Markerless 3D Head Tracking for Motion Correction in High Resolution PET Brain Imaging - DTU Orbit (13/05/2019)

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This thesis concerns application specific 3D head tracking. The purpose is to improve motion correction in position emission tomography (PET) brain imaging through development of markerless tracking. Currently, motion correction strategies are based on either the PET data itself or tracking devices relying on markers. Data-driven motion correction is problematic due to the physiological dynamics. Marker-based tracking is potentially unreliable, and it is extremely hard to validate when the tracking information is correct. The motion estimation is essential for proper motion correction of the PET images. Incorrect motion correction can in the worst cases result in wrong diagnosis or treatment. The evolution of a markerless custom-made structured light 3D surface tracking system is presented. The system is targeted at state-of-the-art high resolution dedicated brain PET scanners with a resolution of a few millimeters. State-of-the-art hardware and software solutions are integrated into an operational device. This novel system is tested against a commercial tracking system popular in PET brain imaging. Testing and demonstrations are carried out in clinical settings. A compact markerless tracking system was developed with an accuracy sufficient for PET imaging (<0.1 degrees and <0.3 mm). Furthermore, the first non-visible structured light system using Pico DLP technology was used. In a proof-of-principle study with two human PET scans, the system was demonstrated to improve PET image quality significantly. The results were similar to motion correction using an integrated commercial marker-based system. Furthermore, phantom studies were performed supporting the system's abilities for PET motion correction.

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