Multi-modal Assessment of Light Transport through Human Anatomy

Introduction
Photonics and imaging have allowed a tremendous growth in medical domains by facilitating non-contact and non-invasive investigations. Such investigations facilitate an overall improvement in the quality of point-of-care treatment of patients, reducing the workload of medical staff.

Our research looks into combining versatile laser light sources with low cost imaging systems, and current diagnostic tools, to present medical staff with patient-specific understanding at the desired anatomical site. We do this by employing an understanding of the transport of light through tissue. This would enhance the knowledge of the medical practitioner regarding the problem to assist in making an informed decision regarding the course of treatment.

As the light interacts with a combination of skin and anatomy, it is absorbed, reflected, scattered and transmitted in characteristic ways. Our primary interest lies in better understanding these interactions in such a complex, multi-layered target.

Aims
- Non-contact mapping and estimation of heart rate from finger vasculature.
- Ultrasound imaging application for optical models
- Optical properties of human skin equivalents.

Research Description
Utilising infrared and red wavelengths, commonly used in pulse oximetry, we are investigating methodologies for detecting and monitoring vasculature for assessing blood transport.

Ultrasound imaging (in collaboration with the Great Western Hospital, Swindon, UK) measures the depth and thickness information which was utilised for constructing optical models with the appropriate properties. This achieves greater accuracy and applicability as the models are patient-specific and allow therapy, like photodynamic therapy (PDT), most suitable to individual patients.

In addition to using Monte Carlo simulations for the optical models mentioned above, our research also looks into using simulations and experiments to better assess the optical properties of engineered tissue, commonly referred to as Human Skin Equivalents. The synthesis of the tissue, performed by researchers at Aston University, is shown.

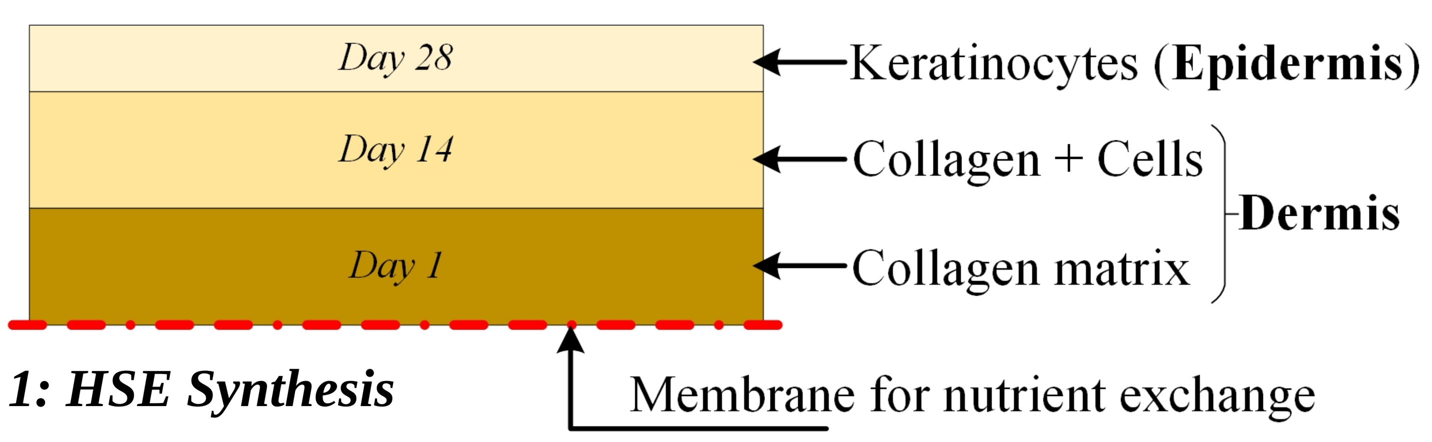


Figure 1: HSE Synthesis

Figure 2: Effectiveness of finger-vein mapping using infrared imaging (Reused with permission)

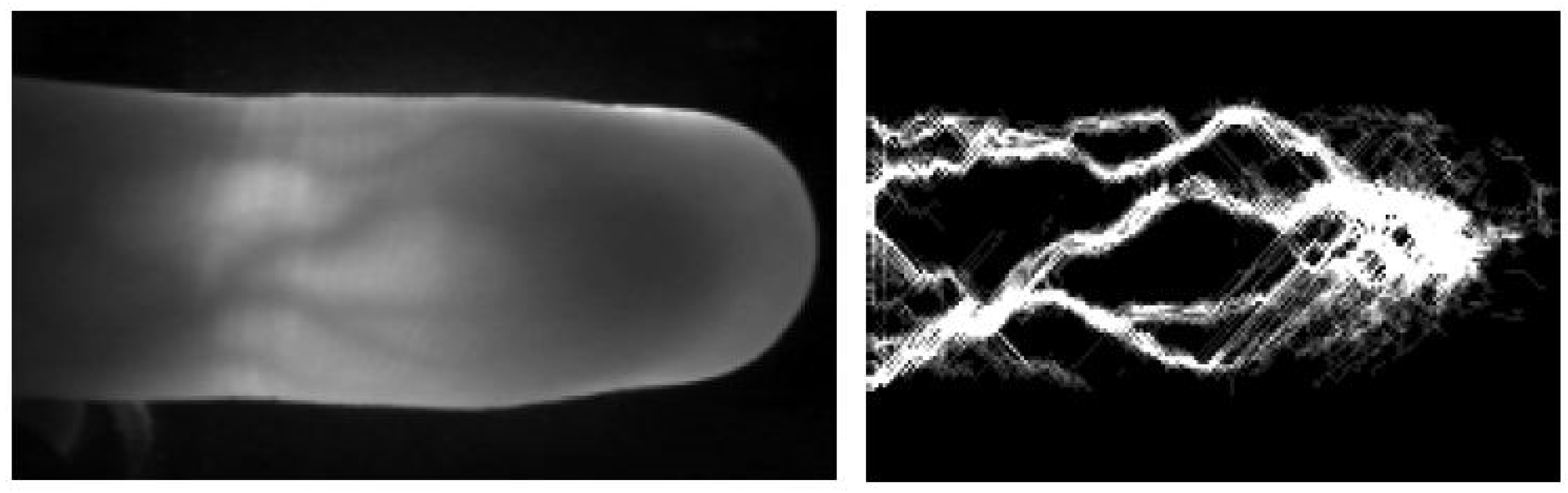


Figure 3: Ultrasound images of the middle phalanx

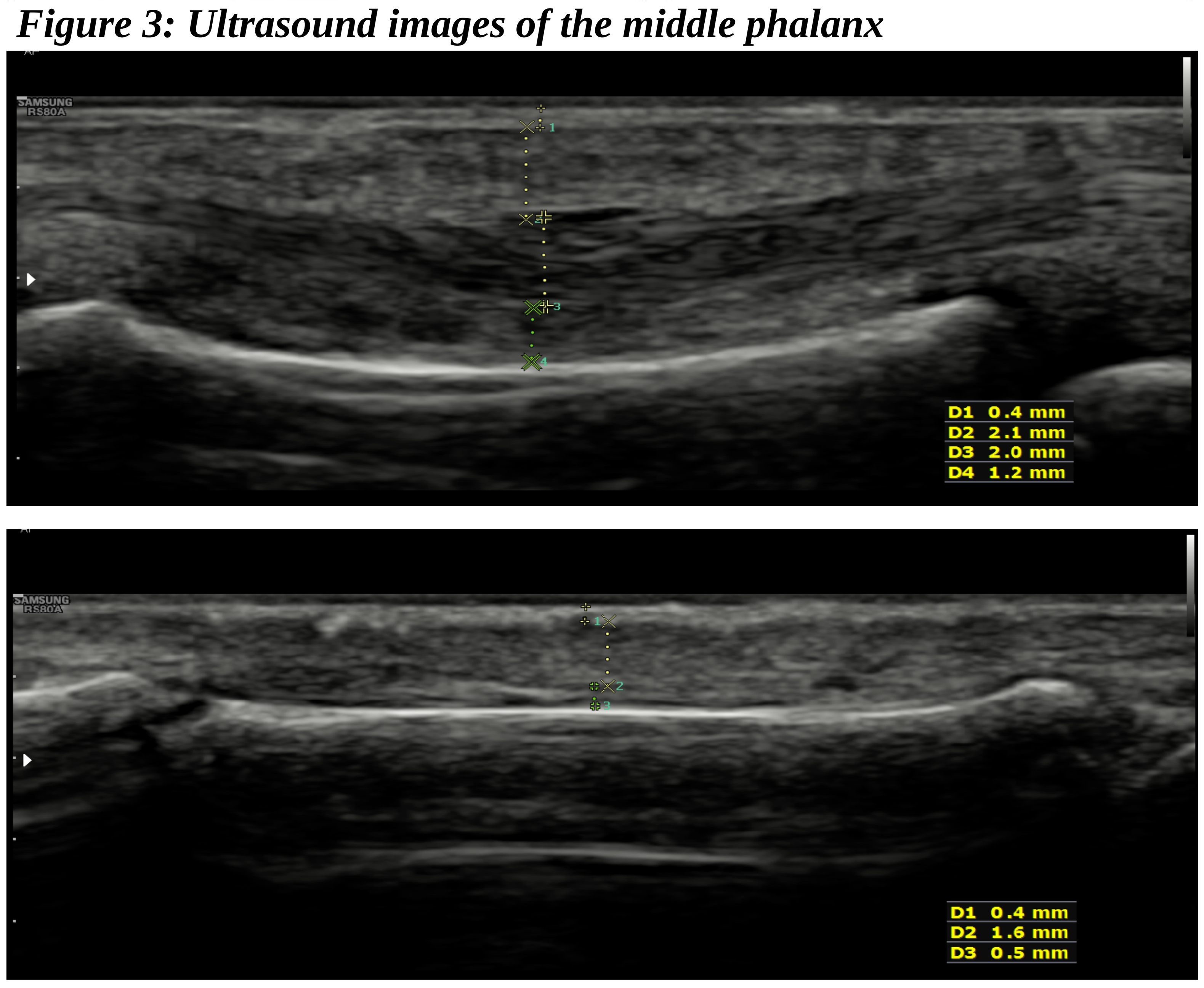
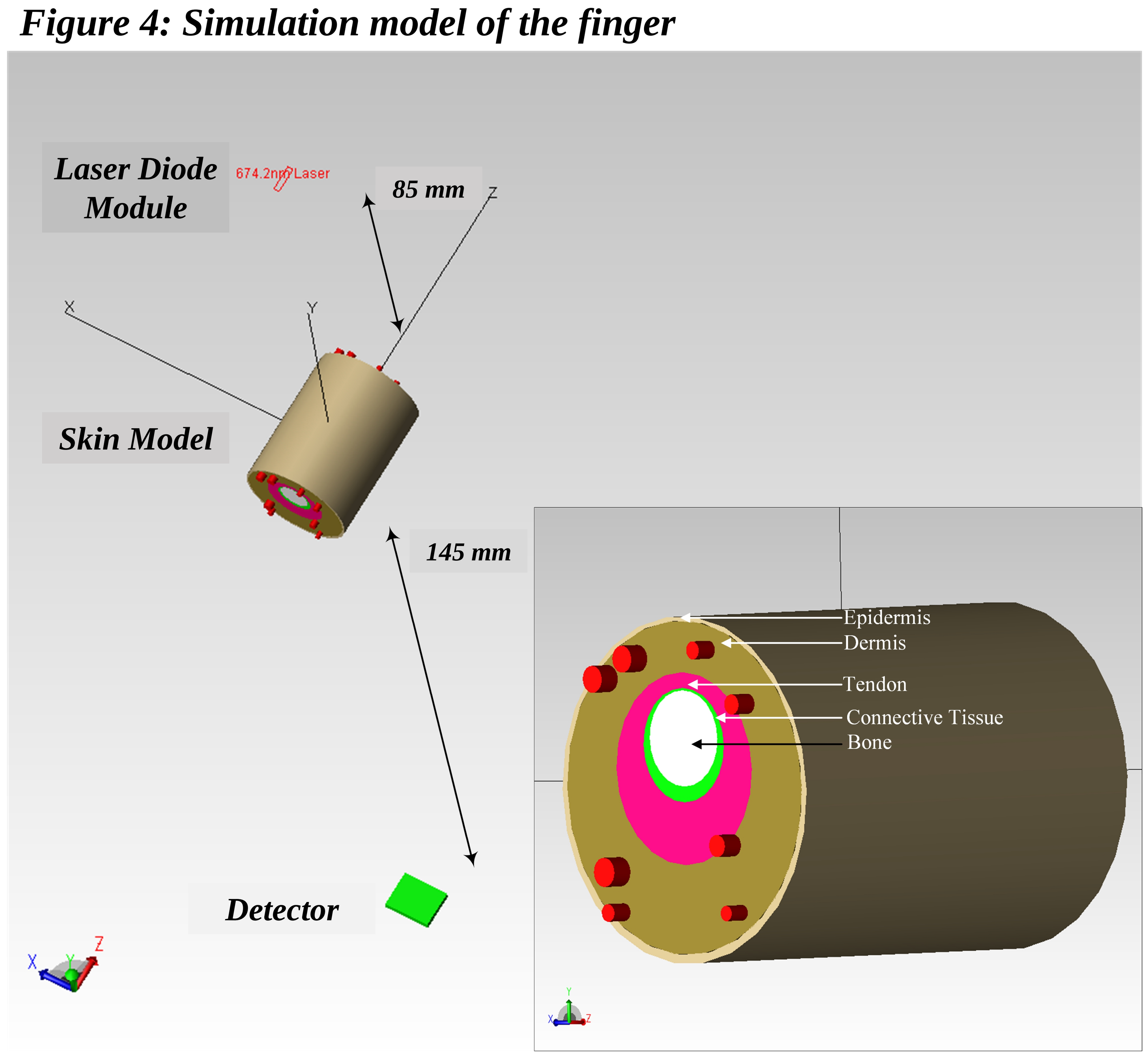


Figure 4: Simulation model of the finger



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NHS Great Western Hospitals NHS Foundation Trust

Aston University

AIMR Aston Institute of Materials Research