# Real-Time Tool Detection in Arthroscopic Surgery

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AutoScribe

Background

Arthroscopic surgery is a minimally invasive procedure, increasingly preferred by medical professionals and patients due to its advantages over traditional open surgery. During arthroscopy, the surgeon makes 3 small incisions into a joint, inserting surgical tools and a tiny camera. The camera displays the inside of the joint on an external monitor as well as records the procedure, which is later annotated by surgeons for diagnosis, patient debriefing, and training future medical professionals.
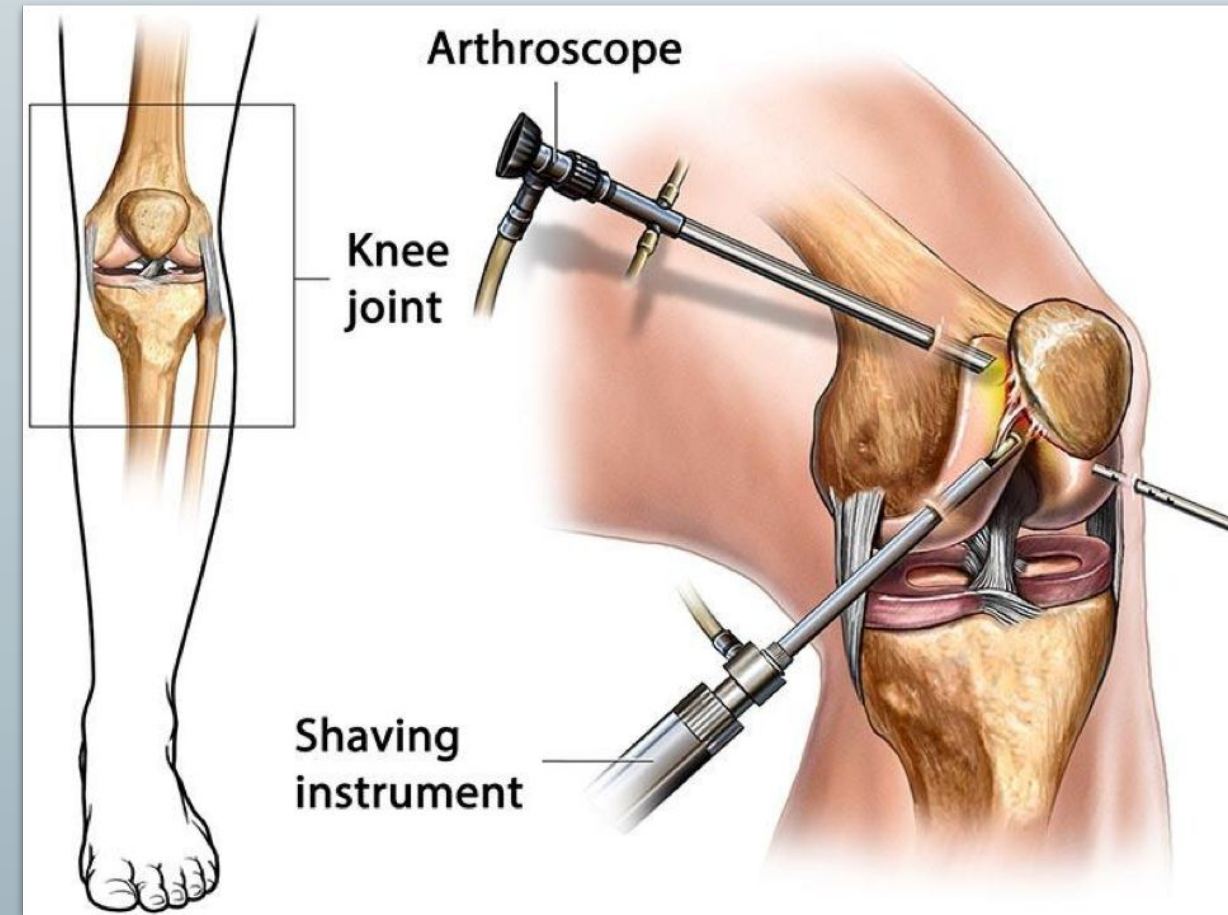
Arthrex AutoScribe Overview

- Implements a convolutional neural network (CNN), a machine learning algorithm that detects which tool is being used and labels the video accordingly
- Deployed onto a small embedded platform that integrates into the Arthrex Surgical Drawer, enabling real-time processing using artificial intelligence
- Leverages data taken from an artificial knee, proving a relationship between artificial and real data, opening the door to more accessible data in surgical machine learning

Functional Flow Diagram
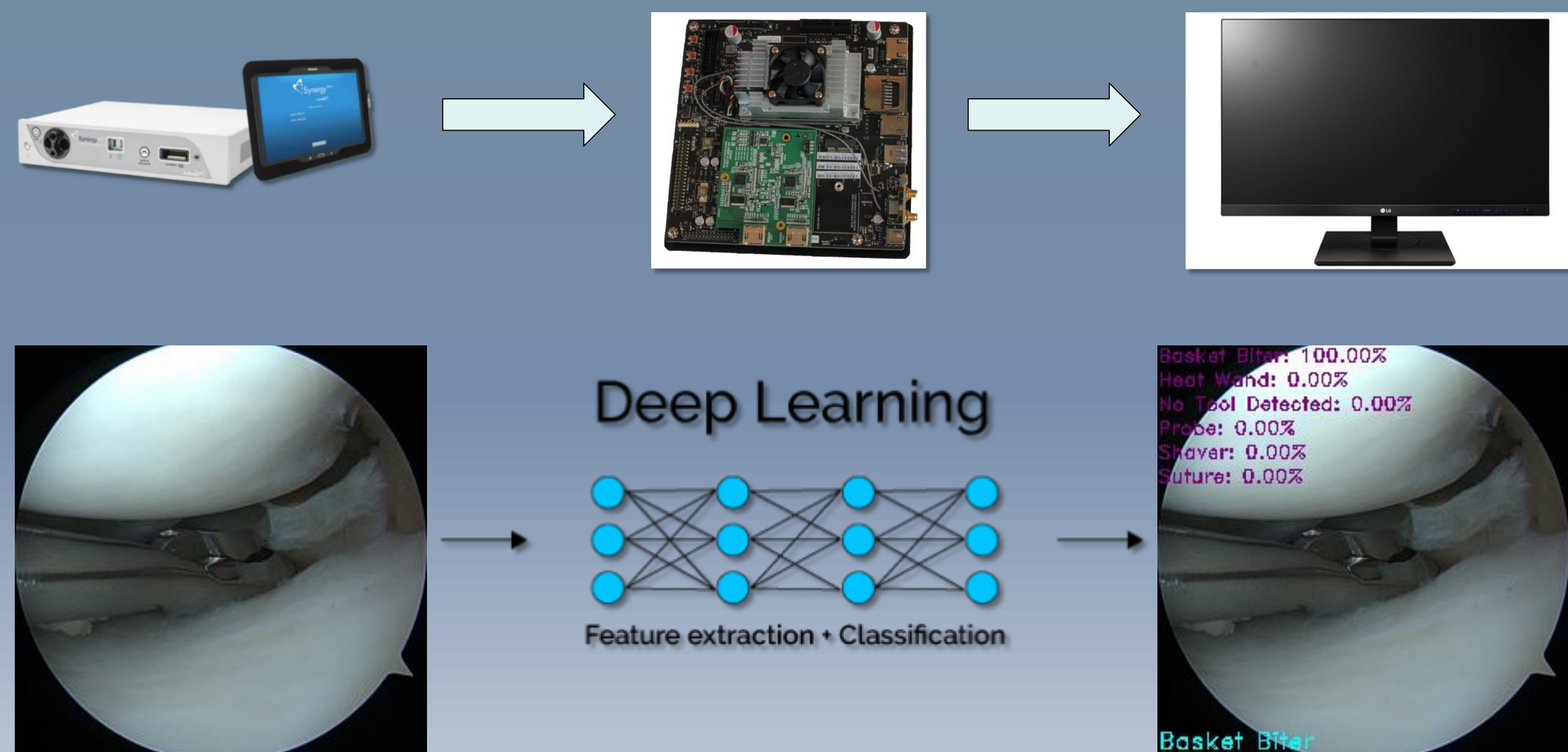
- Hardware (top) flow diagram consists of the Arthrex Surgical Drawer, Jetson TX2 and an external monitor
- Software (bottom) flow diagram has the raw images that are processed and labeled by our machine learning tool
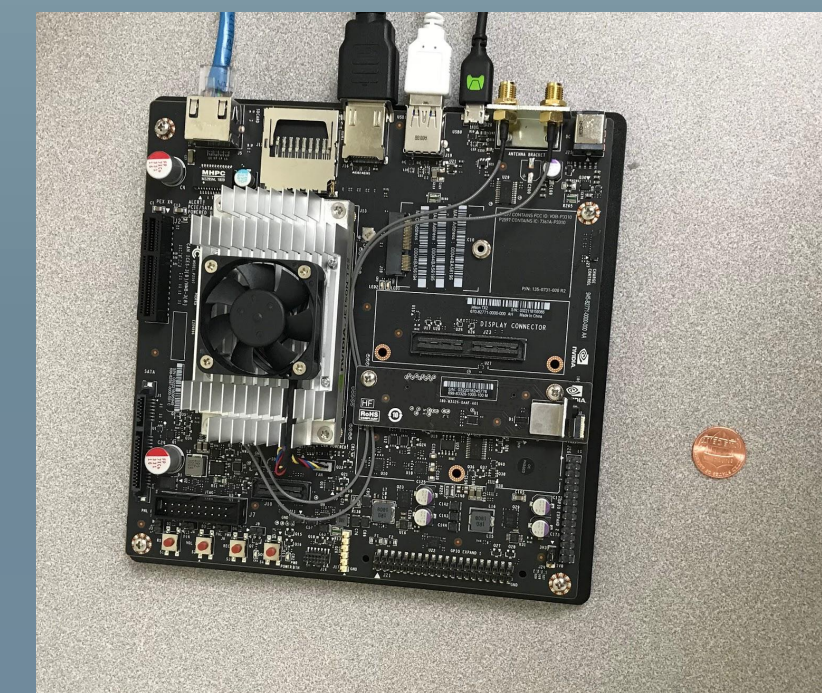
The Tools

- Classes from left to right: Heat Wand, Basket Biter, Suture (Top) Probe, Shaver, No Tool (Bottom)
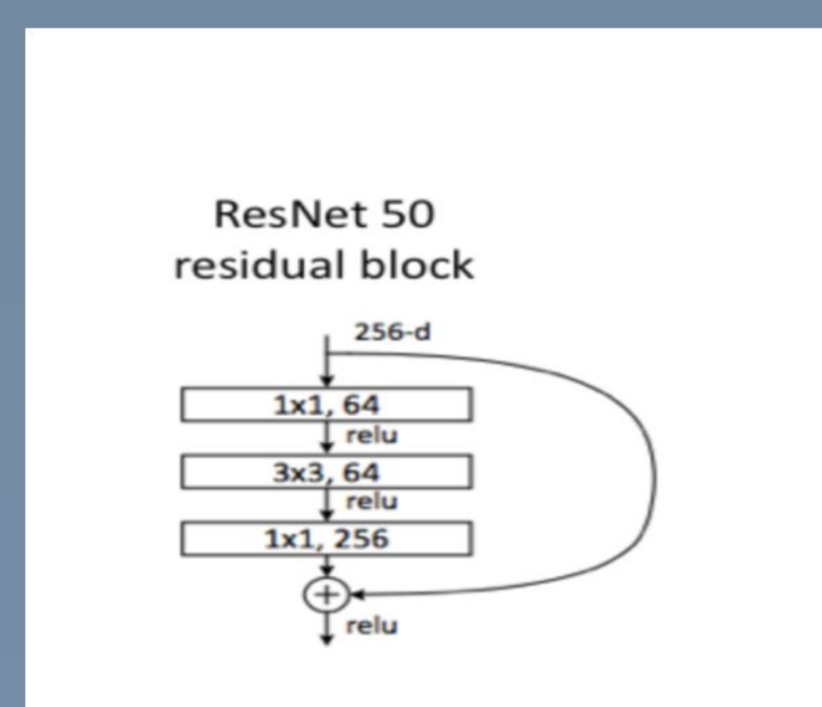
## Key Components

Jetson TX2
Jetson TX2 is a small embedded platform with an onboard graphics processing unit, powerful enough to execute trained machine learning models, but small enough to fit in the Arthrex Surgical Drawer

Resnet 50
Resnet 50 is a specific type architecture for a convolutional neural network. We trained this model on surgical data, and implemented it on the Jetson TX2
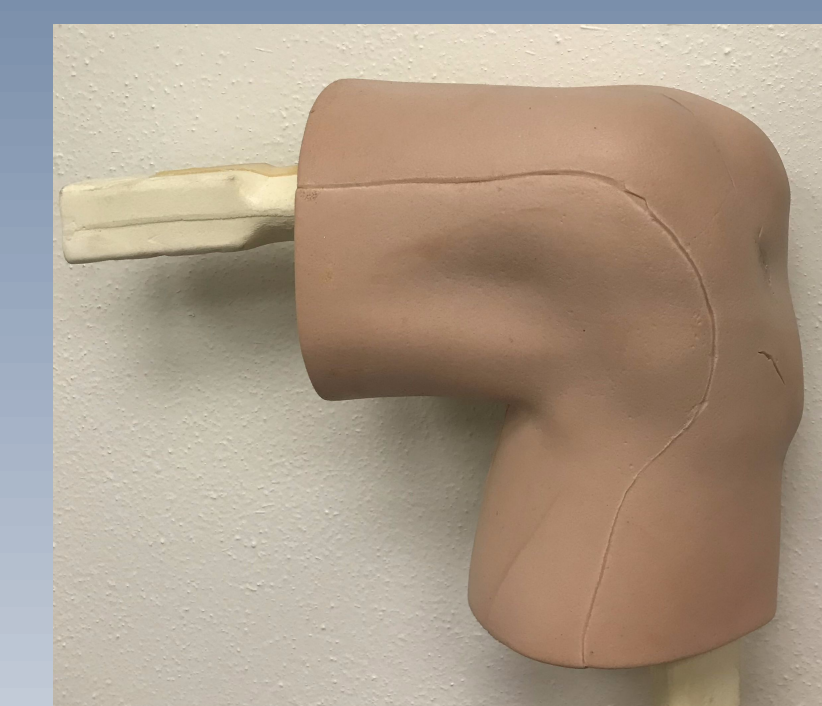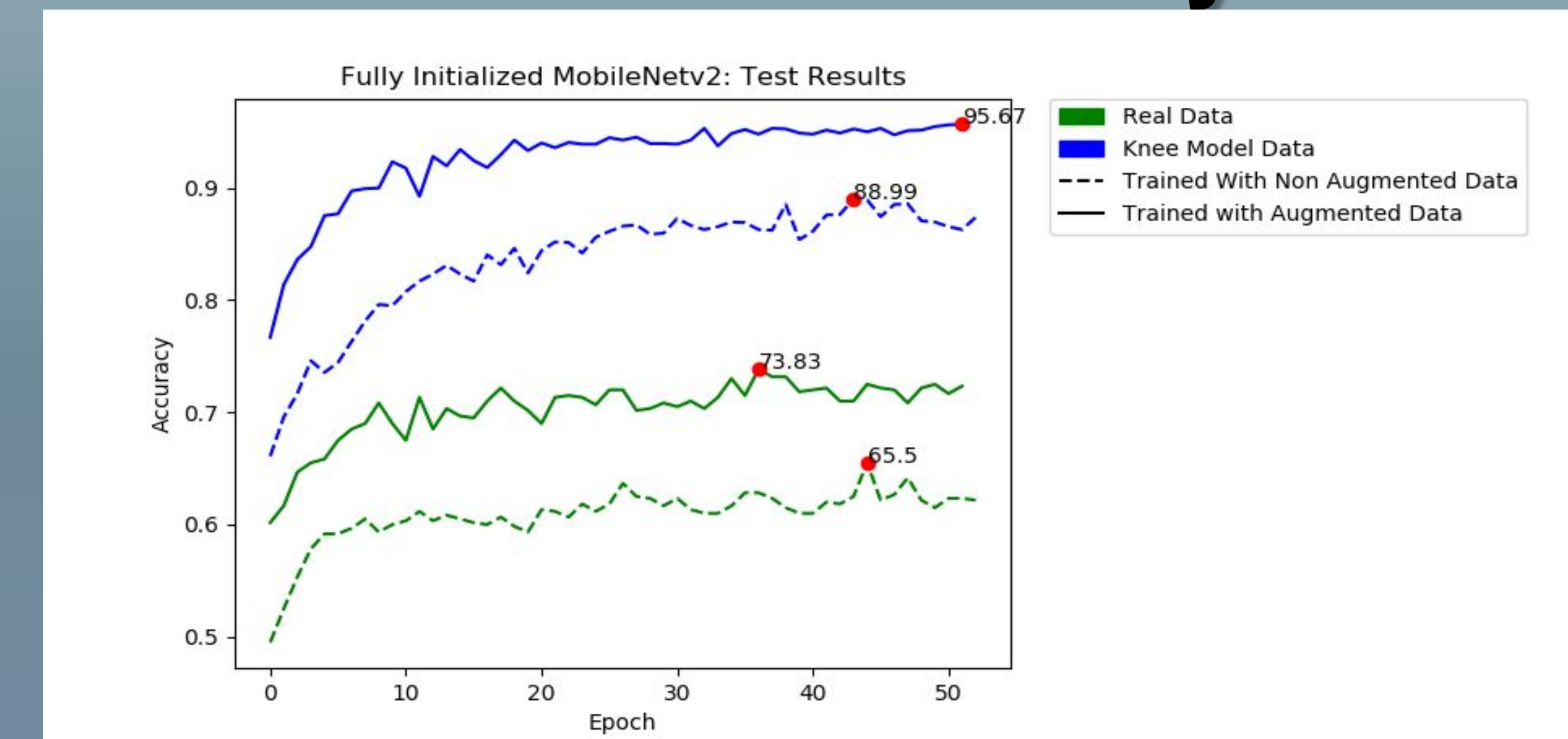
Artificial Knee Data
Using the artificial knee, we created an anatomical model dataset with 3 classes (Basket Biter, No Tool, Probe), establishing correlation between artificial and surgical data through a series of experiments using a MobileNetV2 CNN architecture

Surgical Test Accuracy Results

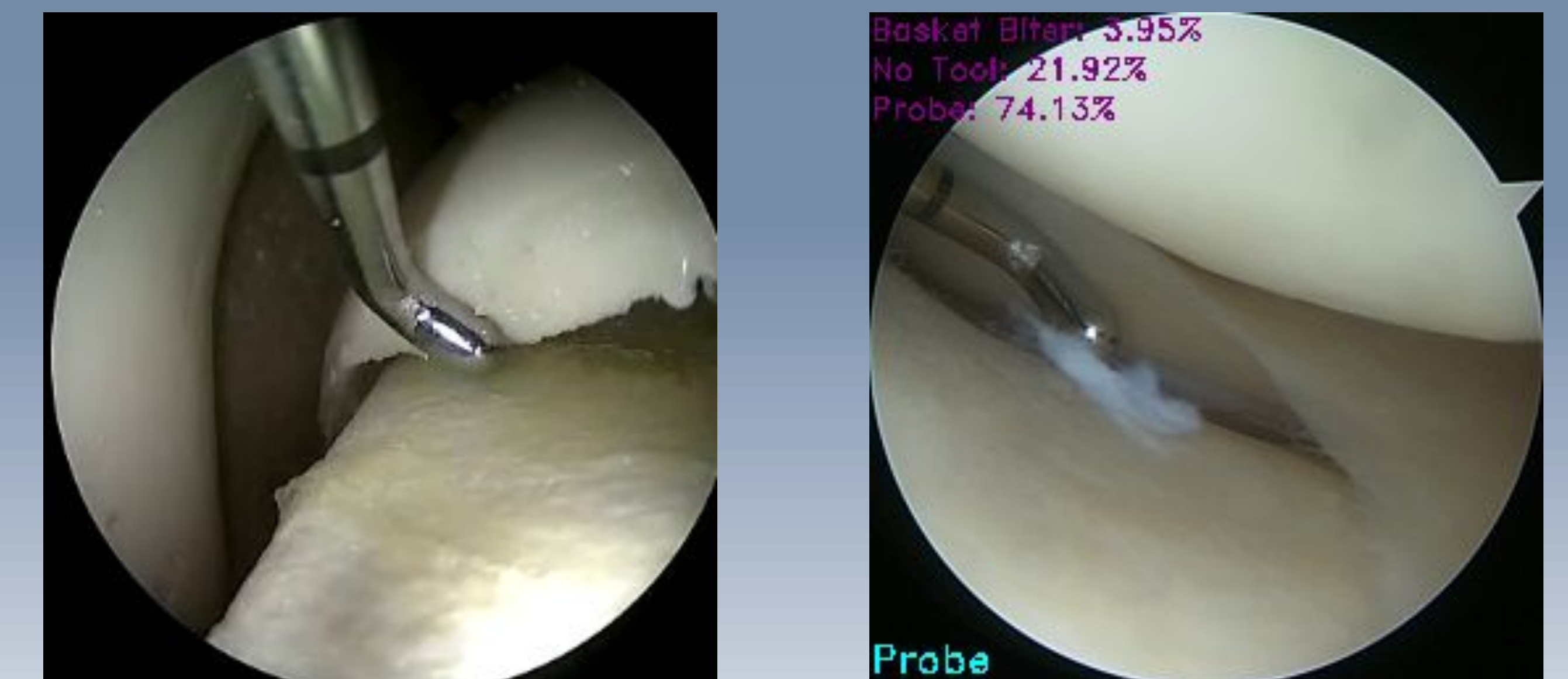| Class	Accuracy (%)
Basket Biter	92
Heat Wand	91.5
Probe	96.5
Shaver	93
Suture	91
No Tool	99
Total Accuracy: 93.83	

- This algorithm runs at 9.74 frames per second on the Jetson TX2

Knee Model Test Accuracy Results

- Results from MobileNetV2 trained with artificial knee data

Results

- On the left is an example of the artificial data that we created with the anatomical knee model and on the right is an example of MobilenetV2 performing on real surgical data

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