

Ultrasound-computerized tomography registration using generative adversarial nets

Naame Cohen¹, Yuval Ron¹, Oren Solomon^{1,*}, Regev Cohen¹, Eyal Berkovich² and Yonina C. Eldar¹

¹ Electrical Engineering Department, Technion – Israel Institute of Technology, Haifa, Israel.

² Medical imaging department, Rambam healthcare center, Haifa, Israel.

* e-mail: orensol@campus.technion.ac.il

Introduction and motivation

- The orientation/position of ultrasound (US) scans are strongly affected by the expertise and probe positioning of the operator.
- Computerized tomography (CT) scans are produced according to a pre-defined and fixed coordinate system.

Main goal: Given an US scan – generate its aligned CT-like scan using conditional generative adversarial networks

Clinical applications:

- Real-time diagnosis in operation or trauma rooms and real-time guidance for surgeons during medical procedures.
- Reduced radiation for the patient and surrounding staff.
- **Generated CT-like image could be used to select the proper slice from a pre-acquired 3D CT volume.**

Conditional generative adversarial networks [Isola et. al. IEEE CVPR 2017, Zhu, et. al. IEEE ICCV 2017]

- GANs constitute a class of deep-learning training policies which comprise of two competing nets (**generative** and **adversarial**) in a **zero-sum game**.
- Conditional GANs (cGANs) are trained to map inputs from distribution $p(x)$ to outputs from distribution $p(y)$.

cGAN joint loss

$$\mathcal{L}_{cGAN}(G, D) = \mathbb{E}_{x,y}[\log D(x, y)] + \mathbb{E}_{x,z}[\log(1 - D(x, G(x, z)))]$$

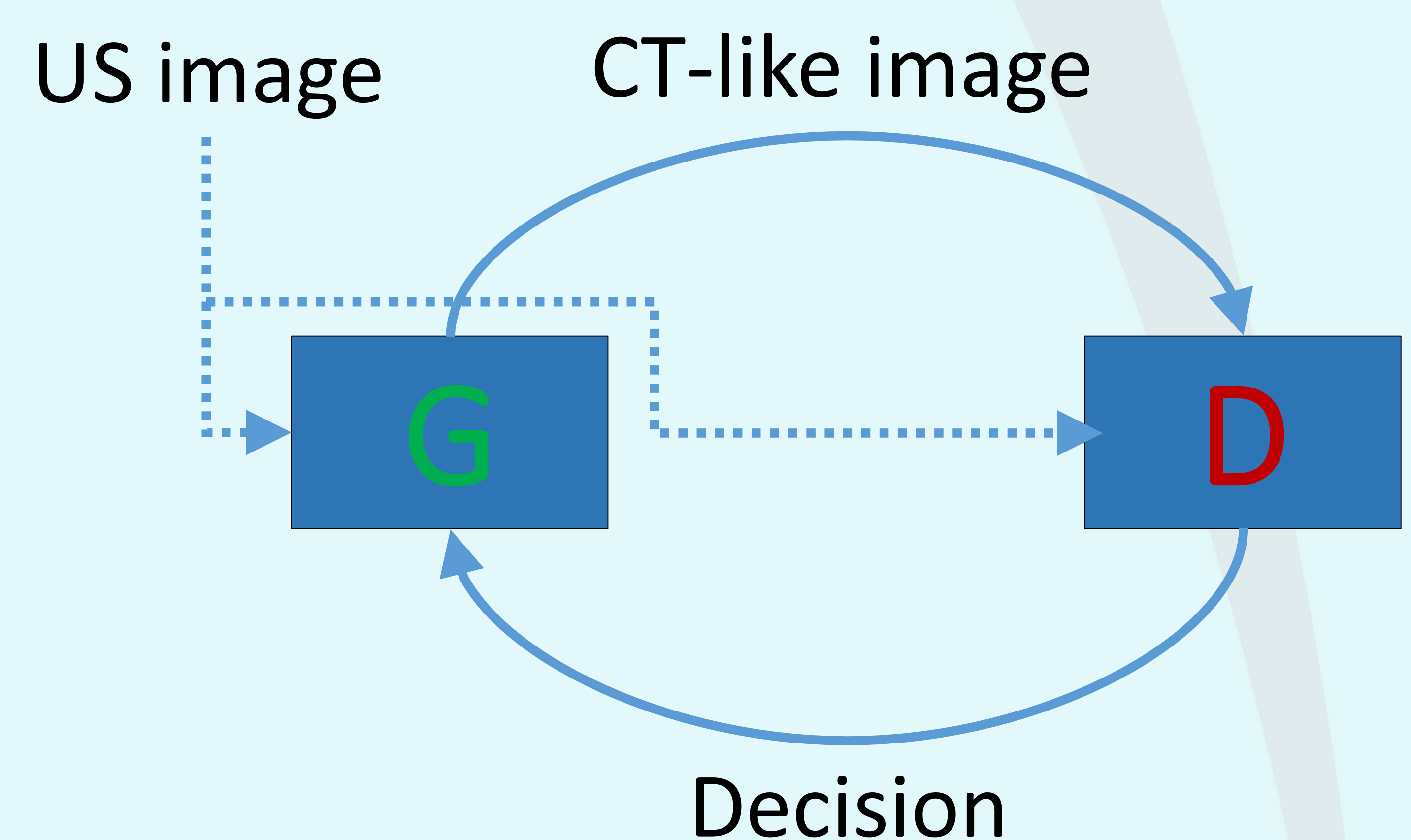
G – generator network

D – discriminator network (True or False)

x – Aligned ultrasound image

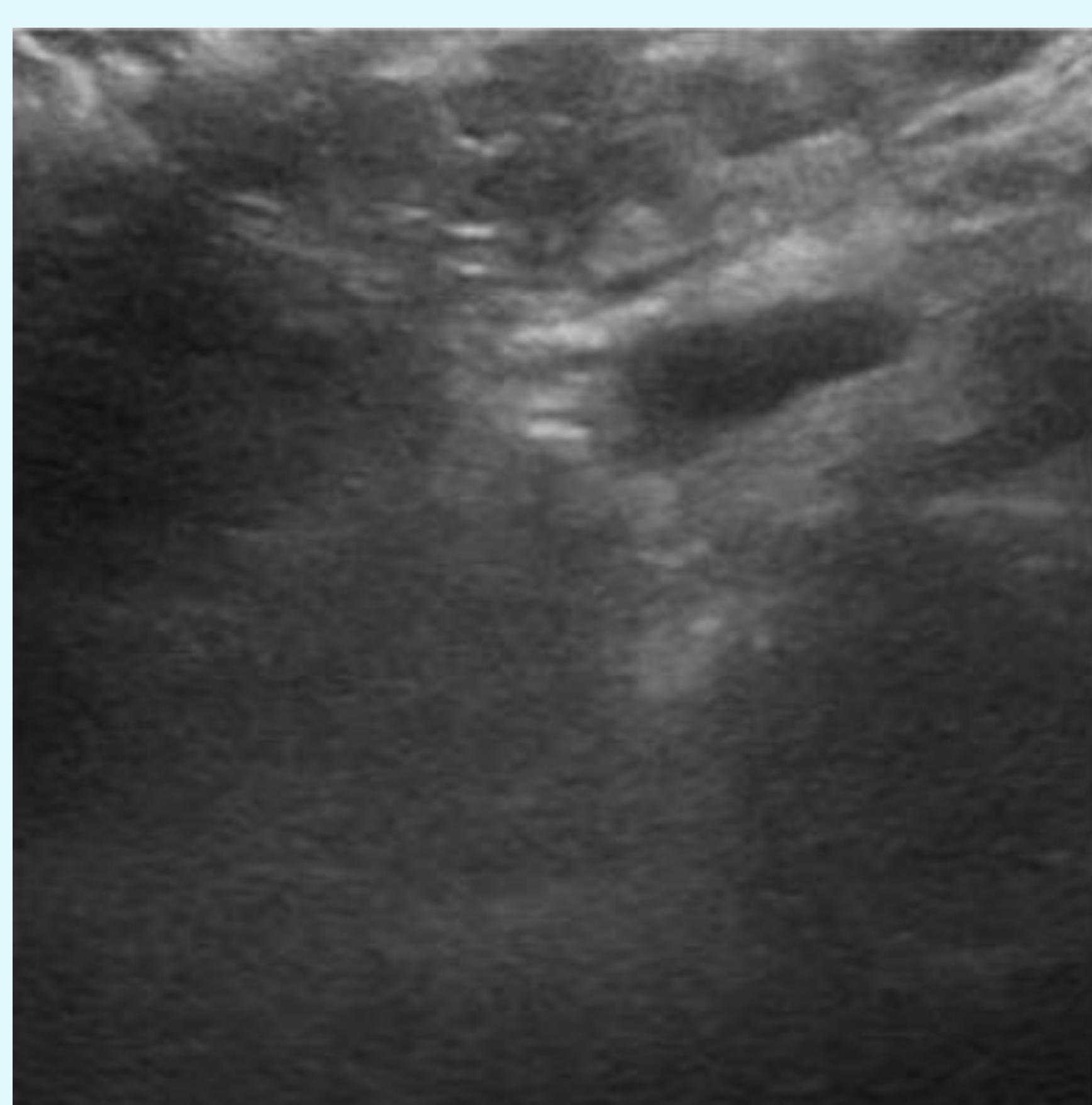
y – Aligned CT image

Joint training process

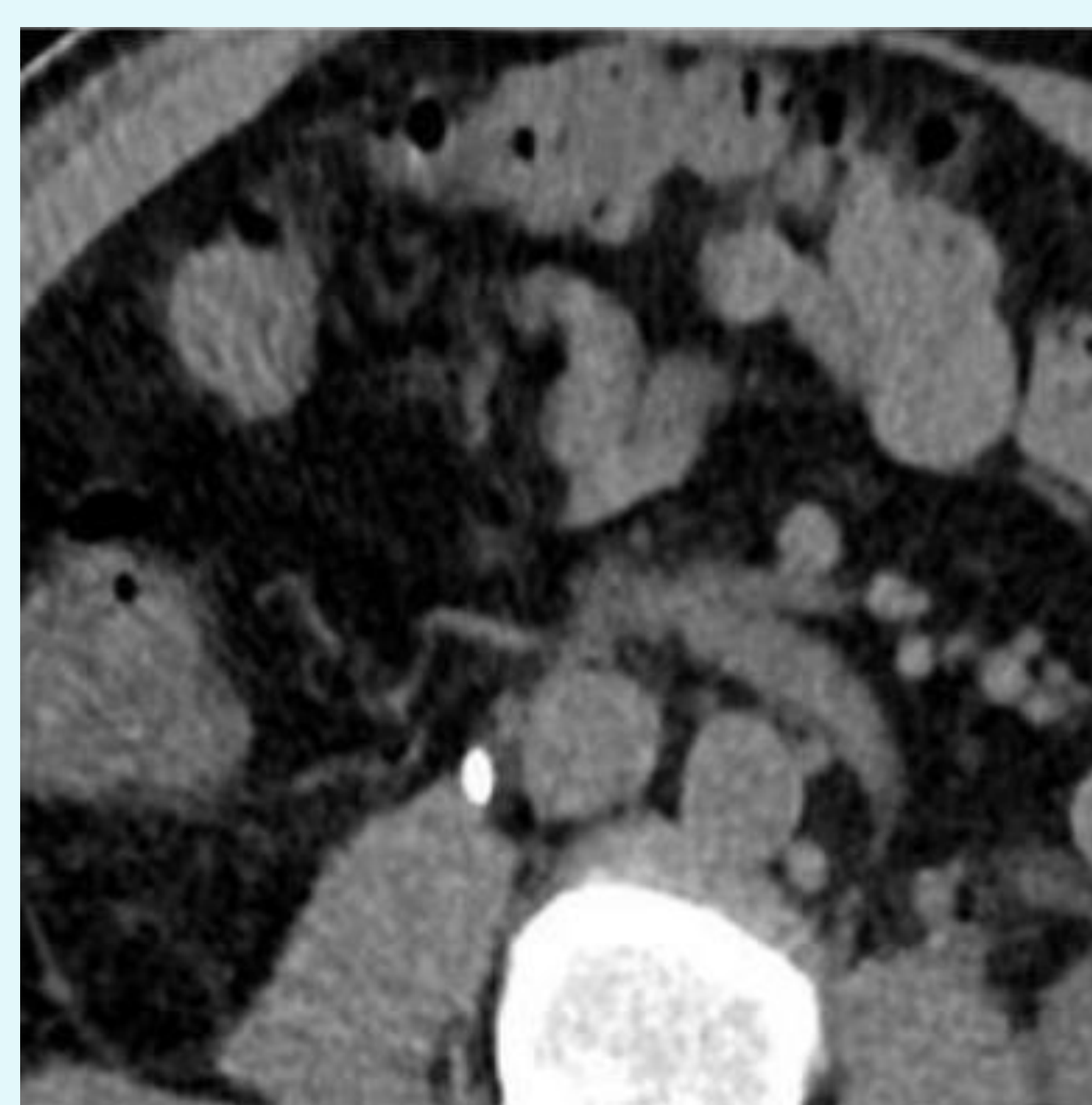


In-vivo results

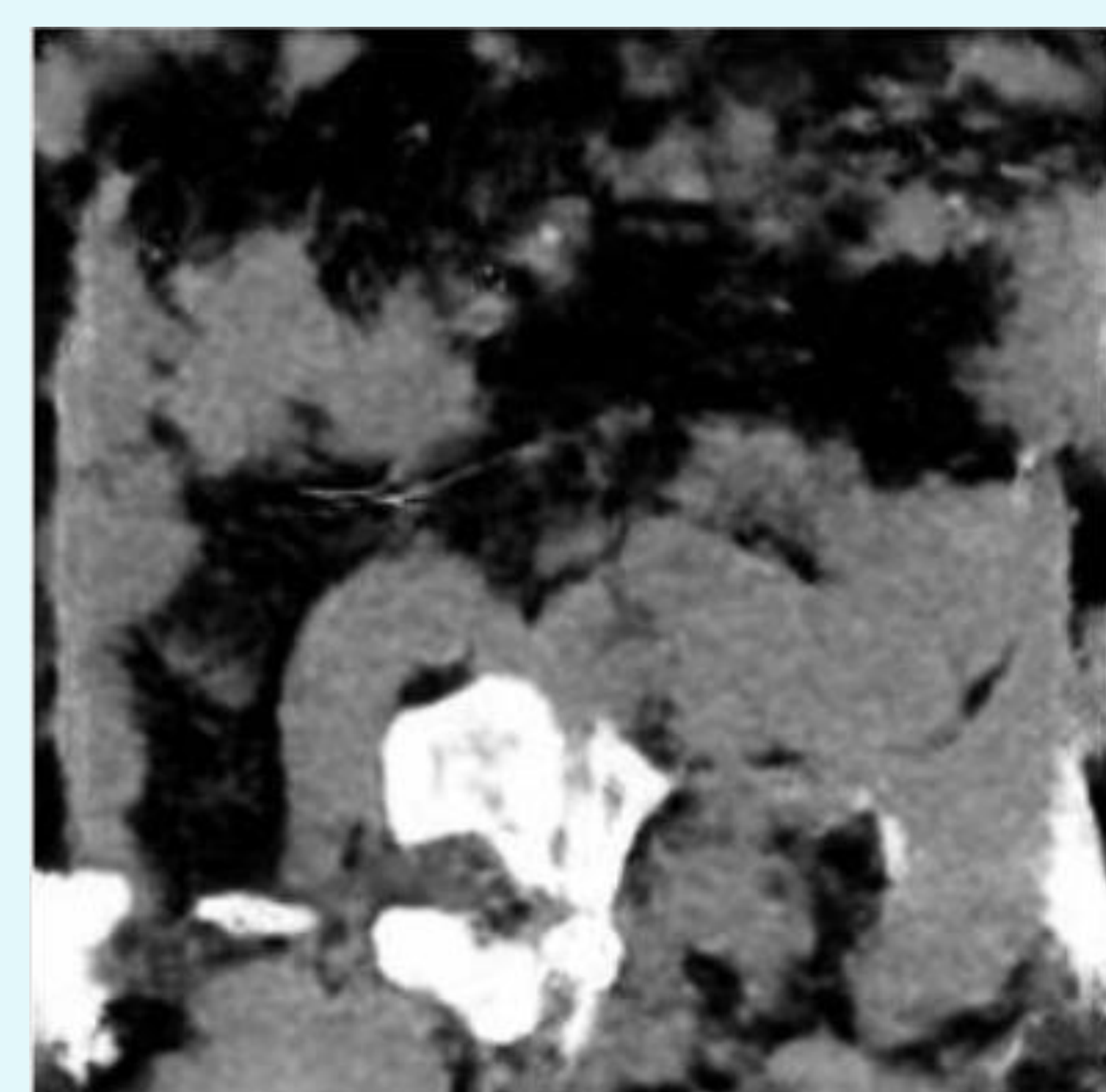
- We train a GAN using aligned pairs of CT and US scans acquired with a Logiq E9 US machine (GE healthcare) of abdominal scans.
- The output is a CT-like image – first initial results on *in-vivo*, clinical acquisitions



US image



Real CT image



Fake CT image