

# Augmented Reality-Guided Transcatheter Septal Puncture in Structural Heart Disease Interventions



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## INTRODUCTION

 Transcatheter septal puncture is an important procedure for the success of leftsided structural heart interventions, including left atrial appendage occlusion devices, transcatheter mitral valve repair therapy and pulmonary vein isolation.

#### 2D X-ray Guidance for Septal Puncture



#### Various Puncture Sites



### Catheter Segmentation using Deep Learning Algorithm (U-Net)

RESULTS



copied over to upsampling.





RAO, Right anterior oblique view; LAO, Left anterior oblique view.

- Transcatheter septal puncture remains a difficult procedure that is burdened by rare but serious complications.
  - Cardiac Tamponade (0.7%)
  - Aortic puncture (1.1%)
  - Arterial thromboembolism
     (3.2%)
  - Pericarditis
  - Death

RA, Right atrium; LA, Left atrium; FO, Fossa ovalis.



 Enhanced visualization technologies may improve procedural accuracy and reduce complications. Here we demonstrate an augmented reality guidance system for a transcatheter septal puncture procedure. U-Net is a modified from fully convolutional network (FCN) in a way where segmentation of medical imaging is more accurate.
3 Components: Downsampling, Bottleneck and Upsampling
U-Net essentially doubles the feature channels during each convolution during downsampling, and upsamples back to a segmented image. The correlations from the feature channels are

**2D X-ray Fluoroscopy** 

**Catheter and Fiduciary** 

**Markers Segmentation** 

**3D Coordinates** 

Calculation



U-Net Model Accuracy



Calculation of 3D Coordinates







2.5 5.0 7.5 10.0 12.5 15.0 17.5 Export as Catheter.csv, epoch Marker.csv

Catheter Position Accuracy Test by Electromagnetic (EM) Tracking System



AR Visualization of Transcatheter Septal Puncture Procedure



# METHODS

#### Patient-Specific 3D-Printed Heart Model

Computed Tomography (CT) images are processed for 3D reconstruction







3D-printed phantom heart model for X-ray fluoroscopy







2D-3D Co-Registration for Augmented Reality (AR) Visualization







HoloLens



## CONCLUSION

 We developed a fully interactive method to guide cardiac interventions based on pre-procedural and intra-procedural imaging with an advanced holographic system and deep learning algorithm.

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