Miguel Xochicale – Introduction

RSGD slides

November 30, 2022

Miguel Xochicale, PhD (@_mxochicale @mxochicale)

Advanced Research Computing Centre and WEISS
Universtiy College London

Table of Contents

Table of Contents

My trajectory

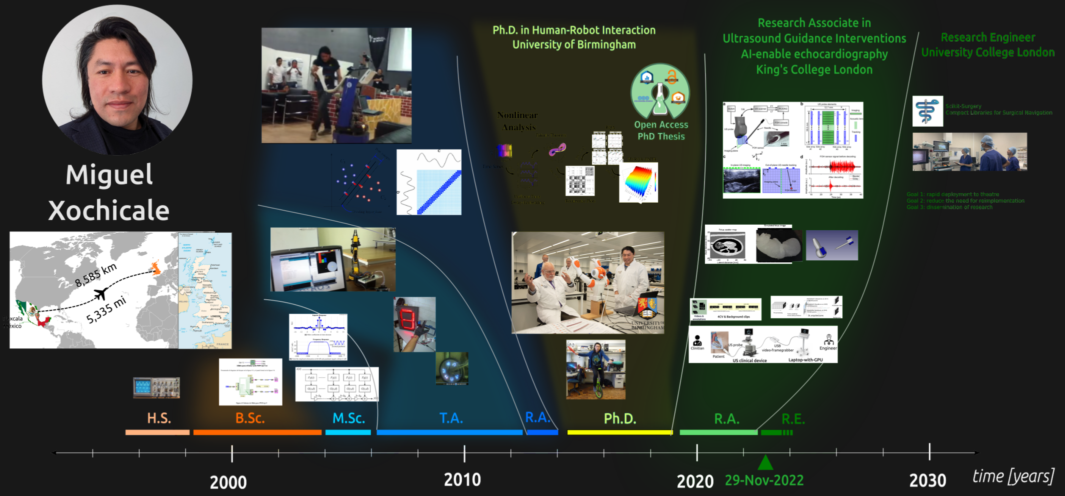
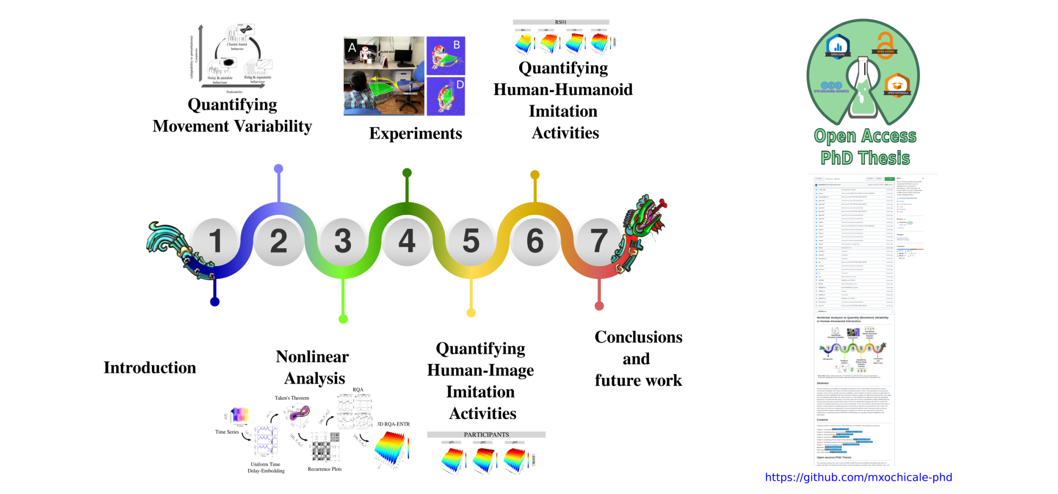


Table of Contents

PhD in Human-Robot Interaction (2014-2019) University of Birmingham



PhD in Human-Robot Interaction (2014-2019)
University of Birmingham

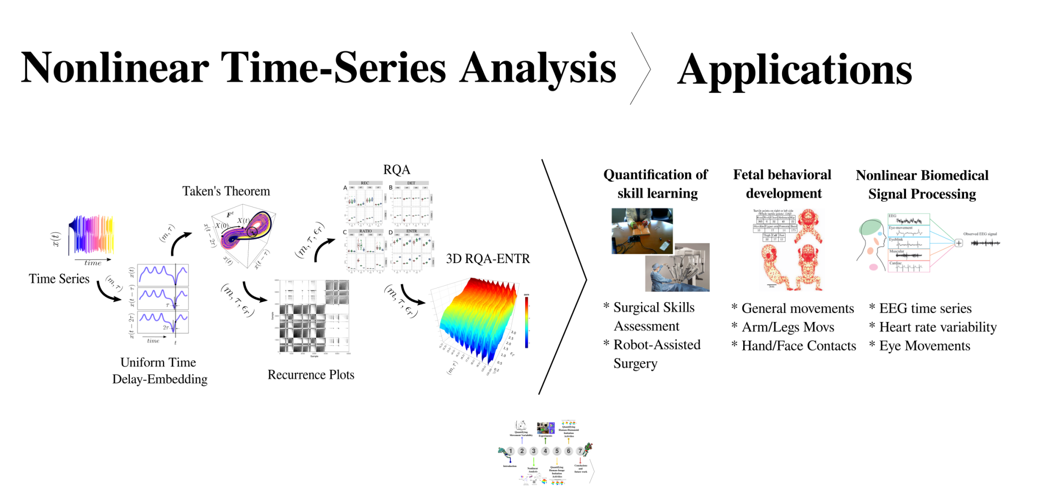
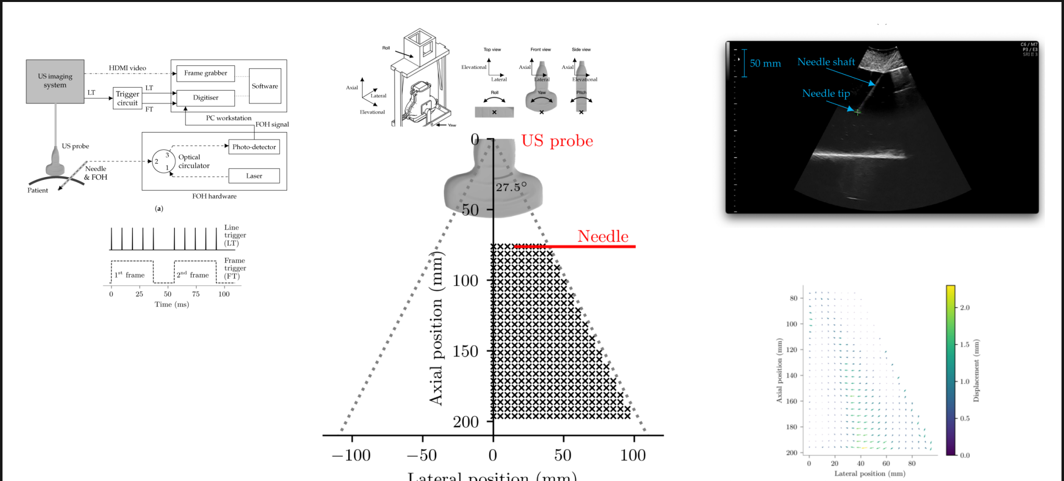


Table of Contents

Intraoperative Needle Tip Tracking (2019-2021) @ KCL

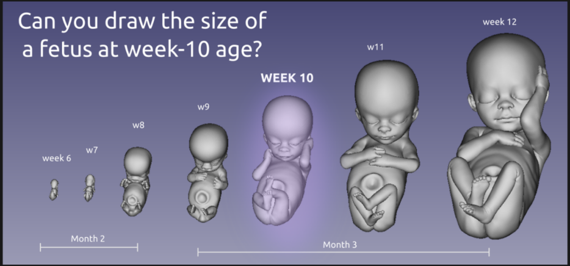


The spatial mean tracking repeatability magnitude was 0.28 ± 0.17 mm

[Baker, Christian; Xochicale, Miguel; et al. "Intraoperative Needle Tip Tracking with an Integrated Fibre-Optic Ultrasound Sensor" Sensors 22, no. 23: 9035. https://doi.org/10.3390/s22239035]

Finding a fETus with UltraSound (FETUS) (2019-2021) @ KCL

[ACTIVITY]: Guessing Fetal Growth



Shu Wang

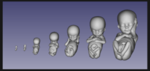
Ou Zhanchong

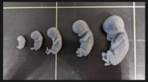
Tareen Dawood

Guilherme Gomes De Figueiredo

Amal Hussein

Souvenirs





[ACTIVITY]: Interactive Ultrasound Imaging

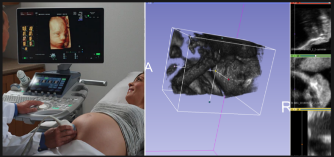
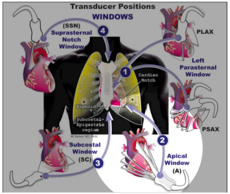
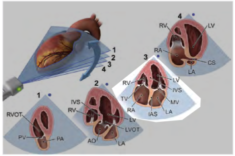
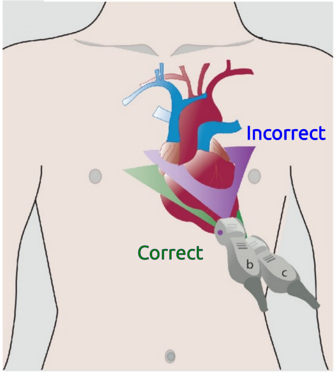


Table of Contents

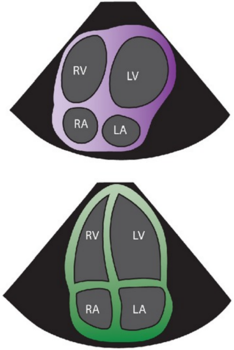
The four-chamber view





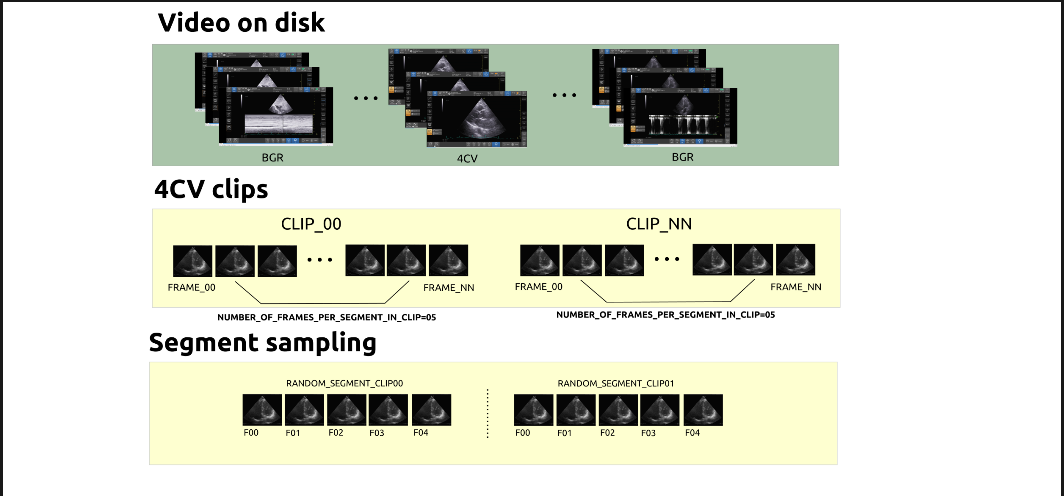


Foreshortening of heart

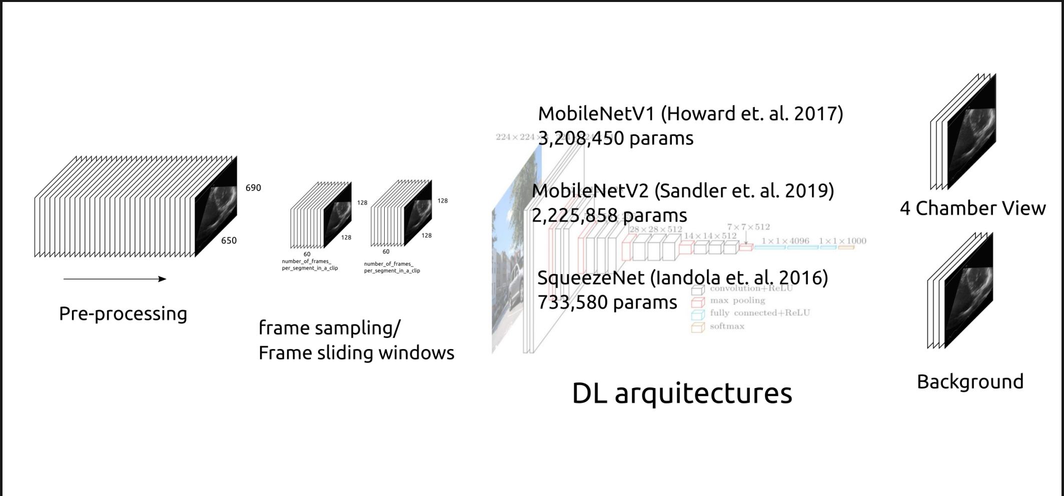


Ideal image for apical view without foreshortening

Processing videos for echocardiography



Classification of US images with thinner neural networks



Low-cost clinical system

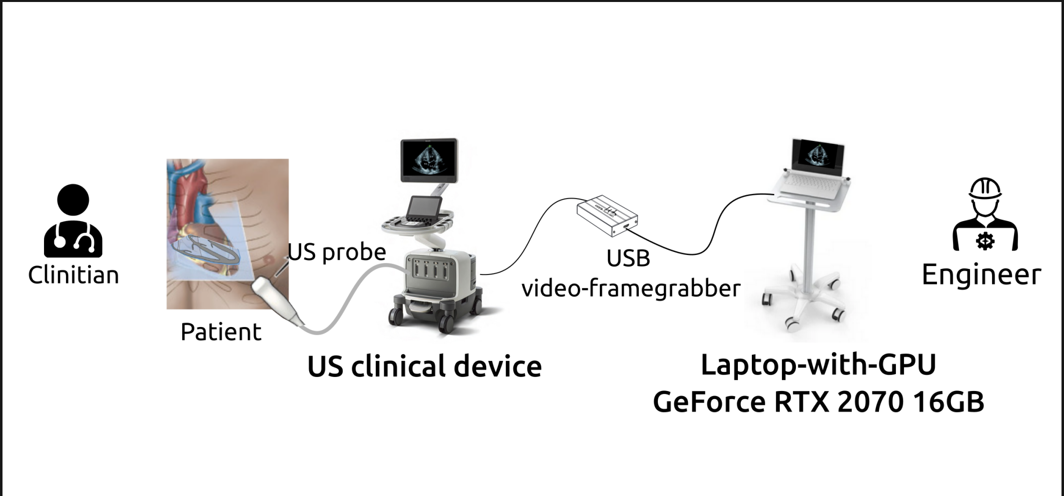
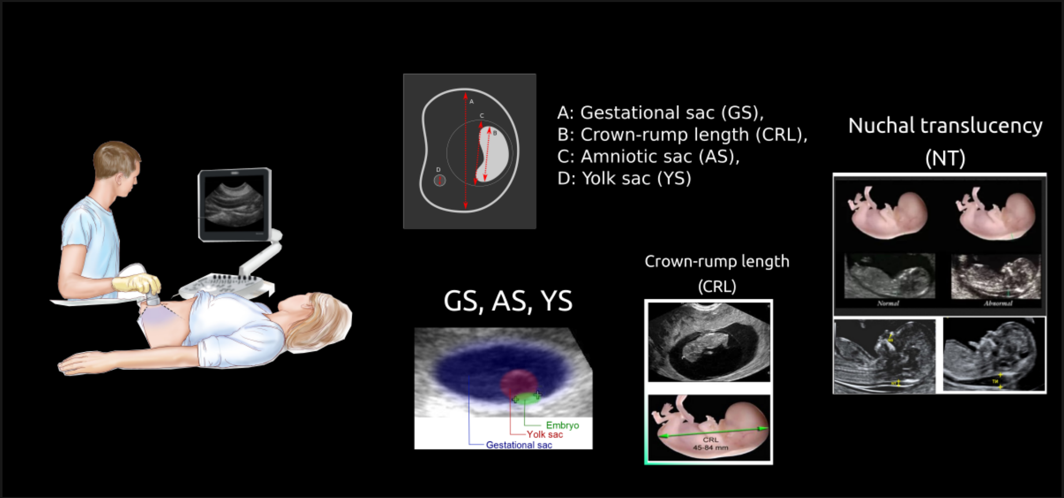


Table of Contents

Dating US scan (12-week scan)



[Wright-Gilbertson M. 2014 in PhD thesis; https://en.wikipedia.org/wiki/Gestational_age; National-Health-Service 2021. Screening for down's syndrome, edwards' syndrome and patau's syndrome. https://www.nhs.uk/pregnancy/your-pregnancy-care]

Challenges of ultrasound biometric measurements

- Operator dependant
- Position of the baby
- Similar morphological and echogenic characteristics in the US
- Few public datasets are available (we have only found two)

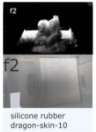
[Sciortino et al. in Computers in Biology and Medicine 2017 https://doi.org/10.1016/j.compbiomed.2017.01.008; He et al. in Front. Med. 2021 https://doi.org/10.3389/fmed.2021.729978]

Research aims

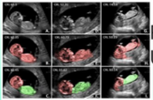
- Investigate and implement deep-learning methods for synthetic fetal ultrasound imaging of normal and abnormal cases;
- Propose and apply methods to evaluate quantitative and qualitative images to investigate fetal biomechanics; and
- Design and test fetal phantoms that mimic various poses, and fetal ages.

GAN-based fetal US imaging

1. Small datasets of 100 images (10-14 weeks gestation)

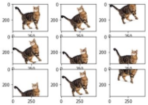


Phantoms (age, US-devices, pose)

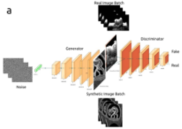


Real fetal US images

2. Image processing (anonymization, cropping, augmentation, etc)



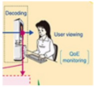
3. GANs (loos functions, autoenconders, hyperparameter search, etc)



GAN architectures

- MNIST-GAN (+basic net)
- Fast-GAN (+small datates of 100 images)

4. Quality assessment of Synthethic US images



- Visual Turing test
- CNR
- Texture Analysis

GAN-based fetal imaging

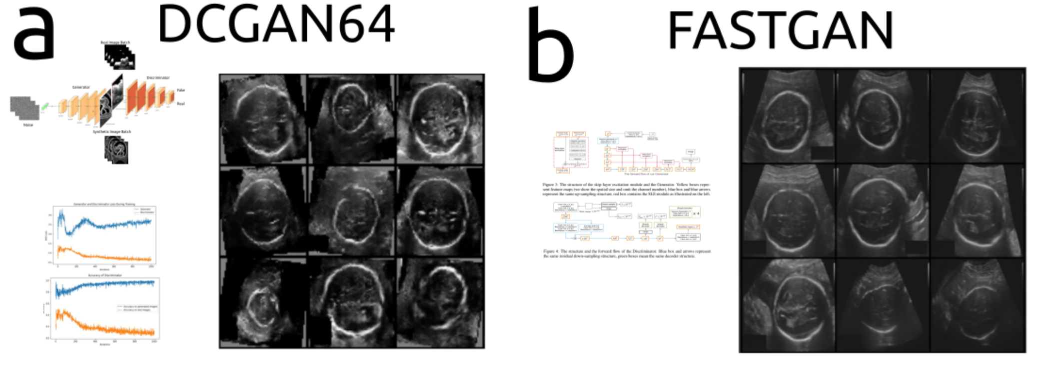
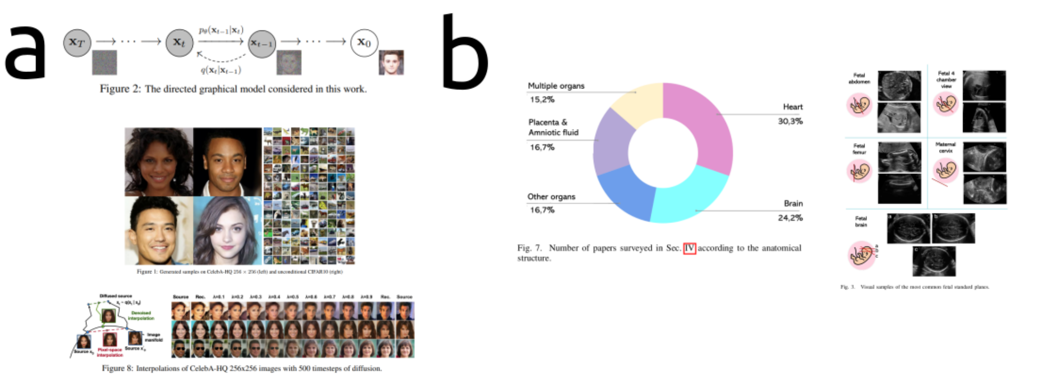


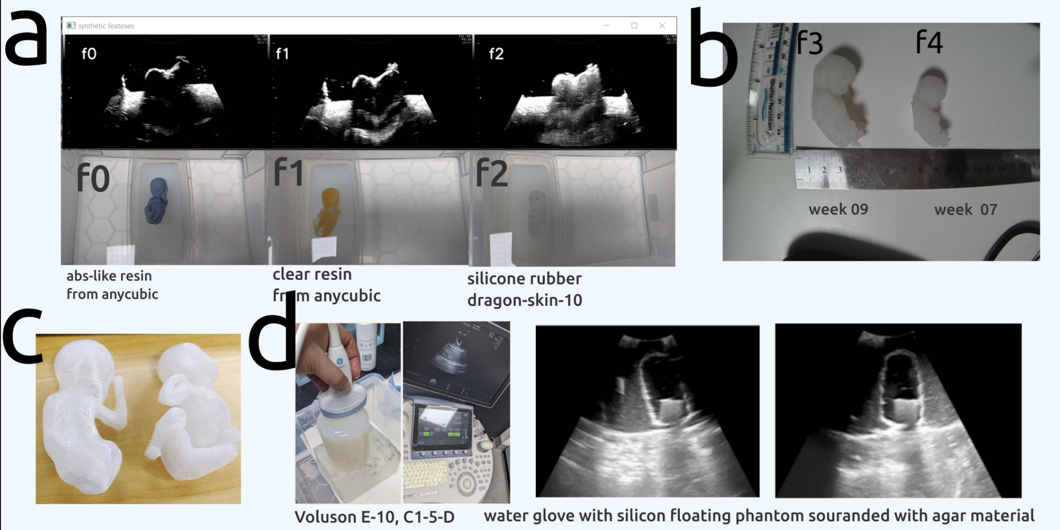
Figure: (a) DCGAN arquitecture, loss functions for DC-GANs and batches of synthetic fetal head images, (b) FASTGAN arquitecture and batches of synthethic fetal head images

[(a) Bautista et al. 2022, "Empirical Study of Quality Image Assessment for Synthesis of Fetal Head Ultrasound Imaging with DCGANs" MIUA https://github.com/budai4medtech/miua2022 (b) Liu et al. 2021 "Towards Faster and Stabilized GAN Training for High-fidelity Few-shot Image Synthesis" https://arxiv.org/abs/2101.04775]

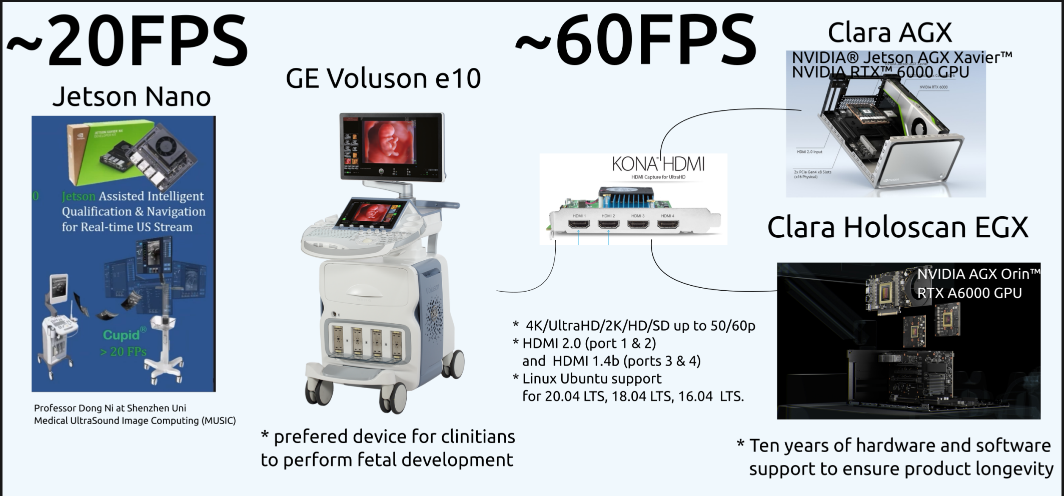
Difussion models for fetal imaging



Phantoms for AI-based fetal biomechanics



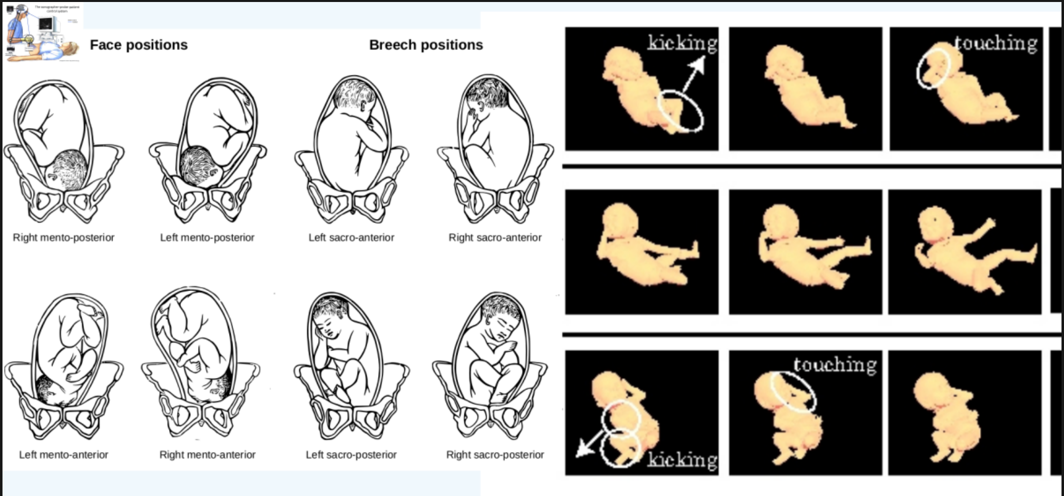
Building AI for Medical Devices



[Clara AGX: https://www.nvidia.com/en-gb/clara/intelligent-medical-instruments/; Clara holoscan EGX: https://developer.nvidia.com/clara-holoscan-sdk]

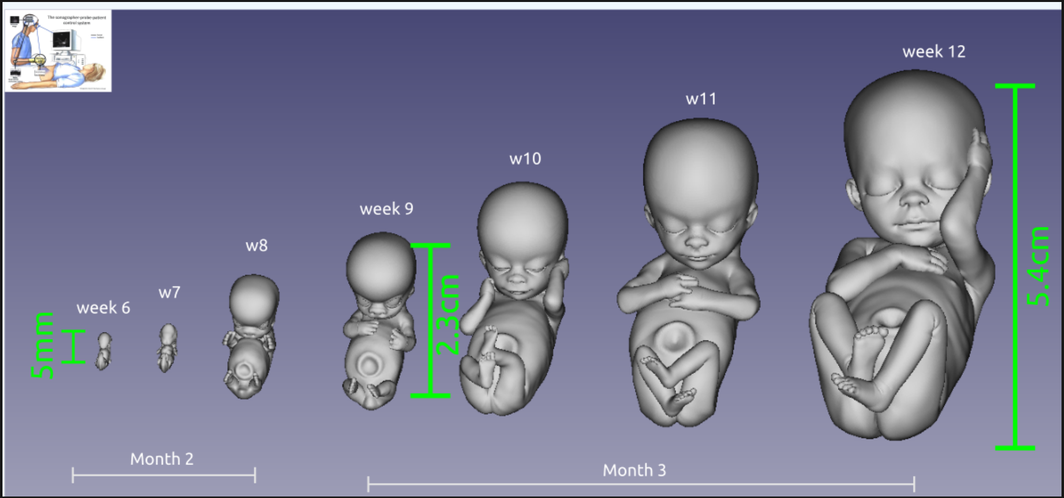
Table of Contents

I: Fetal Poses, II: Fetal Behaviours



[Ferguson and Haultain 1889 in Handbook of Obstetric Nursing, pages 150–153; Mori et al. 2010 in ICDL]

III: Fetal Growth



[Growing Baby: 3D Print-ready Models]

State-of-the-art on modelling fetus