VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Nastaran Nourbakhsh Kaashki**

The public defense will take place on **Thursday 9th February 2023 at 4:00pm** in room **D.2.01** (Building **D**, Brussels Humanities, Sciences & Engineering Campus)

To join the digital defense, please click here
Meeting ID: 336 864 811 288
Passcode: Q7V2uq

3D ANTHROPOMETRIC MEASUREMENT EXTRACTION

BOARD OF EXAMINERS

Prof. dr. ir. Bram Vanderborght

Prof. dr. ir. Wendy Meulebroeck

Prof. dr. ir. Bruno Da Silva Gomes

Prof. dr. ir. Bruno Cornelis

Dr. Ljiljana Platisa

Prof. dr. Bogdan Iancu

Prof. dr. ir. Walid Darwish

PROMOTORS

Prof. dr. ir. Adrian Munteanu

VRIJE UNIVERSITEIT BRUSSEL

Abstract of the PhD research

3D Anthropometric measurement extraction is of paramount importance for several applications such as clothing design, online garment shopping, and medical diagnosis, to name a few. State-of-the-art 3D anthropometric measurement extraction methods estimate the measurements either through some landmarks found on the input scan or by fitting a template to the input scan using optimization-based techniques. Finding landmarks is very sensitive to noise and missing data. Template-based methods address this problem, but the employed optimization-based template fitting algorithms are computationally very complex and time-consuming. To address the limitations of existing methods, we propose two automatic measurement extraction frameworks: AM-DL and Anet.

To the best of our knowledge, AM-DL is the first approach for automatic contact-less Anthropometric Measurements extraction based on Deep-Learning (AM-DL). A novel module dubbed Multi-scale EdgeConv is proposed to learn local features from point clouds at multiple scales. Multi-scale EdgeConv can be directly integrated with other neural networks for various tasks, e.g., classification of point clouds. We exploit this module to design an encoder-decoder architecture which learns to deform a template model to fit a given scan. The measurement values are then calculated on the deformed template model. Experimental results on the synthetic ModelNet40 dataset and on the real scans demonstrate that the proposed method outperforms state-of-the-art methods and performs sufficiently close to a professional tailor. However, this method requires a post processing step for transferring and refining the measurements from the template to the deformed template.

The second proposed method is Anet which is a deep neural network architecture fitting a template to the input scan and outputting the reconstructed body as well as the corresponding measurements. Unlike existing template-based anthropocentric measurement extraction methods, including AM-DL, the proposed approach does not need to transfer and refine the measurements from the template to the deformed template, thereby being faster and more accurate. A novel loss function, especially developed for 3D anthropometric measurement extraction is introduced. Additionally, two large datasets of complete and partial front-facing scans are proposed and used in training. This results in two models, dubbed Anet-complete and Anet-partial, which extract the body measurements from complete and partial front-facing scans, respectively. Experimental results on synthesized data as well as on real 3D scans captured by a photogrammetry-based scanner, an Azure Kinect sensor, and the very recent TrueDepth camera system demonstrate that the proposed approach systematically outperforms the state-of-the-art methods in terms of accuracy and robustness.

The human hand and foot are among the most complex mechanical human body parts: the hand consists of 34 muscles and 27 bones, equaling a quarter of the bones in human body, which leads to the fact that the human hand can have various shapes and complicated poses. The human foot includes 26 bones, 33 joints and over 100 muscles, ligaments and tendons. This makes scanning and measuring hundreds of thousands of real hand and foot subjects very time-consuming, inaccurate, and difficult. Therefore, we propose two methods trained separately for the foot and hand measurement extractions. To this end, we update AM-DL and Anet for hand and foot measurement extraction by adapting the proposed loss function and synthesizing new large set of synthetic hand and foot samples. Experimental results on both synthetic data and real scans captured by Occipital structure sensor Mark I and Pro demonstrate that the proposed methods outperform the state-of-the-art methods in terms of accuracy and speed.