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The need for DICOM encapsulation of 3D scanning STL data

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To the Editor:

The recent introduction of digital dentistry has made it important to store and utilize 3-dimensional (3D) graphics and images in addition to existing X-ray and magnetic resonance images. These 3D graphics or surface geometry files are created in an optical scanner or by segmentation of existing images.[1] In particular, optical scanning is currently being used to scan oral structures for the purpose of replacing or supplementing dental impressions to produce restorations, or to digitize and store dental casts.[2]

The Digital Imaging and Communications in Medicine (DICOM) file format is intended to store and transmit medical image files, and has been revised several times to reach its current format in terms of header structure and contents. DICOM files are particularly essential for medical image archiving and management because image data 1) cannot be manipulated or changed, and 2) are stored in a unified way so that they are linked to a picture archiving and communications (PACS) system even if the equipment is changed. The DICOM format is widely used because of these advantages.[3,4]

Three-dimensional graphics file formats, such as STL (an abbreviation of "stereolithography") in the dental field, have been used to design restorations or guides for implants or orthognathic surgery.[5,6] STL files are commonly used for 3D printing and capture geometry as a triangular mesh, but contain no color or texture information.[7] Recently, as oral scanners have become popular, a wider variety of 3D graphics file formats are being used in digital dentistry. These formats, such as PLY, OBJ/MTL, X3D, VRML, AMF, 3MF, and G-CODE, contain additional material properties and color information.[8] More than 140 file formats are already used for 3D graphic representation and object manufacturing.[9]

There are many practical reasons for DICOM encapsulation of 3D scanning data.[10] First, facial and oral scan data are valuable personal information that needs to be protected.[11] Additionally, the identity of the patient from whom these data were obtained can be ascertained when the encapsulation is queried by a user with proper credentials. Second, once encapsulated 3D scanning data are integrated with the existing images on the PACS, more comprehensive treatment planning and evaluation will be possible by displaying, editing, storing, and reusing the scanning data with reference to existing images. Third, encapsulation makes the record management of both existing and 3D scanning images more efficient by enabling the use of the PACS system. As part of this effort, standardization work has begun to incorporate STL images into the DICOM system to facilitate preservation of the STL file in its exact form, while at the same time unambiguously associating it with the patient.[12] The current version of DICOM (2018d) is managed by the Medical Imaging and Technology Alliance, a division of the National Electrical Manufacturers Association (NEMA).

However, the revised DICOM protocol must be complemented for the following reasons. First, surface information that is only made by binarization of existing images can be stored in the DICOM format (DICOM C.35),[7] while optical scanning data still cannot be converted to DICOM files. Therefore, there is the limitation that 3D scanning data, which have been used in various clinical applications, cannot be utilized in the PACS system for diagnosis, treatment planning, and prosthodontic design purposes. Second, the current DICOM protocol only supports STL files (DICOM PS 3.2[12] and 3.3[13]) and cannot use other formats, such as OBJ and PLY, which contain additional information. For accurate diagnostic dentistry, various information such as color and texture are essential, in ad-

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dition to the surface geometry, so it is also urgent to encapsulate these additional file formats to be used freely in optical scanners and PACS system.

Digital dentistry is already widely used. Previous physical and clinical procedures have recently been replaced by digital scanners and software,[14] and efforts are even underway to produce final restorative products using 3D printing.[15,16] Therefore, there is a need to integrate digital scanning data with existing images efficiently. This need is expected to grow with the release of advanced equipment, such as a CBCT machine with simultaneous face-scanning ability.[17] At this point, encapsulation of digital scanning data should be accomplished at an early stage so that the relevant equipment and software companies can support its integration into the PACS system. This is essential for the current PACS system, which is based on existing X-ray and MRI images, to make the leap of becoming a more efficient and integrated digital imaging system.

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