UTS:CAS
CENTRE FOR AUTONOMOUS SYSTEMS

Winter School Project 5

Direct 3D Ultrasound Fusion for Transesophageal Echocardiography

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Problem description: Real-time three-dimensional transesophageal echocardiography (3D TEE) has been increasingly used in the clinic for fast 3D analysis of cardiac anatomy and function. However, 3D TEE still suffers from the limited field of view (FoV). It is challenging to adopt conventional feature-based methods to 3D TEE images because they tend to fail in the ultrasound scenario.

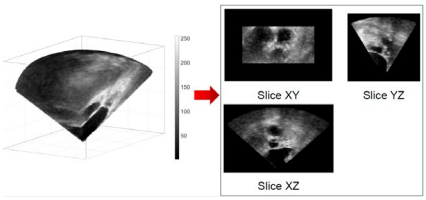

Fig. 1

Purpose: In this project, participants will learn to use techniques such as intensity-based image registration and fusion to extend the FoV of 3D TEE in a single frame in a rigid scenario.

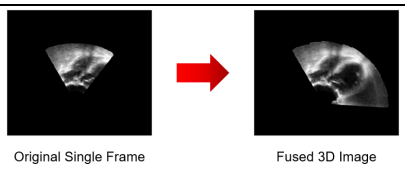

Fig. 2

Project step: The participants will be asked to complete the following exploration steps based on the provided materials (ECG-gated 3D TEE data*, designated software, codes, etc.)

- Image registration (intensity-based methods):
  In this step, participants will implement an intensity-based image registration algorithm or use designated software-3D Slicer to estimate transformation matrices (relative poses) between image frames. A part of codes are available in this repository.

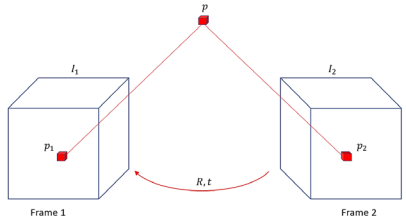

Fig. 3

- Image Fusion:
  In this step, participants can choose any methods to composite the aligned images. An easiest method is to average the intensity of images. The image averaging code *ImageAverage.m* is available in this repository.

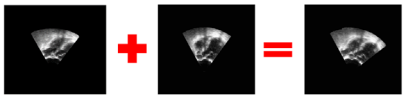
Fig. 4

- Panoramic image reconstruction:
  In this step, participants will learn to use a sequential strategy to register and fuse a sequence of 3D TEE images. In the end, a panoramic image with a larger FoV than the original single volume will be reconstructed.

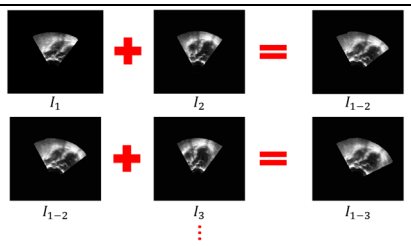

Fig. 5

- Evaluation:
  In this step, participants can use some estimation metrics such as Hausdorff distance (HD) which are available in MeshLab to evaluate the accuracy of the registration.

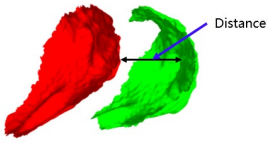

Fig. 6

Main reference: Mao, Z., Zhao, L., Huang, S., Fan, Y., & Lee, A. P. W. (2021). Direct 3D Ultrasound Fusion for Transesophageal Echocardiography. *Computers in Biology and Medicine*, 104502. https://doi.org/10.1016/j.compbiomed.2021.104502

* All participants must keep the clinical data confidential, you cannot publish, copy, sell, rent, transfer, promulgate, let out, disclose, or reveal the confidential datasets.