USING MICROWAVE TECHNOLOGY FOR DETECTING TRAUMATIC INTRACRANIAL BLEEDINGS – TESTS ON A BRAIN PHANTOM

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1. Introduction

Traumatic brain injury (TBI) is the leading cause of death and severe disability among young people, and frequently occurs in road traffic accidents, falls, sports injuries, etc. [1, 2]. Intracranial bleedings is the most important complication of TBI, and need to be detected and treated at an early stage to save the lives of these patients [2]. Computed tomography (CT) is the clinical standard for detecting intracranial bleedings. The main disadvantage with CT is that it is not suitable for portable use. Microwave technology (MWT) has shown promising results for detecting intracranial bleedings in stroke patients using a microwave helmet [3]. MWT could be well suited for field use, as a complement to CT. In this study we assess the potential of using the microwave helmet for detecting intracranial bleedings in tests on a brain phantom. We model subdural hematoma, which has very high mortality, 50−85%, and is the traumatic intracranial bleeding that most commonly requires surgery [1].

2. Materials and methods

A model of subdural hematoma was constructed by filling a human cranium with a phantom solution consisting of water, sugar, agar and salt, which mimicked the dielectric properties of gray brain matter, and cutting away a crescent-shaped portion of the brain phantom with a scalpel and refill with phantom solution mimicking dielectric properties of blood, see Figure 1. Four phantoms were created, one without bleeding and three with bleeding sizes of approximately 40 mL (width 0.5 cm), 70 mL (width 1 cm) and 110 mL (width 1.5 cm), corresponding to clinically relevant sizes of different degrees of severity [2]. Thirty consecutive measurements were performed on each phantom, and the cranium was repositioned in the helmet after every third measurement. A classification algorithm based on finding the minimum distance to the subspace bases, which were calculated by singular value decomposition of the training data matrix for each class, was used to distinguish between the measurements of the different phantoms. The leave-one-out approach was used, i.e. the sample to be classified was not included in the training data matrix, in order to not overestimate the classification performance.

3. Results and discussion

Figure 2 shows the distance to the subspace basis for each observation and classification test. The classifier correctly identified 100% of the observations. Since the smallest bleeding was estimated to be of smaller size than would require surgery [2], the results indicate that MWT has high potential for detecting subdural hematomas of clinically relevant sizes.

References

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Figure 1: Phantom model of bleeding.

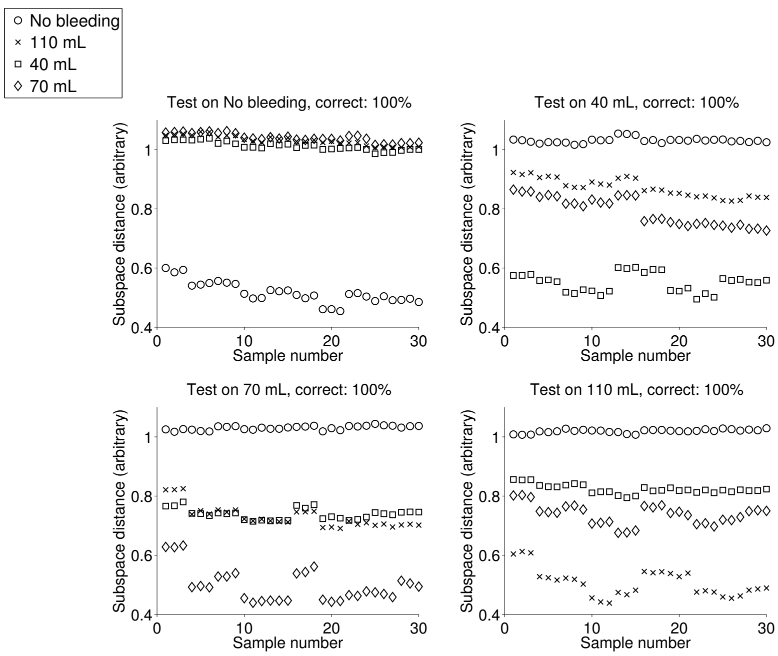

Figure 2: Classification results.