I. Introduction

- The recommendation to change breathing patterns from the mouth to the nose can have a significantly positive impact upon the general well being of the individual.
- We classify nasal and mouth breathing by using an acoustic sensor and intelligent signal processing techniques.
- The overall purpose is to investigate the possibility of identifying the differences in patterns between nasal and mouth breathing in order to integrate this information into a decision support system which will form the basis of a patient monitoring and motivational feedback system to recommend the change from mouth to nasal breathing.
- The first stage was to take recordings of mouth breathing only, nose breathing only and a mix of breath patterns with mouth and nose with the sensor placed in the hollow of the neck (which was discovered to be the most accurate location).
- All recordings were done for 60 seconds each whilst subjects sat in a quiet room. The pre-processing filtered out certain frequency bands and added a window to smooth the signal as well as apply a Fast Fourier Transform.

II. Implementation

- A frequency analysis was carried out on the signals recorded from each of the locations. For each location, each type of breathing was performed for approximately 60 seconds. Every 100Hz range up to 1000Hz was analysed using a short time Fourier transform (STFT) with a window length of 5 seconds and 50% overlap. The spectrogram plots for nasal and mouth breathing for each location and for each frequency band for both locations. The differentiation between the two types of breathing was more discernable for certain recording locations such as the hollow of the neck (see Table 1).
- The interface is shown in Figure 3, where the upper left part is the control, the upper right is the results, the lower left shows the spectrum graph, and bottom right shows the signal wave. The control part has the ‘Choose File’ button to choose an audio file in the ‘wav’ format. The ‘Detect Breath’ button to the right shows the end points in the signal file and extracts the feature of the signal at a certain frequency band under 110 (Hz). The system then passes the features to the Back-propagation Neural Network to detect the breathing patterns. The slider button to the left allows jumping to a specific time to hear the audio.
- The slider to the right adjusts the frequency on the y-coordinate that actually enables the user to zoom in or out the spectrum to get an overview or a more detailed view of the spectrum range from the sampling frequency to a low of 20 (Hz).
- The text box is used for displaying results. The plotting area at the lower right corner shows the signal wave after pre-processing.
- The end-point detection process happens after the ‘Detect Breath’ button has been pushed.

III. Results

- A frequency analysis was carried out on the signals recorded from each of the locations. For each location, each type of breathing was performed for approximately 60 seconds. Every 100Hz range up to 1000Hz was analysed using a short time Fourier transform (STFT) with a window length of 5 seconds and 50% overlap.
- The classification rate is 90% correct in this instance. End-point detection result is not as good as for mixed mode breathing as compared to nasal or mouth alone.
- For the mixed breath pattern sounds, the end-point detection function only detects a little more than half the breath cycles.

IV. Conclusion

- It is well known that the breathing pattern changing from mouth to nose do impact on patients respiratory disease, even a healthy person. We investigated here whether the necessary discriminatory information of nasal versus mouth breathing can be obtained from acoustic sensors placed at various positions on the body [1, 2].
- The experiment result shows that the difference between nasal and mouth breath can be discriminated successfully with a high enough accuracy and therefore integrated into a on-the-body acoustic sensor to try to give appropriate feedback to end-users.
- End point detection for mouth and nasal breathing is detected with 100% accuracy; however mixed breath patterns yield lesser results.
- In addition to this, it has to be taken into account that both a same-day variability and a between-day variability exist in lung sounds.
- On the basis of these large variations, concrete changes in nasal and mouth will be seen only with investigation of a larger number of subjects.
- The purpose of computer-supported analysis of breathing sounds is for objective understanding and archiving [3].
- Because the sensitivity of human hearing is reduced, particularly in the lower frequency ranges, an objective electronic recording for recognizing deviations within these ranges could be helpful. Since the procedure for doing this is not costly, invasive, or particularly intensive, it would be suitable as an examination method for high-risk groups such as pneumonia patients.
- A daily or even more frequent analysis of lung-sound spectra could help to identify patients with say, incipient pneumonia before the appearance of any radiologic abnormality.

Table 1: 1–100Hz average accuracy

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<th>Frequency (Hz)</th>
<th>Window Length</th>
<th>Wake</th>
<th>Sleep</th>
<th>Bin Width</th>
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V. References