Use and Understanding Voice Lab for Singers

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Introduction:

The success of opera made it necessary to seek out new singers and to develop singing training in order to secure growth and continuity in the new art form. To the singer, the voice appears to dissociate itself from the larynx and become present in the resonant resource of the vocal tract and within the acoustics of the opera house.

The different styles of classic, musical theater, and pop music, requires that the singer produce a wide range of tonal qualities. For classical singers, there is a demand to maximize the resonance of the voice and find a mode of production that will allow them to find an accommodation between resonance and clear diction over a wide working range of pitches. For music theater singers, the major demand appears to be related to direct communication of the text and, in this style, tonal quality will always take second place to diction and the word. In the pop field, the sound demand can arrange all the way from coarse and frantic, to mellow, laid back, and sentimental (Miller 1959). In this range of demands, the diction can go from completely unintelligible to crystal clear. The world of pop music covers a wide range of performance styles and within this diverse field, one can encounter performers whose skill levels range from the advanced to the untutored and technically inept.

Over the last decade, understanding of singer voice has rapidly advanced through the availability of computer based instrumentation. Since a wide variety of tonal and articulatory demands are reflected in the different vocal genres, it seems necessary to provide a quantitative procedure which can evaluate singing voice quality and monitor the effect of singing training in modern voice studio. The purpose of this paper is to provide an affordable portable voice lab to voice teachers and/or singers. Designed to enable voice teacher and singers to use the powerful techniques of voice analysis and training without incurring the costs of special hardware, Dr. Speech are Microsoft Window software system which make use of the standard multimedia capability of today's personal computers. With this affordable voice lab, some general guidelines can be given for identifying poor vocal production based on the vocal sound.

Vocal Parameters for Singers

Generally speaking, the vocal sound is acoustically characterized by diction, tone quality, range, pitch, vibrato and singer's formant (Minifie, Hixon, & Williams 1973). Since the vibrato and singer's formant might be instantly recognized by a singing teacher, these two features were investigated.

Vibrato

Vibrato is a 4-6 Hz tremor which appears gradually as a singer develops the neuromuscular ability to sustain vowels in a resonant vocal tract and against substantial transglottal pressure. Vibrato is an essential part of the musical quality of the voice and is not controllable other than by controlling sub-glottal pressure.

The acoustic features of vibrato (Huang, Minifie, Kasuya & Lin 1995) were investigated by Dr. Speech software. In figure 1, the narrow-band spectrogram is excellent for assessing the location of the available formants and observing the relative strength of the harmonics of the sung tone. The positioning of these formants establishes theidentity of vowels and the musical quality of the singer's voice. The spectrogram shows that the excessive amplitude of the vibrato is contained by the low formants. Vibrato is multiplied by the harmonic number and thefirst five harmonics show this increase.

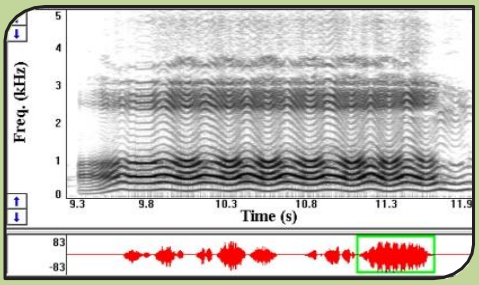


Fig. 1. The narrow-band spectrogram shows a large vibrato as a quasi sinusoidal modulation of the harmonics. (From Dr. Speech)

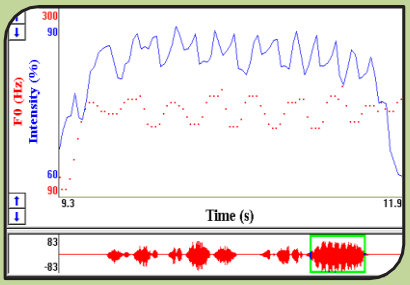


Fig. 2. The pitch and intensity displays show the vibrato cycle with negative and positive movements.(From Dr.Speech)

In figure 2, a plot of pitch and intensity display clearly indicates the effect of vibrato as a means of seeking out formants in order to enhance the musical quality of the sung tone. This plot may be associated with the points where harmonic concur with formants in the negative and positive going sweeps of vibrato. It can be seen therefore that limited vibrato can maximize the singers access to the resonant resources of the vocal tract.

Singer's Formant

In acoustic terms, the advantages gained by the singer with higher harmonic enhancement are very substantial. The human ear is relatively sensitive in 1000 Hz-5000 Hz. In effect, the singer with poor higher harmonic component support looses out in audibility in the opera house and may attempt to compensate by forcing the voice. The 2500 Hz-3500 Hz "Singer's Formant" lies within a bandwidth which successfully clears the masking potential of the classical orchestra.

The acoustic features of singer's formant were investigated by Dr. Speech software. The figure 3 provides the LPC spectral display. The first formant lies at 420 Hz. The second formant is 1840 Hz with the third formant at 2540 Hz. The fourth formant is around 3250 Hz which assists the third formant to establish a higher than normal higher harmonic strength in the case of low pitched opera singers. Adduction of the third and fourth formants is but one explanation for the singer's higher harmonic achievements. The figure 4 shows the power spectrum of the sung vowel positioning against the harmonic distribution.

Fig. 3. LPC spectrum estimates formants & singer's formant.

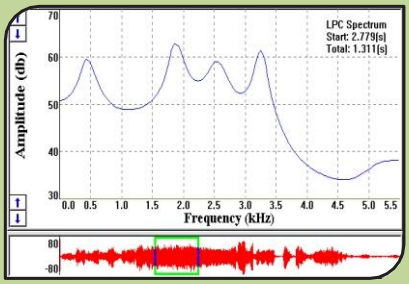
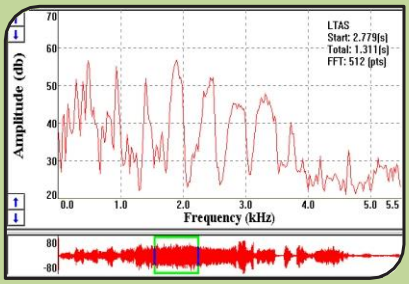


Fig. 4. Power spectrum (LTAS) Estimates harmonic distribution



Vocal Training in Singer's Studio

The huge computer industry investment in sound feature provides dynamic development which is set to diminishthe need for purchases to pay high costs of unique signal processing hardware. With an affordable Dr. Speech software, vocal training become simple.

Real-time F0 Training

The F0 training allows real-time pitch extraction from acoustical input. Model-matching feature can be used fortarget modeling. For singer and voice teacher, this function display the dynamic range of the human voice in termof F0. In figure 5, the F0 pattern of the instructor can be stored on the computer screen in blue color, and then student can compare the performance of an attempt to match the instructor's pattern by tracing in red color.

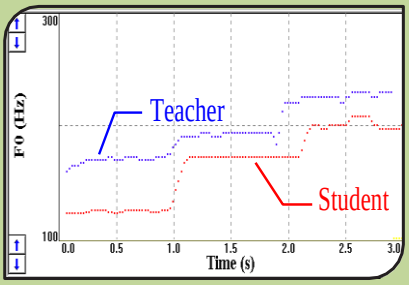


Fig. 5. In the model-matching mode, real-time pitch training is useful for both vocal training and voice teaching. (From Dr. Speech)

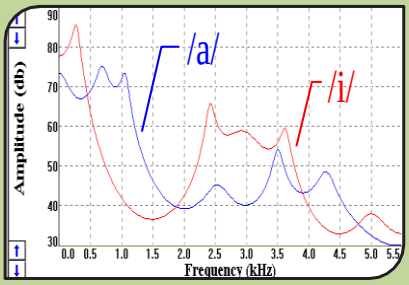


Fig. 6. Real-time plotting of formant is useful to show singer's formant for both vocal training and voice teaching. (From Dr. Speech)

Real-time Formant Training

Real-time formant display (or call LPC spectrum) graphically reveals vowel formants and bandwidth. The singer's formant can be observed dynamically. This real-time training feature provides a powerful tool to singerand voice teacher. With this tool,

singer and voice teacher can easily assess their vocal ability from computer screen. The figure 6 shows a plot of real-time formant display. It also provides a clear display of vowel /i/ and /a/difference (/a/ in blue color, /i/ in red color).

Real-time Spectrogram Training

Real-time spectrogram with visual feedback to the singer provides majors advantages to acoustic assessment of singer's voice. The figure 7 provides a real-time narrowband spectrogram display, illustrating vibrato with regular harmonic pattern in the formant range. The real-time wideband spectrogram as in figure 8 is characterized by singer's formant with highly periodic fundamental frequency.

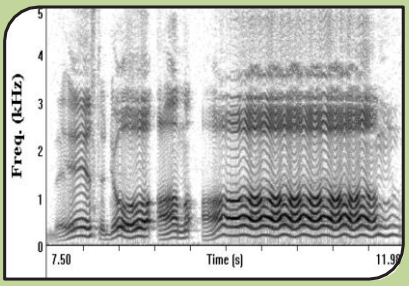


Fig. 7. Real-time narrowband spectrogram display is useful to show vibrato. (From Dr. Speech)

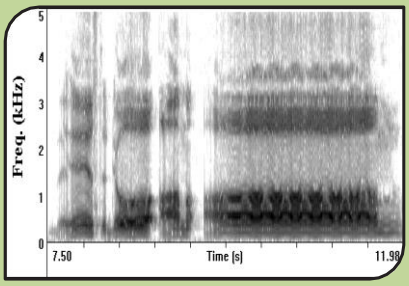


Fig. 8. Wideband spectrogram display in real-time is useful to show singer's formant. (From Dr. Speech)

Acknowledgments

Research for voice disorders has been supervised by Prof. H. Kasuya at Utsunomiya University in Japan. Research for speech acoustics has been supervised by Prof. Fred Minifie at The University of Washington in USA.

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