Abstract - Analyzing the human body by the application of alternating electrical currents is not a widely known method in medicine. In our research, we stimulated test persons by exposing them to different low frequencies and measured their responses to them. This method, known as FAM (Frequency Analysis Method), can be used to estimate the physiological condition of patients. In this study, we present a method of processing the results using neural networks. By producing user-friendly visual data, the processing method aids a physiotherapist in the interpretation of the results, resulting in a more reliable diagnosis.

Keywords - Physiotherapy, biomedical engineering, neural networks, physiological condition, frequency analysis method, FAM, SOM

I. INTRODUCTION

A novel method known as FAM (Frequency Analysis Method) was invented in Oulu [1] to evaluate the physiological condition of the human body, musculoskeletal disorders in particular. The principle of the FAM is presented in Fig. 1. In this study the measurement data of this method was analysed and interpreted using artificial neural networks.

Figure 1. The principle of the FAM. An incrementally strengthening alternative electrical current (IF-current) of different frequencies is fed into the human extremities (wrists and ankles) and the three levels of responses namely the thresholds of sensory, motor and pain reactions are recognized and recorded. In our experimental examples the three frequencies are 10, 30 (or 50) and 100 Hz. The current values of the three response thresholds are recorded in a FAM-matrix. The nine (9) current measures for each extremity in the FAM-matrix carry the diagnostic information of the respective segment of the body.

II. ANALYSIS

In this study 96 subjects were measured. The physiological condition of the subjects was diagnosed to healthy, neck pain and fibromyalgy categories. The measurement of wrist was investigated using Self-Organizing Maps for analysis and diagnostics of the patients as follows:

First, FAM-matrixes were preprocessed using first order curve fitting. A FAM-matrix was fitted to the current both as a function of frequency and of reaction threshold. As a result of curve fitting, the FAM measurement was expressed as

\[ I(\text{react}_\text{th}) = k_{\text{max}_\text{th}} \times \text{react}_\text{th} + b_{\text{max}_\text{th}} \]  \hspace{1cm} (1)
Thus the FAM-matrix was presented using 12 parameters. Moreover, the data included three diagnostic groups. This data was taught for the Self-Organizing Map [3] in supervised mode using the 3-dimensional vector consisting of diagnose indexes indicating healthy, fibromyalgy and neck pain subjects as a target vector. Thus the input of the SOM was 15-dimensional in training phase and 12-dimensional in testing phase. The result of the training is presented in Fig. 2.

\[
m_{j}(t+1) = m_{j}(t) + h_{ij} \left[ x(t) - m_{i}(t) \right]
\]

Figure 2. The result of the training of the SOM as coloured areas corresponding to each diagnose: neck pain, fibromyalgy and healthy.

As an analysis tool, the method shows corresponding FAM-matrix for typical diagnose as illustrated in the picture. In diagnostic use the analysis is utilized in the opposite direction: the FAM-matrix is fed to the SOM in pre-processed 12-dimensional format resulting a projection to the coloured area which presents the corresponding diagnose.

III. DISCUSSION

The problem with the FAM method was that the interpretation of measurement results was too dependent on the personal judgments of physiotherapists who were familiar with the method. To circumvent this limitation, it was necessary to develop a form of numerical analysis to assist in the final analysis of the results.

This study shows that FAM measurements provide essential information on the physiological state of the human body and can be analyzed using the proposed method. However, to obtain more reliable results more FAM-data have to be analyzed, and that will be investigated in further studies. Moreover, the method applies Self-Organizing Maps to produce an easily interpretable analysis. Due to encouraging results the method has potential as a novel basic tool for physiotherapists.

IV. ACKNOWLEDGEMENT

The authors would like to thank the Oulu Polytechnic and the FAM project group for their encouraging contribution. We also extend our thanks to Innokas Medical Ltd and acknowledge the economic support of the National Technology Agency (TEKES).

IV. REFERENCES
