Image Recognition of Arthroscopic Surgery

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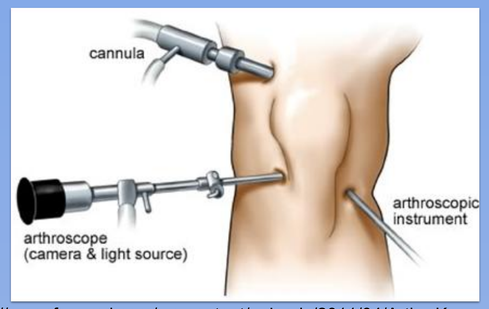
ArthroScout
Eyes of the Surgeon

Background / Overview

An arthroscopy or "keyhole surgery" is a minimally invasive surgical procedure that enables a surgeon to examine and treat a joint by inserting an arthroscope, a pencil-sized instrument equipped with a miniature camera. Worldwide, over 2 million arthroscopy videos are recorded annually. Our goal is to lessen the workload of the surgeons by assisting their task of video summarization/annotation of arthroscopic video feeds.



http://amonferrymd.com/wp-content/uploads/2011/04/ArthroKnee.png

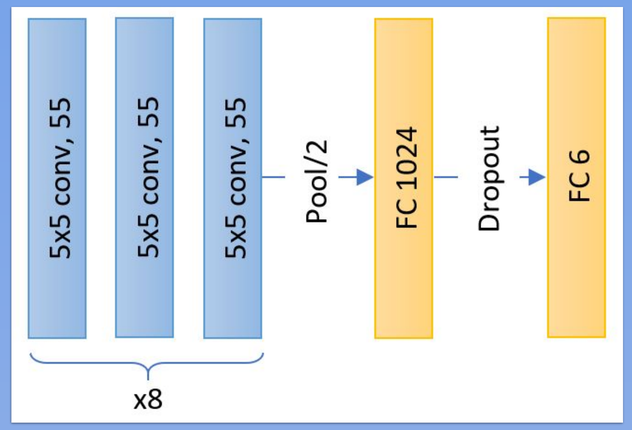
Arthroscout is a tool classification software that utilizes image processing and machine learning methods (specifically convolutional neural networks or CNNs) to detect and classify the types of tools used in the arthroscopic surgery.

Dataset

- 3 data sets: 360,000 training, 6,000 validation, and 1,200 testing images
- 5 image augmentations: brightness, contrast, jpeg compression, motion blur, and color transfer

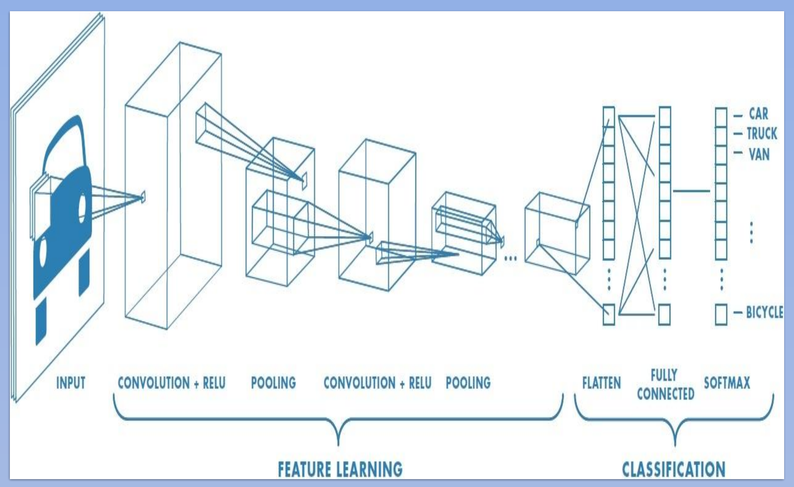
Classes from left to right: Heat Wand, Basket Biter, Suture (top)
Probe, Shaver, and No Tool (bottom)

CNN Architecture



24-Convolutional Layer Network Architecture:

- Batch normalization after each convolutional layer
- Average pooling at every 3 convolutional layers
- Xavier Initialization
- 1.97M trainable parameters
- Residual blocks



https://la.mathworks.com/solutions/deep-learning/convolutional-neural-network.html

General CNN structure:

- Convolution + ReLu extract image features
- Pooling expands receptive fields
- Fully Connected layer classifies image
- Softmax returns classification probabilities

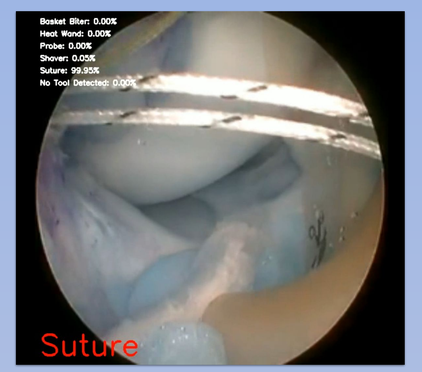
Test Accuracy

Class	Accuracy
Basket Biter	0.780
Heat Wand	0.810
Probe	0.940
Shaver	0.755
Suture	0.875
No Tool	0.955
Average Accuracy: 0.853	

Timing Analysis:

- 29.73 frames per second
- Near Real-Time

Results



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