Congress Proceedings Abstracts

COMPUTED TOMOGRAPHY IMAGE QUALITY ANALYSIS USING REVERSE ENGINEERING FOR PROSTHESIS DESIGN

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Abstract

Introduction. Various diseases and accidents cause facial deformities in people. These deformities are mostly caused by cancer and traumatic events such as motor vehicle accidents, assaults and burn injuries. Patients with severe facial disfigurements suffer physiological trauma and social rejection. To improve their facial appearance, these patients often require facial reconstructive surgery and the placement of custom-made prostheses. A facial prosthesis requires accurate patient anatomy obtained through computed tomography (CT) imaging for the 3D printing of prosthesis. Suboptimal CT images could result in incorrectly sized, ill-fitting prostheses, which may cause additional trauma, repeat imaging, and additional radiation exposure and cost. CT scans must be of high quality so that optimal stereolithography files (STLs) can be produced from the scans to ensure the design of correctly sized prostheses, thereby reducing trauma and cost. The aim of this study was to evaluate the image quality of CT scans. The Centre for Rapid Prototyping and Manufacturing (CRPM) supplied 35 STL files previously used for prosthesis manufacturing derived from original CT scans. Because access to the original CT scans (DICOM files) was impossible, an innovative approach to image quality analysis was devised by reverse engineering existing STL files to produce representative CT scans.

Materials and methods. Initially, the image quality of the STL files were assessed by an expert team using a qualitative measurement rubric to identify high-quality STL files. The metadata of original CT scan parameter values of the top-ranking STLs (n=11) were applied to a Catphan® 500 phantom to generate representative CT scans using the Bone and BonePlus algorithms for a total of 22 scans. The image quality of the CT scans was then evaluated with the CT quality assurance software, Smári. Thereafter, the Smári image quality parameter values were used to identify the top five CT scans by calculating four indices using measurement (Index A), transformed (Index B), ranked (Index C) and unique (Index D) values.

Results. The Smári analysis programme delivered image quality indicator values for pixel size (Bone range 0.37-0.52; BonePlus range 0.37-0.52), contrast (Bone range 16.0-22.0; BonePlus range 15.0-23.0), uniformity (Bone range 0.04-13.05; BonePlus range 1.70-12.31), slice thickness (Bone range 0.88-1.37; BonePlus range 1.01-1.47) and noise (Bone range 14.27-48.45; BonePlus range 19.72-72.36) for both algorithms. The values of the five image quality indicators were mainly similar for the two algorithms. Calculating the different indices, using indicator values, enabled the ranking of the 22 CT scans in terms of image quality. Parameter setting values and ranges for high-image-quality CT scans were then extracted from the top-ranking CT scans. These values were 120 kV, 200-490 mA, Auto mA, the field of view 20-26 cm, and slice thickness 0.625-1.25 mm.

Conclusion and significance. By applying this innovative approach, it was now possible to test the reversed engineered CT parameter values closer to a real-world situation, for example, an anthropomorphic phantom, dry skull or cadaver. These tests could provide insight into which CT parameter settings values and ranges should be used when scanning patients for a prosthesis to improve their facial deformities.

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