Dense vessel detection using an anatomically-aware CNN in non-contrast CT scans

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Abstract

Automatic detection and measurement of dense vessels may enhance the clinical workflow for treatment triage in acute ischemic stroke. Nevertheless it is a challenging task in non-contrast computed tomography (NCCT) scans due to the subtlety of the pathological intensity changes, which are confounded by the presence of vascular calcification (common in ageing brains). We use a 3D Convolutional Neural Network, which incorporates anatomical atlas information and bilateral comparison, to detect dense vessels in NCCT scans. The detector was trained using focal loss [1] to compensate for heavy imbalance between normal and pathological voxels. The training was performed on 112 scans from the ATTEST [2] and WYETH [3] studies and evaluated on 58 scans from the POSH[4] study. We compare automatic dense vessel detection to identification of the dense vessels by clinical researchers in NCCT scans. Our system demonstrates the potential to assist clinical review, reaching agreement 0.64-0.66 with clinical experts. We further compare dense vessel detection (both manual and automatic) to the presence of associated arterial occlusions, as identified by clinical experts in CTA scans.

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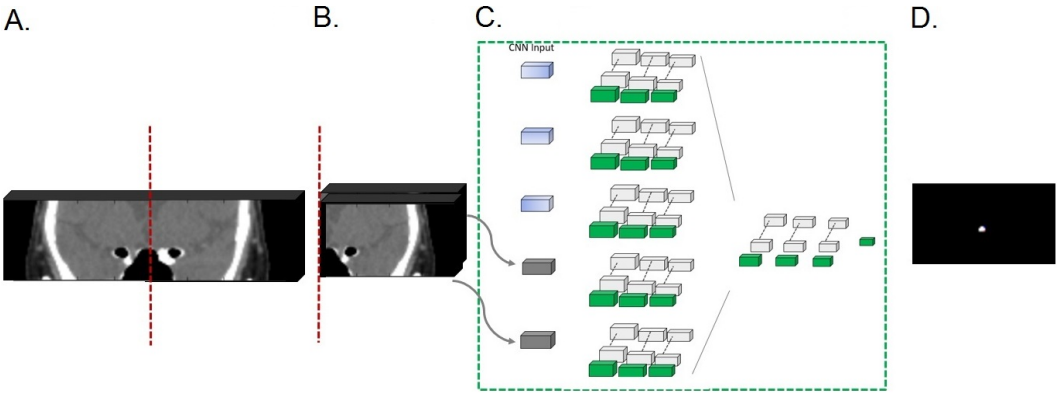

Figure 1: Detection Pipeline.A) Extraction of the block of interest (anterior circulation region) from the novel volume which has been aligned to the atlas. B) Folding of the block along the anatomical midline. C) Corresponding bilateral intensity data is input to parallel CNN channels to allow direct comparison of the left and right sides of the brain. The remaining three input channels encode the x, y and z atlas coordinates. D) CNN outputs probability volumes for the target hemisphere, indicating the voxelwise probability of a dense vessel being present.

References

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