Automatic Prediction of Spirometry Readings from Cough and Wheeze for Monitoring of Asthma Severity

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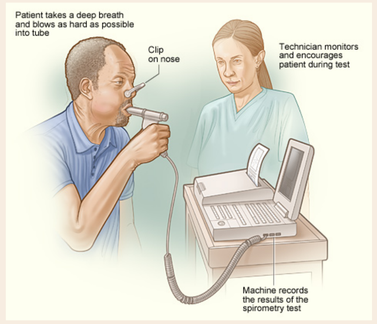
PROBLEM STATEMENT

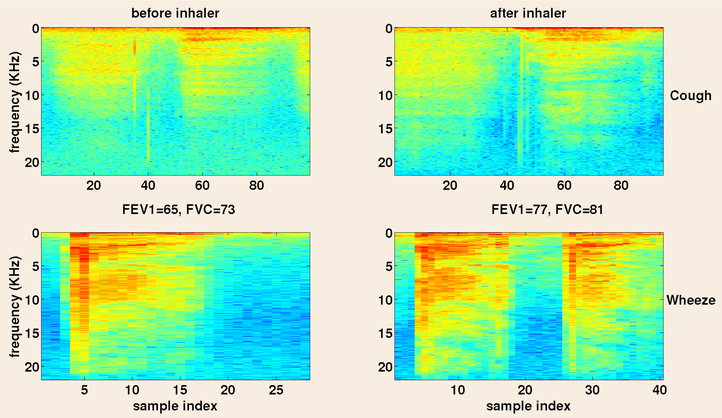
Predicting spirometry readings from cough and wheeze audio for monitoring of asthma severity.

SPIROMETRY



- Asthma is diagnosed using equipment called spirometer.
- Spirometry variables are forced expiratory volume in one second (FEV1), forced vital capacity (FVC) and FEV1 to FVC ratio (FEV1_FVC).

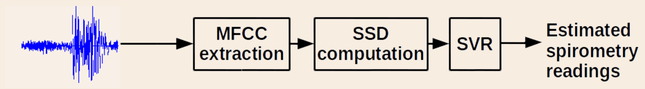
SPECTROGRAM COMPARISON



DATASET

- 28 subjects comprising of 16 healthy subjects (10 males and 6 females) and 12 asthmatic patients (7 males and 5 females).
- The range of FEV1%, FVC% and FEV1_FVC% for of all subjects were 28-100%, 35-100% and 62-100% with their average values of 70%, 68%, and 87% respectively.

PROPOSED METHOD



- We explore the widely used feature in speech, namely, Mel-frequency cepstral coefficients (MFCCs) and computing an average value for each element in the MFCC vectors in the sequence to obtain statistical spectrum descriptor (SSD).
- We use Support vector regression to map from SSD to spirometry readings for each audio instance and the final spirometry reading is computed by taking the **median** of these predicted values across all instances.
- FEV1% is used to classify asthma severity level into **three** classes by using the predefined thresholds[1].

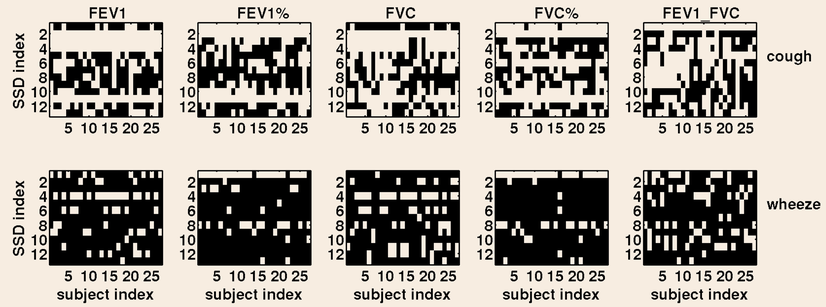
SPIROMETRY PREDICTION ERROR

RMSE leave-one-subject-out setup		FEV1	FEV1%	FVC	FVC%	FEV1_FVC
baseline		0.77 (.69)	15.24 (4.2)	0.81 (.98)	13.80 (3.4)	0.08 (1.2)
w/o feature selection	wheeze	0.70 (0.63)	13 (3.10)	0.77 (0.98)	13 (3.25)	0.09 (0.01)
	cough	**0.48** (0.24)	12.1 (1.77)	**0.57** (0.46)	12.4 (2.57)	0.08 (0.01)
w feature selection	wheeze	0.66 (0.74)	12 (4.41)	0.74 (1.04)	12 (2.86)	0.09 (0.02)
	cough	**0.48** (0.31)	**11.6** (1.64)	**0.57** (0.51)	**10.3** (1.99)	**0.08** (0.01)

CLASSIFICATION ACCURACY(%)

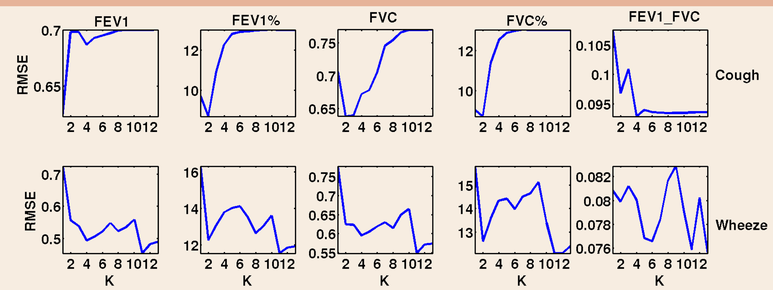
	13 dim SSDs	selected SSDs	ranked SSDs	baseline
wheeze	67.85	67.85	57.14	61.76
cough	62.96	74.04	**77.77**	

SELECTED FEATURES



- A black box for a particular SSD and test subject indicates that the corresponding SSD is not selected for the respective test subject.
- Second SSD is consistently selected for all subjects and it computed from second MFCC which captures the spectral tilt.

RMSE FOR TOP K RANKED SSDs



- Rank order the SSDs in the decreasing order of their occurances as selected features across different training sets. Use top K SSDs from this ranked list of SSDs and use as a fixed set of features for all test subjects.

CONCLUSION

- We present a technique for asthma severity classification based on cough and wheeze sound by predicting spirometry readings.
- Spectral tilt is an important feature to predict the spirometry readings.
- Cough is better than Wheeze for predicting spirometry readings.

REFERENCES

1. Yawn, Barbara P. "Factors accounting for asthma variability: achieving optimal symptom control for individual patients." Primary Care Respiratory Journal.

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