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Segmentation and Filtering of Noisy and Ambiguous Volumes from Discrete Tomography - Artificial Intelligence Challenge

X-ray computed tomography (XCT) is an established method for investigation of internal structure of objects. Its current use in medicine is irreplaceable. In standard CT, hundreds to thousands of radiograms of the investigated object are acquired from different projection angles. These radiograms are then processed to extract the virtual 3D model of the investigated object. To obtain sharp, high-quality model, the object must be stable during scanning. This requirement limits the usability of XCT for visualizing the time-dependent processes only to very slow ones, since the process-under-test must not undergo significant changes during one scan. At the same time, creating a sequence of 3D models of a dynamic process (so-called 4D CT) is a very attractive technique. There are basically two possibilities of shortening the scanning time and thus allowing faster processes to be scanned: 1) to lower the exposure time; and 2) to decrease the number of projection angles. As for the option 1), the technological progress allowed to shorten the exposure times on modern digital X-ray detectors to tens of milliseconds with sufficient contrast. With hundreds of projections for one scan, this means units to tens of seconds, during which the process cannot undergo big changes. This is sufficient for controlled processes, such as compression tests of materials etc. However, for faster processes, we additionally have to lower the number of projections, sacrifying the resultant 3D model quality.

My contribution presents an experiment with a model of human esophagus, swallowing a bolus with added contrast particles. Two projections in orthogonal setup are acquired simultaneously every 15 ms. The corresponding frame rate of 66 frames per second is fast enough to document the process of swallowing from the two directions, but the radiograms suffer from high noise and low contrast. The goal is to visualize the movement of contrast particles as a sequence of 3D models. However, the reconstruction from only two projections is a highly underconditioned task with ambiguous result. We were able to create the 3D models and filter out the most of false detected particles in a conventional way, with a moderate success. It would be possible to improve the resulting 4D sequence by manual

assessment and confirmation / exclusion of each particle in each successive 3D model, but such a task is technically impossible to be done by a human force. Would the artificial intelligence resolve the problem?