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Application of a high-speed CMOS image sensor for geometric calibration of cone-beam computed tomography system

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The Cone-Beam Computed Tomography (CBCT) system has been widely used for medical diagnostic and surgical application. However, the 3D reconstructed images in CBCT are significantly affected by a variety of vibrations of the operating gantry system.
In this work, the geometric calibration in our developing CBCT was performed and analyzed in order to solve these problems by using a high-speed CMOS camera and infrared reflecting mark. The images for a geometric calibration were acquired by putting a high-speed camera with 120 fps (frame per second) on an X-ray source position and a reflection mark on flat panel detector position in our developing CBCT system. The geometric calibration during rotation of gantry system from 0 degree (reference point) to 360 degree (stop point) was done. Also, its gantry system with 5rpm (rotation per minute) and still images at a regular interval of 10 degree were applied. The calibration parameters through the Euclidean distance were calculated using the difference between reference point and each rotation point. The experimental results were used for geometric calibration of u-coordinate (forward-backward) and v-coordinate (left-right) in CBCT gantry system
The CMOS camera (MV-D640, photon focus) having a 6.34mm x 4.75mm active optical area with 9.9μm pixel pitch and 640 x 480 pixels was used for geometric measurement and analysis in our CBCT system. The 1440 (120fps x 12s) moving images were used for precise analysis of gantry system with 5rpm. Because a lot of images than commercial X-ray CBCT images with maximum 30 fps were acquired through our proposed method, the geometric measurement of gantry system as a function of each phase were significantly improved. After we solved the geometric problems from the first experiment results, gantry vibration of u and v-coordinates of CBCT system from secondary measurement was largely improved to 94.4% and 25%, respectively.

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