Virtual Dosimeter for Interventional Fluoroscopy

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Introduction

- Interventional fluoroscopy: an imaging modality the provides a real-time x-ray image of a patient's anatomy.
- Radiation dose delivered to patients and operators may be substantial
- Dosimeter badges measure radiation at discrete points, and the dose is only known after the procedure.

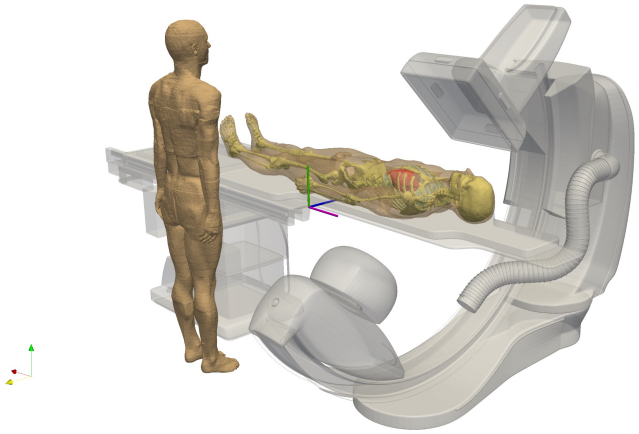

Figure 1. Computational model of an operator standing next to a patient during an interventional fluoroscopy procedure (Badal et al. 2013)

Figure 2. Skin injury due to radiation dose delivered by interventional fluoroscopy. (Balter et al. 2010)

Aim

- To develop a new Conductor software tool that coordinates the execution of the 3 existing modules of the Virtual Dosimeter:
    1. Virtual x-ray source
    2. Operator position tracker
    3. MC-GPU x-ray transport
- To create a new Display module.

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New Software Tool Requirements

- Written in Python for the Linux operating system.
- Runs in a NVIDIA Jetson TX2 embedded computer.
- Sends and receives messages between the independent processes using the Robot Operating System (ROS).

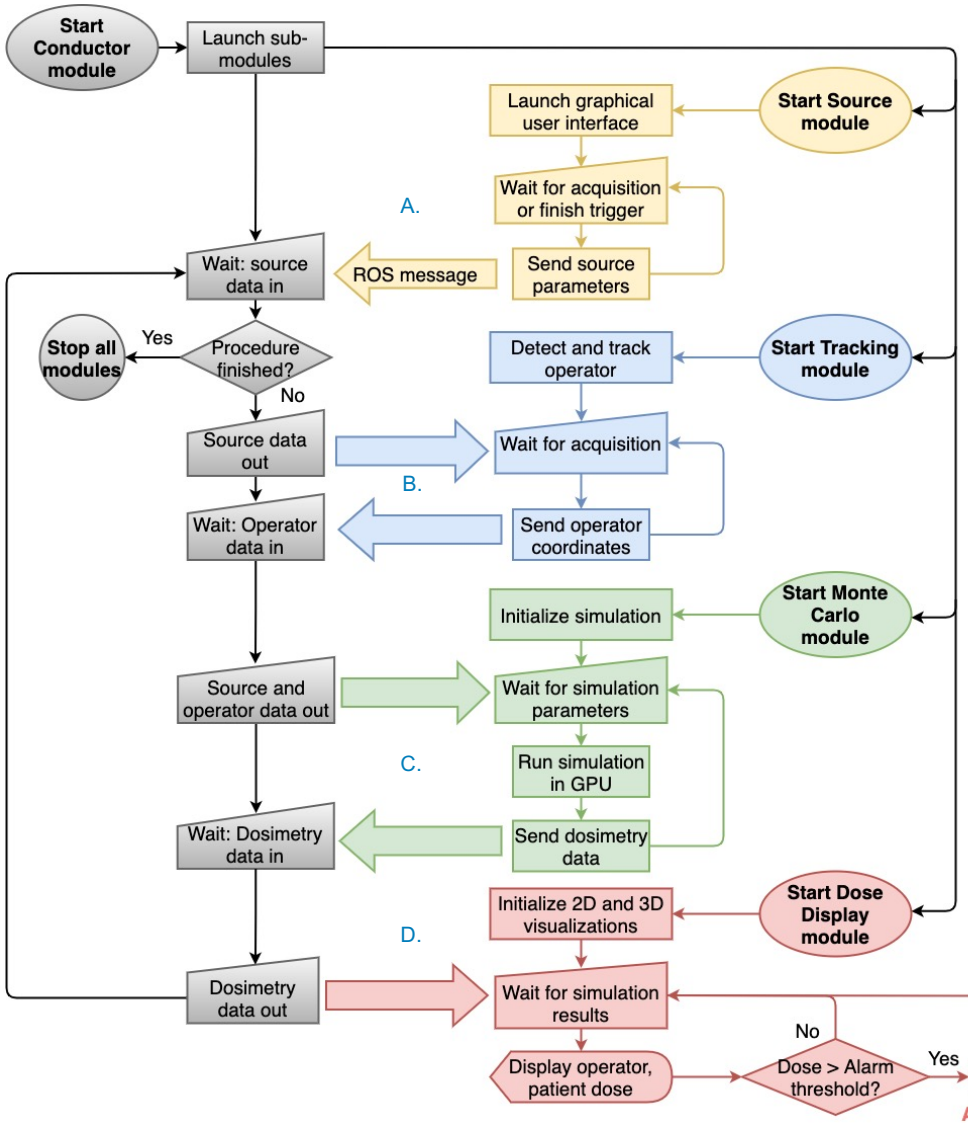
New Software Tool Operations

A. Receive x-ray source data from Source module.

B. Communicate with Tracking module to receive the operator position at the time of the irradiation.

C. Send source and operator data to Monte Carlo module for fast x-ray transport simulation using MC-GPU and receive the estimated organ and skin doses.

D. Send dosimetry results to Display module to inform the operator of the received radiation exposure.



Results and Discussion

- The new *Conductor* software communicates with the python and C++ modules with ROS messages.
- The modular design of the system allows testing different version of modules.
- The *Display* module shows a 2D plot of the computed operator organ doses in each exposure.

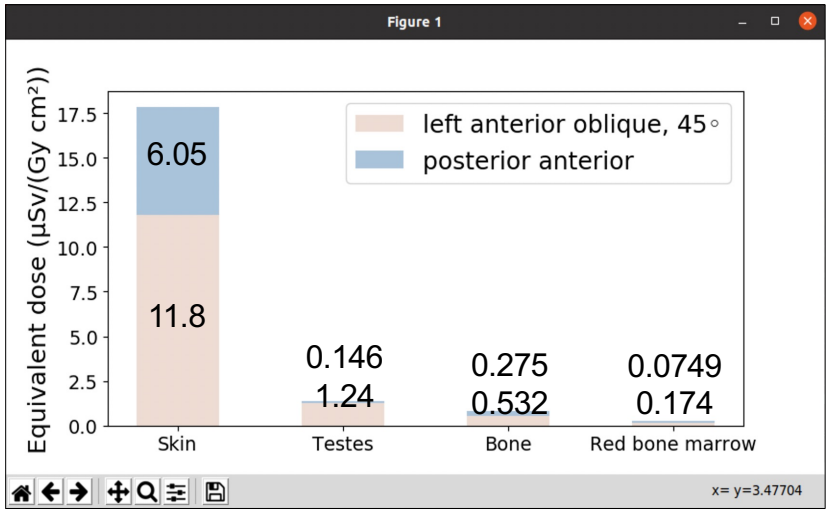


Figure 3. Bar graph of computed operator organ doses in two fluoroscopy views generated by the *Display module.*

Figure 4. Example volume rendering of an operator dose distribution.

Conclusion and Future Work

- Updated Virtual Dosimeter software package:
  - New software tool that uses the Robot Operating System library to coordinate the execution of the system.
  - Dose display module
- Volume renderer for the Display module