Adaptive Pitch Compensation of Singing and Its Application

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Abstract In singing, we sometimes encounter various difficulties. Some of them can be easily solved by using conventional algorithm. However, when song has wider voice range than that of singers or singing voice is out of tune, there are few effective solution at present. This paper describes the outline of the LPC based pitch compensation to preserve the personal phonetic feature of the singer together with its application.

1 Introduction

When we sing a song, we sometimes encounter such difficulties as: (1) Voice range of a singer doesn't fit properly to the original key, (2) Singing tempo doesn't synchronize with the tempo of accompaniment, (3) Singing is out of tune, (4) Song has wider voice range than that of the singer. The first problem can be easily solved by shifting the key of music. As a solution for the second problem, automated accompaniment systems are proposed which can adaptively change the accompaniment tempo according to singing tempo[INOUE,W et.al] [KATAYOSE,H et.al]. On the other hand, there are few effective solution at present for the third and fourth problems. When the pitch of singing voice is out of tune, the difference between the singing pitch and the correct one has to be detected and compensated. Besides, we have to change only the pitch of voice while preserving the information of the personal phonetic feature. When we correct the pitch of the singing voice using a conventional pitch changer, the compensated voice sounds artificial and unnatural. The reason is considered that the pitch changer shifts not only the fundamental frequency but also the frequency spectrum envelope. In human voices, the spectrum envelope contains information on the phonetic and personal feature of the singer. Therefore, we must not change the spectrum envelope to preserve the singer's personal feature. We have proposed a pitch changing algorithm based on Linear Predictive Coding(LPC) method [SASAHIRA,Y et.al]. In this paper, we apply the proposed pitch changing algorithm for the adaptive pitch compensation system.

2 Pitch Changing Algorithm

2.1 Extraction of the Vowel Region

In speech analysis, voiced region and non-voiced region has to be clearly distinguished. However, for pitch compensation of singing voice, it is more important to distinguish the vowel region. Because, vowel has a clear pitch frequency while consonant has continuous spectrum but not the fundamental frequency. We can discriminate vowel region from speech signal by using the short time average of the signal power, as vowel has large power in comparison with consonant.

2.2 Linear Predictive Coding

Linear prediction method which was first proposed by N.Wiener [Wiener,N] has been widely used and applied in the field of speech analysis-synthesis. In LPC, data prediction is done by the linear combination of the previous data. The coefficients of linear predictor are determined by the least mean square criterion using the auto correlation function of the past data. In speech transmission, the coefficients of the linear predictor and the prediction error are sent separately to the receiving side where the decoding synthesis is done to recover the original voice. We can easily restore the original voice by using merely the data of residual error and the coefficients of the linear predictor. LPC method is also employed in the instrumental sound synthesis recently.

2.3 Pitch Changing Method

In human voice, it is known that the spectrum envelope has the information of personal phonetic feature. We must not change the spectrum envelope in preserving the singer's personal timbre. Recently, several analysis-synthesis methods for pitch changing processing have been reported to treat pitch information and the spectrum envelope separately

[SEIYAMA,N et.al] [TAKAGI,T et.al]. It should be noted that information of personal feature are given by the predictor coefficient in LPC and pitch information are given by the residual error. Therefore, by changing the pitch of residual error, we can perform the natural pitch changing because we use the original predictor coefficient in the restoring process. To change the pitch of residual error, the cut and paste technique is employed in our system. The overview of the LPC based pitch changer is illustrated in Fig.1.

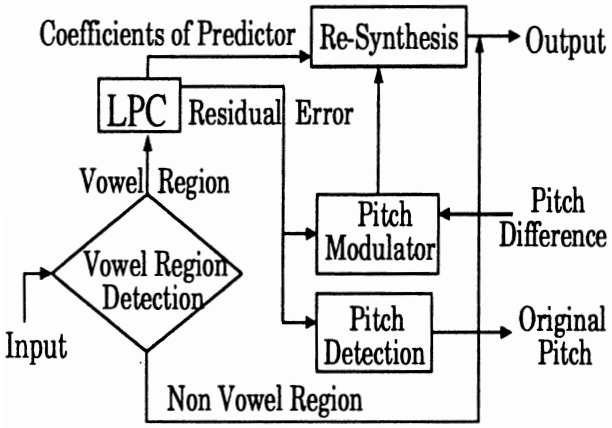

Fig.1 LPC Based Pitch Changer

3 Pitch Compensation System

In case that the key of the singing voice is not the same to that of the accompaniment, shifting the key of accompaniment is a simple and good solution. But in case that singing is out of tune, it is required to revise the wrong pitch part to maintain the correct melody line. The developed pitch compensation system examines the fundamental frequency of the residual error by referring the score information, and revise only the singing part which is out of tune. The block diagram of the proposed system is shown in Fig.2. At present the system does not work in real time. Singing voice without tune or recited poem at the fixed tempo is given to the system as a wave file of MS-Windows at the recording phase. Then the system create a new file which contains the singing voice after compensating the pitch sequence according to the score data.

4 Conclusion

Pitch compensated voice by the proposed method sounds more natural than the voice using commercially available pitch changing machine. The remained problems are:(1) small noise appears in the pitch changed voice, (2) the case of singing at the incorrect tempo is not considered. We are going to improve a real time system which can be applied not only to the Adaptive KARAOKE but also to a new type musical instrument which is driven by human voice.

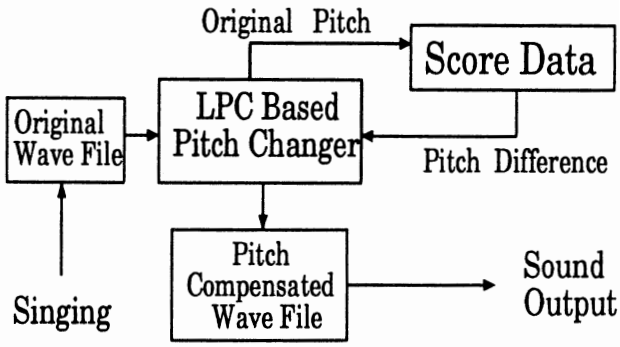

Fig.2 Pitch compensation System using Musical Score

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