DETERMINATION OF BALL GIRTH FROM BALL WIDTH AND BALL HEIGHT

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INTRODUCTION

In fitting a shoe, ball girth is an important foot measure. In the field of foot scanning devices it is therefore important to be able to determine the ball girth from foot scans. Foot scanners can be divided into 2 dimensional and 3 dimensional foot scanners. With a 3 dimensional scanner the 3 dimensional shape of the foot is measured, while a scan from a 2 dimensional scanner is based on pictures of the foot from a certain view (for instance bottom or side views). The choice to use one system or the other now depends on the need of a user to determine 2 dimensional (lengths, widths) or 3 dimensional (girths) foot measures. Because a 2 dimensional scanner is a relatively simple and cheap device, it would be very interesting to make it possible to calculate certain girth measures from 2 dimensional data by validated mathematical rules rather than to measure the 3 dimensional shape.

In literature and shoe business it is often assumed that the ball girth is 2.5 times the ball width (ball girth = 2.5 • ball width). In this study the possibility of determining the ball girth from 2 dimensional foot scans is examined. Both ball width and ball height are considered to be important and are taken as input parameters.

METHODS

In this study 134 male volunteers on active Dutch military duty participated. They are all from western-european origin and do not suffer from severe foot problems. The age of the volunteers varies between 18 and 30 with a mean age of 22 years (standard deviation 3 years). The right feet of the subjects were scanned with a Pedus foot scanner [www.human-solutions.com]. These scans were used as input for the TNO software for automatic determination of anatomical foot measures. Important foot points are determined (heel and toe point, ball points, foot centre) and corresponding width and girth measures.

RESULTS

In figure 1 the relationship between calculated ball girth, ball width and ball height are presented.

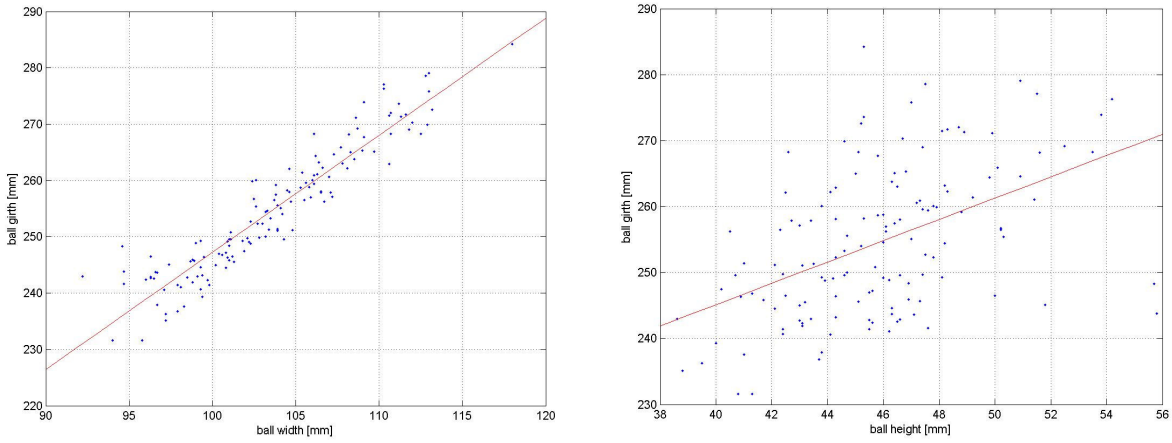

Figure 1: Ball girth as a function of ball width (left, equation of linear fit: y = 2.0787*x + 39.3719, correlation coefficient=0.938) and ball height (right, equation of linear fit: y = 1.6146*x + 180.5551, correlation coefficient 0.485).

A correlation analysis shows a Pearson correlation coefficient of 0.938 for ball girth and ball width, which means that there is a very strong correlation between ball width and ball girth [Cohen, 1988]. The equation of a linear fit through the data points equals y = 2.0787 * x + 39.3719.

The Pearson correlation coefficient between ball height and ball girth is smaller and equals 0.485, which means a moderate correlation (0.485<0.5 (threshold for strong correlation)) [Cohen, 1988].

DISCUSSION

Within the measured population, the assumption that both ball width and ball height might be necessary to predict the ball girth proves to be false. The results show that the ball girth can be predicted with only the ball width and that there is no strong correlation with ball height. The fact that there is no strong correlation between ball girth and ball height means that there is a large variation in height-distributions along a cross-section of the foot at the ball line. This also means that to get information about the shape of the ball cross-section, the height can not be predicted, so it should be measured.

To define the relationship between ball girth and ball width a linear fit is performed with the data points. With the equation of the fit (*y = 2.0787 * x + 39.3719)*, it is possible to predict the ball girth for a known ball width. The mean error that is made when using this equation equals 3.1 mm with a standard deviation of 2.4 mm. The difference between two width sizes for shoes is generally 5 mm.

REFERENCES

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