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Computerized gender determination from human sternum& manubrium X-Ray Measurements

Mahima Shanker Pandey[1], Sudhir Singh Soam[2], Surya Prakash Tripathi[3]
Computer Science and Engineering Department, Institute of Engineering And Technology, Sitapur Road Lucknow Uttar Pradesh, India.mahimashanker@gmail.com[1]
Institute of Engineering And Technolgy, Sitapur Road Lucknow, Uttar Pradesh, India sssoam@gmail.com[2]
Institute of Engineering And Technology, Sitapur Road Lucknow, Uttar Pradesh, India, tripathee_sp@yahoo.co.in[3]

ABSTRACT

Social class resolution from human bones is one of the important results of investigative research. The technique of gender evaluation has to cope with the calculation of bone length. Different studies were suggested based on methodologies where the use of laboratory equipment was used to evaluate manuals. Individual bones will be assessed for gender identification on human bone remains, such as the skull, pelvic bone, lengthy bones that provide precise readings of 95% to 100%. In this research, we suggested a method for the relationship between different sternal lengths and the known sex of the deceased was studied in a sample to use automated sex assessment from the Indian population's rib-cage image.

Key words: Hytrl Law, Thresholding, Erosion, Masking, X-ray, Manubrium, and Meso-sternum.

1. INTRODUCTION

The study of the bone image is an important topic of research in bone science and associated areas. Generally, bone image processing is done through manual methods that are prone to error and repetitive. As such, the extraction of whole bone cross-sections is impractical, if ever necessary. It means conclusions from a very small number of bone samples have to be drawn.

In forensic or archeological conditions, gender identification of unknown skeletal remains is one of the main functions. Skeletal organ evaluation is a very effective and helpful area of research. Gender assessment is among these the most important to explore the identity of a skeleton. The size, shape, and composition of human bones differ between males and females. Many bones such as the skull, pelvic, and long bones that measure skeletal sexual orientation with 95-100 percent accuracy. In case the skull and pelvic are not offered, the sternum for gender estimation can be evaluated as a reliable bone.

1.1 Skeleton Anatomy

Although the term sternum refers to the straight bone in the front of the chest. The ribs and sternum contain what has been known as the ribcage. Lungs, veins, and heart, alongside segments of the spleen, stomach, and sternum ensured kidney. The sternum comprises three parts called the manubrium, the body and the procedure of xiphoid. The pieces of the sternum are joined in grown-ups. Manubrium or handle is the highest point in the sternum. as depicted in Figure 1 accepted,

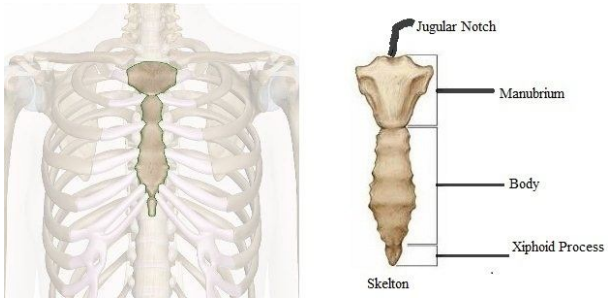

Figure 1: The structure of the human skeleton and sternum

1.2 Hytrl Law*:* In 1890, Hyrtl has predicted a sexuality norm in the sternum bone, [1][2] that is:

(i) The sternum body in male samples will exceed twice the manubrium length

(ii) The sternum body in female manubrium samples is more than half the sternum body size.

2. PREVIOUS WORK

Table 1: List of a review article for the measurement of manubrium and meso-sternum

Author	Description
Dwight and Hyrtl[1][2]	Contribution: "The ratio of manubrium and meso-sternum was 1: 2 in women and

	lower in men."
Dahiphale et al.[3]	Contribution: "The length of the meso-sternum was more than 88 millimeter, the sternum was male, and if less than 76 millimeters, the sternum was female."
Ashley(1956)[4]	Contribution: "In the European population, the sternal length for males was 149 millimeters and smaller in the female."
Jit et al.(1986) [5]	Contribution: "In the northern Indian population found that the manubrium length in men was 51.73 millimeters and in women, the length was 48.42 millimeter. The summation of the length of manubrium and meso-sternum was 147.08 millimeter in men and 127.02 millimeter in women."
Gautam et al.[6]	Contribution: Manubrium – Male – 53 mm Manubrium – Female – 48 mm Total(Manubrium + Mesosternum) – Male – 149 mm Total(Manubrium + Mesosternum) – Female – 124 mm
Atal et al.(2008)[7]	Contribution: "The size of the manubrium in females is less than 33 mm, in male manubrium length is more than 63 mm. The sternum is less than 48 mm in the female body size, more than 106 mm in the male body."
Osunwoke et al.[8]	Contribution: "The manubrium sizes estimated were 60.7 10.7 mm and 46 6.13 mm respectively. The meso-sternum sizes for males and females were 101.3 13.22 mm and 77.9 7.07 mm."

Dr. Partha Pratim Mukhopadhyay [9] designed a study to find adult sternum sexual dimorphism in a population-specific autopsy using discriminating feature analysis of 70 adult bones (35 males and 35 females). The researcher found that sternum had sexual dimorphism while reading about the population (Indian Bengali). Selthoferet al.[10] the sternum was standardized according to the size, structure, and intercourse, and the stage of the well-known sternum was reached. Bongiovanni R[11] used a feature to provide the United States population with an accurate classification attribute for estimating and using gender. An average cross-validation classification rate of 84.12 percent for intercourse assessment was generated by the discriminating characteristic assessment. The cross-validation price for men and females used to be 80 percent and 88.24 percent respectively. Mahajan et al [12] suggested that, out of all the parameters of the sternum, the blended length of manubrium and meso-sternum is the most vital parameter which, when applied to a character specimen, can help to effectively sex the stern in the North Indians. Automated techniques for evaluating bone's age then detect human bone's disease which has been already suggested. This paper introduced a semi-auto methodology that integrates image processing methods to simplify the sex estimation process.

3.AUTOMATIC APPROACHES FOR MEASUREMENT OF BONE FEATURES

There are various automated techniques proposed by various researchers for bone feature analysis and measurements like bone age assessment and disease diagnosis. Z.-Q, LIU et al [13] presented an approach to the quantitative theory of human bone cross-sections using digital imaging techniques. They involve steps like pre-processing, image segmentation and other image processing techniques. Sergio Vera [14] presented a method for detection and characterization of finger joints in hand radiography images. Here a fully automatic method for detection and characterization of hand joints has been developed. The proposed method substituted existing strategies with a detection rate above 95 percent. A web-based histogram technique for bone age assessment has been proposed by Marjan Mansourvar and others [15]. Marjan et al [15] image identified with 551 male and 549 female X-rays of hand and wrist. It method uses CBIR to extract images based on object quality and metadata using the corresponding histogram to improve sensitivity to main hues. The mechanism was tested using 32 samples from four different ethnic and gender groups, having returned an average error rate of -0.170625 years.

3.1 Applications Challenges

(a) **Time-consuming manual estimation of sex:** The manual gender evaluation technique requires quite some time as it requires many measurements to predict the actual bone trait to be analyzed.

(b) **Human error occurs during manual measurement:** The conclusions got through the manual approach for sex assessment may be inaccurate which is caused by evaluating bone characteristics by human manual calculation.

(c) **Expertise needed for manual measurement instruments:** To handle the laboratory instruments utilized for evaluation of various characteristics of bone to determine the sex of unknown human skeleton found, then an expert understanding of the genetic and structural characteristics of the human body is needed.

(d) **Costly specialized instruments for manual measuring:** To evaluate the bone characteristics to be analyzed, certain particular measuring and statistical instruments are needed.
(e) **Skeleton Distorted Bones Availability:** Sometimes the skeletons found have damaged structures and distorted bones as death can result from an explosion or natural disaster. The correct results will not be obtained by manual measurement.

3.2 Experimental data set

The Skeleton X-ray image is taken by the Department of Medical Informatics [16], Aachen University of Technology, Germany, entitled "10,000 IRMA images in 57 categories for Image CLEFmed 2005." From this dataset, with any distortion in pixels, we consider only the front seen and clear images.

4. MATERIAL AND METHODS

The proposed method was used to test IRMA[16] image dataset of sternal bone images of obscure human collections of individuals over 25 years of age. We looked at 200 skeleton images of every Indian male and female. Manubrium and mesosternum are the combined portion of the sternum, which is shown in Fig2. The tool tries to find the manubrium(X) and mesosternum (Y)length in the sample.

Figure. 2: Parts of Sternum
X= Length Of Manubrium
Y= Length of Mesosternum(Body)

Since acquiring X & Y, we'll identify a comparison respectively. The data collected will also be evaluated to determine the gender variations. When Y is more than twice the human male sternum image, and vice versa [6].

4.1 Applied Methodology

1. Read the image in the MATLAB environment
2. Resizing the image
3. Binarization of the image
4. Masking the image at an appropriate threshold
5. Open operator
(Remove all area that is more than specified pixels)
6. Erode and hole filling
7. Extracted edge
8. Split the Manubrium and Meso-sternum
9. Measure the length of the split object
10. Result analysis for the determination of gender (Flow chart is given in figure)

4.2 Flow Chart

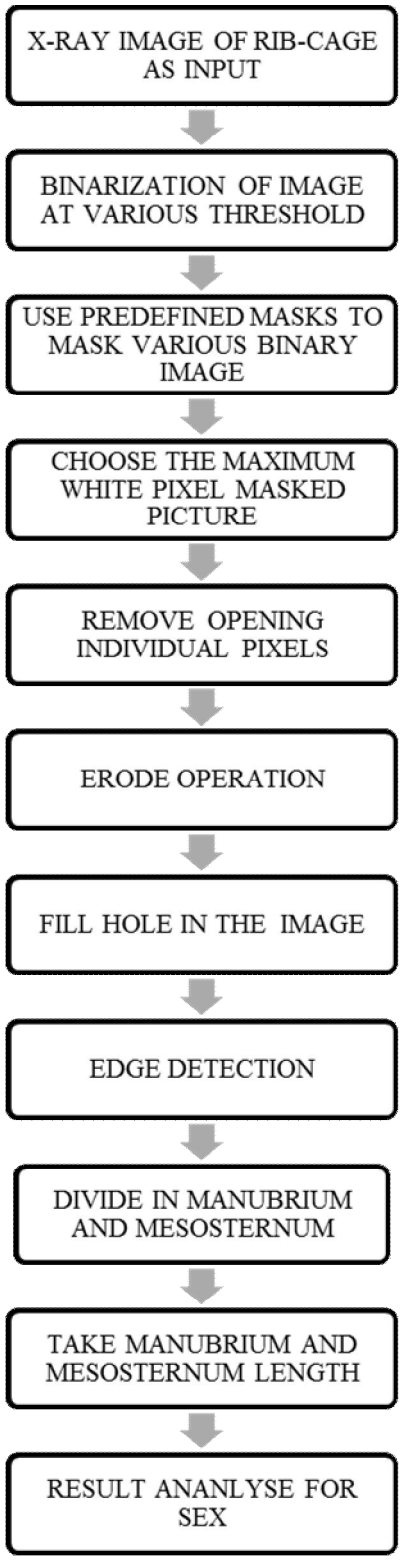

Figure 3: Flowchart

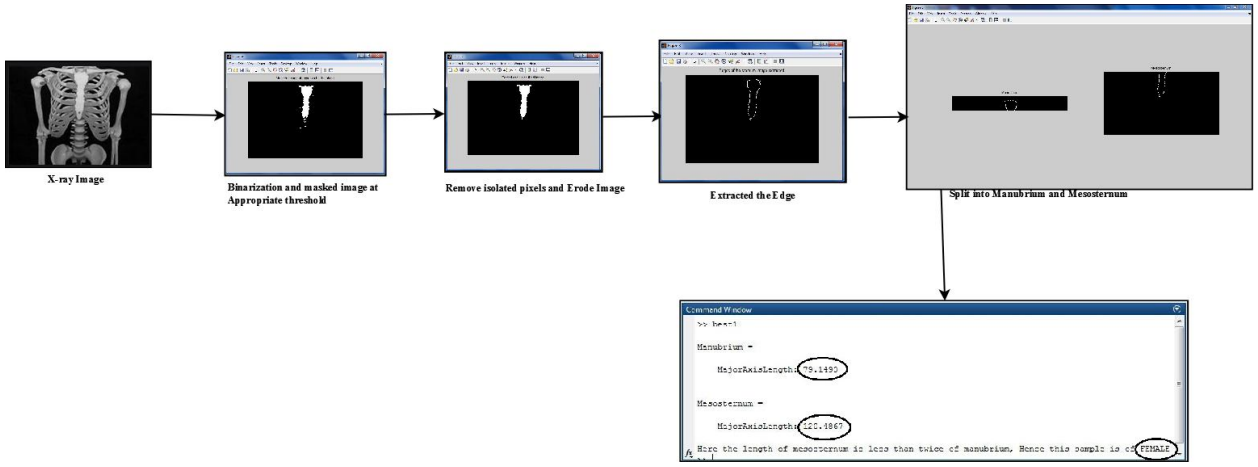

Figure 4: Proposed Approach

The provisions of the estimations just as the files of estimation are characterized in the table and relate to given in fig.3 The information got was then assessed by distinct measurements, finding the mean, standard deviation, least and limit of all information for each sex. An autonomous t-test was utilized to quantify the centrality of varieties in both genders for both mean estimations of various parameters. One sample Kolmogorov – Smirnov test to all parameters was performed to decide whether the information was ordinarily appropriated Two estimations of manubrium and meso-sternum were determined to discriminant examination to choose the variable among guys and females with a higher percentage.

Table 2: Description of the measurements used in this document the calculation is shown in figure 2 and Figure 3

Measurement	Definition
Manubrium Length(X)	Distance from the front and midline, from the jugular to the manubriosternal junction
Mesosternum length(Y)	Distance from the front and midline, from the manubriostern to the mesoxiphodial junction
The combined length of manubrium and body(X+Y)	Sum of length manubrium and meso-sternum (X+Y)
Sternal Index (SI)	Division of X is computed by Y, multiplied by 100:[(X/Y)x100]

5. RESULT

Table 3: Showing an examination of the aftereffects of the present investigation with a similar researcher for manubrium length and length of mesosternum

				Manubrium (X)		Mesosternum (Y)		Manubrium+Mesosternum		
Sr. No.	**Authors**	**Gender**	**No. of samples**	**Mean Length**	**Difference In Mean**	**Mean Length**	**Difference In Mean**	**Mean Length**	**Difference In Mean**	**Sternal Index**
1	Dwight(1881)[1]	M	30	51.5	5.1	105.9	16.5	156.7	20.6	48.63078
		F	26	46.7		89.4		136.1		52.23714

2	Dwight(1890)[2]	M	142	53.7	4.7	110.4	18.5	164.1	22.8	48.6413
		F	86	49.4		91.9		141.3		53.75408
3	Ashley(1956) [17]	M	85	45.9	1.7	96.5	13.6	142.6	15.5	47.56477
		F	13	44.2		82.9		127.1		53.31725
4	Jit (1986)[18]	M	312	51.73	3.31	95.35	16.75	147.08	20.08	54.25275
		F	88	48.42		78.6		127.02		61.60305
5	Gautam,R.S. et al[6]	M	56	53	5	95	19	149	25	55.78947
		F	44	48		76		124		63.15789
6	Dahiphaie V.P et al(2002)[3]	M	96	48.458	4.677	94.427	24.236	142.196	29.324	51.31795
		F	47	43.781		70.191		113.872		62.37409
7	Staurch(1881)[19]	M	200	…..	……	110	20	…..	….	
		F	….	….		90		……		
8	Paterson(1904)[20]	M	310	52	4.7	103.7	12.7	…..	…….	50.14465
		F	126	47.3		91		…		51.97802
9	Present Work	M	90	50.88	1.56	116.66	32.32	167.55	15.46	43.45
		F	110	52.44		86.68		152.09		59.89

Table 4: Statistical examination of different sternal estimations (N = 200, Male = 90, Female = 110)

Parameter	Gender	No. of samples	Mean of sample	**Standard Deviation	Minimum	Maximum	Difference of Mean	The level of value for the mean difference
X(Manubrium Length)	M	90	50.88	27.84	21	115	6.21	p<0.001 t=0.7903
	F	110	57.09	23.11	23	97		
Y(Mesosternum Length)	M	90	116.66	62.35	56	262	21.66	p<0.001 t=-0.7279
	F	110	95	37.23	40	170		
Combined Length(X+Y)	M	90	167.55	90.023	77	377	15.46	p<0.001 t=-0.2253
	F	110	152.09	59.48	63	260		
Sternal Index(X*100/Y)	M	90	43.45	4.02	37.5	47.91	16.44	p<0.001 t=5.989
	F	110	59.89	7.45	52.04	75.28		

****Standard Deviation:** It is estimated standard deviation based on the sample.

Table 4 shows that all sternal measurements examined, manubrium length (X) and meso-sternum length (Y) were in males higher than in females, with p=<0.001 in all measurements studied.

According to Wenzel (1788)[21], the manubrium in both genders is practically identical in size, however, the meso-sternum in males is relatively longer than in females. This led to Hyrtl's assertion that the index of manubrium corpus (sternal index) reaches 50 in females and less than 50 in males. Table 5 shows the percentage of cases obeying the law in the two sexes. In this report, 55 % female and 45% male samples comply with the law.

Table 5: Ability of Hytrl's Law(X/Y *100) as Recorded by various authors

Number & percentage of cases that comply with the law of Hytrl((X/Y x100=< 50 Male, >50 Female) as reported by a different researcher

Sr. No.	Authors	Gender	No of Specimens	% Obeying Law
1	Dwight(1881)[1]	M	30	
		F	26	
2	Dwight(1890)[2]	M	142	59.10%
		F	86	60.40%
3	Ashley(1956)[17]	M	85	64.70%
		F	13	69.20%
4	Jit (1986)[18]	M	312	
		F	88	
5	Gautam, R.S. et al[6]	M	56	
		F	44	
6	Dahiphaie V.P et al(2002)[3]	M	96	52.20%
		F	47	100%
7	Staurch(1881)[19]	M	200	
		F	….	
8	Paterson(1904)[20]	M	310	
		F	126	
9	Patermoller(1890)[22]	M	90	65.00%
		F	100	
10	Krause(1897)[23]	M	..	
		F	14	43%
11	Narayan & Varma (1958)[24]	M	126	34.12%
		F	27	81.48%
12	Present Study	M	90	45%
		F	110	55%

6. CONCLUSION

This algorithm works on sternum image shapes and sizes. The hypothesis of Hyrtl is strongly confirmed by the result obtained using this technique. Thus, this computer analysis enabled the automated sternum bone detection technique to estimate the gender of unidentified human skeletons. This reduces the time and expenses of manual sex identification.

This algorithm can be improved by applying a gender estimate to other bones of the unseen human skeleton. The solution is a fully automated process with pre-processing, ROI segmentation, thresholding, edge detection, and decision making. The unknown human skeleton's age, height, and sexual orientation can be distinguished by using the algorithm.

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