Rocaloid3 Full Reference

Rocaloid Development Team

Built on March 5, 2014

Contents

Chapter 1

System Structure and Development Status

1.1 About Rocaloid

Rocaloid is a free vocal synthesis **system**.

Please notice the bold word "**system**", which differs it from a "software" or "application": in a broad sense, Rocaloid provides a series of tools and libraries from the very basic DSP libs to synthesis engine and musical score editor. In a narrow sense, what Rocaloid represents in this reference is the back-end of this system.

This reference focuses on Rocaloid in its narrow definition.

1.1.1 Purpose

Rocaloid aims at singing voice synthesis rather than speech synthesis(though it is possible to be used as a speech synthesizer).

The description for history of Rocaloid Project can be found on our website:

http://www.rocaloid.org

1.1.2 Why Reinventing the Wheel?

In the back-end of Rocaloid, we code everything from scratch. The author Sleepwalking himself is a pure enthusiast in voice signal processing and he does not really care about development cycle. If you are looking for a reason for reinventing the wheel, we would suggest:

- Our wheels are smaller and faster than other wheels(on certain conditions and platforms which are commonly used by our users). e.g. CVEDSP performs 1024-point FFT 1.3 times faster than fftw3 on x86 with SSE.

- Our wheels are interrelated with great consistency. e.g. variable naming convention.

- Our wheels focus on audio signal processing. Surely they are more relevant to our topic.

- We intend to minimize dependencies of Rocaloid(libc only).

- By reventing the wheels we are sure that Rocaloid will be forever free(because we own all of the libs from bottom to top).

- And finally, the developers themselves learn from the project as they reinvent the wheels.

1.2 Current Status

The development of Rocaloid3 started in September, 2013. The core synthesis engine, CVE3, was finished in December. However, a crucial defect was detected in the algorithm and we had to redesign the engine.

Our decision was to abandon CVE3 and move on to CVE3.5, by the way restructuring the whole project.

We have adopted SMS technique for the new synthesis engine. The detailed algorithm will be discussed in Chapter 2.

Currently we are **just about to start** the restructuring.

1.3 About the System

1.3.1 General Diagram

From the users' point of view, Rocaloid reads in a musical score file with melody and lyrics, accesses to a soundfont database, and outputs a .wav sound file.

The soundfont is sampled from a real person(the sound provider). The raw samples undergo preprocesses(e.g. segmentation) and are then converted to sound font format.
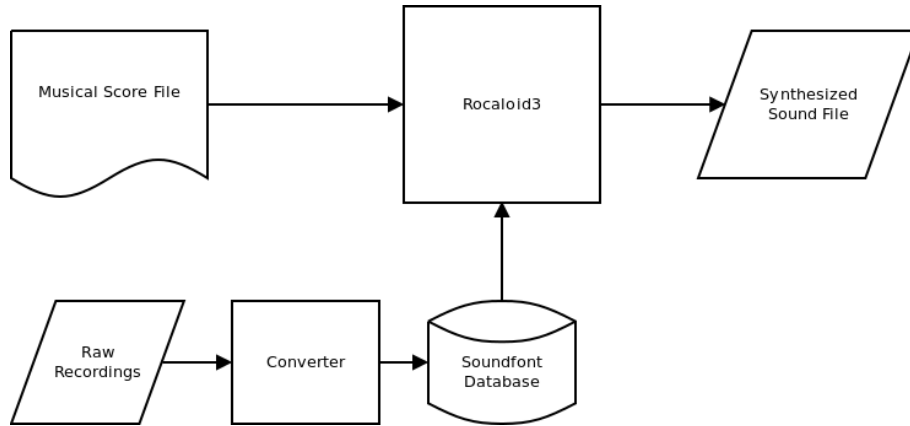
Figure 1.1: General Concept of Rocaloid3

1.3.2 Inside Rocaloid

After Rocaloid starts up, the musical score file is first converted to a vocal description file. This file describes voice in a phonetic level(lower than muscial level). The second step is to convert the voice description file to a soundfont-specific engine script. Many details of voice are generated in this step, such as the exact duration for each phoneme.

Then the CVE synthesis engine is called. CVE directly reads the soundfont-specific script and the soundfont database. The synthesis process may take a while, and finally a .wav file is produced.

1.3.3   Modules

Rocaloid3 is composed of the following modules:

RUtil2	A tiny library for Objected Oriented Programming and dynamic data structure in C.
RFNL	A fast float-point numeric library. Contains basic techniques such as FFT and interpolation methods.
CVEDSP2	A digital signal processing framework that wraps some DSP techniques in interconnectable modules.
CVESMS	A voice signal processing toolbox based on CVEDSP2.
RFILE3	A library for file support and input/output.
CVE3.5	The core synthesis engine.
RParagen	The soundfont-specific script generator.
CVDBToolChain	A set of tools for building the soundfont database.

Beyond these modules, Wavetave is an audio processing sandbox written in Octave Language and C++. All algorithms used by Rocaloid are first tested in Wavetave.

One undocumented module is CVEANN, a small Artificial Neuron Network library initially designed for formant detection and voice parameter generation. However the performance of CVEANN was unsatisfactory and it has been obsoleted.
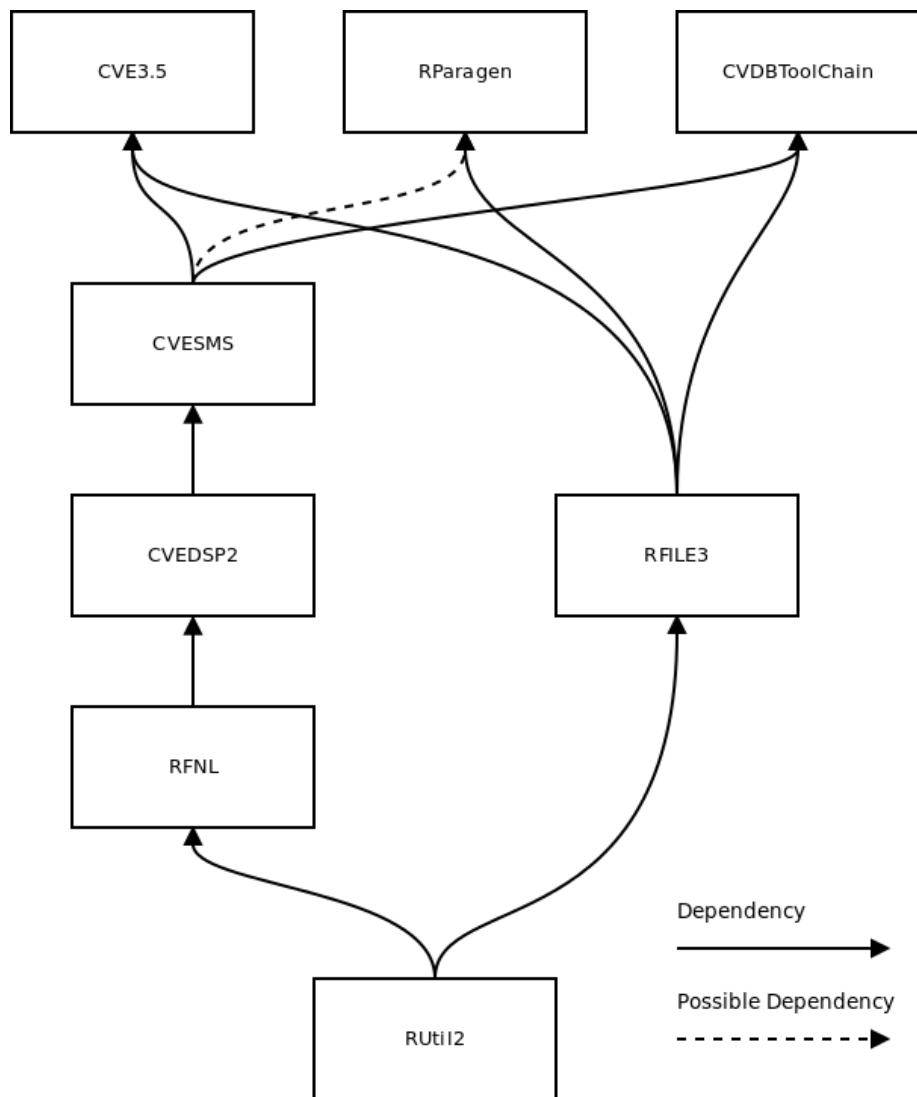
Figure 1.2: Dependency Chart of Rocaloid3

1.3.4 File Types

.rvs **Rocaloid Vocal Script**: Phonetic description of voice.

.cvs **CyberVoice Script**: Detailed soundfont-specific description of voice.

.cvdb **CyberVoice DataBase**: A soundfont particle which contains a diphone or a single phoneme.

1.4 About this Reference

The composition of this reference is parallel to the construction of Rocaloid3. Even if the project is unfinished and actually in the very beginning, we will make detailed record of usages and descriptions here.

This reference is written in LaTeX. Diagrams in this reference are created with Dia.

Source code of this reference:

https://github.com/Rocaloid/Rocaloid-Doc

1.4.1 For Developers

We are glad you are willing to contribute to Rocaloid.

Please read through this reference first, then send an email to Sleepwalking and describe yourself to join the development team:

sleepwalking@rocaloid.org

Chapter 2

Wavetave and the Underlying Algorithms

2.1 About Wavetave

Wavetave is an audio analysis and processing sandbox written in Octave Language and C++. The initiative of creating Wavetave is to test the feasibility of new algorithms, for example, the improved EpR Voice Model for CVE3.5.

Before any new algorithm is put into application, it should be implemented and tested out in Wavetave first.

Wavetave has two parts: SpectrumVisualizer and MinCVE. The former is a powerful audio analyzer based on gnuplot; the later is a minimal and **very incomplete** version of CVE3.5, being developed just for testing the feasibility of CVE3.5.

2.1.1 Source Code Quick Guide

The code repository for Wavetave:
https://github.com/Rocaloid/Wavetave

- All source codes of Wavetave are placed under /src.

- SpectrumVisualizer and all of its plugins are placed under /src.

- MinCVE is placed under /src/MinCVE.

- Some useful code snippets are placed under /src/Util.

- All C++ written modules are placed under /src/Oct.

Dependencies

You need gnuplot, octave, octave-dev and g++ to compile and run Wavetave.

Building Wavetave

```
1  $ git clone https://github.com/Rocaloid/Wavetave
2  $ cd Wavetave/src/Oct
3  $ for i in *.cc; do mkoctfile $i -s; done #This may take a while
```

2.2 SpectrumVisualizer

2.2.1 Basic Usage

SpectrumVisualizer can be activated in two ways: direct execution or activating from an octave console.

```
1  $ cd Wavetave
2  $ ./SpectrumVisualizer.m
```

Or

```
1  octave:1> SpectrumVisualizer
```

After starting up you will get two three windows: two plot windows and one terminal.

Figure 1 is used to display the time-domain signal.

Figure 2 displays the decibel-magnitude spectrum of the analyzed part of the signal.

The terminal shows hints and extra information of the analyzed signal.
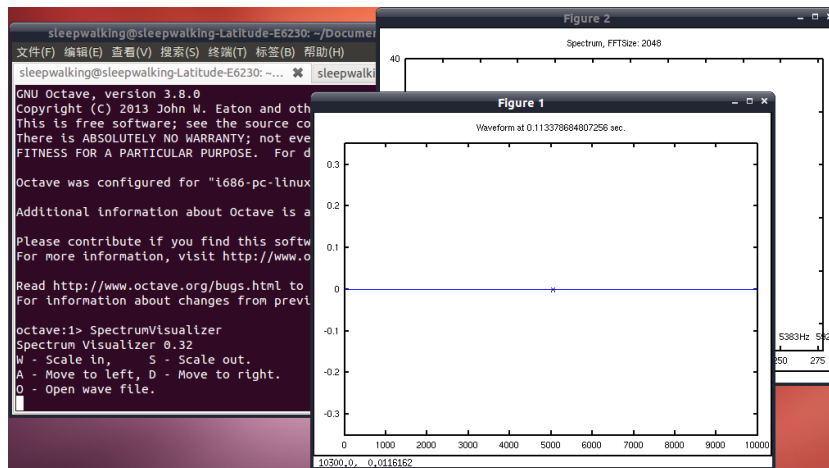
Figure 2.1: SpectrumVisualizer starts up

When interacting with SpectrumVisualizer, you should always keep Figure 1 focused because it is the figure listening for mouse and key events.

By default no wave is loaded when SpectrumVisualizer starts. Waves can be loaded by pressing O, then a prompt goes out in the terminal:

```
Wave to open(enclosed by quotes):
```

Input the file path with quotes. Currently SpectrumVisualizer only supports **single channel** wav files. The recommended sample rate is **44100Hz** and the recommended length is **1 to 5 seconds**. For example:

```
Wave to open(enclosed by quotes):'/tmp/test.wav'
```

If you are using gnome-terminal, this can be simply done by dragging the file into the terminal.

Then press enter.

Our example is a short pronunciation of 'A' that lasts for 1 second.
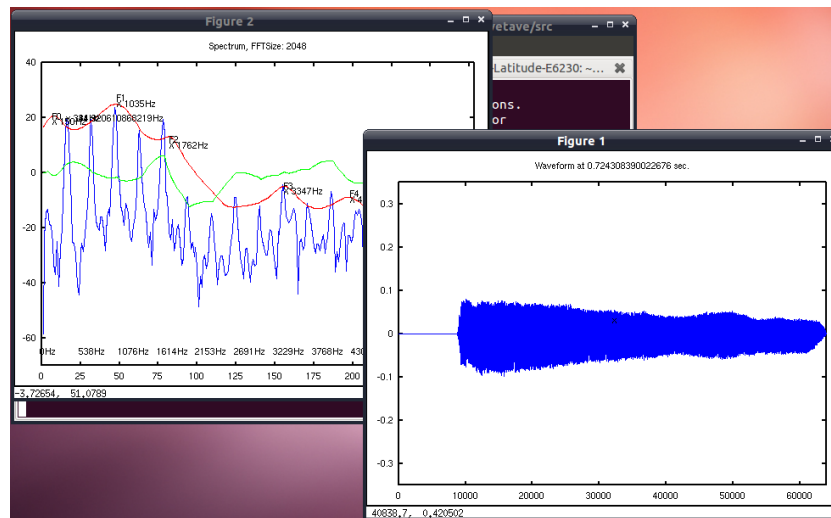
Figure 2.2: 'A'

Some plugins for Wavetave are activated by default, as shown in Figure 2 above. The red and green line and the labels come from Plugin_FormantFitting. We are not sure about which plugins are set to be activated by default because the settings are constantly changed.

Surfing through the Wave

You can change the position of the analysis window by clicking on Figure 1.

Press W to scale in; Press S to scale out.

Press A to move the window to left; Press D to move to right.

Depending on the speed of your device and the number of plugins that are activated, the response speed of SpectrumVisualizer may vary a lot. When it appears to be too slow, try to disable some plugins.

Configuring the Plugins

Open /src/SpectrumVisualizer.m with your favourite editor. Look for the following lines:

```
1  global Plugin_Load = [
2              "Empty"
3              "Plugin_Load_EpRInitialization"
4         #    "Plugin_Load_PulseMarking"
5         #    "Plugin_Load_PulseMarking_Stable"
6         #    "Plugin_Load_PulseMarking_Naive"
```

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```
 7            ];
 8   ...
 9   global Plugin_Wave = [
10              "Empty"
11          #       "Plugin_UnvoicedDetection"
12          #       "Plugin_PulseMarking"
13          #       "Plugin_VOTMarking"
14          ];
15   ...
16   global Plugin_Spectrum = [
17              "Empty"
18              "Plugin_F0Marking"
19              "Plugin_F0Marking_ByPhase"
20              "Plugin_FormantFitting"
21          #       "Plugin_Freq2Pitch"
22          #       "Plugin_HarmonicMarking"
23          #       "Plugin_HarmonicMarking_Naive"
24          #       "Plugin_PhaseFigure"
25          ];
```

Activate or deactivate a plugin by removing or adding the comment mark before it.

- Plugin_Load stands for plugins that are called when a new wave file is loaded.

- Plugin_Wave stands for plugins that are called when Figure 1 is repainted.

- Plugin_Spectrum stands for plugins that are called when Figure 2 is repainted.

If you have implemented your own plugin, you can add its name to the above list. Make sure in each group of plugins there is at least an "Empty" because it keeps the list from being empty.

2.3 Plugins

2.4 MinCVE

2.4.1 Basic Usage

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Chapter 3

RUtil2: Minimalistic OOP in C

Chapter 4

RFNL: Rocaloid Fast Numeric Library

Chapter 5

CVEDSP2: Signal Processing Framework

Chapter 6

CVESMS: Voice Processing Toolbox

Chapter 7

RFILE3: I/O Support

Chapter 8

CVE3.5: The Synthesis Engine

Chapter 9

RParagen: For the Generation of Natural Voice

Chapter 10

CVDBToolChain: Behind the Scenes

Chapter 11

Appendix

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