BEST: International Journal of Management, Information Technology and Engineering (BEST: IJMITE)
ISSN 2348-0513
Vol. 2, Issue 1, Jan 2014, 91-96

ENVISAGING TORSO AND FOOT FEATURES OF HUMAN BODY USING TOPINARD'S CANON SYSTEM

MANIMALA S & C. N. RAVI KUMAR

Department of Computer Science Engineering, SJCE, Mysore, India

ABSTRACT

Human body is composed of two arms, two legs, head, neck and torso. The organs are proportional in nature. In this paper, an attempt is made to anticipate the features of torso and leg of human body. Geometric features of the torso, leg and foot from 75 female and 78 male subjects were extracted. Topinard's Canon System is used to predict various features like throat to navel length, navel to knee top, knee length, beneath of knee to ankle, ankle to floor, navel to floor, hip to floor, body width near elbow, waist width, thigh width, knee width calf width, ankle width and shoulder width using only height of a person. Most of the features are estimated with an accuracy of more than 90%.

KEYWORDS: Human Body, Mean Absolute Error (MAE), Torso and Foot Features

INTRODUCTION

Human body is made up of head, neck, torso, two arms and two legs. Human torso is central part of the human body from which neck and limbs extend.

Canon proposed by Topinard is used widely by the artists to sketch the human structure. He defines the proportions of the human body. Human body is divided into 100 parts. All other features of the human body are computed as number of parts. Height of the person is first divided by 100. Topinard says that his work is an essay in rational anthropometry, and a very remarkable attempt for the period. According to Topinard's canon all the features are estimated using one hundredth part of the Height as shown in equation 1 [1].

$$\text{part} = \frac{\text{Height}}{100} \cdots \quad (1)$$

LITERATURE REVIEW

Takahashi and others have investigated a method to estimate human body posture. They have used back projection of human silhouette images which were extracted from multi-camera images in order to achieve an effective method [5]. Li, Jing-Feng and others have proposed a real-time system for tracking and modeling 3D human upper body. This system uses both color and depth information in order to track the upper human body [6]. Yamauchi and others have presented a method for 3D human body modeling using range data. The authors have proposed an iterative closest point (ICP) algorithm in order to resolve the gaps in the available body data [7]. Powar and others have proposed a methodology to analyze facial expression using two and three dimensional features [8]. Dan Luo and others have presented an approach to combine facial expression and hand gestures to analyze human gestures [9].

Manimala and Ravi Kumar are able predict various geometrical features of human structure using taalamana system with very good prediction accuracy [2, 3, 10]. They are successful in envisaging hand and facial features with the application of Topinad's canon system.

All 28 features of hand and face are envisaged with an accuracy of more than 85% using only height of a person [11]. They have forecasted the geometrical features of torso and leg using only height of a person by applying divine proportion or golden ratio [1].

MATHEMATICAL MODEL

All the features of the torso, leg and foot are estimated with the help of Topinard's canon system. One hundredth part of the Height is used to predict all the features. Body width at elbow is extracted using equation 2. Length of the body from throat to navel is computed using equation 3. Waist width is extracted with the help of equation 4.

$$\text{Body Width at Elbow} = 18 * \text{parts} \tag{2}$$

$$\text{Throat to Navel} = 23 * \text{parts} \tag{3}$$

$$\text{Waist Width} = 18 * \text{parts} \tag{4}$$

Length of the human body from navel to knee top is calculated as shown in equation 5. Knee length and width is extracted with the help of equation 6.

$$\text{Navel to Knee Top} = 30 * \text{parts} \tag{5}$$

$$\text{Knee Length} = 5 * \text{parts} \tag{6}$$

Length of the human body from knee to ankle, knee to floor, navel to floor, hip to floor using equations 7 to 10 respectively. Shoulder width is forecasted as twice head length using equation 11.

$$\text{Knee to Ankle} = 21 * \text{part} \tag{7}$$

$$\text{Knee to Floor} = 27.5 * \text{parts} \tag{8}$$

$$\text{Navel to Floor} = 60 * \text{parts} \tag{9}$$

$$\text{Hip to Floor} = 53.3 * \text{parts} \tag{10}$$

$$\text{Shoulder width} = 2 * \text{Head length} = 26 * \text{part} \tag{11}$$

FOOT FEATURES

The measurement of the foot is of peculiar interest to artists. Foot features are also been used as a canon of stature.

$$\text{Foot Height} = 3.3 * \text{parts} \tag{12}$$

$$\text{Left Foot Length} = 0.15 * \text{Height} \tag{13}$$

$$\text{Left Foot Width} = 5 * \text{part} \tag{14}$$

$$\text{Left Heel Width} = 3.5 * \text{part} \tag{15}$$

$$\text{Right Foot Length} = 0.15 * \text{Height} \tag{16}$$

$$\text{Right Foot Width} = 5 * \text{part} \tag{17}$$

$$\text{Right Heel Width} = 3.5 * \text{part} \tag{18}$$

ESTIMATION ANALYSIS

In order to quantify the difference between the actual and predicted value MSE (Mean Square Error) is used

extensively in statistics. The error is the amount by which the estimated value differs from the quantity being estimated [4]. Root mean squared error or RMSE is computed using equation 19 as the square root of MSE.

In order to measure the similarity between the forecasted value and the actual value Mean Absolute Error is used. The mean absolute error (MAE) is an average of the absolute errors and computed as in equation 20.The estimated value is f_i and y_i represents the true or actual value.

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{k}(f_i - y_i)^2} \tag{19}$$

$$MAE = \frac{1}{n}\sum_{i=1}^{k} abs(f_i - y_i) \tag{20}$$

Using Topinard's canon system all the length features are estimated with an average accuracy of more than 90%. Some of the width features like thigh width, calf width, ankle width are not possible to predict with good accuracy. Table 1 tabulates the statistical features like minimum, maximum, mean, standard deviation, root means square error, mean absolute error and prediction accuracy of the Torso and Foot features. Table 2 tabulates statistical features and analytical features of only female samples. All 16 features of torso, leg and foot are estimated with an accuracy of more than 90%. In table 3 shows statistical analysis of all 16 features of only male samples of human structure. Some of the features have prediction accuracy of less than 90%.

Table 1: Statistical Analysis of All the Samples

Features of Human Body		Min	Max	Mean	STD	RMSE	MAE	Prediction Accuracy
Torso Features	Body width at elbow	20	42.5	26.327	3.6159	3.3684	2.5096	90.735
	Throat to Navel	29	44.3	37.285	3.7929	2.9697	2.4578	93.483
	waist width	25	39	29.694	2.5269	2.9573	2.2905	92.158
	Navel to Top of knee	32.5	57.8	49.051	4.1454	2.7884	2.1639	95.586
	Knee length	5	10	6.9647	1.0727	1.8949	1.5178	90.818
	Lower of knee to ankle	29.5	42	35.929	3.5012	2.288	1.8218	94.864
	Knee to floor	41	55.3	47.288	3.7775	2.9033	2.3793	94.794
	Navel to Floor	80.5	117	98.982	7.1974	4.4095	2.6614	97.339
	Hip to Floor	66.3	102.5	89.147	7.3889	10.755	7.8313	91.972
	Shoulder Width	29.5	44.7	37.124	3.1373	4.0778	3.4035	90.145
Foot Features	Height of foot	4.6	10	6.9059	1.5705	1.3383	1.1265	84.557
	Left Foot Length	19.9	28	24.554	1.721	0.8886	0.69624	97.164
	Left Foot width	7	11	9.0556	0.95732	1.0268	0.85376	89.779
	Left Heel width	4.7	7.4	5.7144	0.63341	0.44248	0.3631	93.773
	Right Foot Length	19.9	28	24.572	1.7507	0.88009	0.68154	97.218
	Right Foot width	7	11	9.0565	0.95497	1.0277	0.85467	89.765
	Right Heel width	4.1	7.4	5.7118	0.66143	0.47349	0.38271	93.405

Table 2: Statistical Analysis of Only Female Samples

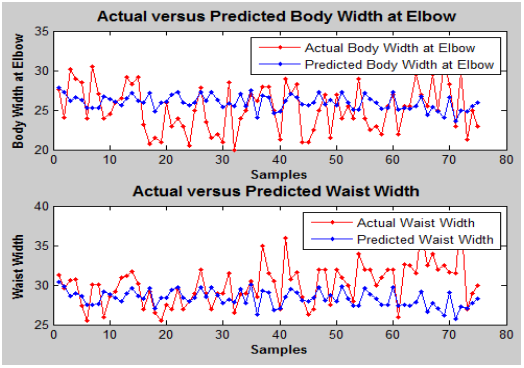
Features of Human Body		Min	Max	Mean	STD	RMSE	MAE	Prediction Accuracy
Torso Features	Body width at elbow	20	31	25.229	2.9099	3.0612	2.5227	90.26
	Throat to Navel	29	43.5	34.752	2.8851	2.9154	2.3627	93.461
	waist width	25.5	39	30.113	2.6639	3.3207	2.5198	91
	Navel to Top of knee	32.5	54	46.784	3.777	3.1361	2.3431	94.984
	Knee length	6	10	7.8107	0.66973	0.68463	0.50433	93.594
	Lower of knee to ankle	29.5	41.5	33.688	2.5836	2.1412	1.6634	95.08
	Knee to floor	41	50	44.78	1.8671	2.3395	1.9931	95.368
	Navel to Floor	86	102.5	95.1	3.7432	2.1353	1.6965	98.197
	Hip to Floor	83	100	92.064	3.848	2.69	2.0365	97.748
	Shoulder Width	31.5	44.7	37.905	2.8259	4.6135	4.0892	90.224

Table 2: Contd.,

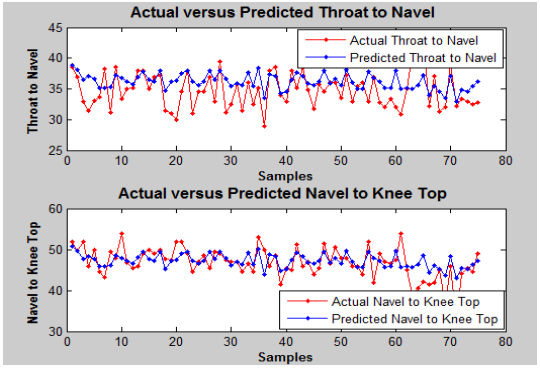
Foot Features	Height of foot	4.6	7	5.4707	0.57652	0.57831	0.50074	90.905
	Left Foot Length	19.9	25	23.201	1.1271	0.96383	0.74367	96.838
	Left Foot width	7	9.5	8.22	0.48015	0.61752	0.47753	93.856
	Left Heel width	4.7	6	5.2387	0.27257	0.39395	0.33406	93.981
	Right Foot Length	19.9	25	23.2	1.1189	0.95574	0.73433	96.878
	Right Foot width	7	9.5	8.22	0.48015	0.61752	0.47753	93.856
	Right Heel width	4.1	6.6	5.2293	0.36047	0.45269	0.37006	93.29

Table 3: Statistical Analysis of Only Male Samples

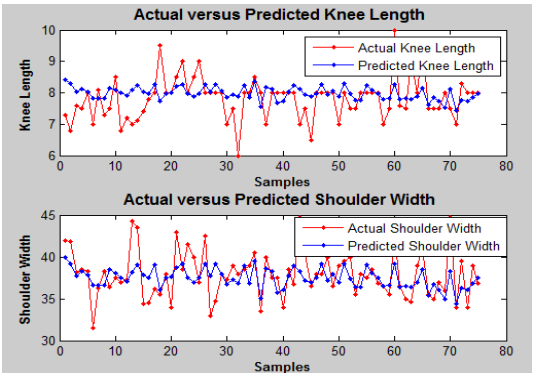
Features of Human Body		Min	Max	Mean	STD	RMSE	MAE	Prediction Accuracy
Torso Features	Body width at elbow	20.3	42.5	27.383	3.9203	3.6394	2.4971	91.191
	Throat to Navel	34.5	44.3	39.72	2.8536	3.0211	2.5494	93.504
	Waist width	25	33.2	29.291	2.3343	2.5596	2.07	93.272
	Navel to Top of knee	47	57.8	51.231	3.2236	2.4072	1.9917	96.165
	Knee length	5	8.1	6.1513	0.68798	0.9818	0.86872	87.383
	Lower of knee to ankle	31	42	38.085	2.861	2.4207	1.9741	94.656
	Knee to floor	42.9	55.3	49.699	3.5778	3.3574	2.7506	94.243
	Navel to Floor	80.5	117	102.71	7.7461	5.81	3.5891	96.514
	Hip to Floor	66.3	102.5	86.343	8.7915	14.83	13.403	86.417
	Shoulder Width	29.5	41.9	36.373	3.2541	2.8736	2.3675	93.521
Foot Features	Height of foot	6.4	10	8.2859	0.78343	0.82825	0.66154	91.518
	Left Foot Length	23.4	28	25.854	1.0632	0.8097	0.65064	97.476
	Left Foot width	8.8	11	9.8591	0.50345	1.3044	1.2155	85.859
	Left Heel width	5.4	7.4	6.1718	0.53686	0.48457	0.39103	93.573
	Right Foot Length	22.6	28	25.891	1.1187	0.80064	0.63077	97.545
	Right Foot width	8.8	11	9.8609	0.49159	1.3058	1.2173	85.831
	Right Heel width	5.4	7.4	6.1756	0.54229	0.49266	0.39487	93.514



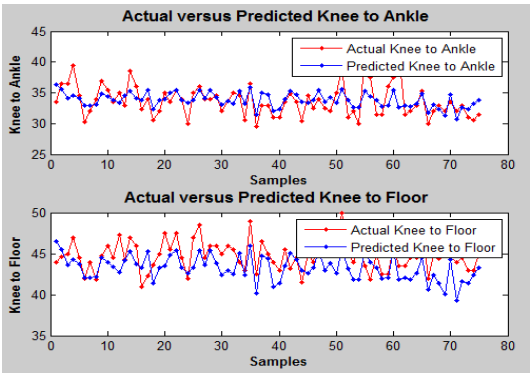
(a)



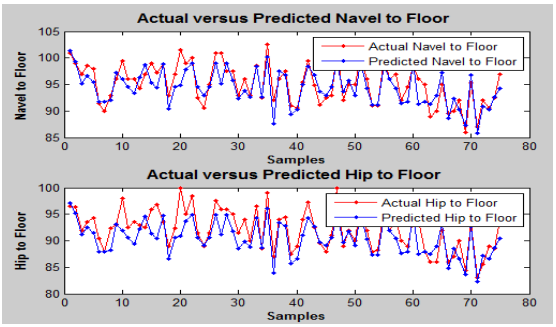
(b)



(c)

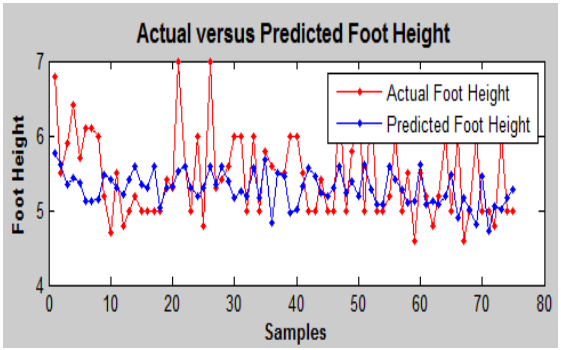


(d)

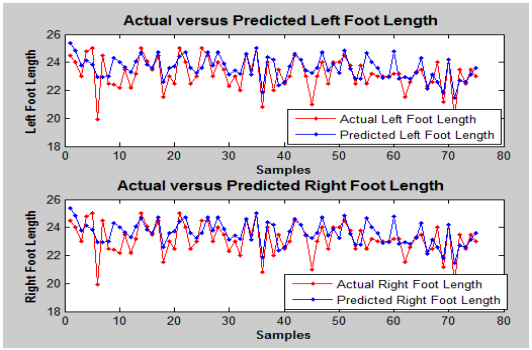


(e)

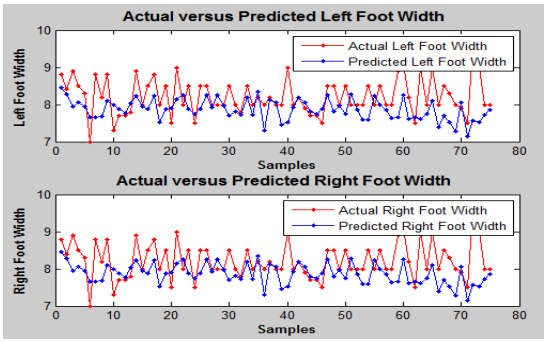
Figure 1 (a-e): Actual and Predicted Torso Features



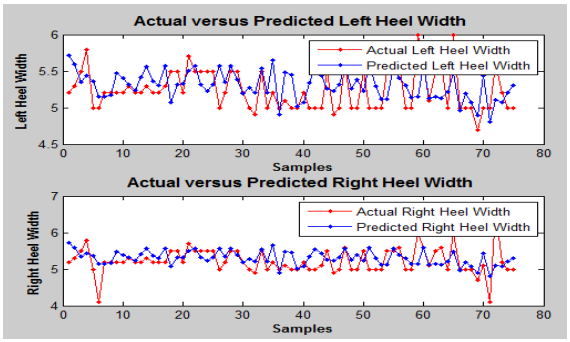
(a)



(b)



(c)



(d)

Figure 2(a-d): Actual and Predicted Foot Features

In figure 3, a set of around eighty samples are plot. Blue line indicates forecasted value and red line shows the actual value. An overlap in the plot depicts close association of actual value with that of the estimated value. In figure 3a actual and predicted value of body width at elbow and waist width is shown. Figure 3b shows the plot of distance between throat to navel and navel to knee top. Figure 3c shows knee length and shoulder width. Figure 3d indicates the plot of knee to ankle and knee to floor length. Distance between navel to floor and hip to floor is shown in figure 3e. All seven features of foot are shown in figure 4. Foot height is plot in figure 4a. Left and right foot length, foot width and heel width is drawn in figure 4b, c and d respectively.

CONCLUSIONS

The task of estimating 10 features of the torso and leg is accomplished with the help of Topinard's canon system. All the features are estimated with an accuracy of more than 90%. Height of the foot and 3 features of left and 3 features of the right foot are predicted with the help of height of a person. Table 1, 2 and 3 tabulates the statistical analysis of all the features for both male and female samples, only female samples and only male samples respectively. Only height of the person is used to predict all the features of torso, leg and foot.

REFERENCES

1. Manimala. S and C. N. Ravi Kumar, "Anticipating Torso and Leg Features using Golden Ratio", International Journals of Management, IT & Engineering (IJMIE), IJMRA, Vol: 4 , Issue:1, ISSN: 2249-0558
2. Manimala. S and C. N. Ravi Kumar, "A Novel Method of Anticipating Torso and Leg Features using Taalamana System", International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE), ISSN: 2277 128X Vol:3 Issue:10, Oct 2013, pp 254-260
3. Manimala.S and C.N.Ravi Kumar, "A Novel Method Of Estimating Facial Features Using Taalamana System", International Journal of Computer Science Engineering an Information Technology Research (IJCSEITR); ISSN(Online): 2249-7943; June 2013, Transstellar Journal Publications, Vol 3, Issue 2, pp201-208
4. http://en.wikipedia.org/wiki/Mean_squared_error
5. Takahashi, Kazuhiko, Nagasawa, Yusuke; Hashimoto, Masafumi, "Remarks on 3D human Body Posture Estimation using Simple Multi Camera System", 32nd Annual Conference on IEEE Industrial Electronics, IECON 2006.
6. Li, Jing-Feng, Xu, Yi-Hua; Chen, Yang; Jia, Yun-De "A Real-Time 3D Human Body Tracking and Modeling System" IEEE International Conference on Image Processing, 2006
7. Yamauchi, Koichiro, Bhanu, Bir; Saito, Hideo, "3D Human Body Modeling Using Range Data" 20th International Conference on Pattern Recognition (ICPR), 2010
8. Powar, Nilesh U. , Foytik, Jacob D.; Asari, Vijayan Vijayan; Vajaria, Himanshu "Facial expression analysis using 2D and 3D features", IEEE conference on National Aerospace and Electronics Conference (NAECON), 2011
9. Dan Luo, Ekenel, Hazim Kemal, Jun Ohya "Human Gesture Analysis Using Multimodal Features", IEEE International Conference on Multimedia and Expo Workshops, 2012
10. Manimala. S and C. N. Ravi Kumar, "Forecasting Arm And Foot Features Of Human Body", International Journal of Management, Information Technology and Engineering, BEST Publications, Vol:1 , Issue:3, ISSN:, pp : 147-158
11. Manimala.S and C.N.Ravi Kumar, "Envisaging Hand and Facial Features of Human Body using Topinard's Canon System", International Journal of Advanced Research, ISSN: 2320-5407, impact factor: 1.659, Vol: 1, Issue:8, Oct 2013, pp:215-222