A TCD STUDY OF ZERO-CROSSING DYNAMICS OF SOLID AND GASEOUS MICROEMBOLIC SIGNALS (MES).

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Introduction

Micro-emboli of both solid or gaseous origin can occur during cardiac surgery. It is important to differentiate both, because solid emboli are generally associated with an increased stroke risk, whilst gaseous emboli are not (unless the embolic load is extremely high). Intensity and duration of MES are not reliable indices for discrimination. Therefore, the zero-crossing dynamics of solid and gaseous MES were examined to look whether this parameter could make a reliable distinction between gaseous and solid MES.

Methods

From a recording of a cardiovascular procedure 300 MES which were clearly associated with the entrapment of air into the circulation were selected and labeled by a human expert. Another 300 MES were selected and labeled from a recording of the postoperative phase of carotidendarterectomy. These events were associated with the presence of solid emboli. To make the problem more practical another 300 HITS which were clearly no MES were selected from both files. MES and artefacts were detected by the 2 MHz transcranial Doppler (EMS-9U/DelicaSystem/Shenzen Delicate Electronics Co. Ltd./China). and classified by the Embolus Detection System (see Fig.1) (EDS, SMT Medical, Wuerburg, Germany). The EDS allows to verify of every event the velocity display, the audio file and calculates for every event: intensity, duration and a socalled zerocrossing index (ZCI) For details of ZCI see reference Keunen.
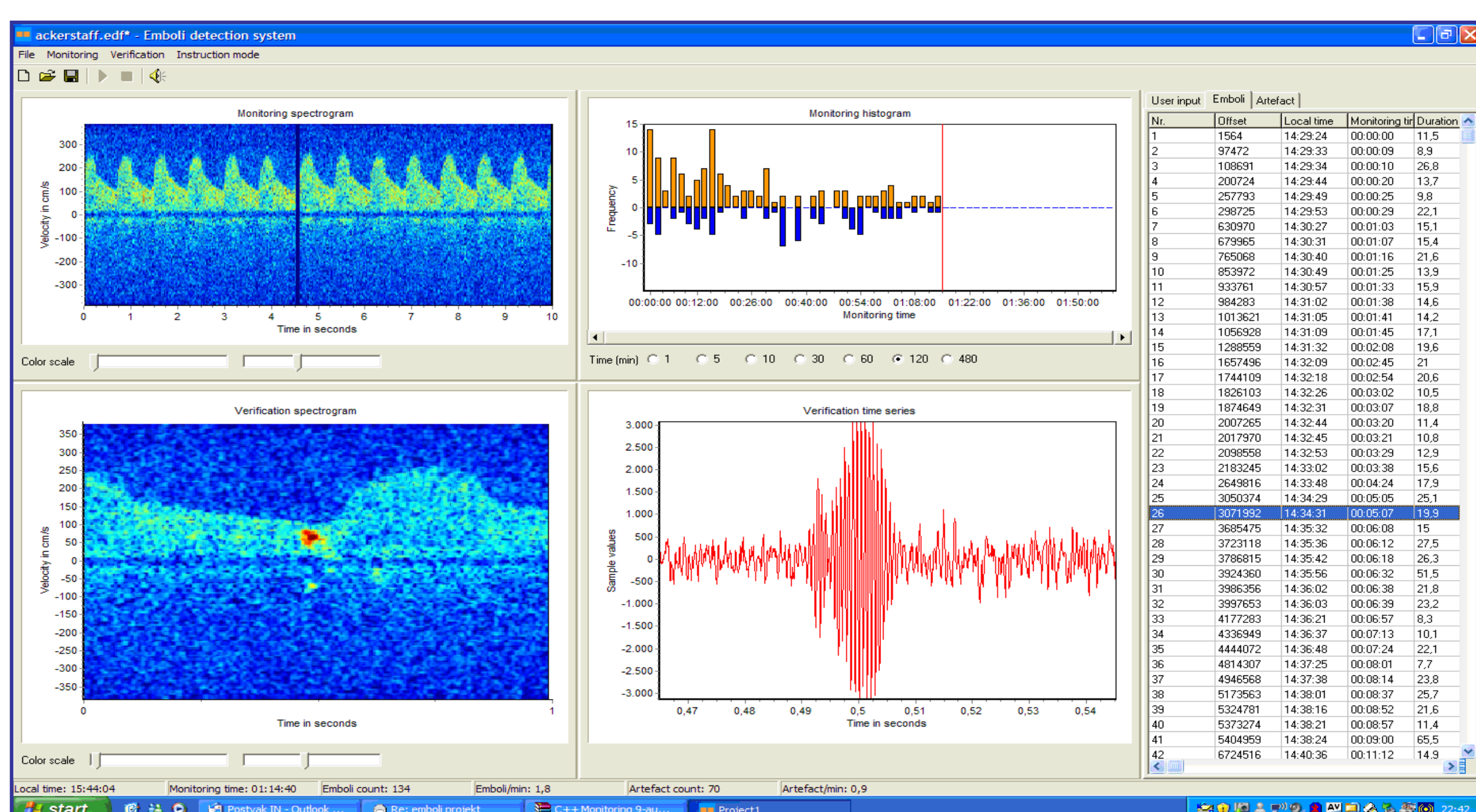

Fig.1. The EDS

Results

Individual classification performance of the discussed feature was 86% for the given three class problem. In combination with other features such as length and intensity classification performance was over 90% (see Fig 2.)
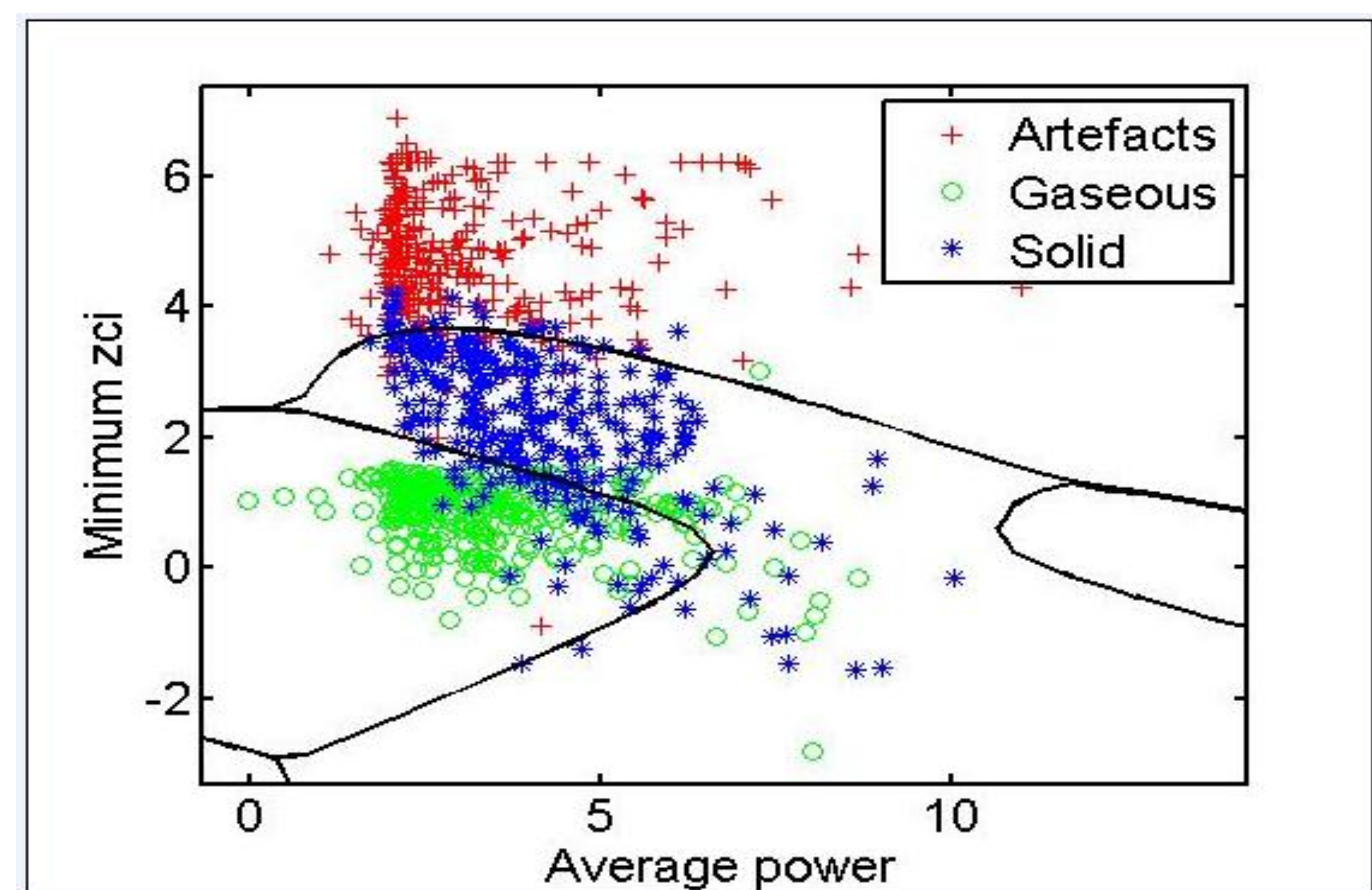

Fig.2. Distribution of solid MES, gaseous MES and artefacts in a ZCI and average power diagram.

Conclusion

Signals produced by gaseous emboli, solid emboli and artefacts exhibit different zero-crossing dynamics. Gaseous MES and artefacts do not overlap in the present data-set. However solid MES and both gaseous MES and artefacts have to a certain extend an overlap. Therefore future emboli detection systems which uses zero-crossing dynamics to differentiate between gaseous and solid MES need to give a probability score to indicate to which extent the overlap is present or not The present observation opens up the possibility to detect both gaseous and solid MES with single gated TCD equipment.

Reference.

Keunen RWM et al. J Med Engineering &Technology 2008 32(4):296-304. (www.strokeprevention.nl)