On calculation of the human circumferential measures using wide angle lens photogrammetry system

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Abstract. To obtain circumferential measure from two photogrammetric images, one have to approximate cross-section of the body part by some parametric curve. In the present paper, different ellipse – like approximations are considered with the aim to minimize difference between results of the direct and photogrammetric measurements.

Keywords: anthropometrics measurements, photogrammetry**.**

Introduction

Measurements of the human body geometric parameters often become the important part of the patient screening programs. In particular, such measurements as height (recalculated to the body mass index), waist ant tight circumference are the first indicators of the overweight; the latter is an important risk factor. For modern screening applications, that is a tendency to replace traditional measurement tapes, rulers and calipers with computer-based devices; this allow to "unite" various diagnostic modalities in a single screening complex [1].

There are number of techniques, proposed for the measurement of the anthropometrics parameters; examples include rather expensive 3D scanners, stereophotography, marker-based systems etc. Photogrammetry, although requires just single camera and simple calibration object still demonstrates reasonable accuracy in evaluation of posture via linear or angular measurements [2]. Besides, for circumferential measurements, such as waist, hips etc, the accuracy of the measurement, based on two person's images, say lateral and frontal, depends on the shape, used to replace real body cross section [3].

The goal of the present research is to find approximation of the human cross-section that could minimize the inaccuracy of the photogrammetric measurements of the waist and hip circumference.

Method and results

Waist and hip circumferences of the twenty one (21) young volunteers, born 1991–1993, was measured by means of the flexible measuring tape. Further, subjects was positioned on the square platform (side 50 cm) with the cross, marked at the center and used for further image calibration. Frontal and lateral images were obtained by means of wide lens camera (focal length 2.3 mm), placed 2 m from the center of the platform and at the height of 1.5 m. Camera lens distortion was corrected, following [4].

Subject's cross-sections was approximated by ellipse-like lines:

$$y = \pm b\left(1 - \left(\frac{x}{a}\right)^2\right)^{1/2} \text{ – ellipse.} \tag{1}$$

$$y = \pm b\left(1 - \left(\frac{x}{a}\right)^3\right)^{1/3} \text{ – cubic ellipse.} \tag{2}$$

$$y = +b\left(1 - \left(\frac{x}{a}\right)^2\right)^{1/2}, y = -b\left(1 - \left(\frac{x}{a}\right)^3\right)^{1/3} \text{ – combined ellipse,} \tag{3}$$

where *a* and *b* are the semi-axes of the curve.

Semi-axes *a* and *b* were measured from the patient image for the waist and hip level cross-sections. The circumference of the corresponding cross-section was calculates by numerical integration of the Eqs. (1)–(3). The correlation between circumferences, measured by the tape and calculated form image measurements, are presented at the Fig. 1

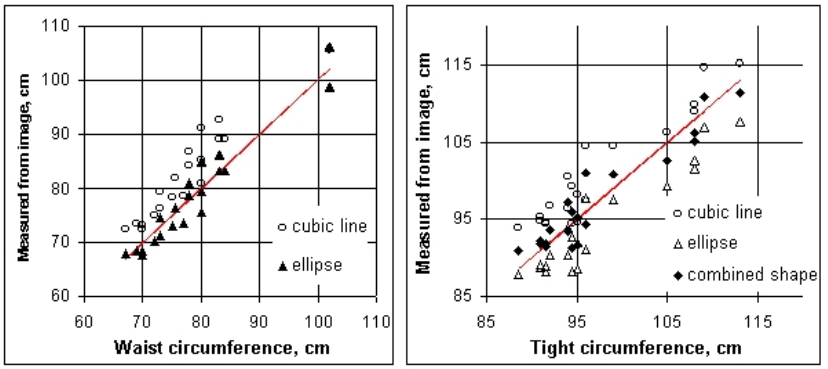

Fig. 1. Correlation between circumferential measures made "in nature" and from image: waist – left, tights –right

When the waist circumference is approximated by ellipse (Eq. 1), the difference between the photogrammetric and natural measurements of the waist was smallest and does not exceeded ±5.0 cm (P = 0.95). For the hip circumference, the best result was obtained for approximation 3, where the front side of the body is approximated by elliptic line (1), but rear side – by third order line (2): the above difference does not exceeded ±4.5 cm (P = 0.95).

Conclusions

With the proper selection of the approximation curve, circumferences measurements, made by photogrammetric method, demonstrates reasonable agreement with the "natural "data.

Acknowledgements

This work has been carried out in the framework of the European Regional Development Fund Project "Mobile Telemedicine Screening Complex", agreement Nr. 2011/ 0007/ 2DP/ 2.1.1.1.0/ 10/ APIA/ VIAA/ 008

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