Using A Machine Learning Prediction Model And Structured Light Plethysmography Diagnosed Lung To Predict Physician Disease From Tidal Breathing.

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INTRODUCTION

Structured Light Plethysmography (SLP) is a non-invasive, non-contact method of assessing the movement of anterior thoraco-abdominal wall. SLP projects a grid of light onto the subject's anterior chest and abdomen. The movement of the grid due to chest wall movement (i.e. breathing) allows both the analysis of compartment volume change and assessment of the surface motion.

We present a novel method for breaking down the surface motion of tidal breathing that we believe to be able to characterise a subject's healthy or diseased state.

METHODOLOGY

The study was conducted in the respiratory outpatients of a large teaching hospital.

Tidal Breathing data was collected from 132 subjects (70 female, 61 male, 1 unknown), age range 16 – 80 years (mean age 55).

Subjects were a mix of healthy (Normal) n=58, and patients with physician diagnosed lung disease n= 74, (Asthma n=36, COPD n=20, Emphysema n=4, and Other n=14). "Other" consisted of bronchiectasis, sarcoidosis, and a patient post lung transplant.

Each was studied using Structured Light Plethysmography (SLP) (Thora3Di TM PneumaCare Ltd, UK).

Each subject was asked to change into a close fitting white stretchy top and was asked to sit down on a chair with their neck in a neutral position and their back as straight as possible.

The participant was asked to breathe "normally" for 5 minutes of tidal breathing. Spirometry (PFT) was also performed in a separate measurement with a ViaSys spirometer.

The movement of the projected grid of light is analysed to derive a Konno-Mead loop (KM) from which a range of tidal breathing outputs can be calculated including:

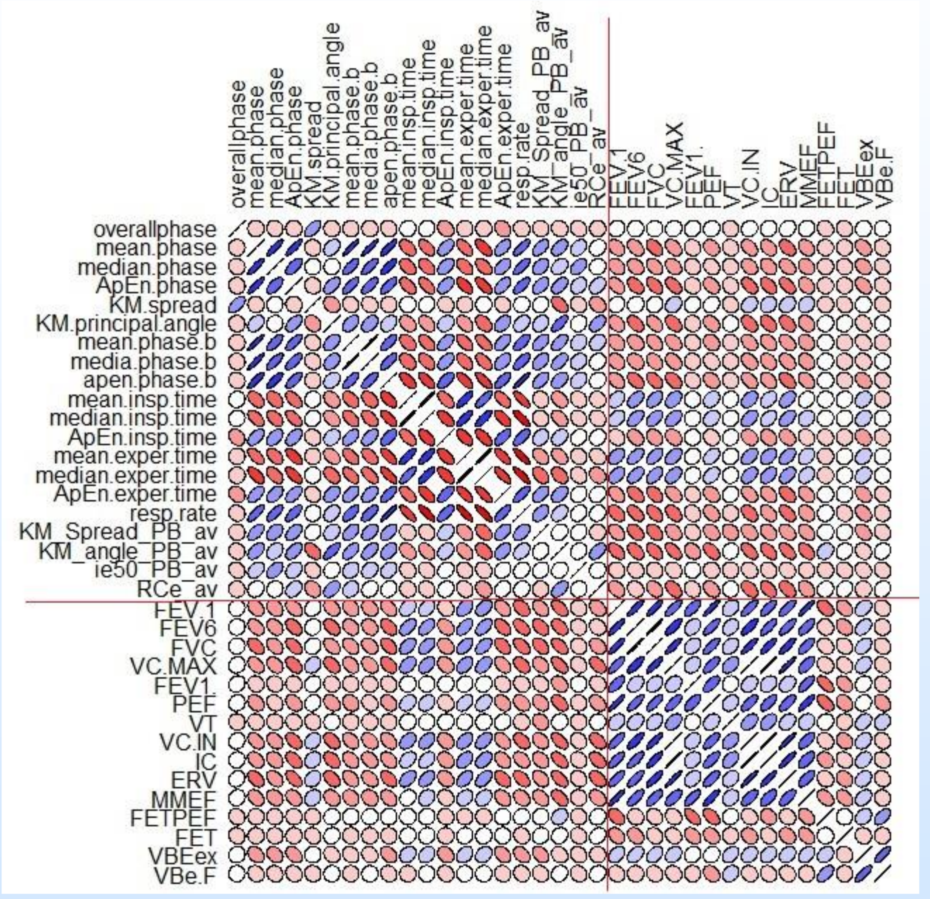
- Phase (Phi)
- Approximate Entropy of Phase
- Angle Change
- Inspiratory Time

A 3 stage process was undertaken to correlate a subject's breathing pattern to physician diagnosis:

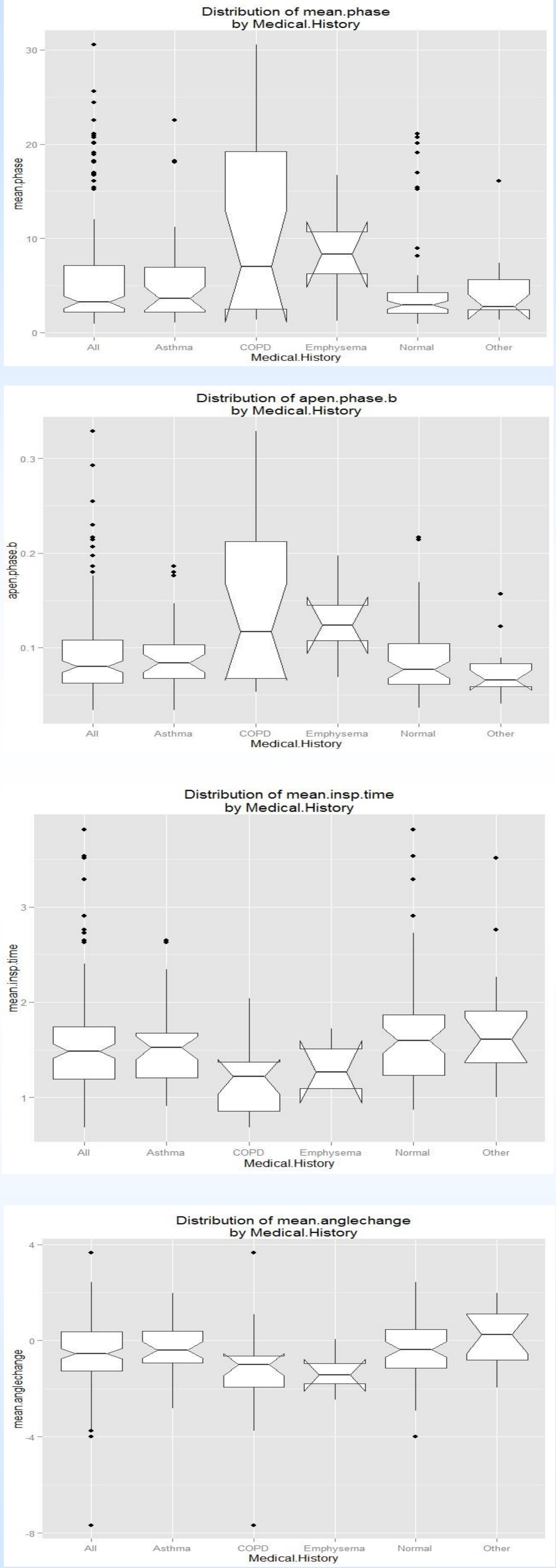
SLP outputs were correlated against standard spirometric output parameters (PFT) to identify relations between the two outputs.

A Kruskal-Wallis (KW) analysis was performed on each SLP output to find significant differences between the physician's diagnosis groups.

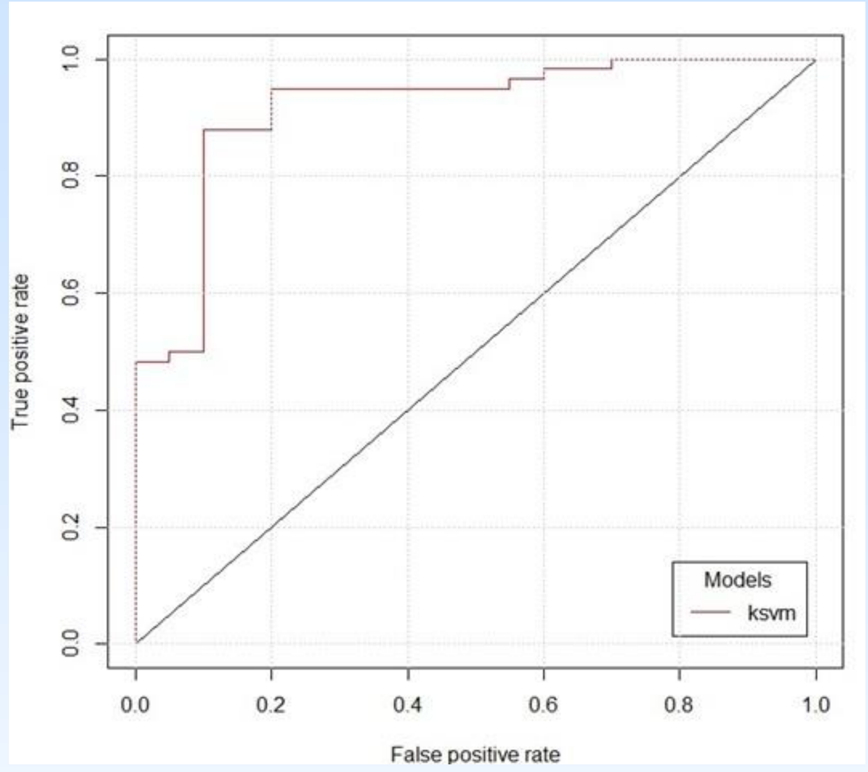
A supervised classification algorithm (Kernel-based Support Vector Machine, or KSVM) was trained on a random set of 70% of the subjects, and its performance in discriminating between the different physician's diagnosis groups was tested on the remaining 30%.



Correlation matrix between SLP output and PFT



Box plots of parameters that are significantly different (Kruskal-Wallis)



ROC curve of the performance of the KSVM classifier in distinguishing between COPD and Healthy

RESULTS:

There were no significant correlations

The KW showed that Mean Phase, Entropy of Phase, Median Inspiratory time, Median Angle Change, and RCe, were significant when compared to physician diagnosis.

The KSVM predicted:

Asthma in 22 of 36, COPD in 16 of 20,

Emphysema in 3 of 4, "Other" in 10 of 14,

and normal in 54 of 58 subjects.

	Predicted				
Actual	Asthma	COPD	Emphysema	Normal	Other
Asthma	25	0	0	11	0
COPD	0	16	0	4	0
Emphysema	1	0	3	0	0
Normal	3	1	0	54	0
Other	1	0	0	3	10

CONCLUSION

Non-invasive, non-contact interpretation of breathing pattern, in conjunction with a machine learning prediction model is able predict Physician diagnosis with a high degree of certainty for COPD, Emphysema and "Normal / Healthy" subjects.

As many of the subjects with asthma had good disease control when they attended clinic and were indistinguishable from normal, they were less easy to classify using the model.