Singer Identification using Autocorrelation Method

Sharmila Biswas, Sandeep Singh Solanki

Abstract: ***songs are the compositions embedding voice and different instrument's sound. Different human emotions can be created by playing the appropriate song .autocorrelation algorithm is used here to find out singer identification. In the first experiment three singers with three hindi songs (vocal) are taken as data set. Tempo is used as musical features. Then autocorrelation is proposed on concerning a total of three singers. Using bartlett test we have found the most significant autocorrelation values of those songs of three singers. In second experiment three singers with one hindi song (vocal) are taken as data set. Here rms is used as musical features. Then autocorrelation is proposed on concerning those three singers. Using bartlett test we have found the insignificant autocorrelation values of the song of three singers. The first experiment is used to identify the singers for each song. Here three singers identify their own identification test giving most significant values of their songs .the second experiment gives the insignificant value. The insignificance values of musical features of three singers does not give the singer's identification test.***

keywords : tempo, rms, autocorrelation, song .

I. INTRODUCTION

Autocorrelation[1-2] is used here to identify the singers. It measures the relationship between a variable's current value and its past values. Tempo [3-5] and its application on autocorrelation is proposed, concerning the three singer's songs. For experiment purpose Musical feature or Audio feature[6-9] like tempo and rms are used as a dataset.In the first experiment three singers with three Hindi songs (vocal) without accompanying instruments each are taken as data set. Then autocorrelation is proposed on tempo concerning the three singer's voice. Autocorrelation defines to the correlation between members of a series of numbers arranged in time. Here the members are tempos which are taken 5 sec time duration . Bartlett test [10-11] is applied on these autocorrelation values of the singers for significance test . Using the Bartlett test we have found the most significant values of those songs of three singers. Three singers identify their own identification giving most significant values of their songs. Another experiment we have found the insignificance values of musical feature of those three singers. So it does not identify the singer's own song. Autocorrelation is often used in signal processing and time domain signals.Using autocorrelation speech and music results are given [12] . Different musical instruments like tabla, harmonium, guitar, and flute are recognized by autocorrelation process [13]. Autocorrelation is also used as a feature for classification of musical instruments [8]. The previous work of singer identification researchers used different classifiers like Random Forest Classifier, Decision Tree Classifier, K-Nearest Neighbour Classifier, Naive Bayes Classifier, MLP Classifier etc. In our paper a new technique of singer identification used based on autocorrelation algorithm. The significant results for all singer's identify the singers successfully. In this paper Section 2 describes methodology, Section 3 results and discussion and Section 4 conclusion.

II. METHODOLOGY

The block diagrammatic representation of the proposed singer identification process is presented in Figure 1.

Step 1 songs excerpts are taken.

Step 2 features are extracted.

Step 3 Autocorrelation algorithm is used on the extracted features. Using this algorithm the autocorrelation function (acf) is found out.

Step 4 Bartlett Test is used on this (acf) . If the acf value is greater than critical value, the singer is identified with significance.

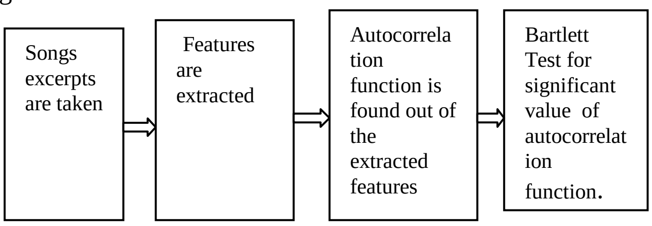

Fig 1. Block Diagram of singer identification

A. Database collection- In this research, we have recorded three singer's three Hindi songs (vocal) without accompanying instruments. For recording purpose we used behringer mic, behringer mixer, creative 5.1 sound card and sonic foundry sound forge 7.0 software. In experiment 1 three singers with three Hindi songs (vocal) without accompanying instruments each are taken as data set . These songs are cliped in .WAV format. These songs are clipped 10 divisions with 5 sec duration. The clips are taken as 0-5sec,5-10sec,10-15 sec,15-20 sec,20-25sec,25-30sec,30-35sec,35-40 sec,40-45sec and 45-50 sec time duration. In these experiments we used 10 tempo and rms features as input dataset . The input audio files have various attributes such as file type (wav), sampling rate (44.1k), audio type (mono) etc . The clipping process is done by the MATLAB14 and MIRTOOLBOX1.5.

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B.Feature Extraction

In this research, we have found out Tempo and Rms for experiment1 and experiment 2.

Tempo is measured by the speed of a musical piece. It is defined the number of beats per minute. Tempo is evaluated by detecting periodicities from the onset detection curve. Once the onset detection curve is formed by detection function, a determination of periodicities in the curve gives us an estimate of the tempo.

Root Mean Square (RMS) energy denotes the square root of the mean square of the amplitude values of the audio signal

$$x_{rms} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} x_i^2} \quad (1)$$

where x_i denotes the magnitude of the i^{th} sample and the total number of samples is n.

C.AUTOCORRELATION

The **autocorrelation function (ACF) at lag *k*** is denoted by ρ_k of a stationary stochastic process.

ACF is defined as $\rho_k = \gamma_k/\gamma_0$ (2)

where $\gamma_k = \mathrm{cov}(y_i, y_{i+k})$ for any *i and* γ_0 is the variance of the stochastic process.

D.The Bartlett test

Bartlett test is the significance test of the autocorrelation function (acf) values. To find out 95% confidence test of the null hypothesis of no autocorrelation at lag *k* the bartlett test is used. We compare the value of the sample coefficient with the critical values $\pm 1.96/T^{1/2}$ (3)

where T denotes the sample size.

If the value falls outside the bands, the null hypothesis is rejected at the95% level.

III. RESULT AND DISCUSSION

In experiment 1 we find out autocorrelation function on tempo concerning the three singer's Hindi songs (vocal) without accompanying instruments each using the equation (2). First singer's three Hindi songs(vocal) without accompanying instruments each are used to calculate the autocorrelation function values. First singer's first song's autocorrelation function are(-0.62371, 0.050851, 0.40284, -0.74896, 0.705083)at lag1,lag2,lag3,lag4 and lag5. First singer's second song's autocorrelation function are (-0.32137, -0.4174, 0.79353, -0.23434, -0.33731)at lag1,lag2,lag3,lag4 and lag5. First singer's third song's autocorrelation function are (-0.09252, -0.4009, -0.28048, -0.0493, -0.80003)at lag1,lag2,lag3,lag4 and lag5. Similarly, second singer's three Hindi songs (vocal) without accompanying instruments each are used to calculate the autocorrelation function values . Second singer's first song's autocorrelation function are(-0.10915, -0.69351, 0.392267, 0.591371, -0.60736)at lag1,lag2,lag3,lag4 and lag5. Second singer's second song's autocorrelation function are (0.325111, -0.11794, -0.56994, -0.71024, -0.49476)at lag1,lag2,lag3,lag4 and lag5. Second singer's third song's autocorrelation function are (0.837289, 0.559859, 0.335426, 0.054805, -0.63029)at lag1,lag2,lag3,lag4 and lag5. Finally third singer's three Hindi songs (vocal) without accompanying instruments each are used to calculate the autocorrelation function value. Third singer's first song's autocorrelation function are(-0.58562, 0.558215, -0.83792, 0.579571, -0.64029)at lag1,lag2,lag3,lag4 and lag5. Third singer's second song's autocorrelation function are (-0.15889, 0.025811, 0.00502, -0.82717, 0.057235)at lag1,lag2,lag3,lag4 and lag5. Third singer's third song's autocorrelation function are (-0.2734, 0.098204, 0.116549, 0.611106, -0.75607)at lag1,lag2,lag3,lag4 and lag5. Table 1 to Table 9 shows the different autocorrelation function at different lag values.

Using the Bartlett test equation (3) we find the critical values. The critical values are 0.6198. The sample size is T=10. We compare the value of the sample coefficient with the critical values . The first singer's first song , second song and third song whose autocorrelation function values greater than critical values are(-0.62371, -0.74896, 0.705083, 0.79353, -0.80003). The second singer's first song , second song and third song whose autocorrelation function values greater than critical values are(-0.69351, -0.71024, 0.837289, -0.63029). The third singer's first song , second song and third song whose autocorrelation function values greater than critical values are(-0.83792, -0.64029, -0.82717, -0.75607). Since the values falls outside the bands, the null hypothesis is rejected at the95% level.Significance measurement for all singer's songs gives most significant values. Same singer's features gives significant values for every three songs. Three singers identify their own identification test giving most significant values of their songs. Fig 3, gives the graphical representation of significant values of three singer's different three Hindi songs (vocal) without accompanying instruments.

Table1First singer's 1st song's autocorrelation using tempo

Tempo	lag	acf
80.81429	lag1	-0.62371
76.03075	lag2	0.050851
166.0723	lag3	0.40284
59.78754	lag4	-0.74896
86.87201	lag5	0.705083
167.7571		
45.32916		
189.4219		
80.17233		
75.33856		

Table2First singer's 2nd song's autocorrelation using tempo

Tempo	lag	acf
65.45388	lag1	-0.32137
108	lag2	-0.4174
155.5944	lag3	0.79353
77.335	lag4	-0.23434
123.6755	lag5	-0.33731
150.8898		
102.2857		
123.089		
119.3986		
133.5894		

Table3 First singer's 3rd song's autocorrelation using tempo

Tempo	lag	acf
73.69403	lag1	-0.09252
161.744	lag2	-0.4009
111.3461	lag3	-0.28048
75.43913	lag4	-0.0493
76.9693	lag5	-0.80003
99.77903		
76.05898		
110.6176		
109.0149		
119.8549		

Table4Second singer's 1st song's autocorrelation using tempo

Tempo	lag	acf
78.68252	lag1	-0.10915
84.44606	lag2	-0.69351
110.8491	lag3	0.392267
110.1496	lag4	0.591371
66.03057	lag5	-0.60736
111.7673		
165.7399		
84.38965		
82.63125		
118.8151		

Table5Second singer's 2nd song's autocorrelation using tempo

Tempo	lag	acf
138.8445	lag1	0.325111
183.8151	lag2	-0.11794
97.15035	lag3	-0.56994
107.0583	lag4	-0.71024
69.42679	lag5	-0.49476
52.56768		
72.3562		
107.0178		
177.945		
106.4288		

Table6Second singer's 3rd song's autocorrelation using tempo

Tempo	lag	acf
158.0637	lag1	0.837289
168.7915	lag2	0.559859
162.7669	lag3	0.335426
172.5092	lag4	0.054805
175.9941	lag5	-0.63029
96.84827		
56.05359		
64.73223		
64.51314		
68.66323		

Table7Third singer's 1st song's autocorrelation using tempo

Tempo	lag	acf
138.2076	lag1	-0.58562
167.7047	lag2	0.558215
69.96528	lag3	-0.83792
121.2631	lag4	0.579571
84.6072	lag5	-0.64029
176.2889		
92.09325		
174.762		
113.6345		
153.1263		

Table8Third singer's 2nd song's autocorrelation using tempo

Tempo	lag	acf
129.9735	lag1	-0.15889
180.5715	lag2	0.025811
144.9542	lag3	0.00502
68.5158	lag4	-0.82717
150.5224	lag5	0.057235
67.23679		
119.9162		
148.8025		
134.7729		
171.6447		

Table9Third singer's 3rd song's autocorrelation using tempo

Tempo	lag	acf
70.77796	lag1	-0.2734
70.83192	lag2	0.098204
158.8872	lag3	0.116549
57.6677	lag4	0.611106
81.94267	lag5	-0.75607
82.90668		
161.5633		
53.3687		
172.5636		
159.9205		

In experiment 2 we find out autocorrelation function on rms concerning the three singer's Hindi songs (vocal) without accompanying instruments each using the equation (1). First singer's song's autocorrelation function are(0.170632, -0.07472, -0.245, -0.34188, 0.481768)at lag1,lag2,lag3,lag4 and lag5. Second singer's song's autocorrelation function are(-0.20939, 0.114115, -0.05261, -0.4455, 0.46502)at lag1,lag2,lag3,lag4 and lag5. Third singer's song's autocorrelation function are (0.588672, 0.101042, -0.13514, -0.53226, -0.42252)at lag1,lag2,lag3,lag4 and lag5. Table 10 to Table 12 shows the different autocorrelation function at different lag values. Using the Bartlett test equation (2) we find the critical values. The critical values are 0.6198. The sample size is T=10.

We compare the value of the sample coefficient with the critical values . The first singer's first song , second singer's first song and third singer's first song's autocorrelation function values are not greater than critical values. Since the values does not falls outside the bands, the null hypothesis is not rejected at the95% level. These three acf values are insignificant. So different features do not give significance values.

Table10 First singer's 1st song's autocorrelation using rms

rms	lag	acf
0.02118	lag1	0.170632
0.017478	lag2	-0.07472
0.028429	lag3	-0.245
0.019021	lag4	-0.34188
0.013902	lag5	0.481768
0.068257		
0.044609		
0.045443		
0.023467		
0.020736		

Table11 Second singer's 1st song's autocorrelation using rms

rms	lag	acf
0.008089	lag1	-0.20939
0.107087	lag2	0.114115
0.054396	lag3	-0.05261
0.041515	lag4	-0.4455
0.117884	lag5	0.46502
0.045762		
0.19527		
0.116155		
0.075295		
0.05627		

Table12 Third singer's 1st song's autocorrelation using rms

rms	lag	acf
0.014589	lag1	0.588672
0.01474	lag2	0.101042
0.016473	lag3	-0.13514
0.016249	lag4	-0.53226
0.021794	lag5	-0.42252
0.021889		
0.01878		
0.018129		
0.019465		
0.018707		

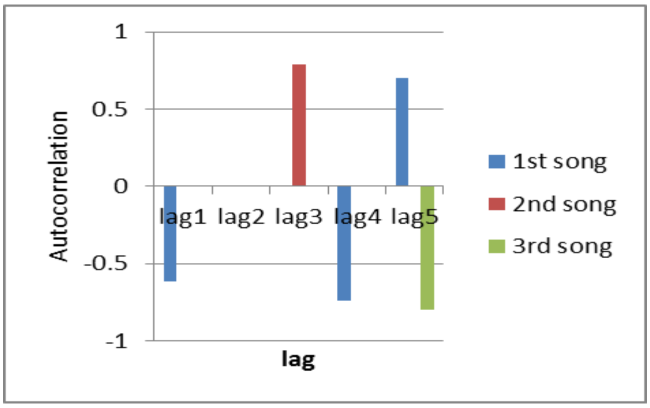

Fig3 Graphical representation of significant values of first singer's different three Hindi songs (vocal) without accompanying instruments.

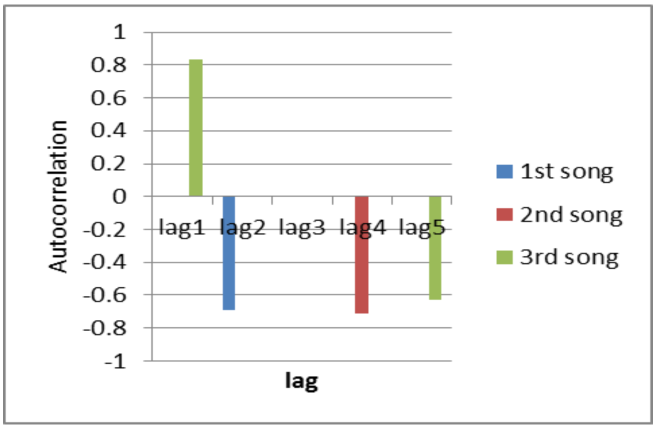

Fig4 Graphical representation of significant values of second singer's different three Hindi songs (vocal) without accompanying instruments.

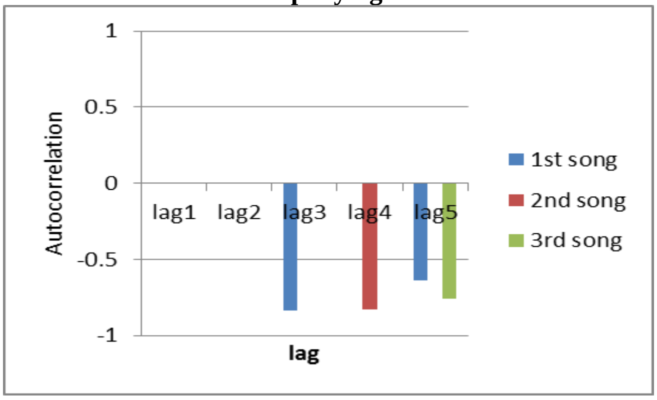

Fig5 Graphical representation of significant values of third singer's different three Hindi songs (vocal) without accompanying instruments.

IV. CONCLUSION

In this paper, we correctly identified the autocorrelation of similar features among three singers. The autocorrelation is used on the similar features related to tempo. To find the significance between similar musical features, Bartlett test is used. The first experiment considers the autocorrelation in tempo features concerning the three singer's rendition of songs without accompanying instruments. Using these autocorrelation values we calculate the sample coefficient values of these songs.

So we can say all significant values of three songs determine that the singer is the same. Three songs of each singer give significant values. In this way we can identify the three singers individually. This is an identification process of a singer. The second experiment gives the insignificant values of the three singer's songs. Another feature is not used to identify the singer's individuality. So it does not identify the singers.

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