Artificial Intelligence Methods for Modelling Tremor Mechanisms

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Thesis summary

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The paper summarises a Doctoral Thesis in which we focus on two main goals: (1) building models for differentiation between three most common tremors: Parkinsonian, essential and mixed type tremor and (2) development of a novel method for attribute visualisation on series.

Povzetek: Članek povzema vsebino doktorske disertacije, v kateri se osredotočamo na dva glavna cilja: (1) gradnja modelov za razločevanje med tremi najpogostejšimi tremorji: parkinsonskim, esencialnim in mešanim tipom tremorja ter (2) razvoj nove metode za vizualizacijo atributov na vrstah.

1 Introduction

Tremor is an involuntary movement of the body and is one of the most common movement disorders. It is primarily associated with various diseases of the nervous system, including Parkinson's disease. Since there are more than 20 different types of tremors, differentiation between them is important from the treatment point of view.

Spirography is a diagnostic method where the subject's task is to draw a left-twisted spiral while the doctor observes the process of drawing (speed, hesitation, etc.) and the final drawing. With the development of tablets digitalised spirography emerged, making it possible to store the course of spiral drawing and the analysis of the acquired time series.

In order to increase confidence in such a system, we would need to provide an explanation of the results to doctors. One option is to visualize the anomalies and results onto the drawn spirals. These visualizations must make sense to physicians and, above all, they must be consistent with their medical knowledge of the domain.

This paper summarises a Doctoral Thesis [1] which tries to address the need for automatic differentiation of tremors and visualisation of the decisions such system would give.

2 Diagnostic models for tremor differentiation

In the thesis, we focus on differentiation between three of the most common tremors: Parkinsonian, essential and mixed type of tremor. For the purpose of building the diagnostic models, we used the digitalised spirography for collecting the data needed.

The first diagnostic model distinguishes between the three tremors, based on clinical examination data, family history and digital spirography. The process of building a model was carried out using argument-based machine learning technique which enabled us to build a decision model through the process of knowledge elicitation from the domain expert (a neurologist). The obtained model consists of thirteen rules that are medically sensible. The process of knowledge elicitation itself contributed to the higher classification accuracy of the final model in comparison with the initial one [2, 5].

In the first diagnostic model, attributes derived from the spirography were included in more than half of the rules. This motivated us to build a model based solely on the digital spirography data. For the needs of constructing an understandable model, we first built several attributes which represented domain medical knowledge. We have built more than 500 different attributes which were used in a logistic regression to construct the final diagnostic model. The model is able to distinguish subjects with tremors from those without tremors with 90% classification accuracy. The final diagnostic model is built into the freely available PARKINSONCHECK mobile application [6].

3 Method for attribute visualisation

During the process of attribute construction, we wanted to know what our attributes were detecting. Thus, we have developed a method for attribute visualisation on series. The method not only helped us with attribute construction, but it is also useful for visual interpretation of the diagnostic model's decisions. The visualisation method and consequently the decision model were evaluated with the help of three independent neurology experts. The results show that both the diagnostic model and the visualisation are meaningful and cover medical knowledge of the domain.

Different visualisation approaches and their benefits have been published in several peer reviewed publications [3, 4, 7].

4 Conclusion

The Thesis [1] describes the development of different diagnostic models for digitalised spirography systems. The emphasis is given to elicitation of expert's knowledge and including that knowledge into the built-in attributes. To increase physicians' confidence in such systems, a novel method for attribute visualisation has been proposed. The results were published in several peer-reviewed publications [2, 3, 4, 5, 6, 7].

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