

# Vibrappo

**D.A.S Final Review**

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Vibrato is an effect that periodically deviates in pitch from the fundamental frequency, typically used on sustained notes. Vibrato is one of the few audio phenomenon's that can be created naturally or implemented digitally. The result is a dynamic sound rich in harmonic variation. It is common practice in singing as it occurs via a tremor in the diaphragm. The two main parameters of vibrato are rate and depth. The depth is determined by the speed at which the pitch or frequency is deviated and the rate refers to the amount of pitch variation. When implemented digitally these functions can be exploited at parameters that far exceed human limitations.

A test conducted by Eric Prame [1], measured the vibrato rate of ten singers to determine that the average minimum vibrato rate of all ten singers, whilst still maintaining the characteristic sounds of vibrato is 5.5Hz, where as the average maximum vibrato rate is 6.6Hz. These values still maintain the tonal qualities of human singing. Here lies the problem, the limitations of the human voice make it impossible to create a vibrato effect that exceeds and sustains at these minimum and maximum values. When implemented digitally these values can be advantageously exploited to sound artificial and creatively removed from a personable sound experience.

With recent advances in mobile technology, it is possible for advanced digital signal processing to take place in the mobile domain at computational costs low enough for smartphones to handle efficiently. The goal of the proposed project is to produce and commercially release a vibrato effect smartphone app. The decision to use a

smartphone app as the platform for release is based off the accessibility, low cost and computational power of mobile smartphones. Smartphones are an all in one portable solution for digital signal processing with the capabilities for recording and playback via internal speakers and headphone output.

This product proposal will outline the digital adaptation of vibrato as an app rather than the specifics of its implementation into Matlab. The proposal will oversee the underlying business opportunity of the app and its short and long-term goals but will not detail operational procedures, marketing strategy or finances. Approval will shortly follow this document with a full strategic business plan. The goal of this document is to present an opportunity for investment.

## VIBRATO IN THE DIGITAL REALM (SPECIFICATION)

Vibrato is simplest and the foundation of delay based effects. It is implemented in the digital realm by creating a delay line of the original signal then modulating it using an LFO. Contrary to other delay based effects, there is no need to mix the dry original signal back into the wet signal. The two main parameters of vibrato are rate and depth. The depth determines the speed at which the pitch or frequency is deviated and the rate refers to the amount of pitch variation. Typically the parameters range between a delay time of 5 – 10ms and a LFO modulation between 5-14Hz [2]. When the delay time is in exceedance of the above mentioned parameters and combined with feed forward and feed back signals, new delay based effects are created. For example if the parameters were to be set to a delay range of 10 – 25ms and combined with a feed forward signal a chorus will be created.

$$y(n) = x(n - M)$$

Figure 1: *Vibrato mathematical expression (Udo Zolzer, "DAFX – Digital Audio Effects" [2]).*

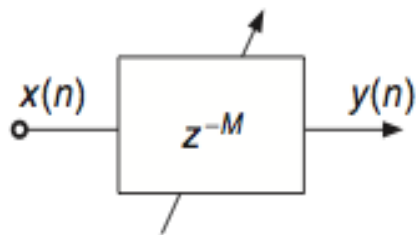


Figure 2: *Vibrato* (Udo Zolzer, "DAFX – Digital Audio Effects" [2]).

## VIBRAPPO (IMPLEMENTATION)

The proposed mobile smartphone app titled *Vibrappo* will inherit the above-mentioned principles of creating a digital vibrato effect, in a user-friendly and intuitive app interface. *Vibrappo* is designed to provide users a portable all in one solution with the capabilities of recording, processing vibrato and playback. The app itself will be created using Xamarin, an efficient programming platform for app development. Xamarin is built off C# and is multi-platform, having the ability to be ported across to iOS, Android and Windows apps.

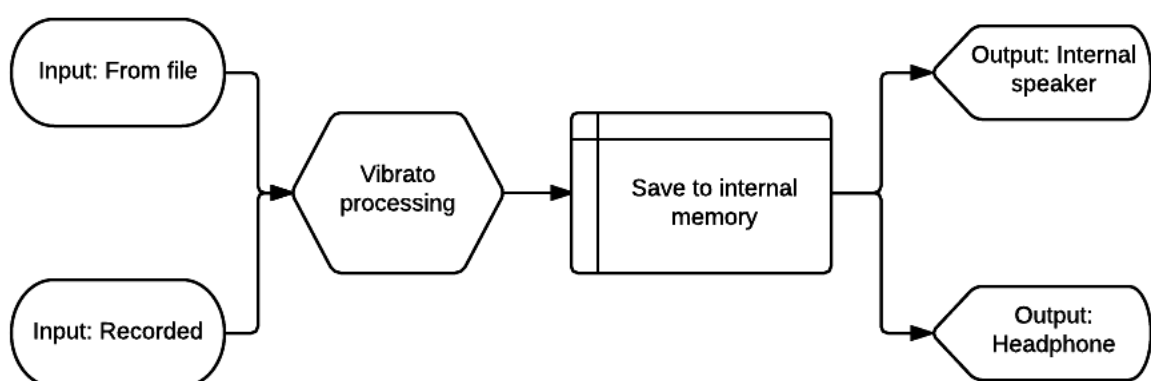


Figure 3: Signal flow chart [4]

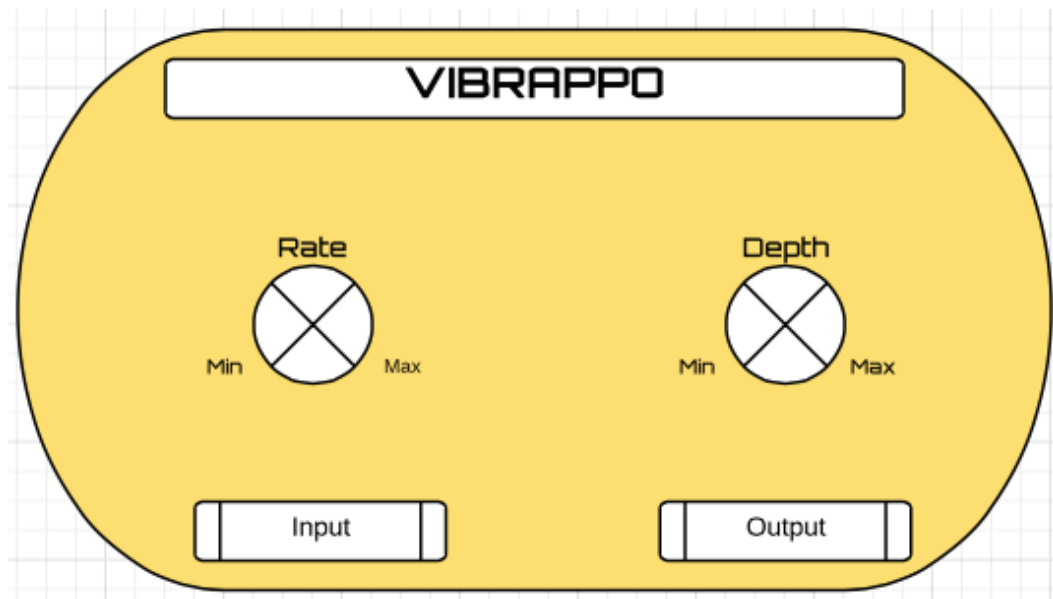


Figure 4: Vibrappo graphical user interface [4]

The app will be streamlined with a limited amount of user-defined functions to accomplish a simple user-friendly interface. Users have control over four functions the input, rate, depth and a nominated output. Numerical values for the rate and depth will be removed to make way for simplified minimum and maximum values. The minimum and maximum values for each parameter are illustrated in the table below, with an incremental rise between min and max.

	<b>Min</b>	<b>Max</b>
<b>Depth</b>	3ms	700ms
<b>Rate</b>	2Hz	22Hz

Figure 5: Table depicting min and max functions of Vibrappo [4]

## THE PERCEPTION OF VIBRAPPO (EVALUATION)

To evaluate it's human performance, data from a subjective listening test has been analysed from the paper "*Categories of Perception for Vibrato, Flange, and Stereo Chorus: Mapping out the Musically Useful Ranges of Modulation Rate and Depth for Delay-Based Effects*" by William L. Martens and Marui, Atsushi [3]. The paper evaluates a number of delay-based effects including vibrato and whether the depth is musically useful, with the pair performing a subjective listening test with 25 participants. The participants were asked to judge whether the stimulus would be too subtle for effective use, quite musically useful or too extreme for most musical applications.

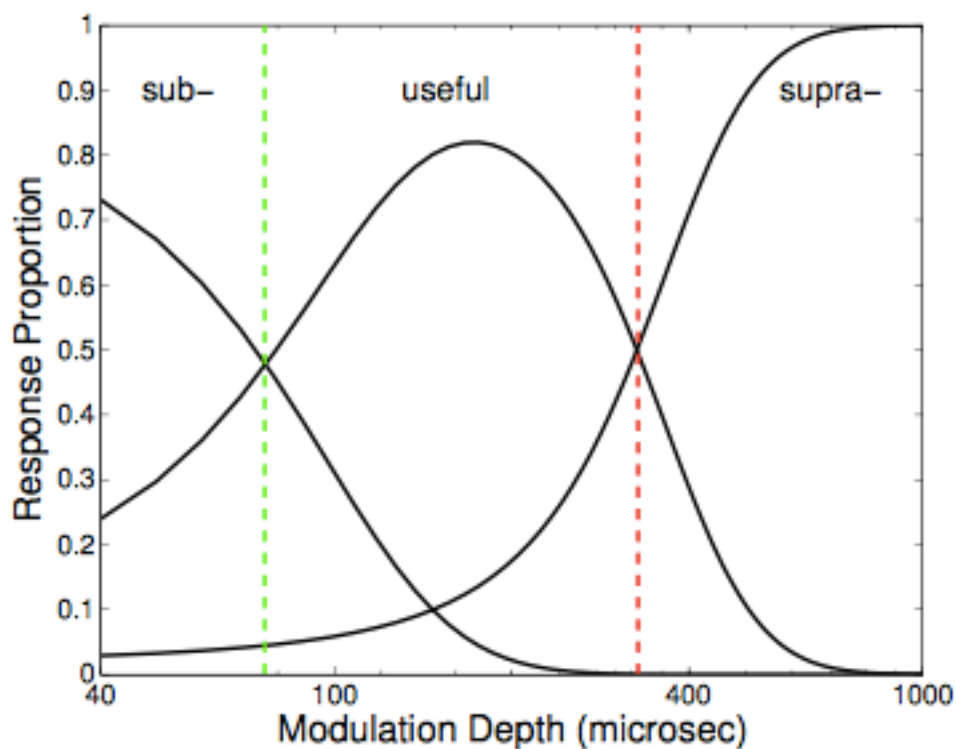


Figure 6: "*Categories of Perception for Vibrato, Flange, and Stereo Chorus: Mapping out the Musically Useful Ranges of Modulation Rate and Depth for Delay-Based Effects*" by William L. Martens and Marui, Atsush [3]

The above plot depicts a three-category response task with vibrato stimuli modulation depth between 40 and 1000ms, at a fixed modulation rate of 6Hz. The middle curve represents modulation depth that has been deemed as musically useful by the test subjects, where as sub- and supra- indicate that modulation depths are either too subtle or too strong for musical use respectively. For the purpose of this vibrato app all data whether it has been deemed musically useful or not is relevant, as the primary goal of the app is to explore interesting and creative sounds using vibrato, which is why values for modulation depths far beyond the cut off point of what has been deemed musically useful have been included in the app.

The following app achieves its purpose by providing interesting variations of vibrato at values that are impossible for humans to sustain. One of the main challenges of this app is to explore the creative limits of vibrato whilst maintaining the integrity and definition of vibrato. The proposed product is accessible by taking the form of a cross-platform smartphone app whilst maintaining a user-friendly environment with four simple user defined functions. Vibrappo maximises overhead costs by taking advantage of smartphone technology that many of us already keep in our pockets. Vibrappo has the ability to lead the way to an entire collection of digital signal processing plugins, with an all in one solution via a smartphone app.

## References:

[1] E. Prame, “*Measurements of the vibrato rate of ten singers*”, *STL –QPSR.*, vol. 33, no. 4, pp. 73-86, 1992.

[2] U. Zölzer, *DAFx—Digital Audio Effects*. John Wiley & Sons, 2002.

[3] W.L. Martens, M. Atsushi, “*Categories of Perception for Vibrato, Flange, and Stereo Chorus: Mapping out the Musically Useful Ranges of Modulation Rate and Depth for Delay-Based Effects*”, *DAFx-06, 9<sup>th</sup> Int. Conference on Digital Audio Effects*, pp. 149-152, September 2006.

[4] P. Krishnan, originally created diagrams and tables, 2015.