

PhD Thesis Title: Studies on the Usefulness of Biological Fingerprint in Magnetic Resonance Imaging for Patient Verification

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ABSTRACT:

PURPOSE

Patient misidentification error management is one of the important factors of patient safety. Positive patient identification is essential to avoid patient misidentification and for the prevention of malpractice. It is necessary to reduce the possibility of patient misidentification risk caused by human errors. We studied the use of multi-planar reconstruction (MPR) images generated from three-dimensional magnetic resonance (MR) imaging of the brain for the purpose of biometric patient identity verification, and show the accuracy of verification performance for clinical use.

METHODS

Eleven anatomy-related MPR images generated from one three-dimensional fast scout scan of each MR examination were used as biological-fingerprint images in this study. We calculated the correlation value as a similarity score between current and prior biological-fingerprint images of the same patients and also all combinations of two images for different patients to evaluate the effectiveness of our method for patient identification and verification. This procedure consists of three major steps, i.e., biological feature extraction, normalization, and calculation of correlation value.

In order to evaluate the verification performance, we calculated a false rejection rate (FRR), a false acceptance rate (FAR), and a half-total error rate (HTER) by the discriminant analysis utilizing the squared Mahalanobis distance to declare the patient as genuine or an impostor. Moreover, to evaluate overall verification performance deliverance from a receiver operating characteristic (ROC) curve at various threshold correlation value settings, the area under the ROC curve (AUC), and its equal error rate (EER) were calculated. The identification performance of our method was evaluated in terms of cumulative match characteristic (CMC) curves and its rank-one identification rate (R1).

RESULTS

The database of this study consisted of 730 temporal pairs of MR examination of the brain. Many patients of this study have the following disorders: brain tumor and cerebrovascular angiopathy, and 168 patients have undergone surgical operation of the brain before the current examination.

Our results indicated a high performance in identifying and verifying patients. The best performance value for each biological fingerprint analysis gave an HTER of 1.59% with an FAR of 0.023% (62/266,085), and an FRR of 3.15% (23/730). The best AUC, EER, and R1 value were achieved at 0.998, 1.37%, and 98.6%, respectively. Our results indicated a high performance in verifying patients. An FRR of 16.7% in 72 patients, who underwent surgical operation between the prior and current examinations indicated lower performance. However, the FRR of 3.13% in 96 patients, who have undergone surgical operation before the prior examination, have high performance levels like the other patients.

CONCLUSION

Our method makes it possible to verify the identity of the patient only using some existing medical images without the addition of incidental equipment. It is useful when we have no other way of confirming whether the registered patient information is correct or not, and has the potential for discovering misfiled patient information after examination. We expect our method to be a key solution to patient misidentification problems.

References to author publications that relate specifically to the dissertation:

1. Ueda Y, Morishita J, Kudomi S, Ueda K. Usefulness of biological fingerprint in magnetic resonance imaging for patient verification. *Med Biol Eng Comput.* 2016 Sep;54(9):1341-51. doi: 10.1007/s11517-015-1380-x. Epub 2015 Sep 4.
2. Ueda Y, Morishita J, Kudomi S, Ueda K. SU-E-I-72: Biological Fingerprint for Automatic Patient Identification and Verification by Use of Three-Dimensional Magnetic Resonance Imaging with Multi-Planar Reconstruction Scout Images. *Med. Phys.* 2015 June;42(6):3258. doi: 10.1118/1.4924069. Conference Paper (Abstract Only).