A 3D MODEL OF HUMAN EJACULATORY DUCTS

Chathuri Lakshani Gunasekera

(138049A)

Degree of Master of Science

Department of Electronic and Telecommunication Engineering.

University of Moratuwa.
Sri Lanka.

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DEDICATION

To my husband, my parents and my brother…

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LIST OF ABBREVIATIONS

Abbreviation	Description
BPH	Benign Prostatic Hyperplasia
TURP	Transurethral Resection of Prostate
ASM/AAM framework	Atlas segmentation or Active Shape/Appearance model
RBF	Radial basis function
MPGA	Multi Population Genetic Algorithm
GA	Genetic algorithm
TRE	Target registration error
TPS	Thin-plate Spline

ABSTRACT

Benign Prostatic Hyperplasia (BPH) is a common non-malignant ailment effecting in ejaculatory duct of aging men. BPH induces bothersome lower urinary tract symptoms. The standard treatment for BPH is Transurethral Resection of the Prostate (TURP), which mitigate urinary symptoms and enhance urinary flow. Smooth sphincter of the bladder neck accumulates and resides seminal fluid as it reaches the prostatic urethra before it ejects during ejaculation. Retrograde ejaculation occurs due to removal of this smooth sphincter of the bladder neck during TURP. Hence, about 53-77% patients develop retrograde ejaculation after the procedure. The research has shown that preserving the portion of supramontanal prostatic tissue during TURP leads to preserve antegrade ejaculation in about 80% of patients. The accuracy of this surgical procedure could be enhanced by the aid of 3D modelling. A literature survey on the existing procedures for model construction indicated that further improvements could be achieved through reconstructing a 3D model. A 3D model will enhance the understanding of the anatomical relationship of the ejaculatory ducts and prostatic urethra in cross sections of the prostate gland and to determine a safe zone with the prostate to remove without damaging the ejaculatory ducts.

We used photographic images of prostates obtained from male cadavers above the age of fifty years. The prostate samples fixed on to a wax block and uniform 2 mm thick slices were removed sequentially while taking photographs with a digital camera. Major steps in constructing a 3D model from the acquired images include: image registration to align series of slices, segmentation of the prostate, urethra and ducts and 3D modelling of the segmented structures. A simple landmark based image registration technique was employed by manually selecting points along the four edges of the wax block and automatically detecting the vertices of the block using intersections. Then rotation, translation and scaling were estimated on individual slices to align all the slices. The prostate was then segmented manually using an existing software tool program. The ejaculatory ducts and the urethra were segmented using a simple active contour based segmentation tool. Finally, a 3D mesh model was developed using boundary points of each of the segmented structure. The following three surgically important measurements calculated using to the model: the angles of the centre of the left duct, to the centre of urethra and to the centre of right duct, perpendicular distance from the centre of urethra to the line joining the two centres of ducts, and width of the prostate. Results showed a large angle both proximally and distally, 3D relationships of ejaculatory ducts and urethra depended on the maximum width of the prostate. During TURP, safe distances to resect the prostate without damaging the ducts are calculated based on the maximum width of the prostate. Depth can be safely resected without damaging the ejaculatory ducts. In the future, it is quite essential to test these results on clinical grounds.

Keywords: Benign Prostatic Hyperplasia (BPH), Transurethral Resection of the Prostate (TURP), 3D modelling.