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Estimate BMI for Elderly Adults Based on Body Shape Remotely

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***Abstract*— Remote health monitoring of elderly adults is important. Since Body Mass Index (BMI) is highly correlated to many diseases, it is a good indicator for health monitoring. This paper presents new approaches to estimate BMI from 2D body images and videos. Besides proposing new anthropometric features, we create two visual-body-to-BMI datasets. The simulation results confirm the excellent performance of the proposed method comparing to other methods.**

I. INTRODUCTION

Aging in the population is an increasingly serious problem. Remote health monitoring with biometrics measurement will be important for the elder. Biometrics reflect health status and BMI is one of the most commonly used. Increased BMI is associated with an increased risk of many serious diseases. There are studies focusing on estimating BMI using 3D body and face features, frontal face images and 2D image/video. We present two methods for BMI estimation based on body shape extracted from the images/videos while protecting privacy. Two image datasets and one video dataset are used. Several anthropometric features are proposed and compared for BMI analysis. Two deep-learning models are developed based on body shape and Long Short-Term Memory (LSTM).

II. DATASETS AND METHODS

This work uses two datasets. The first one is a video dataset from a continuing care senior housing community including elderly adults' videos of various tests. Semantic segmentation[1] and face detection are used to detect and preserve the body area while blocking privacy. 91 objects' videos are used as the video dataset and 273 images are selected as the image dataset. The second dataset is an image dataset first collected by Min et al.[2]. We delete the improper images to form a new dataset.

To estimate BMI from images/videos, we first extract the anthropometric features. Body contour detection and skeleton detection[3] are applied on pre-processing. With body contour and skeleton joints' locations, related anthro-pometric features can be calculated. We propose a set of 8 features including head, shoulder, 4 waists, hip and thigh width to height ratio as illustrated in Fig.1. Extracting one feature vector for each image and using them in support vector regression, BMI can be predicted. For the video dataset, the first method applies SVR to predict BMI for each frame and then takes average of the prediction for a video to take advantage of large number of frames. The second algorithm is based on LSTM where the input consists of feature matrix with one feature vector per frame. We use stack-LSTM with one layer of LSTM and one layer of Bidirectional-LSTM which performs better than single layer.

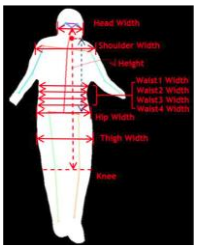

Figure 1. Computation of anthropometric features.

III. RESULTS

Mean absolute error (MAE) and mean absolute percentage error (MAPE) are used to compare performance. For image dataset, we apply 5-fold cross-validation, random shuffle and average the prediction performance over trials. Table I shows the performance. For the video dataset, we compare SVR with RBF kernel and LSTM method containing time information which performs better, as shown in Table Ⅱ.

TABLE I. COMPARISON ON CCSHC DATASET

Method	Feature extraction	MAE	MAPE
Min et al. [27]	5 features	4.086	14.37%
Proposed method	8 features	3.618	12.89%

TABLE II. COMPARISON OF BMI ESTIMATION ON VIDEO DATASET

Method	MAPE
SVR	12.3%
LSTM	11.6%

IV. DISCUSSION & CONCLUSION

We investigate the relationship between BMI and visual body shape and estimate BMI from body images and videos. We propose and extract a set of anthropometric features. A new dataset has been processed and a previous image dataset is modified to facilitate related study. The proposed approach yields better performance.

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