Speech Feature Selection of Normal and Autistic children using Filter and Wrapper Approach

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Summary

Two feature selection approaches are analyzed in this study. First Approach used in this paper is Filter Approach which comprises of correlation technique. It provides two reduced feature sets using positive and negative correlation. Secondly Approach used in this paper is the wrapper approach which comprises of Sequential Forward Selection technique. The reduced feature set obtained by positive correlation results comprises of Rate of Acceleration, Intensity and Formant. The reduced feature set obtained by positive correlation results comprises of Rasta PLP, Log energy, Log power and Zero Crossing Rate. Pitch, Rate of Acceleration, Log Power, MFCC, LPCC is the reduced feature set yield as a result of Sequential Forwarding Selection.

Key words:

 Correlation; Filter; Pitch; Reduced; Wrapper.

1. Introduction

The process of selecting the set of variables from the input is called feature selection. The good prediction result is provided by the subset of variables that is selected while reducing effects from irrelevant variables and noise [1]. To make the algorithm run efficiently, dimensionality reduction is a valuable approach. The advantage of this dimensionality reduction helps to discover the grouping of features that for sure efficiently run the algorithm with improved accuracy [2]. Detection of projection subspace-basis evaluation is suggested by K.Morris et.al. [3]. For deduction it uses generalized hyperbolic mixture (HMMDR) fit. This method is well accepted along with discriminant analysis, model based classification, and clustering analysis. Two techniques of SDR are demonstrated by Y.W.Lin et.al [4]. Relationship between Partial least square (PLS) and Principle component regression (PCR) is explained. Dimensionality reduction by joining features is one of the best strategies proposed so far [5]. Sparse partial least square regression (SPLSR) is investigated in depth in one study [6]. It was revealed that up to 79.23% is the recognition rate of SPLSR and it was found to be superior when compared to other methods used for dimensionality reduction. This chapter is about the filter and wrapper approaches in order to reduce the feature set for the Normal and Autistic children speech in four different emotions that is Angry, Happy, Neutral and Sad. Total ten features are extracted out of which the best features are selected using the filter and wrapper approaches.

The filter approach comprises of Correlation technique and decision trees [7] while the wrapper approach consists of Sequential Forwarding Selection. The reduced feature set obtained by all methods are applicable collectively to both Normal and Autistic children samples in four emotions. In Both approaches, the feature selection process is to be stopped based on certain criterion called stopping criteria. The most commonly used stopping criteria are as follows:

a.   The search completes
b.   The algorithm reached the given bound.
c.   A better subset is not produced by subsequently adding or deleting any feature.
d.   Selection of sufficiently good subset

2. Methodology

2.1 Filter Approach for Feature Selection

The principle criteria in filter method are the use of variable ranking technique for variable selection by ordering [8].For modern approaches differential evolution and fuzzy logic is used [9].The filter approach used in this study for feature selection is Correlation Technique.

2.1.1 Correlation Technique

Factors consisting of seven features and three coding schemes are taken into consideration for correlation analysis and include pitch, intensity, formant, Rate of Acceleration, Zero Crossing Rate (ZCR), log energy, log power, Mel frequency cepstrum coefficient (MFCC), Linear Prediction cepstrum coefficient (LPCC), and Relative spectrum transform perceptual linear prediction (Rasta PLP). The data set is same comprising of the Classification Accuracy results of the algorithm for Normal and Autistic children speech emotions is shown in Table 1 [10].

Table 1: Classification Accuracy Results

Category	Emotions	Classification Accuracy (%)
Normal	Angry	83.33
	Happy	90.45
	Neutral	100
	Sad	75
Autistic	Angry	75
	Happy	80.21
	Neutral	100
	Sad	80

Table 2: Correlation Ranking of Features

Features	Correlation Ranking
Pitch	0.161
Rate of Acceleration	0.878
Intensity	0.456
Formant	0.365
MFCC	0.077
Rasta PLP	-0.437
Log Power	-0.356
Log Energy	-0.4697
ZCR	-0.42047
LPCC	-0.2754

The flow chart is shown in Fig. 1. An optimal subset which is best relevant to a class having no redundancy is found out by the correlation based feature selection. Sometime vibration correlation is performed for good predictions [11]. The linear dependencies between variable and target are detected by correlation ranking. The association between the features for sample data is found by correlation method [12]. Feature class and Feature – Feature correlation is obtained by correlation technique [13]. The flow of algorithm starts by input the training data set of ten features and a stopping criteria 'K'. The stopping criteria used in this approach is when the search completes that is when all the features are exhausted.

Table II shows that:

a. Rate of Acceleration, Intensity and Formant contributed to positive correlation so this subset can be used as a reduced feature set.

b. Rasta PLP, Log Power, ZCR and Log Energy contributed to strong negative correlation so this subset can be used as a reduced feature set.

The correlation matrix is shown in Fig. 2. It also shows that the red blocks of ROA, Intensity and Formant shows positive correlation whereas blue blocks of Rasta PLP, Log Power, ZCR and Log energy shows strong negative correlation.
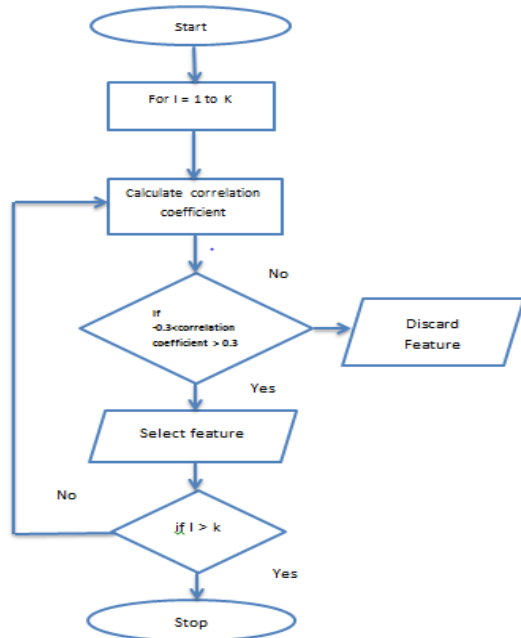
**Fig. 1.** Flow chart of Feature Selection using Correlation Technique
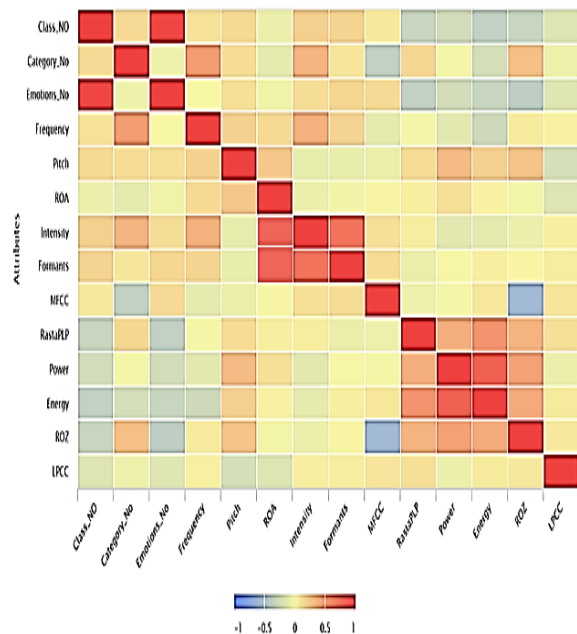
Fig. 2. Correlation Matrix of Features

2.2 Wrapper Approach

An objective function to calculate the variable subset and a predictor as a black box is used in wrapper approach [14]. Wrapper approach with BWOA increase productivity in feature selection [15].

2.2.1 Sequential Forwarding Selection (SFS)

SFS starts with an empty set and for the first step it adds one feature from which the highest value of objective function is obtained. Then from the second step onwards the current subset is added individually by the remaining features and evaluation of new subset is carried out [16, 17]. The flow diagram of SFS is shown in Fig.3. The pseudo code for SFS used in this study is shown in Fig.3 and result obtained by SFS is shown in Table 3.
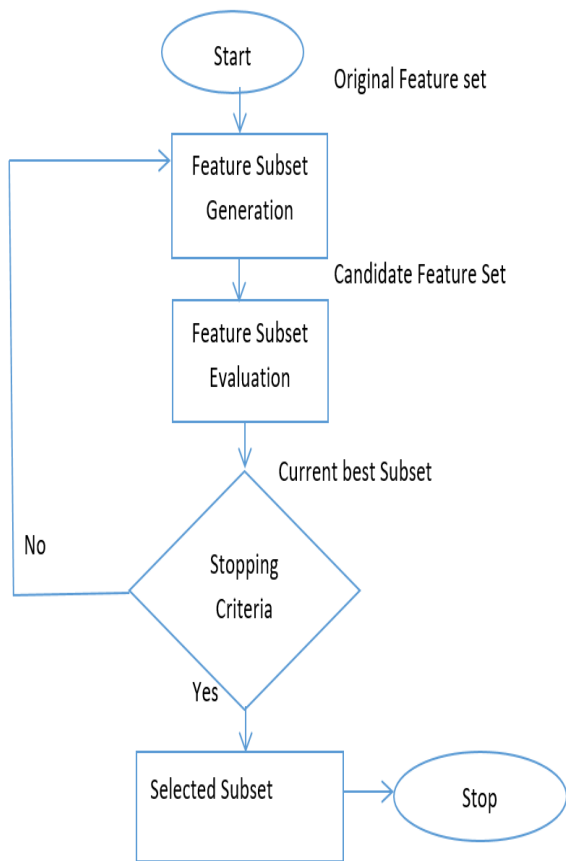
Fig.3. Flow Diagram of Sequential Forwarding Selection

It is shown that SFS yields the reduced feature set comprises of Column 1, Pitch with rate 0.304348, Column 2: Rate of Acceleration with rate 0.604384, Column 5: MFCC with rate 0.417391, Column 7: Log Power with rate 0.703854 and Column 10: LPCC with rate 0.504348.

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%RESULTS

%START FORWARD SEQUENTIAL FEATURE SELECTION:

%INITIAL COLUMNS INCLUDED:  NONE

%COLUMNS THAT CANNOT BE INCLUDED:  NONE

%STEP 1, ADDED COLUMN 1, CRITERION VALUE 0.304348

%STEP 2, ADDED COLUMN 2, CRITERION VALUE 0.604348

%STEP 3, ADDED COLUMN 5, CRITERION VALUE 0.417391

%STEP 4, ADDED COLUMN 7, CRITERION VALUE 0.703854

%STEP 5, ADDED COLUMN 10, CRITERION VALUE 0.504348

%FINAL COLUMNS INCLUDED:  1 2 5 7 10

%FS =

%  1  1  0  0  1  0  1  0  0  1

%HISTORY =

%    IN: [2X11 LOGICAL]

%   CRIT: [0.3043 0.2174]
```

Fig.4. Pseudo code of Sequential Forwarding Selection

TABLE 3: Results of Sequential Forwarding Selection

Column No	Features	Rate
1	PITCH	0.304348
2	RATE OF ACCELERATION	0.604384
3	INTENSITY	0
4	FORMANT	0
5	MFCC	0.417391
6	RASTA PLP	0
7	LOG POWER	0.703854
8	LOG ENERGY	0
9	ZERO CROSSING RATE	0
10	LPCC	0.504348

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3. Conclusion

In this study, the two techniques: filter approach and wrapper approach were used to reduce the ten extracted features of emotion based spoken utterances for the Normal and Autistic children in four different emotions (Angry, Happy, Neutral, and Sad). The following observation has been obtained from demonstrative experiments are:

1) The Correlation technique gives the reduced feature set comprising of Rate of Acceleration, Intensity and Formant using positive correlation.
2) The correlation Technique gives the reduced feature set comprising of Rasta PLP, Log Power, Log energy and ZCR using negative correlation.
3) Sequential Forwarding Selection yields the feature set comprising of Pitch, Rate of Acceleration, Log Power, MFCC, and LPCC.

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