. Wherever any of the color components has varied by 15 units or more, we color that entire pixel red. This has the effect of giving us motion detection for very little effort.

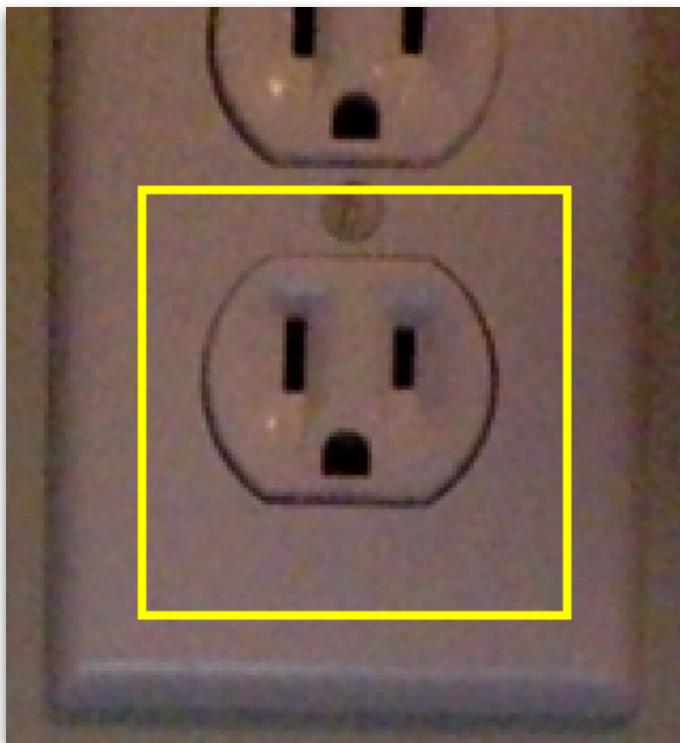
D) This captured pixel data can now be used for face and object detection.

<https://igm.rit.edu/~acjvks/courses/2014-spring/450/code/video/webcam-image-data-demo-3.html>

And to do this, we're going to go ahead and use an existing JS library rather than write this object detection code from scratch.



Turns out that wall outlets and Bowser Jr. Propeller Ship's have faces too:



- turate Sepia
 Noise Shift RGB

 Detect Face

E) Now we can see how a sunglass app (or mustache app) works. This also uses a JS library.

https://igm.rit.edu/~acjvks/courses/2014-spring/450/code/video/JS-Object-Detect/js-objectdetect-master/examples/example_sunglasses_jquery.htm

Pick Your Glasses



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F) Another application we'll look at is motion tracking, which could be used as a game controller, or as input to a visualizer (hint, hint - see project 1). This example is demoing a JS library.

<https://igm.rit.edu/~acjvks/courses/2014-spring/450/code/headtracker/headtracker2.html>

Here the x, y, and z of the subject's face is computed and displayed. Below we're not doing anything fancy, just showing the x/y/z values. Note that the x is negative because the subject is leaning left.

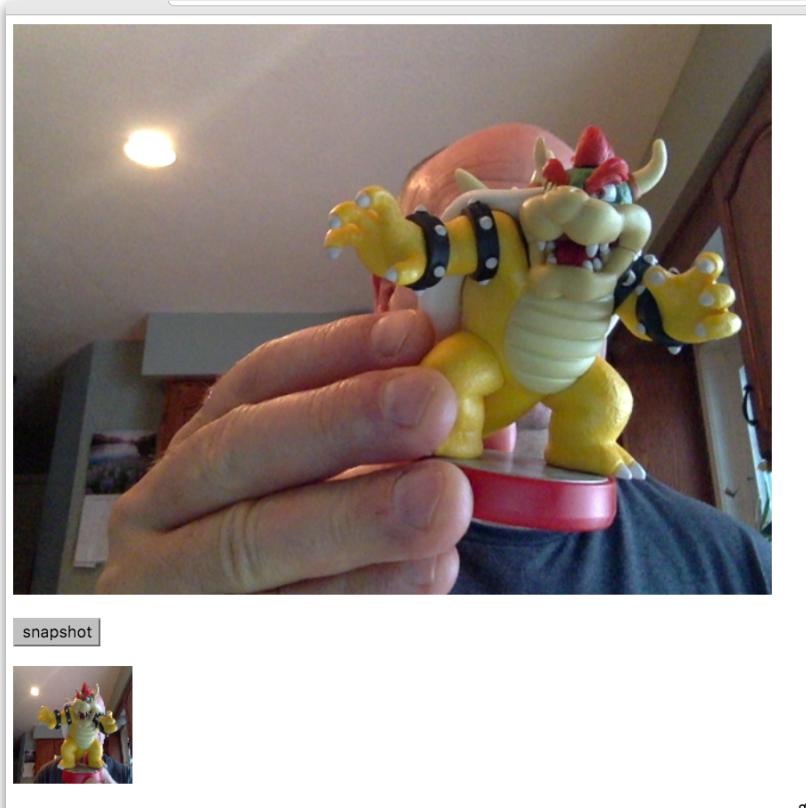


$x = -11.71, y = 12.83, z = 54.91$

G) Lastly, you can grab a frame of the video and save it as an image:

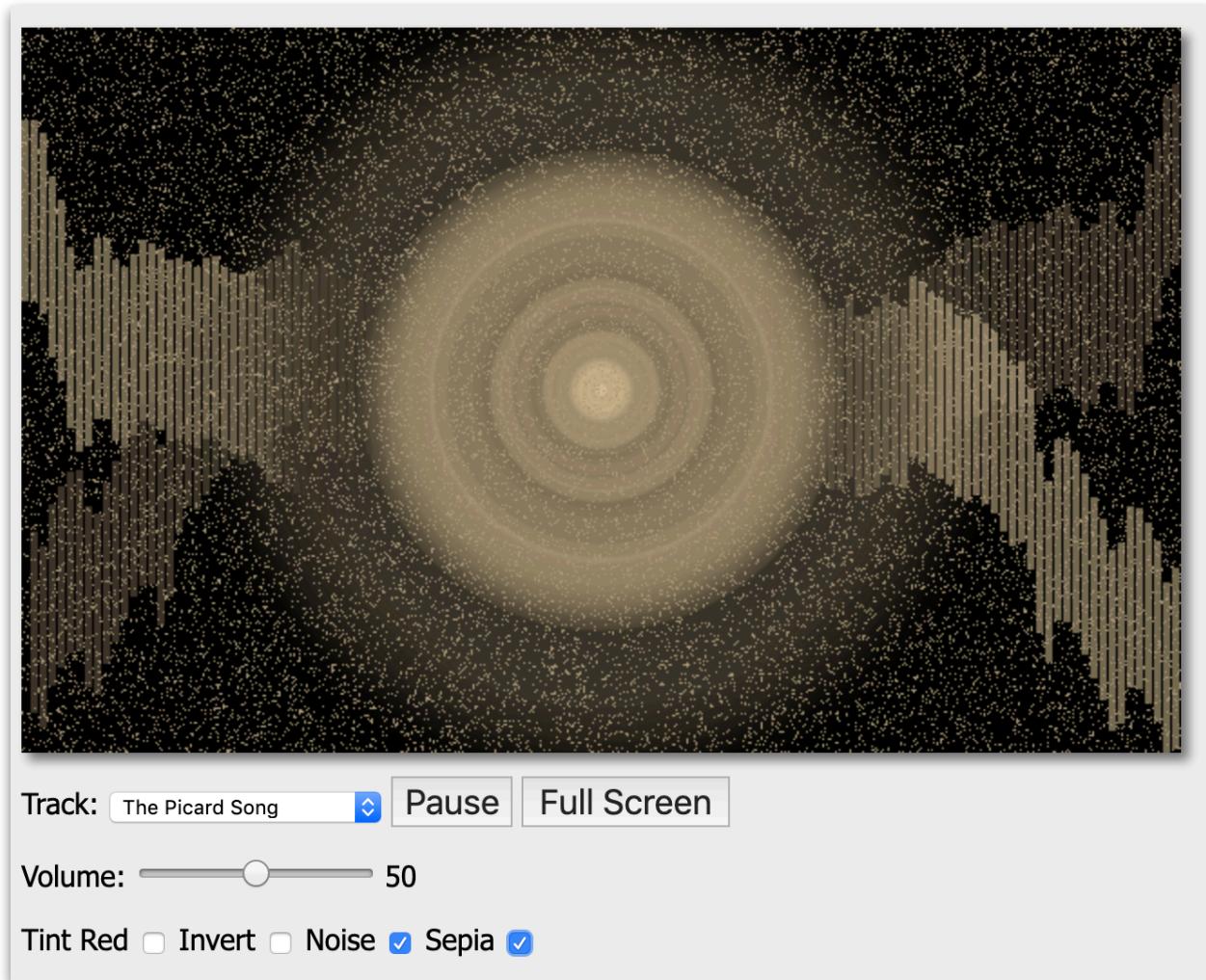
<https://igm.rit.edu/~acjvks/courses/2014-spring/450/code/video/webcam2.html>

<https://igm.rit.edu/~acjvks/courses/2014-spring/450/code/video/webcam3.html>



HW and Rubric!

- Add all 4 of the above pixel effects (tint red, invert, noise, sepia) from way back in section #1 to your completed Audio Visualizer-1 from last time. (2 points)
- Add check boxes (see below) to change the various pixel effect boolean variables so that a user can toggle the effects on and off. Have the initial state of the effects be “off”. See the Speed Circles Starter file in mycourses for how to do checkboxes. (8 points)



Bonus

- For 5 bonus points, add an additional pixel effect that is also user controllable. For example, a *Brightness* slider.
- Tip: create a `brightnessAmount` script variable and have your slider change this value
- Another Tip: If your frame rate crashes, this is because when values are pull from input elements (like sliders) they are of the `String` data type.

This means that you need to convert `brightnessAmount` to a `Number` in your slider code every time the value of the slider changes. Failure to do so means that the browser will have to do this conversion itself every time it uses the `brightnessAmount` variable (which would be over 60 million times a second for a 640 x 400 canvas)

Track:

Volume: 50

Tint Red Invert Noise Sepia

Brightness: +128