Body Weight Estimation Using Virtual Anthropometric Measurements From a Single Image

Jin Sui, Chunguang Bu, Xingang Zhao, *Senior Member, IEEE*, Chen Liu, Lei Ren, *Member, IEEE*, and Zhihui Qian

***Abstract*— Direct estimation of body weight through noncontact methods is crucial for applications such as health monitoring, surveillance, and robot-assisted casualty rescue. Existing methods for body weight estimation from images are often affected by various factors, such as camera distance, human orientation, and body posture, which ignore the fact that bodies typically inhabit 3-D space. To address the problem, we propose an approach for estimating body weight based on virtual anthropometric measurements and deep features instead of estimating by reasoning pixels. Specifically, we develop a three-branch framework that includes face feature extraction, body feature extraction, and deep feature extraction and maps all features with a regressor. The developed method adds 3-D shape reconstruction to explicitly reason about virtual anthropometric measurements. To enable this, our model is trained to robustly compute anthropometric measurements in various orientations and postures. Furthermore, we evaluate our method on a public dataset and Image-VM-BMI, a new dataset of 4740 images, including body mass index (BMI) labels and virtual anthropometric measurement labels with paired 3-D reconstruction. Extensive experimental results demonstrate that the proposed method outperforms pixel-based analysis approaches on BMI estimation.**

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Jin Sui is with the Key Laboratory of Bionic Engineering, Ministry of Education, Jilin University, Changchun 130025, China, also with the State Key Laboratory of Robotics, Shenyang Institute of Automation, Chinese Academy of Sciences, Shenyang 110016, China, and also with the Institutes for Robotics and Intelligent Manufacturing, Chinese Academy of Sciences, Shenyang 110169, China (e-mail: suijin@sia.cn).

Chunguang Bu and Xingang Zhao are with the State Key Laboratory of Robotics, Shenyang Institute of Automation, Chinese Academy of Sciences, Shenyang 110016, China, and also with the Institutes for Robotics and Intelligent Manufacturing, Chinese Academy of Sciences, Shenyang 110169, China.

Chen Liu is with the Tianjin Key Laboratory for Advanced Mechatronic System Design and Intelligent Control and the National Demonstration Center for Experimental Mechanical and Electrical Engineering Education, School of Mechanical Engineering, Tianjin University of Technology, Tianjin 300384, China.

Lei Ren is with the Key Laboratory of Bionic Engineering, Ministry of Education, Jilin University, Changchun 130025, China, and also with the Department of Mechanical, Aerospace and Civil Engineering, University of Manchester, M13 9PL Manchester, U.K.

Zhihui Qian is with the Key Laboratory of Bionic Engineering, Ministry of Education, Jilin University, Changchun 130025, China, and also with the Liaoning Academy of Materials, Shenyang 110167, China (e-mail: zhqian@jlu.edu.cn).

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I. Introduction

ESTIMATING a personalized body weight is crucial for judging personal biomedical information [1], which enables the measurement of personalized health conditions and avatar generation in virtual environments. Although it is convenient to capture body weight using a spring scale when the person is sparsely dressed, many conditions, such as surveillance [2], wound rescue [3], and astronaut health detection [4], cannot support this form of collection. In the application of robot-assisted casualty rescue and operations, biomedical information detection and body reconstruction are the first tasks to be completed. In photographic forensic identification for evidence collection, photographic evidence plays a key role in judging suspect biomedical information. In space station applications for astronaut health detection, it is of great significance to predict human body weight under weightlessness. These applications require noncontact biomedical information detection and a body reconstruction method. To this end, we provide a unified method that jointly regresses virtual anthropometric measurements and deep feature relations in one shot from a single red, green, and blue (RGB) image.

The problem of estimating body weight from images is challenging due to the sensitivity of visual inspection to camera parameters and settings. When we obtain camera parameters, we can accurately calculate human body weight. One universal parameter used for evaluating the weight of adults is body mass index (BMI), which is expressed as the ratio of body mass in kilograms to body height in meters. BMI can be divided into four categories: underweight, normal, overweight, and obese [5]. High BMI can lead to many diseases, such as heart disease, stroke, and some cancers, which can increase mortality [6], [7]. In addition to BMI, body fat can be examined through waist circumstance, underwater weighing, and skinfold thickness. However, the high cost and requirement for highly trained personnel prevent the widespread practical application of these systems [8].

There has been rapid progress in BMI prediction and multidimensional prediction model by analyzing anthropometric features and uncertainties, as well as machine/learning models [9], [10], [11]. For users, providing a personal RGB image to

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