

Programming II - 7CTA1130-0905-2020

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1.Introduction

The purpose of this task was to create an AU/VST3 plugin using the JUCE library and Projucer application.

The plugin designed in this report was a distortion filter. Made combining a ladder filter from the JUCE dsp module and some nonlinear processing functions.

2.Method

1. Implementing JUCE dsp ladder filter
2. Adding distortion dsp code
3. Creating Parameters
4. Creating Sliders and customising GUI

2.1 Implementing filter

JUCE::dsp::LadderFilter<foat>

```
73
74
75 //=====Creating DSP Objects=====
76 juce::dsp::LadderFilter<float> moogFilter;
77 juce::dsp::Gain<float> driveGain;
78
```

Figure 1: Creating Ladder Filter in pluginProcessor.h

There is a lot of precursor work that needs to be done before using the filter from the dsp module. It needs a process spec, and audioBlock and a context replacing object.

The Process spec is a dsp class that creates an object that can hold information about the audio data that will be processed by the dsp algorithm.

```
PluginProcessor.cpp
//=====Creating and populating process spec=====
juce::dsp::ProcessSpec spec;
spec.maxNumChannels = sampleRatePerBlock;
spec.sampleRate = sampleRate;
spec.numOutputs = getMainOutputChannel();
//=====Reset and preparing filter=====
moogFilter.reset();
moogFilter.prepare(spec);
//=====Reset and preparing gain=====
driveGain.reset();
driveGain.prepare(spec);
driveGain.setGainDurationSeconds(0.1);
//=====
//moogFilter.setNode(juce::dsp::LadderFilterNode::BP2A);

```

Figure 2: Creating and using Process Spec

Dsp objects use the information curated by the spec via the prepare function.

The final steps in using the dsp algorithms is in creating an audio block and a context object.

```
174
175 auto audioBlock = juce::dsp::AudioBlock<float>(buffer);
176 auto context = juce::dsp::ProcessContextReplacing<float>(audioBlock);
177
178 moogFilter.process(context);
179 driveGain.process(context);

```

Figure 3: Creating Audio block and Context Replacing

The audio block behaves as the audiobuffer for the DSP filter and the process context replacing behaves like a buffer write pointer, which replaces the original signal with the processed signal from the filter.

2.2 Nonlinear Processing Function

The Hyperbolic tangent function was adapted I to create distortion to the samples.

Name	Acronym	Equation (x = in, y = out, k = saturation)	Notes
Arraya	ARRY	$y = \frac{3x}{2} \left(1 - \frac{x^2}{3} \right)$	No saturation, very mild
Sigmoid	SIG	$y = 2 \frac{1}{1 + e^{-kx}} - 1$	
Sigmoid2	SIG2	$y = \frac{(e^x - 1)(e + 1)}{(e^x + 1)(e - 1)}$	No saturation, very mild
Hyperbolic Tangent	TANH	$y = \frac{\tanh(kx)}{\tanh(k)}$	Good for diode simulation
Arctangent	ATAN	$y = \frac{\arctan(kx)}{\arctan(k)}$	
Fuzz Exponential 1	FEXP1	$y = \operatorname{sgn}(x) \frac{1 - e^{- x }}{1 - e^{-k}}$	

Figure 4: Nonlinear function source. (Pirkle, 2019)

```

for (int channel = 0; channel < totalNumInputChannels; ++channel)
{
    auto* channelData = buffer.getWritePointer (channel);
    for (int sample = 0; sample < buffer.getNumSamples(); sample++)
    {
        float headroom = 0.5;
        // channelData[sample]=channelData[sample]/(1+fabs(channelData[sample]));
        channelData[sample]= tanh(headroom * channelData[sample]) / tanh(headroom);
    }
}

```

Figure 5: Equation in code form

2.3 Creating Parameters

Using the JUCE class audio processor value tree state. A value tree of the plugins parameters were created.

```

juce::AudioProcessorValueTreeState::ParameterLayout ProgrammingIIAudioProcessor::createParameters()
{
    juce::AudioProcessorValueTreeState::ParameterLayout params;
    params.add(std::make_unique<juce::AudioParameterInt>("cutoff",
        130,
        22000,
        500));
    params.add(std::make_unique<juce::AudioParameterFloat>("Q",
        "Resonance",
        0.0f,
        1.0f,
        0.0f));
    params.add(std::make_unique<juce::AudioParameterFloat>("DRIVE",
        "Drive",
        0.0f,
        20.0f,
        0.0f));
    params.add(std::make_unique<juce::AudioParameterFloat>("OUTPUT",
        "Output",
        0.0f,
        100.0f,
        50.0f));
}

```

Figure 6: Parameter Value tree

Creating this class allows you to link parameters with their sliders in the pluginEditor. The class has slider and button attachments.

```

18 //
19 class ProgrammingIIAudioProcessorEditor : public juce::AudioProcessorEditor
20 {
21 public:
22     ProgrammingIIAudioProcessorEditor (ProgrammingIIAudioProcessor&, juce::AudioProcessorValueTreeState&);
23     ~ProgrammingIIAudioProcessorEditor() override;
24
25     typedef juce::AudioProcessorValueTreeState::SliderAttachment SliderAttachment;
26     typedef juce::AudioProcessorValueTreeState::ButtonAttachment ButtonAttachment;
27     typedef juce::AudioProcessorValueTreeState::ComboBoxAttachment ComboBoxAttachment;

```

Figure 7: multiple valuetree attachments

2.4 GUI Design

After creating and positioning the sliders I created a user interface class to manipulate the look and feel functions for the sliders. I downloaded a texture off of the internet and used it as the background of the plugin.

```
Navigate Editor Product Debug Source Control Window Help
programmingll - AU > My Mac 2 Running Logic Pro X : Programmingll - AU
PluginProcessor.h PluginProcessor.cpp PluginEditor.h PluginEditor.cpp
Programmingll > Pr_gll > Source > PluginEditor.cpp > ProgrammingllAudioProcessorEditor:ProgrammingllAudioProcessorEditor(vta) < >
20 //=====Creating cutOff Slider and Label=====
21 addAndMakeVisible(cutOffSlider);
22 addAndMakeVisible(cutOffLabel);
23 cutOffAttachment.reset(new SliderAttachment(valueTreeState,"cFreq", cutOffSlider));
24 cutOffLabel.setText("CUTOFF", juce::dontSendNotification);
25 //cutOffLabel.set
26 cutOffSlider.setSliderStyle(juce::Slider::RotaryHorizontalVerticalDrag);
27 cutOffSlider.setTextBoxStyle(juce::Slider::TextBoxBelow, true, 50, 25);
28 cutOffSlider.setTextValueSuffix("Hz");
29 cutOffLabel.attachToComponent(&cutOffSlider, false);
30 //=====Creating resonance Slider and Label=====
31 addAndMakeVisible(resonanceSlider);
32 addAndMakeVisible(resonanceLabel);
33 resonanceAttachment.reset(new SliderAttachment(valueTreeState,"Q", resonanceSlider));
34 resonanceLabel.setText("RESONANCE", juce::dontSendNotification);
35 resonanceSlider.setSliderStyle(juce::Slider::RotaryHorizontalVerticalDrag);
36 resonanceSlider.setTextBoxStyle(juce::Slider::TextBoxBelow, true, 50, 25);
37 resonanceLabel.attachToComponent(&resonanceSlider, false);
38
39 //=====Creating Drive Slider and Label=====
40 addAndMakeVisible(driveSlider);
41 addAndMakeVisible(driveLabel);
42 driveAttachment.reset(new SliderAttachment(valueTreeState,"DRIVE", driveSlider));
43 driveLabel.setText("DRIVE", juce::dontSendNotification);
44 driveSlider.setSliderStyle(juce::Slider::RotaryHorizontalVerticalDrag);
45 driveSlider.setTextBoxStyle(juce::Slider::TextBoxBelow, true, 50, 25);
46 driveSlider.setTextValueSuffix("V");
47 driveLabel.attachToComponent(&driveSlider, false);
48
49 //=====Creating Output Slider and Label=====
50 addAndMakeVisible(outputSlider);
51 addAndMakeVisible(outputLabel);
```

Figure 8: Creating and labelling Components

```
21 }
22 void drawRotarySlider (juce::Graphics g, int x, int y, int width, int height, float sliderPos,
23                      const float rotaryStartAngle, const float rotaryEndAngle, juce::Slider&
24                      slider) override
25 {
26     auto outline = slider.findColour (juce::Slider::rotarySliderOutlineColourId);
27     auto fill = slider.findColour (juce::Slider::rotarySliderFillColourId);
28
29     auto bounds = juce::Rectangle<int> (x, y, width, height).toFloat().reduced (10);
30
31     auto radius = juce::Jmin (bounds.getWidth(), bounds.getHeight()) / 2.0f;
32     auto takeAngle = rotaryStartAngle + sliderPos * (rotaryEndAngle - rotaryStartAngle);
33     auto lineW = juce::Jmin (0.5f, radius * 0.5f);
34     auto grooveRadius = radius - lineW * 0.5f;
35
36     auto centreX = x + width / 2.0;
37     auto centreY = y + height / 2.0;
38     auto rx = centreX - radius;
39     auto ry = centreY - radius;
40
41     juce::Rectangle<float> newBounds (rx, ry, radius*2, radius*2);
42
43     g.setColour(juce::Colours::transparentBlack);
44     //g.fillRect(newBounds);
45     g.fillRect(newBounds);
46
47     g.setColour(juce::Colours::palegoldenrod);
48
49     juce::Path dialTick;
50     dialTick.addRectangle(0, -radius, 0.5f, radius);
51
52     //juce::DropShadow shadow(juce::Colours::black.withAlpha(0.2f), width * 0.1f, juce::Point<int>{width *
53     //0.5f, height * 0.5f});
54
55     g.fillPath(dialTick, juce::AffineTransform::rotation(takeAngle).translated(centreX, centreY));
56
57     g.setColour(juce::Colours::white);
58     g.drawEllipse(rx, ry, radius*2, radius*2, 1.0f);
59 }
60 }
```

Figure 9: UserInterface class with customised look and feel function

```
114 //=====Background=====
115
116
117
118 // Make sure that before the constructor has finished, you've set
119 // editor's size to whatever you need it to be.
120 setSize (200, 500);
121
122 ProgrammingllAudioProcessorEditor::~ProgrammingllAudioProcessorEditor()
123 {
124 }
125
126 void ProgrammingllAudioProcessorEditor::paint (juce::Graphics g)
127 {
128     // (Our component is opaque, so we must completely fill the back
129     // with a solid colour.)
130     g.fillRect(getLocalBounds().toFloat().toInt());
131     g.drawImage(background, getLocalBounds().toFloat());
132
133 }
134
135 void ProgrammingllAudioProcessorEditor::resized()
136 {
137     // sets the position and size of the slider with arguments (x, y, w, h)
138 }
```

Figure 10: Paint function and background (Wallpaper.dog,2020)

3. Results

The plugin functions on multiple platforms. The pre sets menu would have been a modern addition to the plugin as many plugins today have a selection of presets accessible from the UI of the plugin. The look and feel of the buttons and combo box could have been redesigned to fit the entire aesthetic of the rest of the plugin.

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