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Prostate Volume Measurement Using Image Matching

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Abstract: The main objective of this research is to measure the abnormality of the prostate using image matching techniques by cross correlation to compare the volume of the a reference normal case and patient abnormal prostate enlargement volume case, in order to compute the amount of prostate volume enlargement ratio which represents an approximate amount of prostate volume enlargement and may be used by specialist as a diagnostics tool for farther patient treatment. So the specialist can measure patient prostate irregularity using this approach after overlapping and matching volume enclosed by patient abnormal case with volume of the normal case as reference value taken into consideration both age factor and the body mass index BMI. Furthermore, this paper also implement a statistical analysis by computing average, standard deviation and variance differences respectively between patient image and reference image, the outcomes of the three statistical differences give the exact amount of prostate enlargement, which will be represented by ratio that indicates the exact amount of the prostate enlargement.

Keywords: Image processing, computer vision, computer-medical application, prostate diagnostics tool, Image matching.

1 Introduction

Most men after the fifth decade experience symptoms or have histology consistent with prostate growth and benign prostatic hyperplasia (BPH) where the normal size of prostate gland is about the size and shape of a walnut or golf ball [1-3]. When enlarged, the prostate may obstruct urine flow from the bladder and out the urethra. Comparing normal and enlarged prostate glands for different ages & taken into account Body mass index (BMI) which measure body fat based on height and weight that applies to adult male [6]. Figure 1- illustrates the size of the prostate varies with age [2-5]. In normal adults, the prostate is about the size of a walnut, but it can become significantly larger in older men. Around the age of 40, the prostate gland tends to enlarge as the result of a condition called benign prostatic hypertrophy (BPH) [7-9]. A healthy adult prostate weighs about 20–25 grams (2/3 to 3/4 of an ounce). Body mass index (BMI) is a measure of body fat based on height and weight that applies to adult male, there is a relation between prostate size and weight where the prostate volume would increase if BMI is greater, and in this research BMI calculated using the following formula (1) [10-14]:

BMI = Weight / (height)2 Kg/m2 ….. (1)

Prostate volume significantly increased approximately 25% From the lowest Class-1 to highest Class-4 according to Given body mass index (BMI) categories, for example an age 20 average male of Class-1 has a prostate as the volume of a walnut approximately 10 cm3 while Class-4 male of same age normally has a prostate volume almost 25% greater than male of class1 which is approximately 12.5 cm3. The BMI classes illustrated in table 1

Table 1: BMI categories.

Classes	BMI Value	Weight category
Class 1	<18.5	Under weight
Class 2	18.5-24.9	Normal weight
Class 3	25-29.9	Over weight
Class4	Greater than 30	obesity

2 Literature Survey

Table 2, shows the benchmark of previous researches compared to present work.

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Table 2: benchmark of previous researches compared to present work.

Methodology	Outcome
Ng Kent Hoo et al, study proposes the use of transabdominal scanning in the measurement of prostatic volume.[1]	The findings show that the prostate size is affected by body size, which means weight and height.
Evelyn L.M. Ho, study has important roles including prediction of the progression of benign prostatic hyperplasia BPH ,[2]	The size is correlated with urine flow and rising serum prostate specific antigen levels. Data indicate that there is weak relationship between prostate size and the International Prostate Symptom Score.
Ng Kent Hoo et al The objective of this study is to find the relationship between body weight, height, body mass index and ethnicity to prostatic volume of Malaysian population.[3]	The findings show that prostate volume increases linearly with body weight and height of a person and almost linearly with BMI.
Deian Stefan, The present study introduces a different method of filtering speckle noise without a significant loss of edge detail in the filtering process.[4]	An algorithm based on sticks filtering to detect the body of the prostate is developed, with a success rate of 88.9%. The second goal of the study, to delineate the prostate body, was unsuccessful
Hee Jo Yang et al, the International Prostate Symptom Score (I-PSS) questionnaire implemented. Anthropometric measurements were determined. Serum PSA, urinalysis, and transrectal ultrasound were also performed.[8]	Data showed that PV positively associated with central obesity, as represented by WC. In contrast, serum PSA negatively associated with BMI, which represented overall obesity (ie, hemodilution). Our data also suggested that obesity is not associated with lower urinary tract symptoms in Korean men.
To correlate prostate size estimates performed by single or multiple examiners through digital rectal examination (DRE) with volume measured by transrectal ultrasound (TRUS) and to propose measures for predicting prostate volume using DRE estimates in clinical settings.[11]	DRE underestimates prostate size, particularly if TRUS volume is greater than 30 mL. However, DRE estimates may help identify prostates likely to be larger than certain cutpoints by TRUS. Posterior SA may be useful as a preliminary assessment when prostate size is an important predictor of therapeutic response.
This study use image matching techniques by cross correlation and implements a statistical analysis by computing average, standard deviation and variance differences respectively between patient image and reference image	The outcomes of the three statistical differences give the exact amount of prostate enlargement, which will be represented by ratio that indicates the exact amount of the prostate enlargement.

3 Methodologies

In this research recognition technique based on matching between a normal reference image and the patient abnormal prostate raw image in order to find out the difference between them in volume which represents the percentage of prostate volume enlargement. There is a preparation stage to obtain a suitable pattern to be matched for both the reference and the measured. While, Figure 2; illustrate a prototype model to measure the prostate volume Enlargement, taking into consideration different age indices and BMI. The model preparation and matching stages include the following steps, where the patient Prostate Image will be read then convert from gray to binary scale, Vertical-Horizontal structuring applied. Also filling interior gap, connected object borders to be removed. Then Smoothing object using segmented image. The final image will be ready for matching process as illustrated by the flowchart in Figure 3.

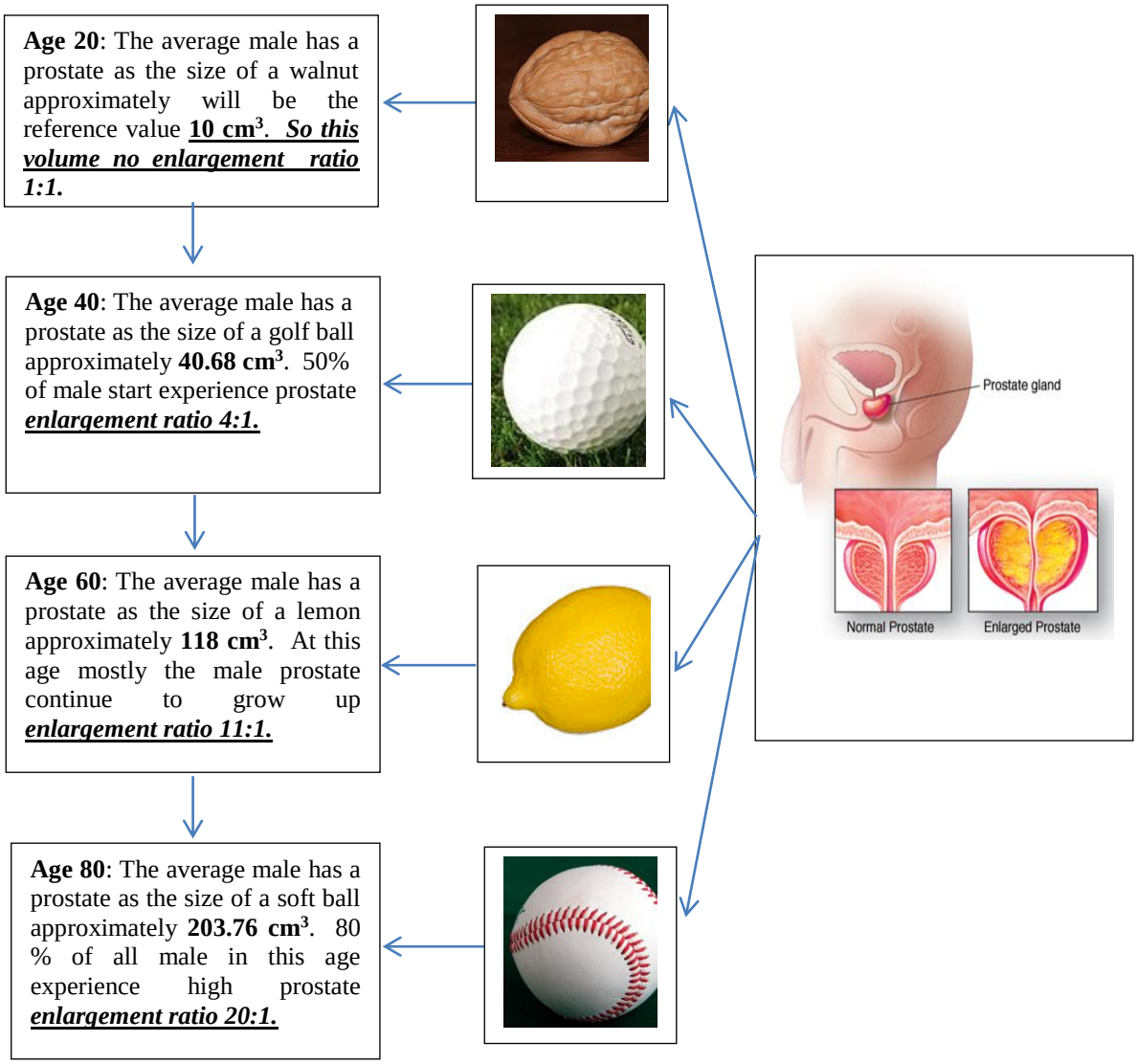

Fig. 1: The Prostate volume enlargement ratio with age life cycle.

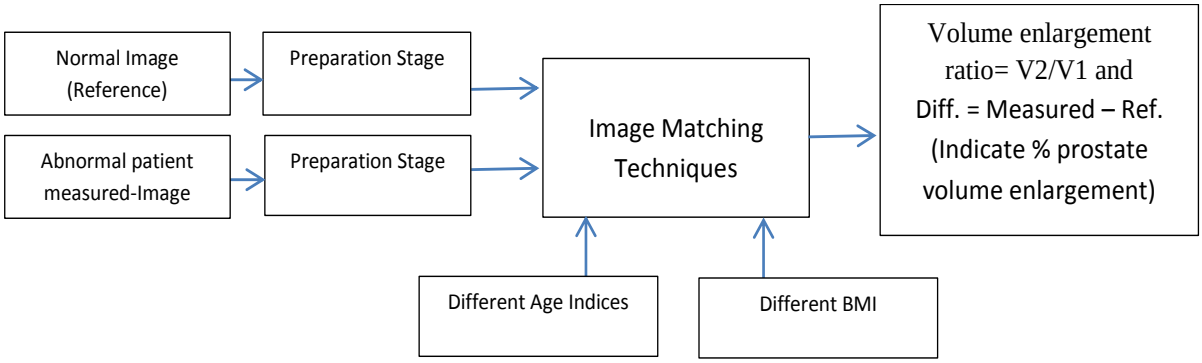

Fig. 2: Image matching model to measure prostate volume enlargement.

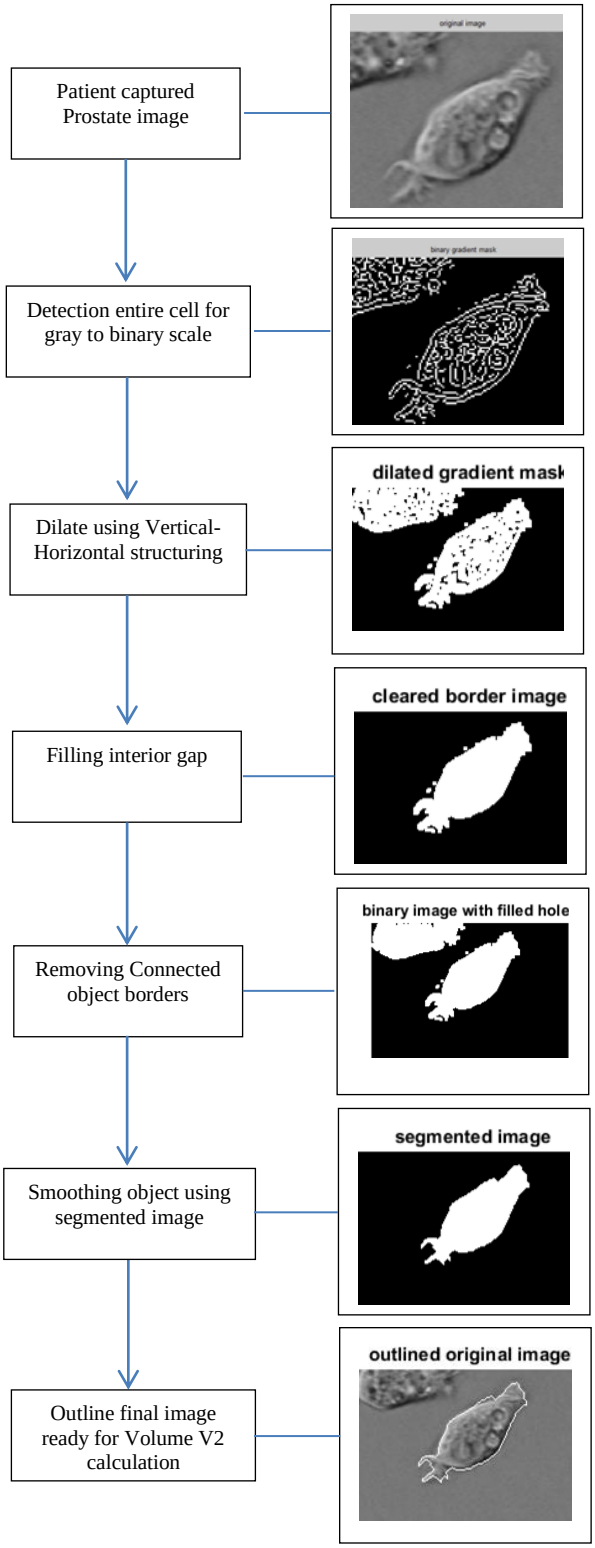

Fig. 3: Image preparation for matching process flow chart.

4 Result Analysis of Image Cross Correlation

The challenges that occurs in template matching is in calculating the similarity measure of the aligned patient measured image 2 captured by ultrasonography obtained in Figure-3 and reference input image1, which is equal to calculating a similarity measure of similar images dimensions by cross correlation. There are 10 samples have been examined and validated in this research from different ages (20-80) and with different BMI (Class 1 - 4). The numeric measure of images similarities is identified as image-correlation, where image1 (represents normal prostate volume V1 for given age & BMI) and image 2 (represents measured patient prostate volume V2 captured by ultrasonography), assuming both images 1, 2 their pixel coordinates p and q have same dimensions.

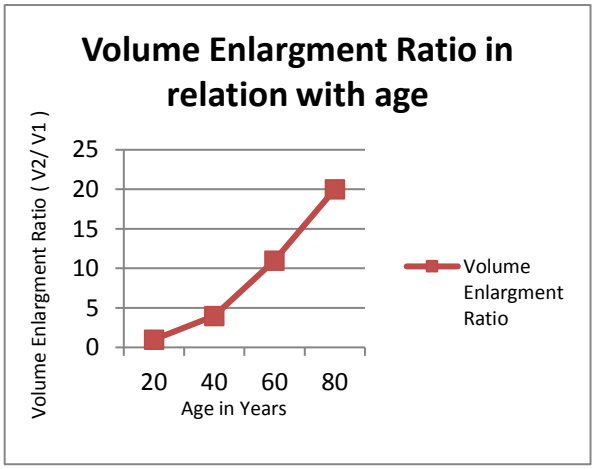

Fig.4: Reference chart of prostate volume enlargement ratio (V2/V1) with age factor.

Figure 4 shows the created reference chart of prostate volume enlargement ratio (V2/V1) with age factor, of course patient BMI also taken into consideration for average BMI classes (1 & 2) in given reference chart. The important strategy of calculating the image correlation is so mentioned to as cross-correlation, which is mainly a simple sum of pair wise multiplications of corresponding pixel values of the images as given below in equation (2):- .

$$\text{Cross\_Correlation}(\text{Image1}, \text{Image2}) \sum \text{image}(1, p, q) \times \text{image}(2, p, q) \quad .(2)$$

5 Results of Volume Enlargement Ratio and Statistical Analysis

- Volume measure of the space enclosed by the normal prostate boundary given by V1 as reference value taken into consideration the 10 samples of different age & BMI factors as illustrated by Figure-4 ;
- Volume enlargement ratio= V2/V1, ratio represent approximated ratio of volume irregularity, where V2 is the volume enclosed by patient abnormal case divided by the volume of the normal case as reference value V1 ;

- Average Difference = patient image average – reference image average
- Standard deviation difference = patient image STD – reference image STD
- Variance difference = patient image variance – reference image variance.

Above volume enlargement ratio (V2/V1) indicates amount of an approximate prostate volume enlargement to be diagnosed by doctor, so doctor can measure patient prostate irregularity using this approach after matching volume enclosed by patient abnormal case (V2) with volume of the normal case as reference value (V1), also the statistical differences analysis implemented to measure exact amount of prostate enlargement in order to calculate the volume of unshaped object obtained as shown in Figure-3.

MATLAB image processing toolbox code has been used to compute prostate object and background of images as illustrated in Figure 5 showing partial code to calculate the prostate object volume which represented by (V2) to be compared to the volume of the normal case (V1) which is already computed as reference value.

```
Object = im2bw(I); % where "1" labeled
by white on the object and "0" as black
on the background as shown in last stage
of figure 3 for binary image

Volume2 = length (find (Object == 1));
```

Fig. 5: Partial of implemented MATLAB code used to calculate prostate volume V2.

6 Processing Time

In this techniques were all processed on an Intel® Coren12 Duo T9300 2.5 GHz processor with 8GB RAM and 32-bit operating system using MATLAB R2010B Student Edition. Execution is the average execution time in seconds for processing 700 x 700 pixel photomicrographs representing each of the staining combinations over the three grades of inflammation (none, moderate and severe). On all counts, the proposed method was slightly faster than the old method. The proposed method performs size and shape analysis for each detected prostate, and its execution time, thus, is a function of the number of prostate present. Such as, computation time varies directly with the rate of infection. In this method and the Thomas method: where the Otsu and the Thomas methods execute in a fraction of a second, the JSEG methods average execution time is nearly a minute.

7 Conclusions

The present study introduces a significant and effective method to measure the abnormality of the prostate using image matching techniques to compare the volume of the a reference normal case and patient abnormal prostate, where enlargement ratio V2/V1 represents an approximate amount of prostate enlargement, MATLAB code implemented to compute the two volumes then overlap ratio calculated that gives an approximate diagnostics of prostate volume enlargement, taken into consideration both age factor and the body mass index BMI. Also present research measures the exact patient prostate irregularity using a statistical analysis by computing average, standard deviation and variance differences respectively between patient image and reference image, three differences represent the exact percentage amount of prostate enlargement.

References

[1] Ng Kent Hoo et al, "Prostate Volume Measurement Using Transabdominal Ultrasound Scanning", Advances in Environment, Biotechnology and Biomedicine, ISBN: 978-1-61804-122-7, 336-341.

[2] Evelyn L.M. Ho, "Prostate size: Is size all that matters", Journal of Men's Health., **8** S22-S24, 2011.

[3] Ng Kent Hoo et al, "Prostate Volume Ultrasonography: The Relationship of Body Weight, Height, Body Mass Index and Ethnicity in Transabdominal Measurement", international Journal of Biology and Biomedical Engineering., **6(4)**, 187-195, 2012.

[4] Deian Stefan, "Prostate Ultrasound Image Processing., www. Acm.org/crossroads., **13(3)**, 2007.

[5] Gonzalez, R. C. and Woods, R. E. "Digital Image Processing" 2nd. Ed. Prentice-Hall, 2002.

[6] Gonzalez, R. C., Woods, R. E. and Eddins, "Digital Image Processing Using MATLAB"®. Pearson, 395-407, 2004.

[7] Martha K. Terris, "Comparison of Ultrasound Imaging in Patients undergoing transperineal and Transrectal Prostate Ultrasound", Urology, **52**, 1070-1072, 2009.

[8] Hee Jo Yang, Seung Whan Doo, Won Jae Yang and Yun Seob Song, "Which obesity index best correlates with prostate volume, prostate specific antigen and Lower Urinary Tract sysmptoms", Urology., **80(1)**, 187-190, 2012.

[9] Mohd A. Jamlos and Eko Supriyanto, "Carotid artery reactivity measurements among healthy young people based on Optimized Ultrasound images", International Journal of Biology and Biomedical Engineering., **4(5)**, 209-220, 2001.

[10] Hee Jo Yang, Seung Whan Doo, Won Jae Yang and Yeun Seob Song, "Which Obesiti index best correlates with prostate volume, prostate specific Antigen and Lower Urinary Tract Symptoms", Urology., **80(1)**, 187-190, 2012.

[11] Roehrborn CG, Girman CJ, Rhodes T etal, "Correlation between prostate size estimated by digital rectal examination and measured by transracial-ultrasound", Urology., 548–57, 1997.

[12] Deepak Sundaram et al, "Correlation of Prostate Gland Size and Uroflowmetry in Patients with Lower Urinary Tract Symptoms", J Clin Diagn Res. 2017 May; 11(5):AC01-AC04. doi: 10.7860/JCDR/2017/26651.9835. Epub 2017

May 1. US National Library of Medicine, National Institutes of Health

[13]Schiffmann J, Fischer J, Tennstedt P, et al. "Comparison of prostate cancer volume measured by HistoScanning and final histopathological results". World J Urol., **32(4)**, 939–944, 2014.

[14] Postema AW, Frinking PJ, Smeenge M, et al. "Dynamic contrast-enhanced ultrasound parametric imaging for the detection of prostate cancer". BJU Int. 2015 Mar 6; doi: 10.1111/bju.13116.

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