Healthcare Innovations
How practice has changed

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Automated detection of cerebral microbleeds without training samples using synthetic data

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Goal: Investigate whether generating synthetic lesion can improve automated detection using machine learning

Background:

- Cerebral Microbleeds (CMB) are hemosiderin deposits caused by structural abnormalities of the blood vessels, leading to brain dysfunctions, stroke and Alzheimer disease.
- Clinical observation of CMB is tedious, time consuming, and subjective.
- Automatic CMB detection algorithms suffer from high false positive and low sensitivity.

Challenges of automatic CMB detection:

- CMB are similar to blood vessel cross-sections
- Big enough training dataset is difficult to obtain
- CMB prevalence is low

Synthetic Microbleed generation

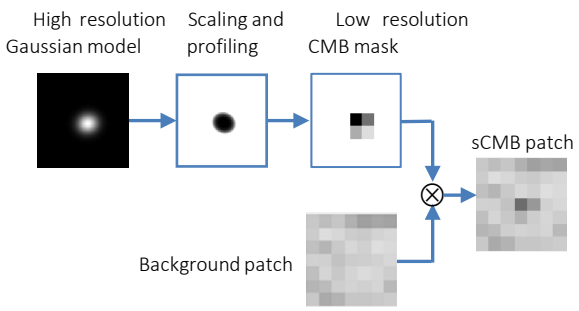


Fig. 1. Different steps of proposed synthetic CMB generation model.

Proposed synthetic Microbleed samples on the SWI image

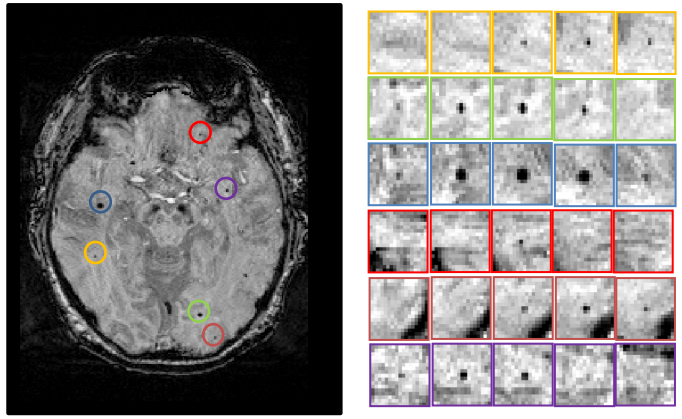
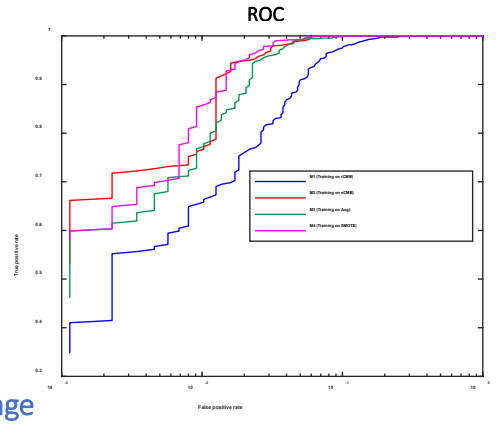


Fig. 2. Samples of proposed sCMB. Different shapes, sizes and locations are shown in an axial plane. The volumes are varied from 0.8 to 20 mm3.

CMB classification results



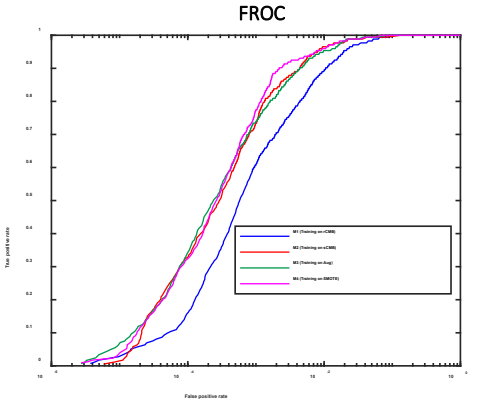


Fig. 3. Comparing ROC and FROC curve from 4 different training models for CMB detection on whole SWI.

Table 1. Result of whole SWI CMB detection for 95% sensitivity.

Training model	results for 8,000 samples		
	AUC	Spe	#FP/ scan
M1 (training on rCMB)	0.995± 0.0003	0.981± 0.0047	208.4± 45
M2 (training on sCMB)	0.997± 0.0007	0.992± 0.0007	86.7± 7
M3 (training on Aug)	0.997± 0.0007	0.990± 0.0013	110.8± 14
M4 (training on SMOTE)	0.998± 0.0008	0.992± 0.0004	85.6± 6

AUC: area under ROC curve; Spe: specificity; FP: false positives; rCMB: real CMB; sCMB: synthetic CMB; Aug: augmented real CMB; SMOTE: synthetic minority oversampling technique.

Results and Discussion: In conclusion, synthetic microbleeds generation is a powerful data augmentation approach and should be considered for training automated lesion detection system from MRI SWI.

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