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Effect of performing skill on the effective duration of autocorrelation function for Chinese instrumental solos

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Abstract

Pipa is a kind of Chinese classical instruments. Various performing skills are applied in pipa music to make it sounds beautiful. When calculating the effective duration of autocorrelation function of pipa solos, there are obvious differences among these pipa music performed with different skills. Ten pieces of pipa motifs were recorded in anechoic room. Each motif was performed three times with three performing skills. The results show that one performing skill increase the effective duration of autocorrelation function, and the two other skills decrease the effective duration of autocorrelation function.

KEYWORDS: Chinese music, performing skill, autocorrelation, effective duration

1. INTRODUCTION

Early research of the sound field in concert hall by Yoichi Ando revealed that the subjective preference of sound field is related to the effective duration (τ_e) of the autocorrelation function (ACF) of the source signals which is a typical temporal parameter of a sound source^{[1][2]}. He analyzed τ_e of piano music and vocal music, then found that some elements related to performing skills had a significant effect on τ_e . For example, the tempo, articulation, and damper pedaling may effect τ_e of piano music^[2], and the falsetto, medium falsetto and operatic singing style may effect τ_e of vocal music^[3]. To investigate the effect of the performing skills on the effective duration of autocorrelation function for Chinese instrumental solos, ten pieces of pipa music with three different performing skills were tested.

2. SELECTION OF MATERIALS

This paper deals with three main pipa performing skills. These three skills are named as skill A, skill B, and skill C respectively in this paper. Skill A can produce overtone. When perform this skill, performer use his right hand to pluck string, and use left hand to touch the string slightly. Skill B, also use right hand to pluck string, and use left hand to press the string and make it shake left and right. Skill C, use five fingers of right hand to pluck the string in succession. These skills are marked clearly with professional signs in music book as showed in figure 1. This figure shows a simple motif, including four notes. The first note is not marked with any sign, so it will be performed without any special skill. Sign on the second note represents skill A which makes it sound silvery. Sign on the third note represents skill B which makes the note unstable and sound gliding. Sign on the fourth note represents skill C which makes the note repeat fast.



Figure 1. Sign of skills A, B, and C

Ten motifs were performed by a professional pipa player and recorded in an anechoic room. The sampling rate was 44.1 kHz. The effective duration was calculated under integration interval of 2s, with 100 ms step. Among the ten motifs, six were performed two times, first without any skills, then with skill A to test the effect of skill A on τ_e . The rest four were performed three times, first without any skills, then with skill B, and then with skill C to test the effect of skill B and C on τ_e .

3. RESULT AND ANALYSIS

Table 1 shows τ_e of six pieces of pipa music motifs. These six motifs were performed two times, first without any skill, and then with skill A. Make sure that the first time and the second time use the same performing rate, so that the values of τ_e will not be effected by performing rate. Results show that the τ_e of these motifs performed with skill A are longer than those performed without any skill, especially for motif 3, 4 and 5. It can be concluded from the result of table 1 that the performing skill A used in pipa music can increase τ_e . Figure 2 shows an example of the measured τ_e values of the running ACF of motif 1 and 5 with 100ms interval. It can be seen that τ_e of music motifs 1 and 5 performed with skill A are much longer than those performed without any skill in the first half second of the two motifs.

Table 1 Comparison of τ_e of the pipa music performed first without skill and then with skill A

No	τ_e (ms) (no skill)	τ_e (ms) (skill A)
motif 1	121	214
motif 2	129	167
motif 3	358	744
motif 4	63	221
motif 5	157	309
motif 6	129	153

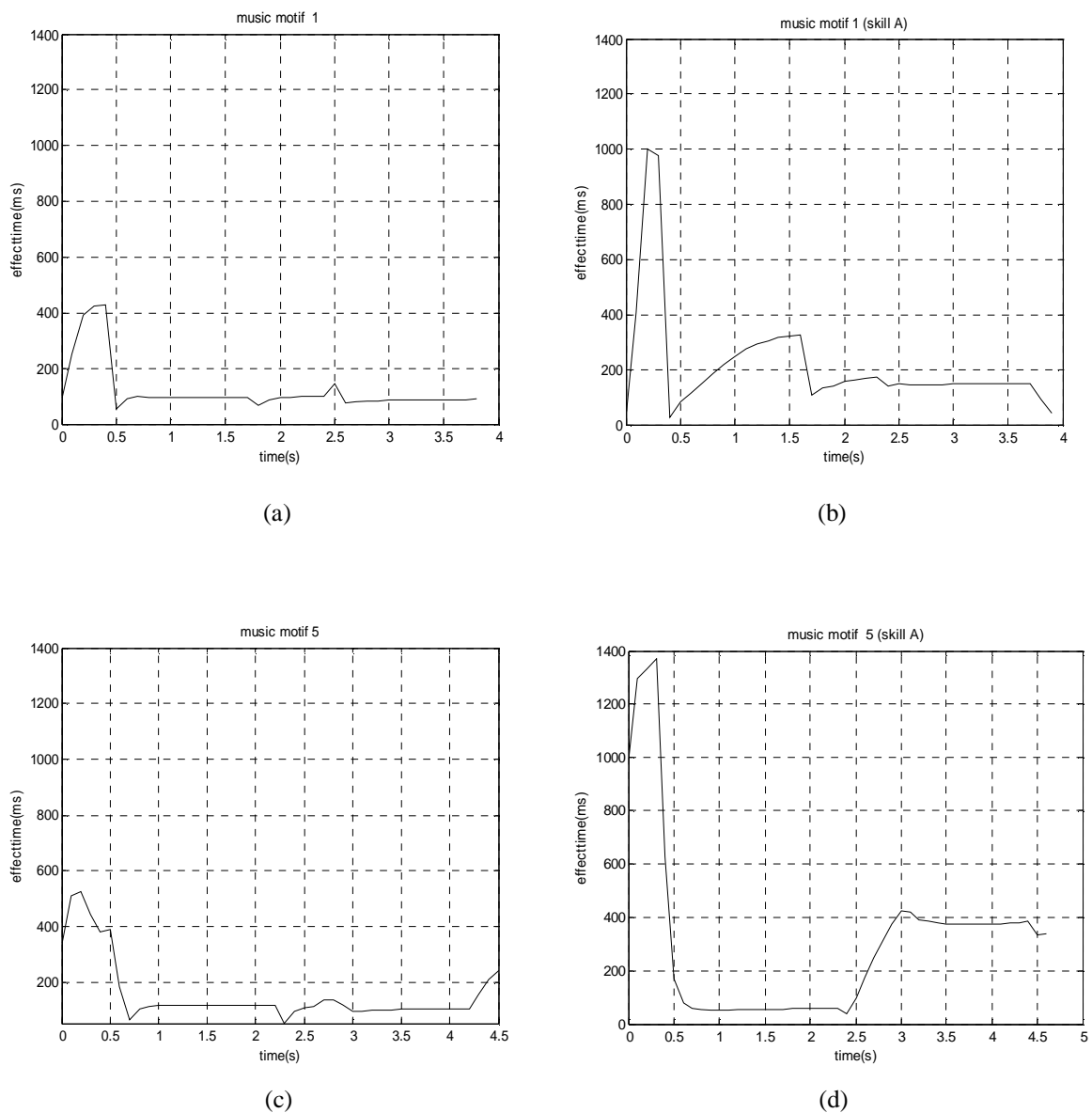
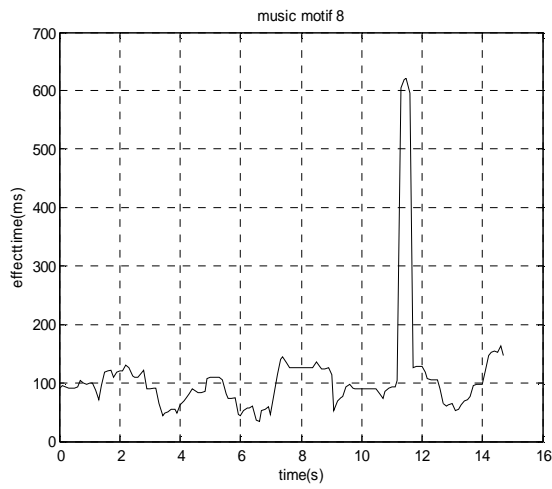


Figure 2. Measured τ_e of the running ACF of motifs 1 and 5. (a) Motif 1 performed without any skill; (b) Motif 1 performed with skill A; (c) Motif 5 performed without any skill; (d) Motif 5 performed with skill A.

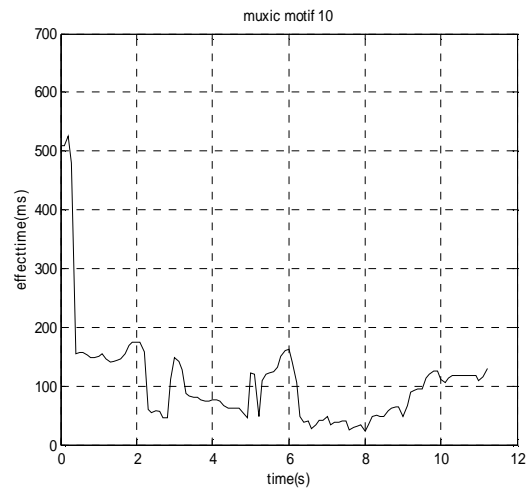
Table 2 shows τ_e of four pieces of pipa music motifs. These four motifs can be performed both with skill B and skill C. So in this experiment, all motifs were performed three times, first without any skill, then with skill B, and finally with skill C. Also, make sure that there's no difference in the performing rate of the three times performing skills. Results show that τ_e of these motifs performed without any skill are longer than those performed with skill B and C. And that music motifs performed with skill B have longer τ_e than those performed with skill C have. That is to say that skill B and C can decrease τ_e , while the effect of skill C are more than that of skill B. Figure 3 shows an example of the measured τ_e values of the running ACF of motifs 8 and 10 with 100ms interval. It can be seen that τ_e of music motif 8 performed without any skill are much longer than those performed with skill B and C at the twelfth second of the two motifs. The similar phenomenon appears at the first second in motif 10.

Table 2 Comparison of τ_e of the pipa music performed first without skill, then with skill B, and then with skill C

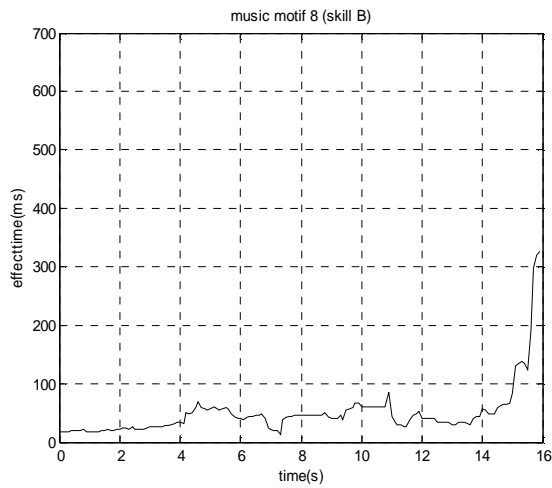
No	τ_e (ms) (no skill)	τ_e (ms) (skill B)	τ_e (ms) (skill C)
motif 7	66	46	37
motif 8	108	49	35
motif 9	159	118	42
motif 10	108	44	32



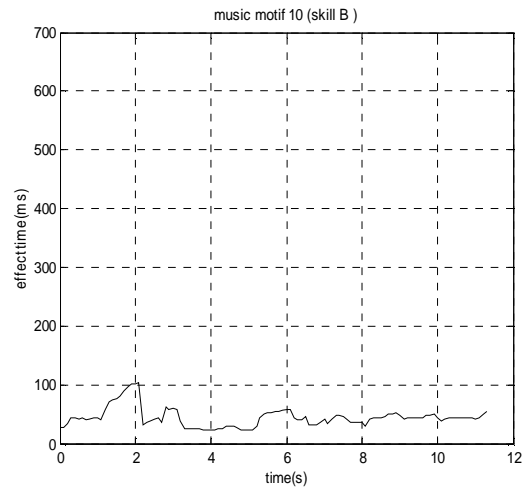
(a)



(d)



(b)



(e)

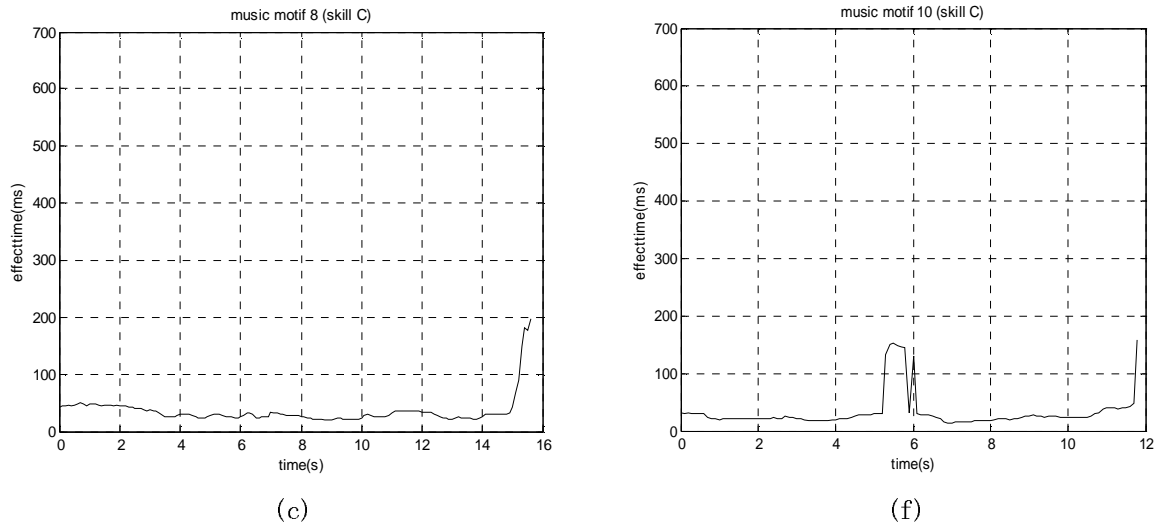


Figure 3. Measured τ_e of the running ACF of motifs 8. (a) music motif 8 performed without any skill; (b) Music motif 8 performed with skill B; (c) Music motif 8 performed with skill C; (d) Music motif 10 performed without any skill; (e) Music motif 10 performed with skill B; (f) Music motif 10 performed with skill C.

4. CONCLUSIONS

The effect of three performing skills on τ_e of the ACF of pipa music was studied. It was found that different skills may affect the effective duration of autocorrelation function differently. Among three skill studied, skill A increases τ_e , while skill B and C decreases τ_e . This phenomenon reveals that the performing skill of Chinese instruments may be more complicated than we thought about before this study. It may be not correct to assume that all skills will decrease the effective duration of autocorrelation, and therefore all skills need less reverberation to be listened clearly. Further experiments are needed to study why these three skills affect τ_e differently.

5. REFERENCES

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