

Visualisation of Audio using Dot Matrix Display

Submitted by

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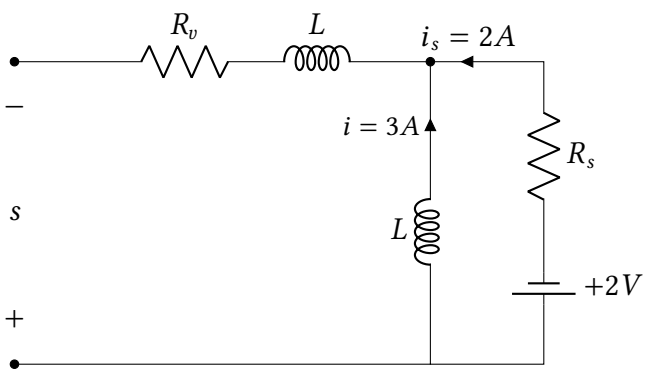
Abstract

From simple music player applications to concerts, audio visualization enhances the ambience and overall experience of the enjoyer. In this project, we replicate a simpler version of such systems using an Arduino UNO development board, 32*8 LED dot matrix display, and a few small components. An audio signal of our interest is preprocessed and fed to one of the analogue pins of Arduino. This signal is then processed using the "ArduinoFFT" library, which splits the audio into discrete chunks and performs FFT on it. The resulting frequency spectrum is then again processed and scaled down to match the width and height of the LED display. Finally, the resulting waveform is displayed. In the end, we try to add more customizations such as different "display modes" and effects.

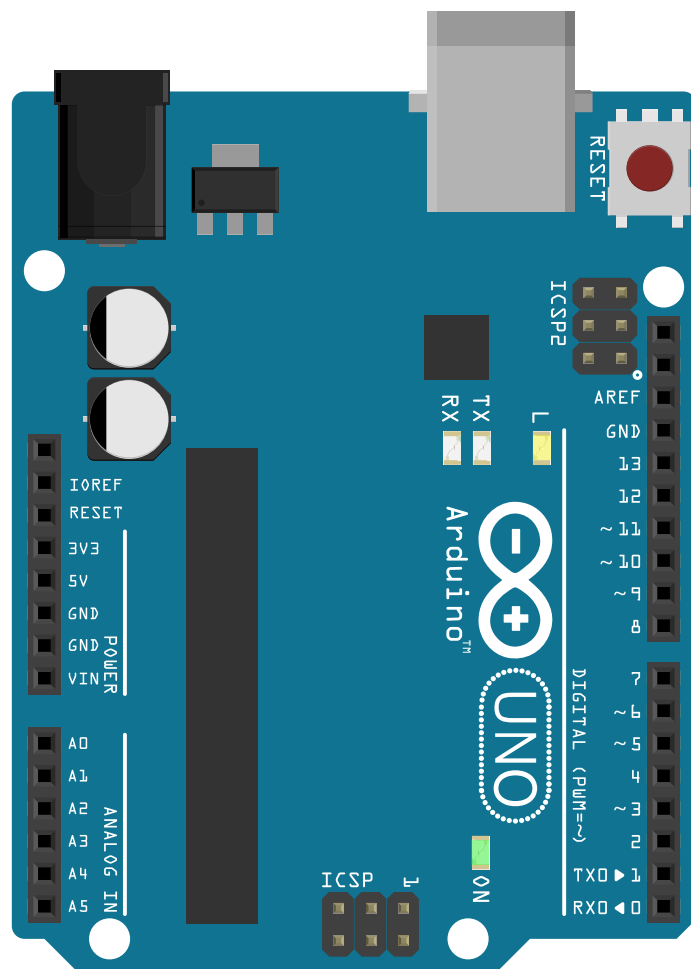
Implementation

Introduction

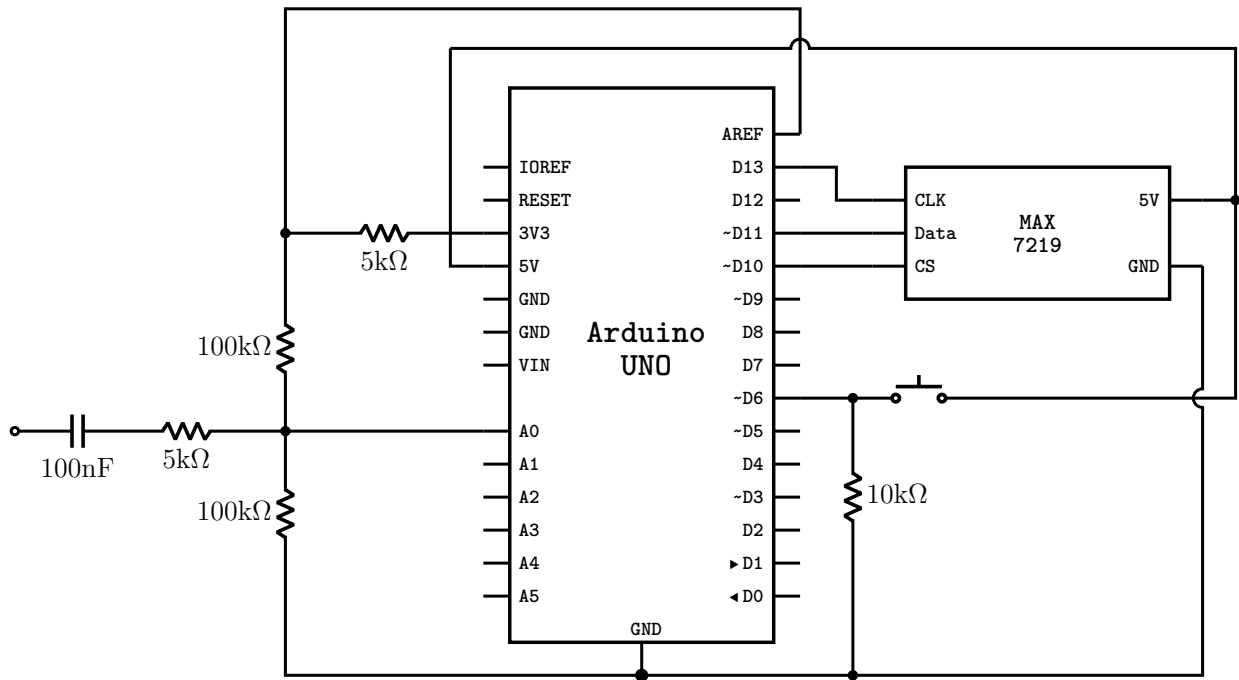
Block Diagram



Arduino UNO



Hardware



Program

```
1  #include <arduinoFFT.h>
2  #include <MD_MAX72xx.h>
3
4  #define SAMPLES 64
5  #define HARDWARE_TYPE MD_MAX72XX::FC16_HW
6  #define MAX_DEVICES 4
7  #define CLK_PIN 13
8  #define DATA_PIN 11
9  #define CS_PIN 10
10 #define xres 32
11 #define yres 8
12
13 const int buttonPin = 5;
14 int displaymode = 1;
15 int previousState = LOW;
16
17 double vReal[SAMPLES];
18 double vImag[SAMPLES];
19
20 char data_avgs[xres];
```

```

21
22 int yvalue;
23 int displaycolumn, displayvalue;
24 int peaks[xres];
25
26 unsigned long lastDebounceTime = 0;
27 unsigned long debounceDelay = 200;
28 const float samplingFrequency = 8000;
29
30 int CURRENT_PATTERN[] = { 0, 1, 3, 7, 15, 31, 63, 127, 255 };
31 const int MODES = 2;
32 int PATTERNS[MODES][9] = {
33     { 0, 1, 3, 7, 15, 31, 63, 127, 255 }, // standard pattern
34     { 0, 1, 2, 4, 8, 16, 32, 64, 128},    // peak pattern
35 };
36
37
38 MD_MAX72XX mx = MD_MAX72XX(HARDWARE_TYPE, CS_PIN, MAX_DEVICES);
39 ArduinoFFT<double> FFT = ArduinoFFT<double>(vReal, vImag, SAMPLES, samplingFrequency);
40
41 void setup() {
42     // set ADC to free running mode and set pre-scalar to 32 (0xe5)
43     ADCSRA = 0b11100101;
44     ADMUX = 0b00000000; // A0
45
46     pinMode(buttonPin, INPUT);
47     mx.begin();
48     // wait to get reference voltage stabilized
49     delay(50);
50     mx.setColumn(0, 63);
51     mx.setColumn(31, 7);
52     delay(900);
53 }
54
55 void loop() {
56     // Sample collection
57     for (int i = 0; i < SAMPLES; i++) {
58         // wait for ADC to complete current conversion
59         while (!(ADCSRA & 0x10));
60         // clear ADIF bit so that ADC can do next operation (0xf5)
61         ADCSRA = 0b1110101;
62         int value = ADC - 512;
63         vReal[i] = value / 8;
64         vImag[i] = 0;
65     }
66
67     FFT.windowing(vReal, SAMPLES, FFT_WIN_TYP_HAMMING, FFT_FORWARD);
68     FFT.compute(vReal, vImag, SAMPLES, FFT_FORWARD);
69     FFT.complexToMagnitude(vReal, vImag, SAMPLES);
70     int step = (SAMPLES / 2) / xres;
71
72     // shift averages
73     for (int i = 0; i < xres; i += step) {
74         data_avgs[i] = 0;
75         for (int k = 0; k < step; k++) {
76             data_avgs[i] = data_avgs[i] + vReal[i + k];

```

```

77     }
78     data_avgs[i] = data_avgs[i] / step;
79 }
80
81 // Display
82 for (int i = 0; i < xres; i++) {
83     data_avgs[i] = constrain(data_avgs[i], 0, 80);
84     data_avgs[i] = map(data_avgs[i], 0, 80, 0, yres);
85     yvalue = data_avgs[i];
86
87     peaks[i] = peaks[i] - 1;
88     if (yvalue > peaks[i])
89         peaks[i] = yvalue;
90     yvalue = peaks[i];
91     displayvalue = CURRENT_PATTERN[yvalue];
92     displaycolumn = i;
93     mx.setColumn(displaycolumn, displayvalue);
94 }
95 // check if button pressed to change display mode
96 displayModeChange();
97 }
98
99 void displayModeChange() {
100     int reading = digitalRead(buttonPin);
101     if (
102         reading ^ previousState &&
103         (millis() - lastDebounceTime) > debounceDelay
104     ) {
105         displaymode = (displaymode + 1) % MODES;
106         for (int i = 0; i <= 8; i++) {
107             CURRENT_PATTERN[i] = PATTERNS[displaymode][i];
108         }
109         lastDebounceTime = millis();
110     }
111     previousState = reading;
112 }

```

Conclusion

References