Comenius University in Bratislava
Faculty of Mathematics, Physics and Informatics

Automatic Human Anthropometric Body Measurements Estimation

Bachelor Thesis

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Abstrakt

Slovenský abstrakt v rozsahu 100-500 slov, jeden odstavec. Abstrakt stručne sumarizuje výsledky práce. Mal by byť pochopiteľný pre bežného informatika. Nemal by teda využívať skratky, termíny alebo označenie zavedené v práci, okrem tých, ktoré sú všeobecne známe.

Kľúčové slová: jedno, druhé, tretie (prípadne štvrté, piate)

Abstract

Abstract in the English language (translation of the abstract in the Slovak language).

Keywords:

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Introduction

Nowadays our physical bodies are not enough for us anymore. Thanks to modern technologies every day we come closer to living a new type of life. Virtual one. The beginnings were quite humble with us sharing our thoughts via text and shortly after empowering our life stories with images. Thanks to these innovations we were able to create a new type of business - online shops. Their popularity rose over the years and are now rivals to traditional ways of shopping. These new online stores however have a significant disadvantage in comparison. You cannot try the clothes on and see whether it will fit. Luckily we have already created clothing sizing system to help us choose the correct size. However to use this system one would need exact body measurements to look up correct size in the table.

Online shops however were not the only blooming business in recent years. A new prospect has appeared only just recently and it caught attention of big companies straight away. The virtual world where we could meet our friends living anywhere in the world without having to leave our home. In this world everyone would have their own avatar that would represent them. Some virtual worlds would let you become whoever or even whatever you could possibly think of while some others decided to stick with realism. Realism sounds great, but this approach requires realistic data to be able to look convincing. To create a clone of human body in the virtual world we amongst many variables would need exact body measurements to provide a believable result.

These are just two examples that require users to obtain their body measurements. While the act of measuring does not seem very problematic the measurements are prone to human error. There are no rules when it comes to measuring body parts. Usually, subjects are only guided via text or image showing them how to measure. This will never satisfy the accuracy that is required.

Thanks to progress in neural networks a new way of obtaining body measurements has emerged. With requiring only picture of body from from front we can train a neural network to predict measurements of human body. This has already been proven

plausible, but the accuracy stil lacked in some measurements. The goal of this work is to compare different .... (To make data better). The methods will vary to see how impactful they are regarding the final result.

For training we will use a synthetic dataset which will allow us to have much larger number of samples for training. For metrics we will use performance on dataset with real samples provided by BodyM dataset.

The first chapter will provide overview of the problematic, will look into traditional measuring methods, delve into obstacles this approach faces and then explain some of the mechanical works of this thesis. Second chapter will look into already existing work that is relevant to topic. In the third chapter we will define datasets. Contents of fourth chapter will focus on proposed solution and implementation. Results of our research will be located in fifth chapter while the sixth chapter will provide conclusion.

Chapter 1

Overview

1.1 Traditional measuring methods

Human body can be measured using many different approaches. All of these have their advantages and disadvantages. In this thesis we only need to introduce two of them.

1.1.1 Hand measurement

This is the traditional method of using tape measure for obtaining measurements. This approach usually needs one extra person that performs the measurement on the subject. This way the measurements are more precise than the subject using the tape measure without help. The measurements however have to be taken at specific locations to provide correct information in further processing. The locations vary depending on the use and thus there is no universal guide for their measurement. Whereas the professionals are familiar with them, the subjects are usually not as informed. This creates space for human error we are trying to avoid.

1.1.2 Digital measuring on 3D model

This method is mentioned because BodyM dataset uses this method to provide ground truth values. Is it based on photogrammetry scanner which creates precise meshes of scanned object. After the human body get acquired from the scanner they are registered to SMPL mesh topology. We can then use the resulting mesh for calculating the measurements.

1.2 Obstacles

One of the issues when working with human body measurements is the lack of real world data. The process of measuring is time-consuming and requires privacy measures to

take place to protect subjects' personal information. This can be avoided by using synthetic datasets.
Moreover the time complexity to train a neural network can be reduced by using powerful device which is not available.

1.3 Problem specification

The goal of this thesis is to expand on body measurements estimation with the use of neural networks. Mainly to explore different data augmentation methods to provide better results when training is done on synthetic dataset.

1.4 SMPL

SMPL is short for Skinned Multi-Person Linear model. This model is based on skinning and blend shapes. The model has been trained on thousands of 3D body scans to create a realistic human model. Full explanation of functions and workflow of this model is out of scope of this work.

1.5 Neural network

Neural network is code built on premises of how human brains work. It consists of connected nodes called neurons. Each neuron takes input variables, processes them and then sends the result to other neurons. Every connection has associated weight which determines the influence said value will have.
Neurons are then organised into layers. They are usually divided into input, output and hidden layers. The function of the hidden layers is to perform the operations needed to calculate output from the input data.
The process of training adjusts the weights of the connections. This automatic process of adjusting is usually based on comparing the output and correct value we provide for the network and minimising the difference.
This process helps the network to find complex relationships or patterns that may not be as understandable for humans.

Hyperparameter

Hyperparameter is a parameter that is not learned but chosen by developer. These parameters do not change over time. These can be - choice of optimizer, learning rate,

number of layers, filter size and more.

Our model is mainly built on the following layers:

Convolution layer

The convolution operation consists of moving small filter called kernel along the image computing the dot product between kernel and input producing activation map for said filter. The values in kernel are learnable parameters meaning they are adjusted over the training process.

Max Pooling layer

Max pooling is an operation of non-linear down-sampling. This means that the output image of this layer is usually smaller than the input. This helps to reduce parameters for next convolutional layer, providing faster training. This layer is defined by two hyperparameters:

- **Filter size** determines how many rows and columns are influenced. In case the filter reaches out of the array, only valid values are taken into consideration.
- **Stride** determines how many columns will the filter move.

The higher these hyperparameters' values are the smaller will the output be.
This layer iterates over input field and looks at subfield with size of filter size. In this subfield it finds the largest number and writes only the largest number into the output field. After this, the filter moves by stride columns left until all columns were checked. In that case the filter moves back to first column of the input field and then moves down by the stride.
This process is repeated until whole input field is iterated.

ReLU

1.5.1 Linear regression

In this thesis we will be using linear regression to predict human body measurements. The predictions are based on assumption of linear connection between variables.

1.6 Keras

1.7 OpenCV

Chapter 2

Related Work

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Chapter 3

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