Seminar Presentation: Detection and Guidance of K-Wire Placement in Pelvic Trauma Surgery

By Irina Bataeva

Team 9: Irina Bataeva and Kinjal Shah
Mentor: Dr. Ali Uneri
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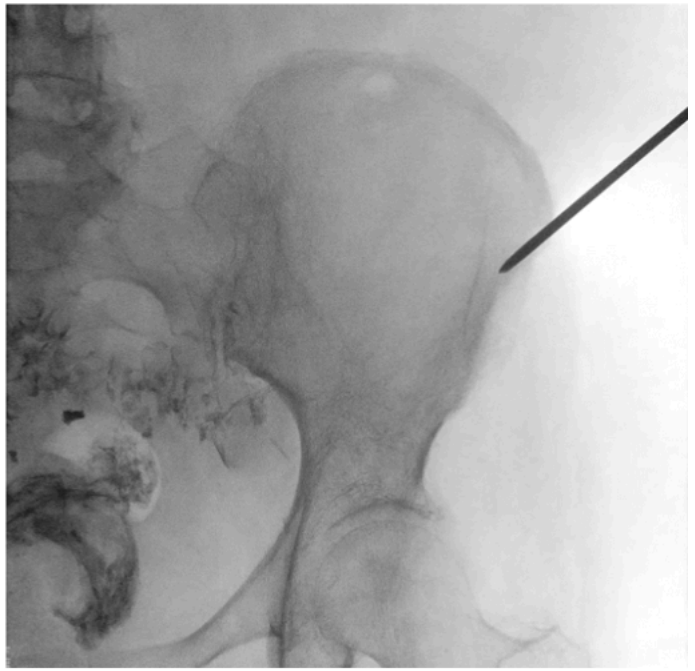
Project Motivation and Goals

Motivation: Improve accuracy of K-wire detection to reduce injury while limiting radiation exposure

Objective: Use deep learning methods to:

(1) Detect K-wires in 2D radiographs of the pelvis

(2) Localize their 3D pose to provide surgical navigation during fracture



J. Goerres, et al."Deformable 3D-2D registration for guiding K-wire placement in pelvic trauma surgery", Proc. SPIE 10135, Medical Imaging 2017: Image-Guided Procedures, Robotic Interventions, and Modeling, 101350A (3 March 2017);

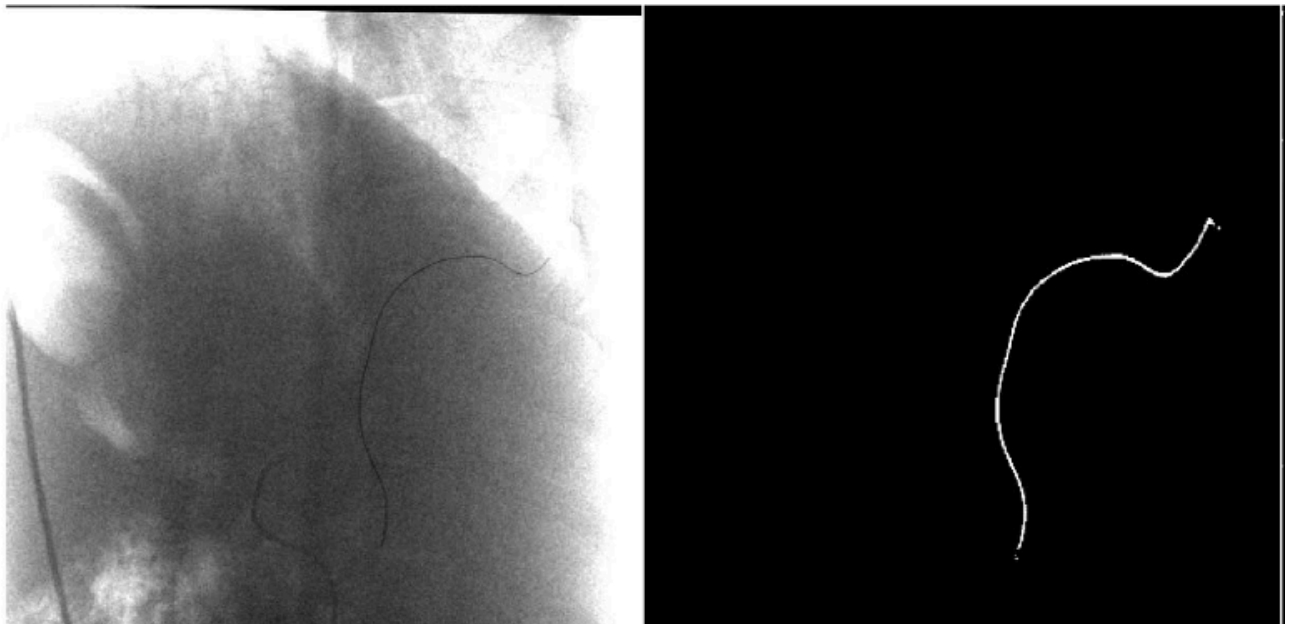
Paper’s Summary

Martin G. Wagner, Paul Laeseke, Michael A. Speidel
"Deep learning based guidewire segmentation in x-ray images ,”
Proc. SPIE 10948, Medical Imaging 2019: Physics of Medical Imaging, 1094844 (1 March 2019); https://doi.org/10.1117/12.2512820

- Creation of a dataset of simulated guidewires on real anatomical X-rays
- Detection of guidewire using deep learning

Paper’s Key Results

- Creation of 90,000+ images for the dataset
- Deep learning performed better than Mask Subtraction



Wagner et al. 2019

Paper Selection Motivation

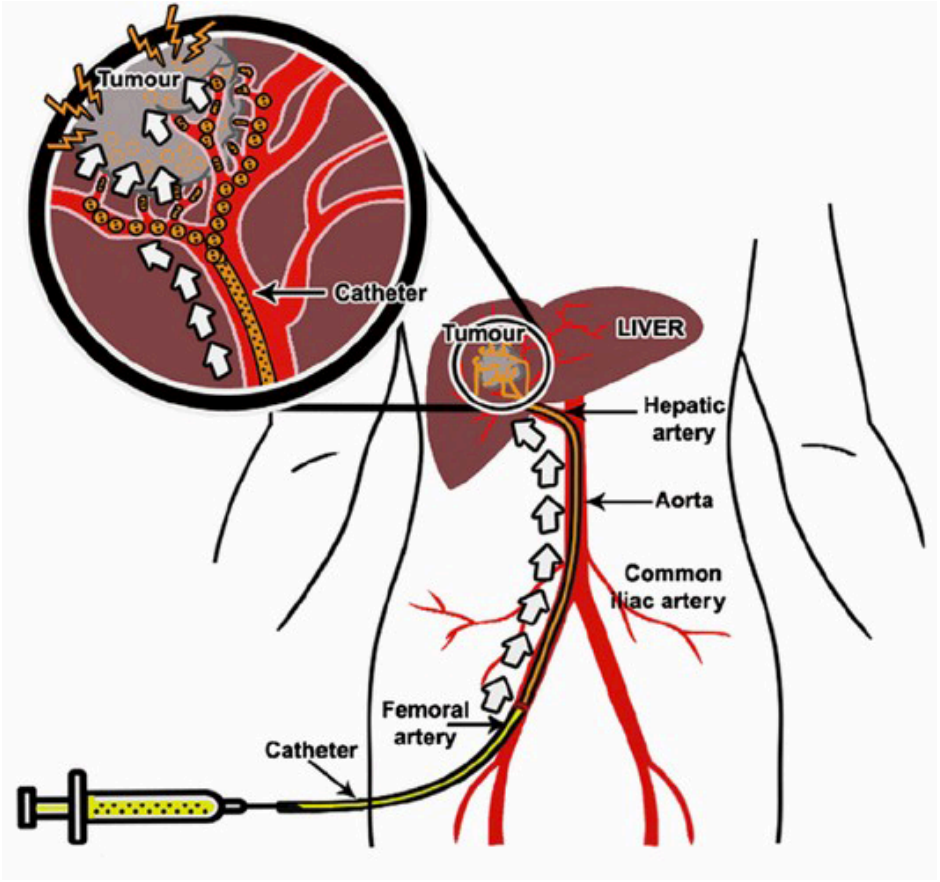
- Similar goal: detection of thin metal objects on radiographs
- Similar methods:
  - **Simulated** devices on the **real X-ray** images
  - Using **deep learning** for pixel-by pixel semantic segmentation of the image
- Recent Study (March 2019)

Background

Liver Embolization:

- Tumor's blood supply comes from hepatic artery
- Injected **microspheres** block blood supply

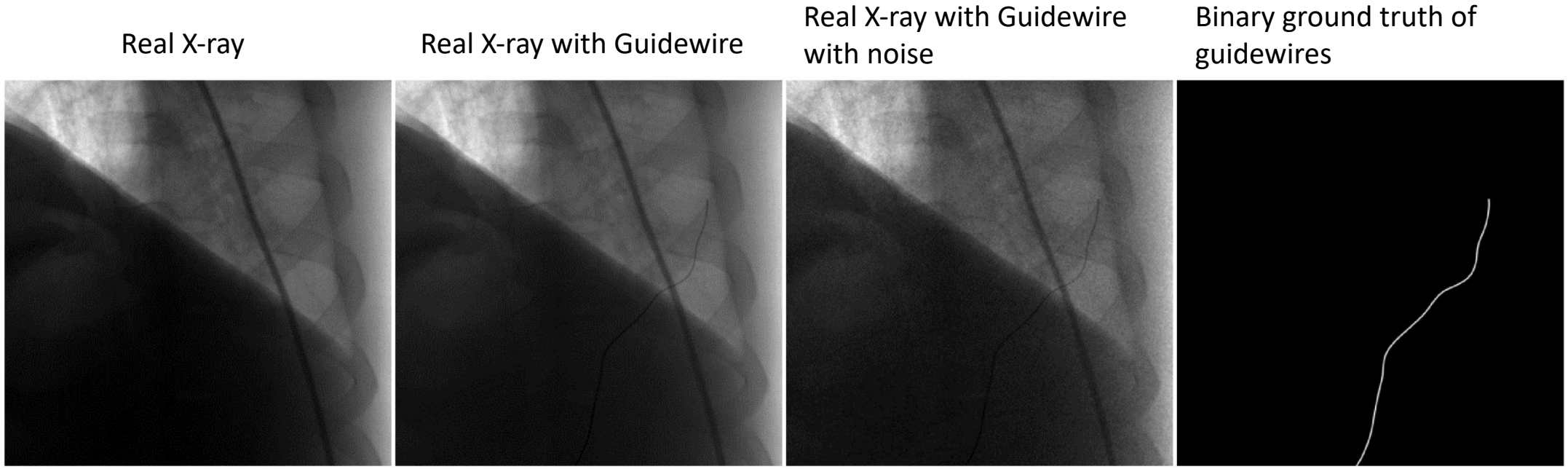
  OR
- Injected **chemotherapy** drugs
- Insertion under fluoroscopy



Yì-Xiáng J. Wáng, Thierry De Baere, Jean-Marc Idée, Sébastien Ballet, **Transcatheter embolization therapy in liver cancer: an update of clinical evidences**
Transcatheter embolization therapy in liver cancer: an update of clinical evidences Vol 27, No 2 (April 2015)

Methods: Dataset

1. 3D Angiography on 10 pigs
2. Image Augmentation: translation, rotation, scaling, noise
3. 32 shapes of guidewires per image: 3D projection and overlaid profile
4. Binary ground truth

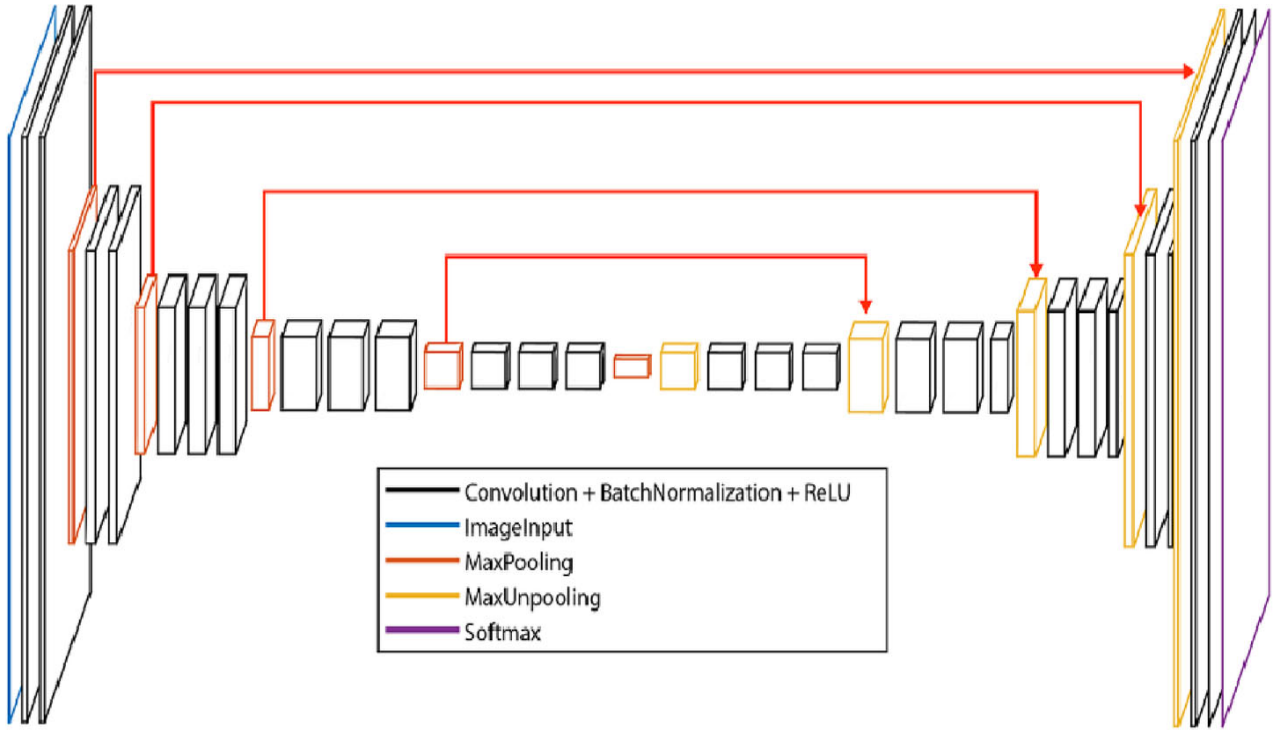


Wagner et al. 2019

Methods: Deep Learning

- SegNet with VGG16 encoder [1]
- ImageNet weights
- 60-20-20 split
- Batch size: 1
- Epochs: 1
- L2 regularization: 0.005

SegNet



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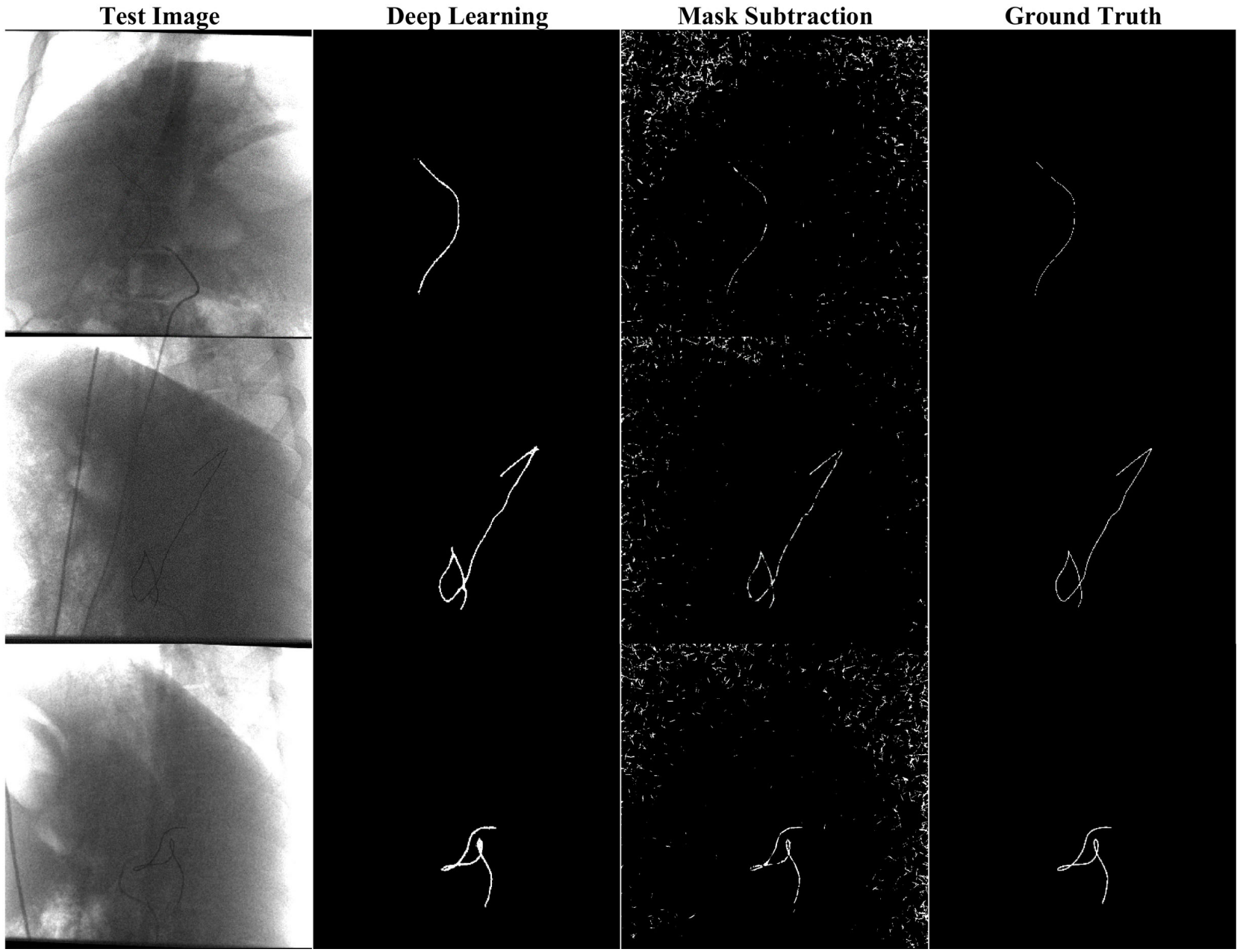
[1] Badrinarayanan, Vijay, et al. “SegNet: A Deep Convolutional Encoder-Decoder Architecture for Image Segmentation.” *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 39, no. 12, Jan. 2017, pp. 2481–2495., doi:10.1109/tpami.2016.2644615.

Results

- 0.5s for prediction
  (single NVIDIA Geforce GTX 1080 Ti)
- Validation Accuracy: 99.91%
- Overall better than Mask Subtraction



Wagner et al. 2019

Results

	Soerensen-Dice Coefficient	False Positive Rate	False Negative Rate	Hausdorff Distance
Deep Learning	58.1%	0.1%	9.6%	16.3 px
Mask Subtraction	23.7%	2.0%	40.8%	90.6 px

Critique

Weaknesses:

- No validation on images with real guidewires
- Slow prediction for the proposed application

Strengths:

- Successful segmentation of the guidewire on a noisy background
- Good description of the dataset generation workflow

Takeaways

- Dataset generation workflow
  - Device simulation
  - Data augmentation parameters
- SegNet

Questions?

Thank you!