CYBERMED INC., ONDEMAND3D TECHNOLOGY INC.

OnDemand3D Fusion Technology

White Paper

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● USA ● Republic of Korea
www.ondemand3d.com

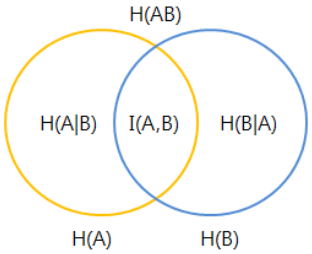
Introduction

OnDemand3D Fusion technology는 서로 다른 시기에 촬영된 DICOM data나 다른 촬영장비(modality)에서 촬영된 DICOM data를 정합(super-imposition)할 수 있는 기술입니다. Fusion 기능을 이용하면, 시간에 따른 환자의 변화양상을 관찰하거나 기존 modality에서 보기 어려웠던 병증을 더 쉽게 파악할 수 있습니다. OnDemand3D Fusion에는 information theory에서 나온 Mutual Information을 이용됨.

What is the Mutual Information(MI)

OnDemand3D fusion technology uses a basic concept from information theory, mutual information (MI), or relative entrophy, as a matching criterion. Using MI in image superimposition is first suggested for registration of 3D CT, MR and PET brain images of single object (Maes F, Collignon A, Vandermeulen D, Marchal G, Suetens P. Multimodality image registration by maximization of mutual information. IEEE Trans Med Imaging 1997;16:187-98).

간단한 개념은 아래와 같습니다. MI is related to entropy by the equations

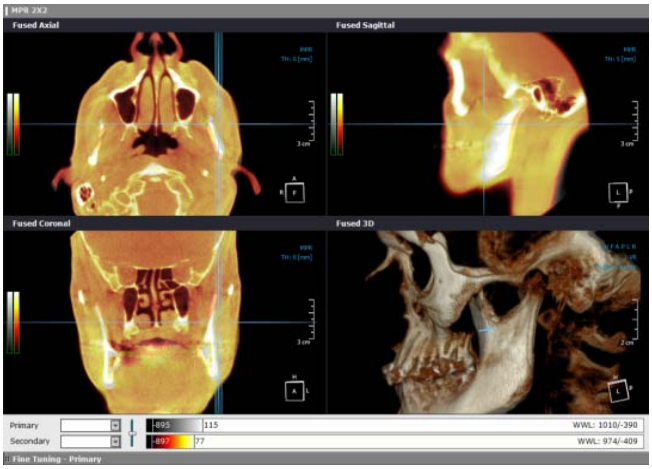


$$I(A,B) = H(A) + H(B) - H(A,B) \quad (1)$$
$$= H(A) - H(A|B) \quad (2)$$
$$= H(B) - H(B|A) \quad (3)$$

With H(A) and H(B) being the entropy of A and B, respectively, H(A,B) their joint entropy, and H(A|B) and H(B|A) the conditional entropy of A given B and of B given A, respectively.
The entropy H(A) is known to be a measure of the amount of uncertainty about the variable A, while H(A|B) is the amount of uncertainty left in A when knowing B. From (2), MI, I(A,B) is the reduction in uncertainty of the variable A by the knowledge of another variable B, or equivalently, the amount of information that B contains about A.
Let us suppose A to be the information of the cranial base in pre-treatment CBCT data, and B to be that in post-treatment data. As correlation between A and B is getting higher, H(A|B) or H(B|A) becomes smaller. If cranial base areas from two data are geometrically aligned, then H(A|B) or H(B|A) is minimized and MI is maximized in (2) and (3). We can produce superimposed CBCT data by maximizing MI with translation and rotation of images.
This method was also used by Cevidanes et al to obtain geometrical information from one software package that was subsequently used in another to compare pre-segmented surface models (article in Dentomaxillofac Radiol). We expanded the scope of this method to volume imaging and slice images and also refined the algorithm and user interface. This result is a very accurate and rapid method to superimposed various images one program.

활용분야

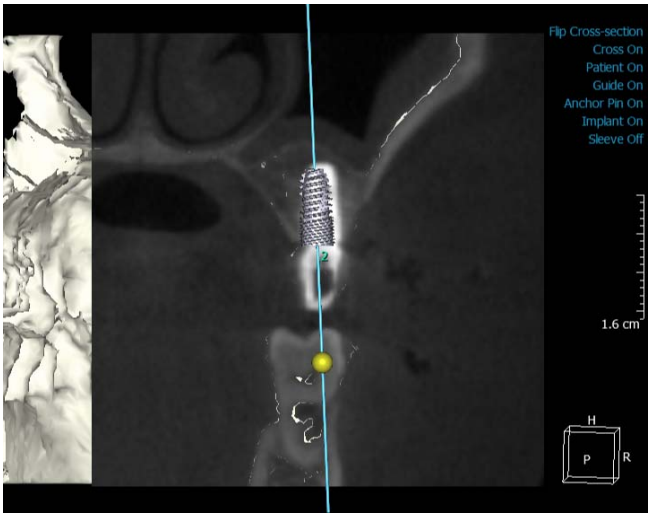
교정 수술 혹은 외과 수술전, 수술후 데이터의 비교



수술 전 DICOM 데이터와 수술 후 DICOM 데이터를 fusion한 모습

왼쪽에서부터 각각 수술전 영상,
수술 후 영상,
Superimposition 영상

Implant 수술 전 후 데이터의 비교



Implant 수술 후 영상 위에 implant planning-g 데이터를 superimposition한 모습
수술 전 영상과 동일한 좌표계를 만들기 위해 수술 후 영상을 fusion한 후 re-slicing 합니다.
수술 전 후의 차이를 measure tool을 이용하여 측정할 수 있습니다.

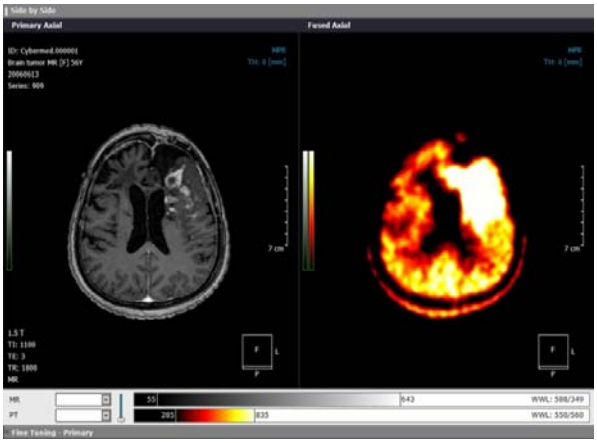
데이터 stitching

51mmx51mm small FOV의 CT 데이터들. voxel size는 0.1mm, 512x512 matrix

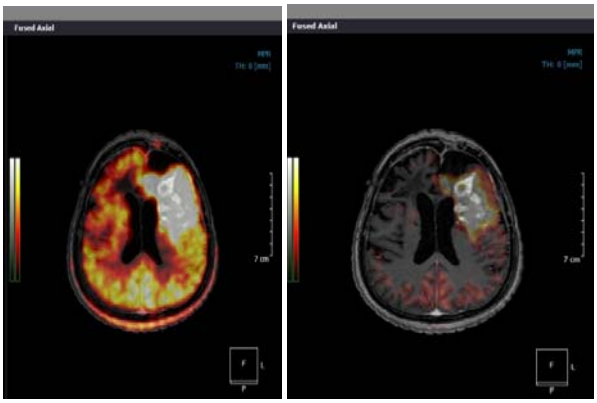
Fusion 기능을 이용하여 seamless stitching된 CT 데이터(하). 912x670 matrix

Fusion 기능을 이용하면 FOV가 작은 CT 장비에서 촬영된 DICOM 데이터를 손쉽게 stitching할 수 있습니다. 상하/좌우 혹은 임의의 방향으로 stitching이 가능하며, 사용자가 수동으로 설정하는 방식이 아닌 자동 registration방법 입니다.

상이한 modality의 데이터 정합



MRI Data와 PET Data를 fusion한 모습. 해부학적인 정보를 잘 나타내는 MRI 영상과 인체의 이상 및 전이도를 잘 보여주는 PET 영상을 fusion함으로써 영상의 질과 진단율을 향상합니다



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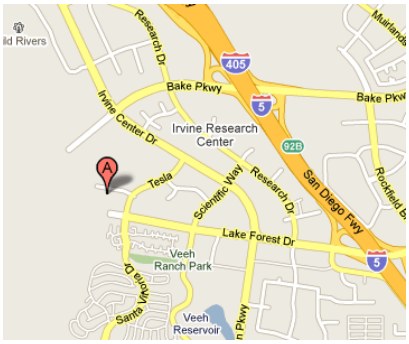

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