IT MUST BE LOUIS 'CAUSE MILES DON'T SHAKE LIKE THAT: TOWARDS IDENTIFYING JAZZ TRUMPETERS BY VIBRATO

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ABSTRACT

We at Rutgers have a special interest in jazz performer identification. Rutgers is the home of the Institute for Jazz Studies, which houses one of the largest collection of jazz sound recordings. Automated performer identification would be an important tool for the curators of the collection. Our focus, therefore, has been on the identification of jazz instrumentalists, specifically jazz trumpet players. Lately, the emphasis in performer identification has been on machine learning, but despite its popularity, there is no apparent agreement as to which acoustic features are most useful. We have decided to return to comparison of acoustic visualizations in order to select features most appropriate to train machines for performer identification. In particular, we intend to examine various acoustic features related to vibrato.

1. INTRODUCTION

Performer identification continues to be a focus of MIR, and jazz performer identification has received increasing attention [1, 12, 13]. We at Rutgers have a special interest in jazz performer identification. Rutgers is the home of the Institute for Jazz Studies, which houses one of the largest collection of jazz sound recordings. Unfortunately, many of these recordings, whether they are commercial pressings or "basement tapes," have incomplete or incorrect performer metadata.

Jazz scholars can identify many of these performers by ear. These experts have the advantage of familiarity with the context: knowledge of jazz history. Nevertheless, in making these judgments, the scholars also rely on aural appraisal of each performer's personal sound and style. One goal of automated performer identification is to have a machine duplicate this type of appraisal, to the extent possible [1].

One approach to performer identification has involved comparing visual representations of acoustic signals [14]. Lately, however, the emphasis has been on machine learning for this purpose [4, 6, 13]. This trend is understandable in that machines can perceive subtle characteristics not obvious to the human ear or eye [4]. Visualizations are still used to analyze performance characteristics, and visualization tools have become more sophisticated [10, 15, 16].

Despite the popularity of machine learning for performer identification, there is no apparent agreement as to which specific acoustic features are most important to the process [4, 7]. We have decided to return to visual comparisons in order to select features most appropriate to train machines for performer identification.

In previous preliminary studies, we examined several spectrograms and other visualizations of the sound produced by instrumentalists playing short selections [8, 9]. Then, as now, our focus has been on jazz instrumentalists, particularly jazz trumpet players. From our examination, it appears that vibrato is one salient feature for trumpeter identification.

2. DISCUSSION

2.1 It's Simple

Figure 1 shows a visualization produced by BeatRoot [5] of Louis Armstrong, Harry James, and Wynton Marsalis playing a few bars of *St. Louis Blues*. From this illustration, one obvious among the trumpeters is their vibrato.

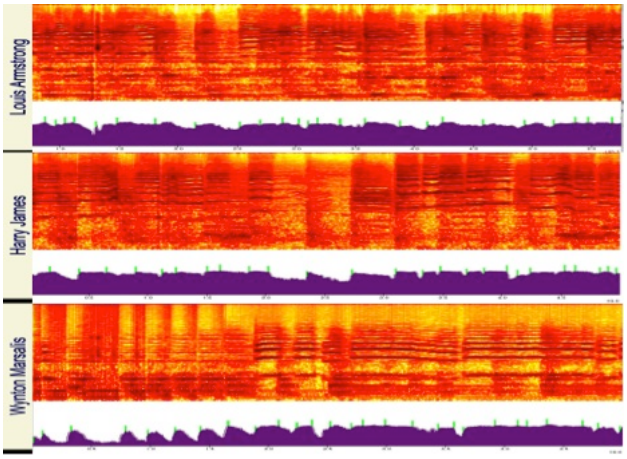

Figure 1. BeatRoot [5] visualizations of three trumpeters playing *St. Louis Blues*

From this image, it is clear that Louis Armstrong plays with the broadest, least regular vibrato, that Wynton Marsalis plays with the narrowest, most regular vibrato, and that Harry James's vibrato is in between.

It seems obvious that vibrato should be a robust feature for jazz trumpeter identification. It is well known, for example, that while Louis Armstrong made extensive use of vibrato, Miles Davis played with very little [1, 3]. Furthermore, individual distinctions in vibrato can be seen with other wind players [1, 9] as well as with singers [4, 6, 12]. For example, in one study [4], a machine trained to identify singers rated vibrato as a meaningful feature. In that same study, humans were also asked to identify singers and likewise chose vibrato as an important consideration.

2.2 It's Complicated

Vibrato is not mere fluctuation in frequency. To put it another way, what musicians refer to as "vibrato" is more precisely a group of "vibrato-motivated acoustic features [12]." In particular, fluctuations in frequency are accompanied by fluctuations in amplitude, and the relationship between these fluctuations varies [2, 4, 17].

Vibrato may also be accompanied by fluctuations in timbre [2, 12]. These fluctuations appear to be produced by alterations in the physiological production of the tone [10]. For example, trumpet vibrato may be produced by any of the following methods: movement of the lips, jaw, throat, or diaphragm; movement of the fingertips on the valves; or movement of the hand holding the trumpet [11]. Any of these movements may affect the timbre of the sound.

In addition, the effect of vibrato on the acoustic signal of a given tone is variable across the set of partials comprising that tone. For that reason, it has been suggested that the fluctuation of each partial should be examined separately [2, 17].

The multiple aspects of vibrato provide numerous opportunities for analysis. Vibrato-associated features that have been studied [1, 2, 4, 6, 10, 12, 15, 16, 17] include:

- Rate of fluctuation in frequency
- Regularity of fluctuation in frequency
- Rate of fluctuation in amplitude
- Regularity of fluctuation in amplitude
- Magnitude of change in frequency
- Magnitude of change in amplitude
- Duration of vibrato
- Fluctuation in individual partials

3. TASKS

At this very early stage of our research, we propose to undertake the following tasks:

- Locate and extract recorded solos by various jazz trumpeters
- Select and isolate appropriate segments for comparison
- Run segments through various acoustic visualization tools, including those created for vibrato analysis
- Carefully examine acoustic visualizations
- Choose subset of vibrato-related acoustic features most likely to be successful in training a machine
- Run machine-learning trials to measure success of feature selection
- Depending on results of trials, design further studies

4. FURTHER QUESTIONS

Associated questions, all of which have been raised by researchers, may need to be answered for a thorough assessment of individuality in vibrato:

- To what extent is vibrato under a performer's conscious control?
- To what extent is an instrumentalist's vibrato influenced by the particular instrument being played (for example, one trumpet as opposed to another)?
- To what extent is vibrato influenced by historical period?
- To what extent is vibrato influenced by musical genre?
- To what extent is vibrato influenced by sub-genre (for example, cool jazz as opposed to Dixieland)?
- To what extent does a performer's vibrato vary over the course of his or her career?

5. CONCLUSION

We believe that a renewed focus on sound visualizations can improve feature selection for the training of machines in the task of automatic performer identification. In this preliminary study, we will focus on attributes that are associated with the vibrato of various jazz trumpet players. Today's sophisticated tools produce images that convey an abundance of information about the acoustic signal. We feel that a visual examination of these images will produce additional insights into feature extraction for the purpose of performer identification. We intend to select those attributes of vibrato that are most likely to be associated with individual trumpeters and so are most likely to be successful when used in supervised machine learning.

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