P65 Sparse tomographic reconstruction of brain tissue from serial section electron microscopy

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High throughput imaging of large volumes of brain tissue at synaptic level has the potential to transform the acquired anatomical maps into the realm of Neuroinformatics. This, however, poses a substantial challenge to imaging technologies due to the requirement of both high resolution and large spatial scale. Various types of volume Electron Microscopy (EM) methods have been proposed in recent years for neural circuit reconstruction [1]. While these methods differ in terms of the utilized type of EM and sectioning technique, they are commonly limited in the resolution in the depth direction due to the involved mechanical cutting process. Low depth resolution could significantly reduce the ability to reliably identify different subcellular structures that may play an important role in structural plasticity of neuron connections. Although Electron Tomography (ET) can be applied together with serial section EM methods [2, 3] to computationally improve the depth resolution, it typically requires tens to hundreds of EM images acquired from series of tilt angles in order to generate a satisfactory reconstruction. This severely limits the throughput and exposes the sample with excessive electron-dose causing sample damage.

In this work, we show that a reasonable tomographic reconstruction can be achieved using limited data from a small number of projection images. By exploring the information from reconstructions of adjacent sections of the sample and the fact that these sections together form a continuous large area of brain tissue with sparse boundaries, multiple sections are reconstructed simultaneously together as a single reconstruction using iterative reconstruction techniques. This approach helps reduce ambiguities raised by the limited number of projections and the missing wedge, and guides the reconstruction algorithm toward a reasonable numerical solution using only a few projection images. The figure below demonstrates the performances of the reconstruction using the proposed technique. In total 30 of the 100nm sections are reconstructed together with only 5 projection images (range from -70 to 70 degree) for each section. The results show that significant greater depth resolution is achieved for the complete reconstruction comparing to the original 100nm depth resolution. The yellow box highlights the results in a smaller region indicating the image quality of the numerical reconstruction. Furthermore, the reconstructed cross-sections appear to be free of distortion and highly continuous among adjacent sections. The proposed technique has the potential to improve both resolution and throughput of 3D reconstruction, and to provide high quality volume information of brain tissue for better understanding of the relation between functions of the nervous system and the underlying neuronal circuits.

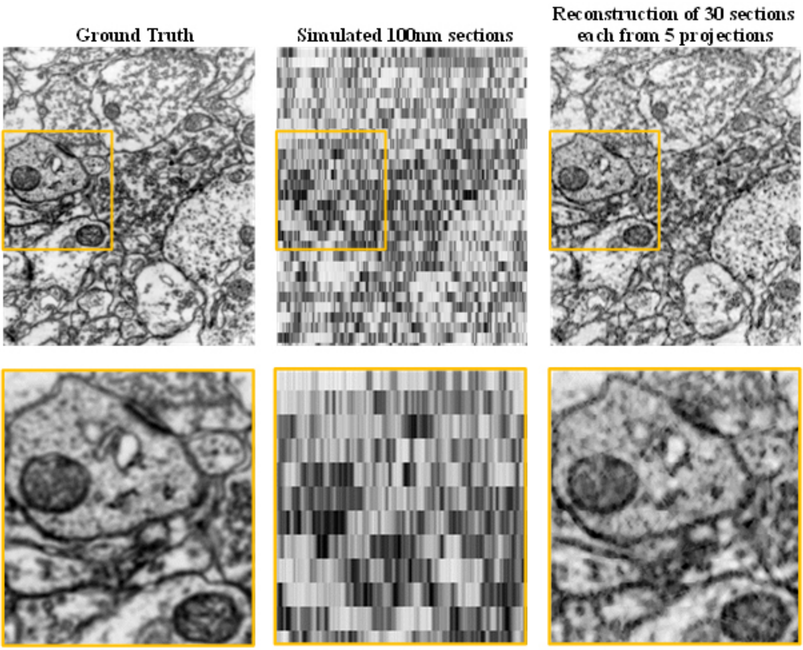

Figure. Cross-section of tomography reconstruction of brain tissue from limited data. Projections of sections from 5 tilt angles (-70 to 70 degree) are used to reconstruct 30 of the 100nm serial sections. Image courtesy to the OPEN CONNECTOME PROJECT [4].

References

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