

# Utilizing Deep Learning to Predict the Number of Panicles in Wheat (*Triticum aestivum*)

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# Potential Yield Predictor

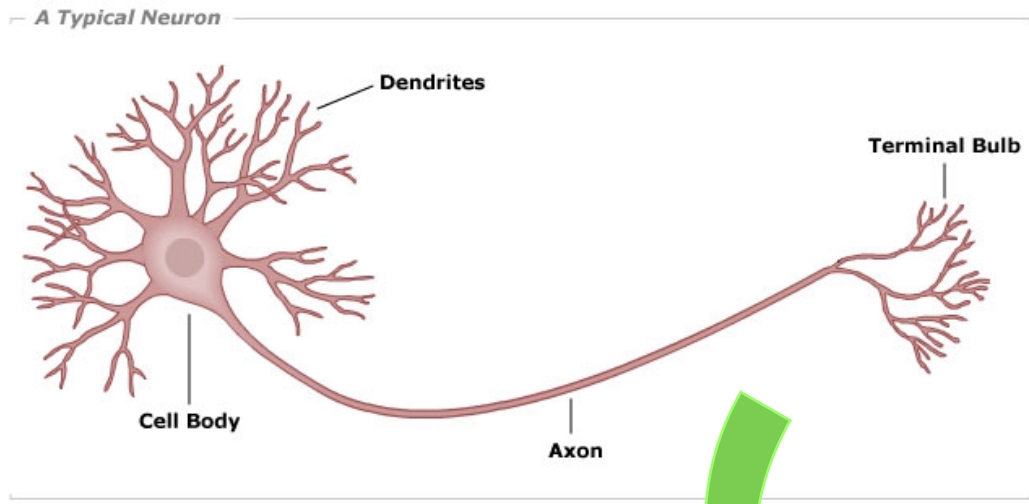
- An early predictor of wheat yield is the number of panicles in a given area (Reynolds et al., 1996).
- The number of panicles in a plot is not measured in current wheat breeding programs
  - Inaccuracy
  - Laborious
  - Time consuming
  - Expensive



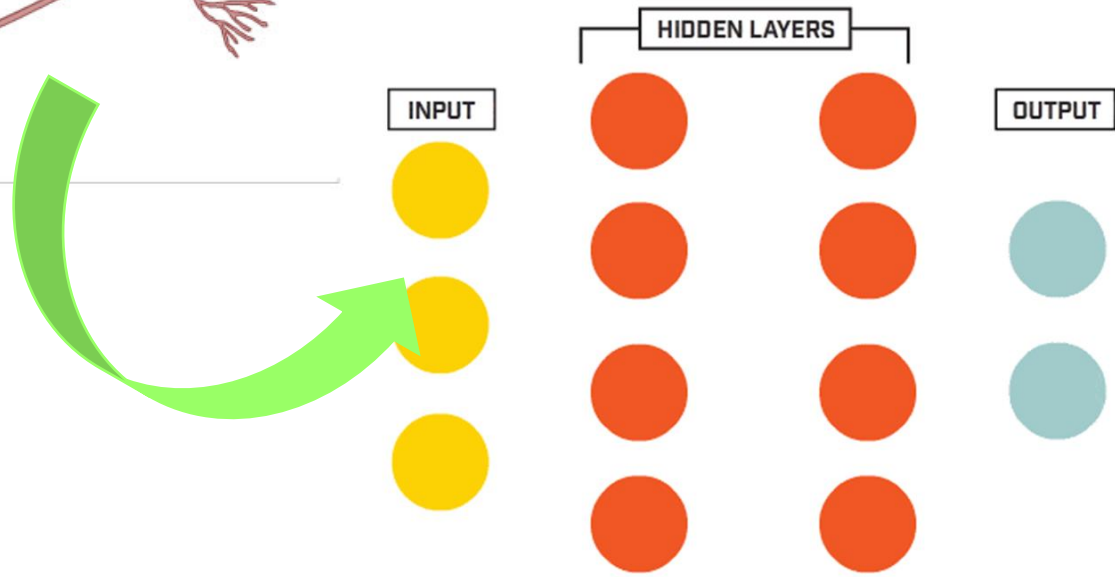
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# Deep Learning

## Human Neuron



## Deep Learning Model

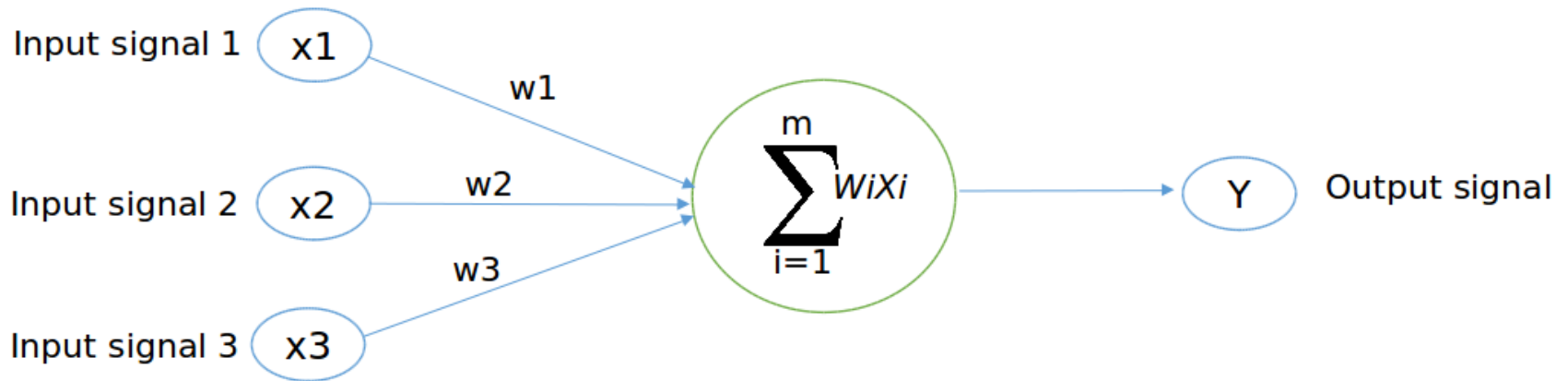


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# Deep Learning Model

- Learns data representations
- classifying images based on the most efficient feature extracted from that image.
- Requirements:
  - Input image
  - Broken down within the hidden layers of the network.
  - Hidden layers of the network identify the most efficient feature to extract from that image
  - Output is a classification of your input.



- **Training Data Set:** is a dataset used to train a model.
- In training the model, specific features are picked out from the training set. These features are then incorporated into the model
- **Epoch:** the amount of times you run the training data set through the model
- **Testing Data Set:** smaller proportion of the data, used to validate your model

# Field Ground-Truthing

- Study took place at Kernen Crop Research Farm, University of Saskatchewan in 2017.
- The total number of panicles were counted in 20 random plots from a *Triticum aestivum* breeding trial.
- Plots chosen included awned and awnless varieties.





# Image Acquisition

- Images were gathered using the **Pheno-Quad**
- Gator with wooden platform mounted in box
- Stabilized on platform is a wooden, moveable arm.
- Wooden arm reaches 144in out from the gator.
- Canon T4i mounted on the end of the wooden arm and is wired back to a shutter switch in the gator.



- GPS receiver (Canon GP-E2) attached to the camera
- Platform fits in pathways of trial
- Gator is drove at a constant 5mph speed
- Images were captured at 1/2000 shutter speed and 400 IOS.
- Two passes per plot required for sufficient overlapping of images
- Increased resolution allows us to see wheat spikes





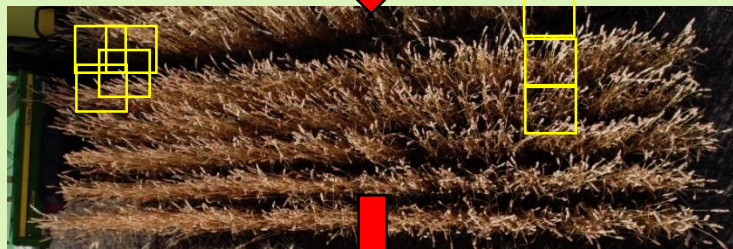
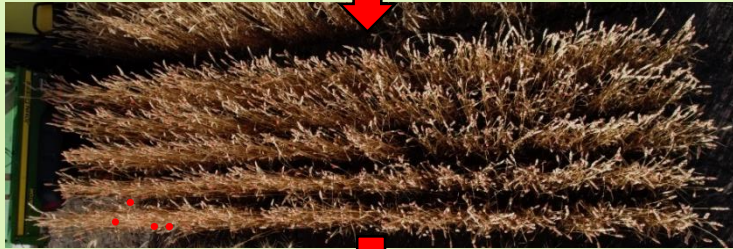
# Pheno-Quad Images





# Image Processing

- Pheno-Quad images that showed zenith view of in-field counted plots
- Segmentation of desired plots and annotation of visible wheat heads
- A CNN was chosen as the deep learning models.
- Networks trained with randomly cropped 224x224 patches from the high-resolution images
- Counts are aggregated over the 224x224 tiles in the test phase.
- Summation of wheat head counts to give final per plot wheat head counts



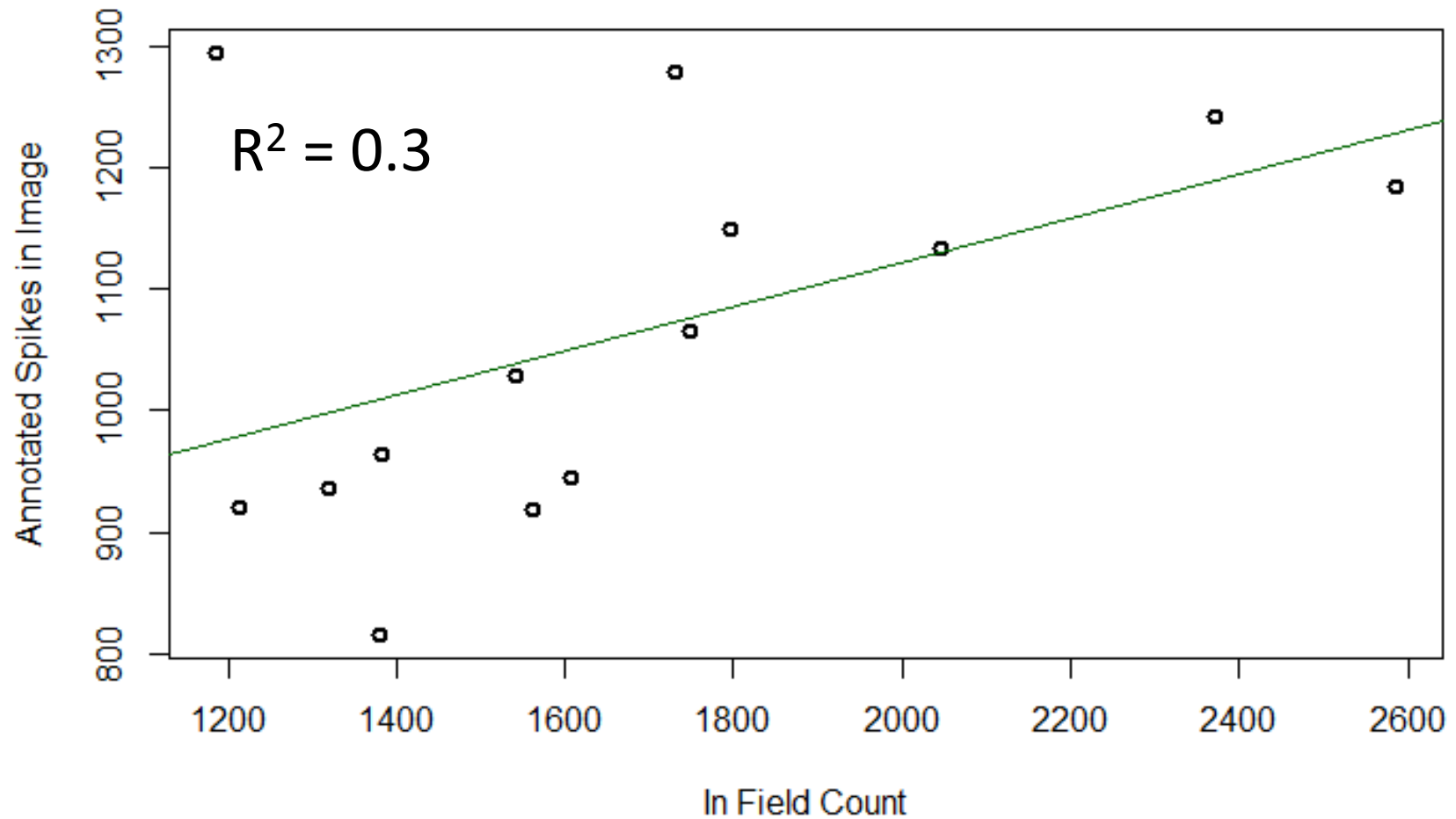
15 34  
9 17

$\Sigma$

Final Per Plot Count

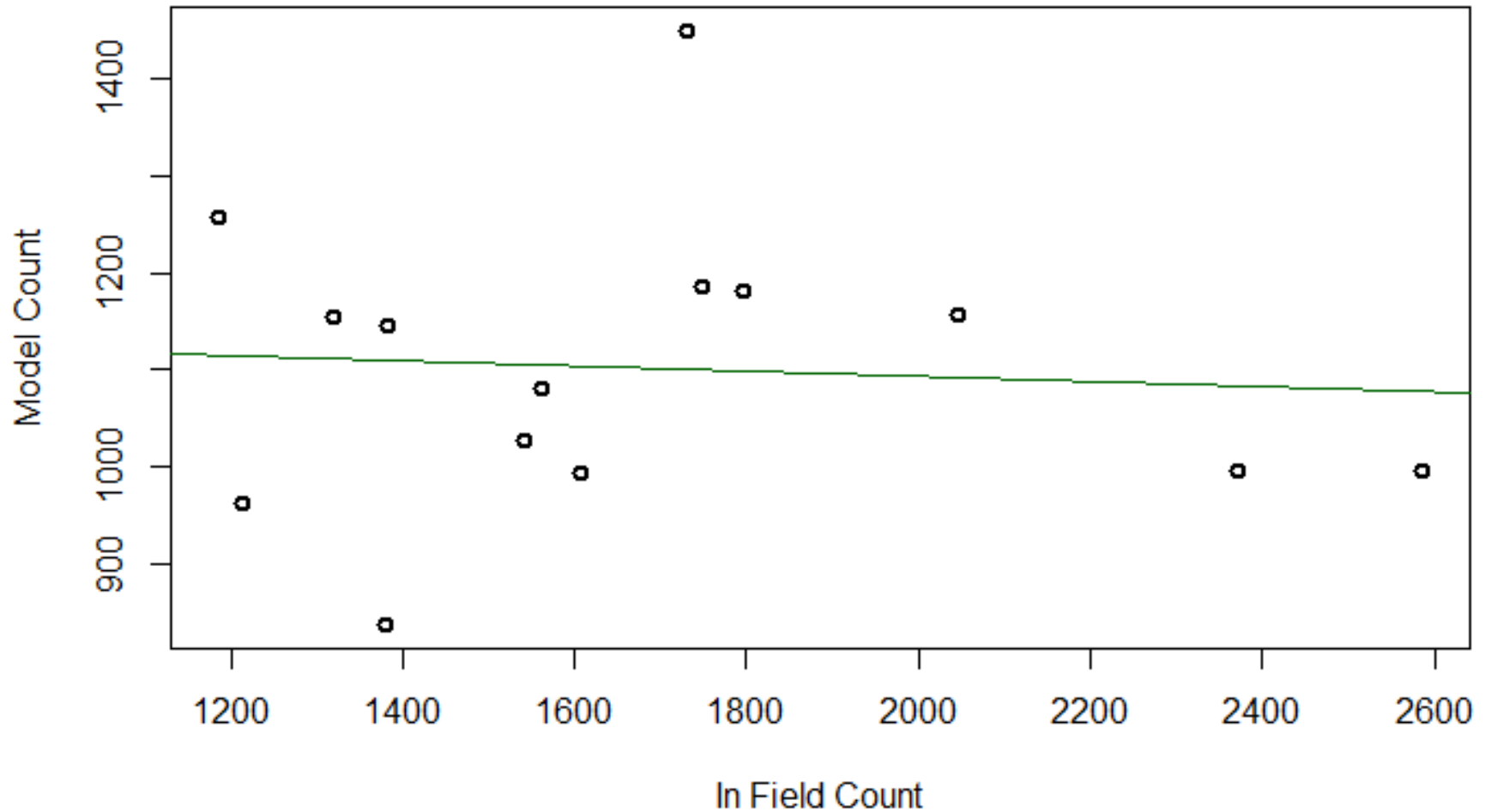
# Preliminary Results

**In Field Count vs. Annotated Spikes in Image**

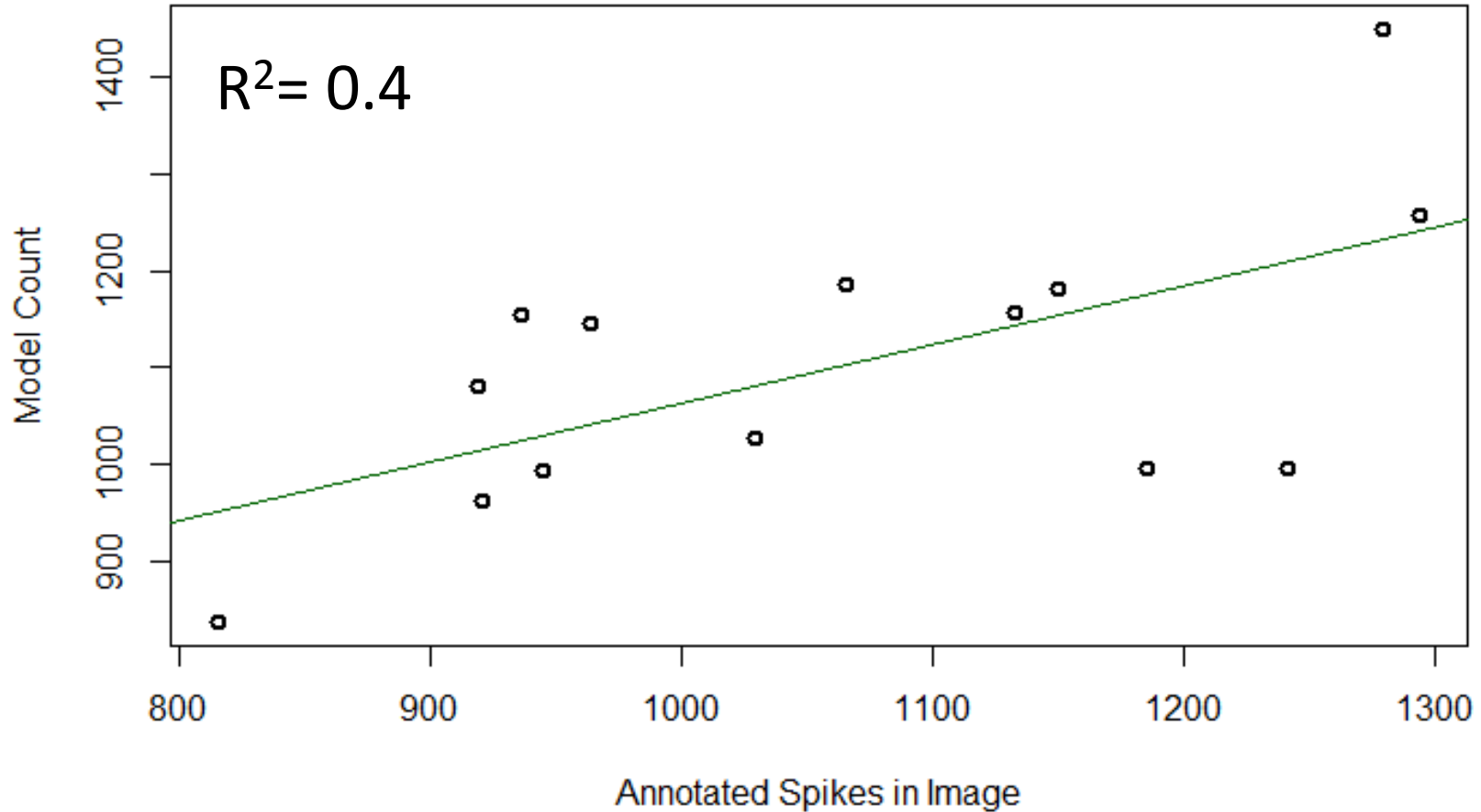


# Preliminary Results

**In Field Count vs. Model 1 Count**



## Annotated Spikes in Image vs. Model 1 Spike Count



**Model 1**

Overestimate (%)

11.43

Underestimate (%)

11.43

Deviation (%)

19.24



# Conclusion

- We believe that relationship between identified spikes in the images and the model spike counts will increase with a larger data set and continued adjustments of parameters.
- The non-significant relationship between in-field counts and annotated panicles is due to the large amount of occlusion present. Tillers would have produced spikes that are not visible from the top of the canopy
- Research is continuing in parameter adjustments of both models as well as identifying more suitable image acquisition techniques.

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Dr. Curtis Pozniak  
Advisory Committee: Dr. Tim Sharbel (chair)  
Dr. Mark Eramian  
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