

Generalizable detection of cardiac implantable devices using a hybrid transformer and convolutional neural network framework.

Maahin Manzoor Khan, MBBS¹; Ali Raza²; Faiq Ahmad²; Meeshaim Manzoor²; Armaghan-e-Rehman Mansoor, MD³

¹Shifa International Hospital, Islamabad; ²FAST NUCES, Faisalabad; ³Division of Infectious Diseases, Department of Internal Medicine, Univ. of Kentucky;



BACKGROUND

- Cardiac implantable electronic devices (CIED) such as pacemakers and defibrillators, are essential components of advanced cardiac care, but their identification can be difficult when image quality or source varies.
- Advanced segmentation models that adapt across variable quality images offer a practical solution for real-world clinical use, especially in low-resource settings

METHODS

- We used the credentialed-access PhysioNet dataset containing 1396 photographed radiographic images of CIEDs.
- A hybrid pipeline consisting of DINOv3 and a convolutional neural network was utilized as our foundation model, with parameter adjustments to enhance the detection and classification of devices captured through non-homogenous smartphone cameras.

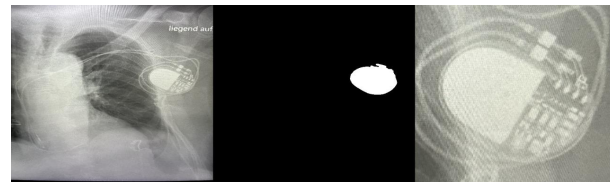


Figure 1: Cropped DICOM image showing the cardiac implantable electronic device with segmentation mask generated.

RESULTS

- The segmentation tool achieved a Mean Dice Coefficient of 0.9386 (IQR: 0.9425–0.9490).
- The hybrid pipeline had an accuracy of 93.81% (95% CI: 90.5%, 96.7%) for CIED manufacturer classification and 75.82% (95% CI: 69.04%, 82.60%) for CIED model classification.
- With the integration of hierarchical reasoning classification, the model achieved an improved accuracy of 84.24% (95% CI: 78.6%, 89.89%) for CIED model classification

CONCLUSIONS

- Our advanced hybrid model demonstrated high accuracy in detection and classification of CIEDs on low quality smartphone captured photos of existing radiographs, while utilizing significantly lower resources than existing models. Our work has significant implications in rapid CIED identification, especially in low-resource or out-of-hospital settings.

Contact:
Maahin Manzoor Khan, MBBS
Mahin.manzoor@gmail.com

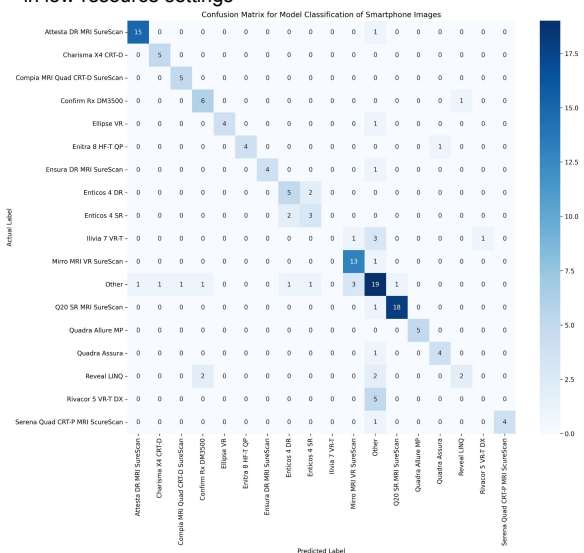


Figure 2a: Confusion matrix for manufacturer classification cardiac implantable electronic devices

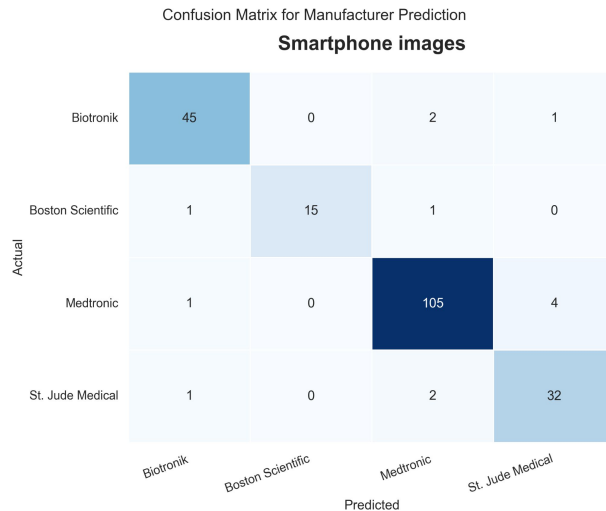


Figure 2b: Confusion matrix for model classification for the cardiac implantable electronic devices.