Iowa Initiative for Artificial Intelligence

Final Report

Project title:	Selecting a Patient Population for a Retrospective Study Using Image Features: An Automated Patient Selection Technique for Navigating Large CT Image Sets
Principal Investigator:	Paul A DiCamillo, Punam Saha, Indranil Guha, Kenjirou Ohashi, D. Lee Bennett
Prepared by (IIAI):	Yanan Liu
Other investigators:	
Date:	

Were specific aims fulfilled:	Y
Readiness for extramural proposal?	Yes
If yes … Planned submission date	Fall 2025
Funding agency	NIH
Grant mechanism	
If no … Why not? What went wrong?	

Brief summary of accomplished results:

We developed and validated a VGG-16 model to automatically detect hardware failure on X-ray projection images with accuracy equals 0.94 per image and 0.92 per patient.

Research report:

Aims (provided by PI):

1) To create an efficient, high throughput pipeline whereby images from the PACS can be pre-selected, anonymized, transferred and ported into a HIPAA compliant supercomputing system.
2) Prepare an augmented training dataset of pairs (versus triplets versus quadruplets) of orthogonal 2D projections of foot and ankle CT scans with knowledge of metal, casting, micro fracture, macro fracture, and kernel; documenting reason for exclusion or verifying legitimate inclusion.
3) Develop a supervised U-Net based classifier to detect metal, casting, micro fracture, macro fracture, and kernel, inclusion criteria in foot and ankle CT scans.
4) Evaluate the performance of the U-Net classifier on a test dataset.

Data:

A set of 3D CT scans of the ankles or foot from 229 patients were collected. Two-dimensional projections of CT data were rendered. Thereby, each 3D CT scan can be used to generate 10-30 projection data sets. In addition, Maximum Intensity Projection (MIP) were generated for each projection. They were classified into normal group (168 patients) and hardware failure group (61 patients).

AI/ML Approach:

In this study, a VGG-16 model was implemented for image classification. Training/validation split was 80/20 (4410/1125 images).

Experimental methods, validation approach:

Data Preparation

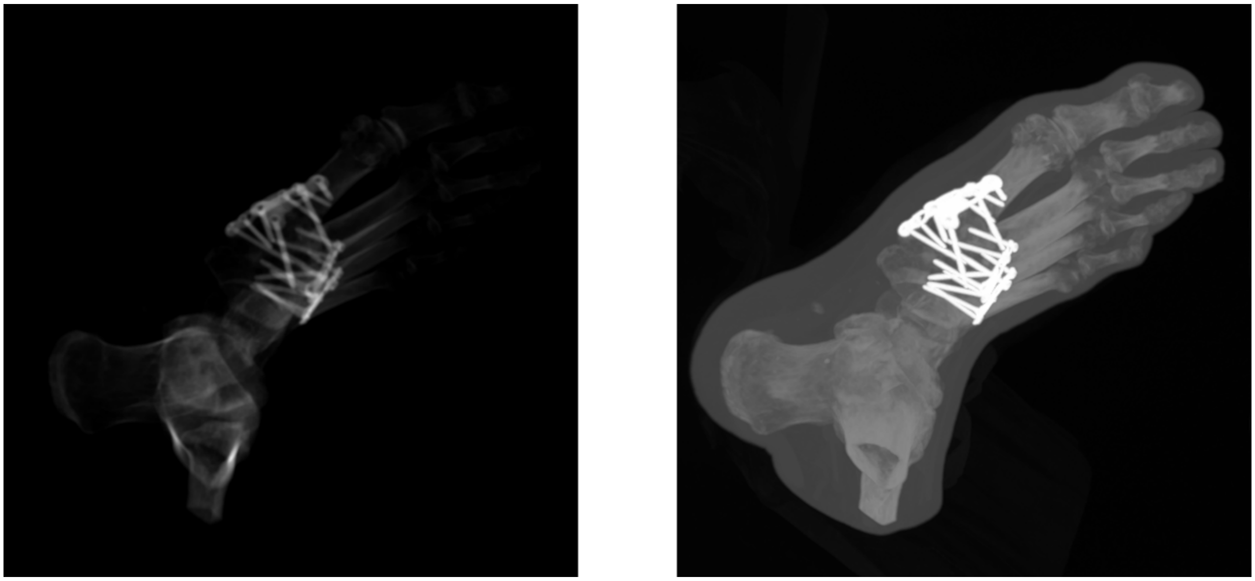
Data preparation or pre-processing is an essential step in any machine learning study. In order to save computation time, we resized the image to [224,224]. In this project, data normalization is an important step which ensures that each input parameter (pixel) has a similar data distribution. This makes convergence faster while training the model. We normalized the image intensity to [0,1] by its maximum and minimum values for CT projections. For MIP image, we normalized the image intensity based on its intensity range 1024-4095. The input image was combined 2 CT projects with different threshold and MIP images.

Image classification

The VGG-16 is one of the most popular pre-trained models for image classification -- see Figure 3.

(a) (b)

Figure 1. Input Example without hardware. (a) CT projection (b) MIP projection



(a) (b)

Figure 2. Input Example with hardware. (a) CT projection (b) MIP projection

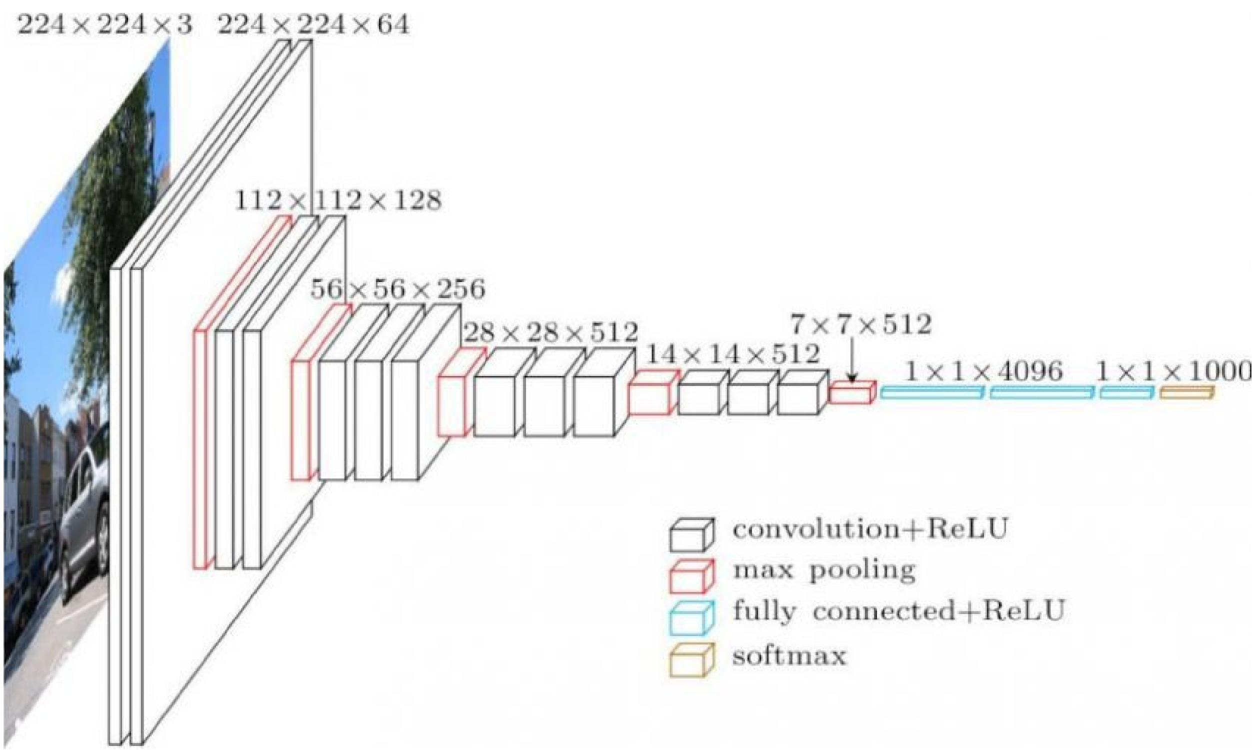


Figure 3. VGG16 architecture [1]

Results:

We developed and validated a VGG-16 model to automatically detect hardware failure on X-ray projection images with accuracy equals 0.94 per image and 0.92 per patient.

Table 1. Confusion matrix per image

Per image	**Predicted No hardware**	**Predicted hardware**
No Hardware	780	30
Hardware	41	274

Table 2. Confusion matrix per patient

Per object	**Predicted No hardware**	**Predicted hardware**
No Hardware	16	1
Hardware	1	17

References:

1. K. Simonyan and A. Zisserman, “Very Deep Convolutional Networks for Large-Scale Image Recognition,” ILSVRC, 2014