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Computer Aided Methods to calculate the volume of the Urinary Bladder

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ABSTRACT

Ultrasound plays a major role in differentiating the soft tissues. Hence, it is suitable for abdominal imaging. Abdominal imaging includes imaging of the urinary bladder. The urinary bladder is screened to find the volume and for the presence of cyst or calculi in it at an early stage. There are various noninvasive techniques proposed, but most of them claims for an accuracy of only 60%. Moreover, it is very difficult to find the exact volume of an irregular shaped organ. This article deals with the use of computer aided software like AutoCAD, CATIA to make the physical surface model which gives the necessary parameters to 3D Light year software to find the bladder volume. This technique provides a 3D model of the urinary bladder which is of an irregular shape. It gives more accurate results compared to other noninvasive methods.

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INTRODUCTION

Ultrasound is a non-invasive, non-ionizing, inexpensive, portable and excellent temporal resolution. It is more suitable to discriminate the soft tissue structures of similar characteristics. The machine sends in the ultrasound waves and receives the reflected echoes to reconstruct the image of the internal structures. It finds its application mostly in imaging abdominal organs including liver, gallbladder, spleen, pancreas, kidneys and urinary bladder. The volume of the urinary bladder is found out by marking the points on the transversal and sagittal scan images by the operator. The points marked would be approximated to the shape of an ellipsoid and the volume of the ellipsoid is displayed as the volume of the urinary bladder. There are various other methods proposed to equate the shape of the bladder to some regular shapes and the volume is calculated. The accuracy is dependent on the operator marking the point. But most of the proposed methods do not find the exact volume of the urinary bladder since it is approximated to some regular shape. The presence of cyst, calculi and tumor will reduce the volume of the bladder. Therefore bladder volume calculation is very important. (Chai X *et al*., 2011 & Tim McInerney., 1996)

Materials:

This article mainly deals with the following computer aided modeling soft wares for the entire process of finding bladder volume from the 2D image. The soft wares used are AutoCAD 2007, CATIA V5 and 3D LIGHTYEAR. AutoCAD 2007 creates the conceptual design of the bladder making it easier for parametric analysis. CATIA V5 features a parametric solid/surface-based package. It provides tools to complete organ modeling, including functional tolerances as well as kinematics definition. 3D LIGHT YEAR helps in building parts for prototyping, testing and casting in a very less time. It performs in high fidelity slice which results in smoother side walls and more accurate parts. It combines the support regions so that supports can be drawn across multiple regions at the same time. (Baradeswaran.A *et al*., 2014)

Methods:

This method makes use of an ultrasound image of a bladder obtained using an ultrasound machine which operates at a working frequency of 2MHz. The dimension of the transducer is 3mm diameter. The image obtained is shown in fig (a) (Naveenkumar R and Sanjay S., 2014). This image is imported into the AUTOCAD software where the XYZ coordinates are marked, assigned geometrical markers, export the CAD objects in

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Solid work and create the sketch of a solid model using CAD. The obtained sketch is imported in CATIA software. CATIA facilitates collaborative engineering across disciplines around its 3D experience platform, including surfacing & shape design. CATIA provides visualization solutions to create, modify, and validate complex innovative shapes to mechanical functional surfaces. CATIA enables the creation of 3D parts, from 3D sketches. It provides tools to complete bladder design. In CATIA coordinates are sketched from the XYZ -lines. The ends of the coordinates are joined to form spline curve which closed the entire lines and curves drawn. The spline curves are joined in the vertical direction to form the surface modeling which gives an exact shape of the bladder being designed, but without the surface cover. The last step is closing the surface to obtain a 3D model of the design which will give a solid model. The resulting 3D image has to be saved in .stl format so that it can be imported and processed by the 3D LIGHT YEAR software to find the required parameters. The particular .stl file is imported into the 3D LIGHT YEAR, where the various parameters like surface area, volume of the designed part can be obtained. (S. J. Pal., 2013), (Pommert, J. K. *et al*., 1996 & J. Wang, V.M., 1998)

RESULTS & DISCUSSION

The figures (a)-(i) explains the steps involved in the calculation of the volume of the urinary bladder.

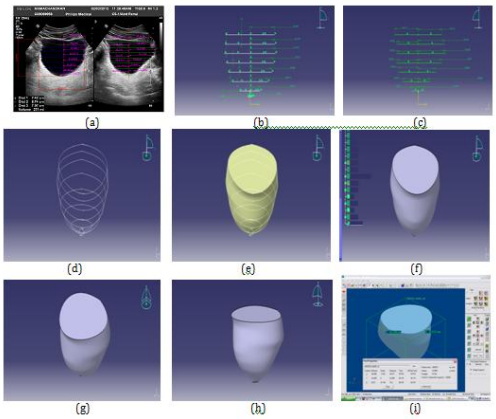
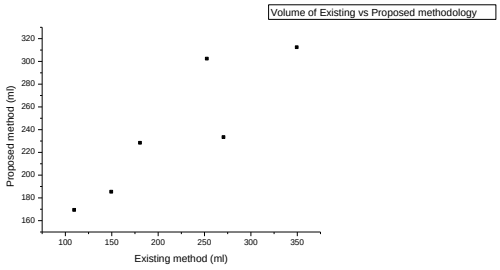


Fig. (a): Ultrasound image of the urinary bladder (b)-(c)Coordinate are marked using AutoCAD (d)Sketching & joining the coordinates (e) End point of the coordinates joined to form a spline curve (f)-(h) Joining the curves in vertical direction results in surface modeling (i) calculation of volume using 3D LIGHT YEAR.

Table 1: Comparison of the readings obtained from the machine and the proposed method.

Sl.No	Existing method (ml)	Proposed method(ml)	Mean	Standard Deviation	Standard Error
Case 1	110	169	139.5	41.7193	29.5
Case 2	150	185	167.5	24.74874	17.5
Case 3	181	228	204.5	33.23402	23.5
Case 4	253	302	277.5	34.64823	24.5
Case 5	271	233	252	26.87006	19
Case 6	350	312	331	26.87006	19



Graphical representation of Table 1:

The table 1 shows the readings obtained from the existing method and the readings obtained by the proposed method. Since the 3D model is created using computer aided soft wares, the volume calculated using the proposed method renders us the result with better accuracy (Dzung L. Pham., 2000). The model was tested by filling it with water. The method provides us 99% accuracy.

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Conclusion:

This article encompasses the volume calculation of the urinary bladder using computer aided modeling soft wares. The surface model of the design is modeled and checked for its accuracy. Since the shape of the bladder is tracked and extracted as such from the scanned image, the accuracy achieved is 99%. The advantage of this method is the entire 3D model can be rotated and visualized using computer aided modeling soft wares.

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