Chapter 27
Modified Distance Regularized Level Set Segmentation Based Analysis for Kidney Stone Detection

K. Viswanath
Pondicherry Engineering College, India

R. Gunasundari
Pondicherry Engineering College, India

ABSTRACT

The abnormalities of the kidney can be identified by ultrasound imaging. The kidney may have structural abnormalities like kidney swelling, change in its position and appearance. Kidney abnormality may also arise due to the formation of stones, cysts, cancerous cells, congenital anomalies, blockage of urine etc. For surgical operations it is very important to identify the exact and accurate location of stone in the kidney. The ultrasound images are of low contrast and contain speckle noise. This makes the detection of kidney abnormalities rather challenging task. Thus preprocessing of ultrasound images is carried out to remove speckle noise. In preprocessing, first image restoration is done to reduce speckle noise then it is applied to Gabor filter for smoothening. Next the resultant image is enhanced using histogram equalization. The preprocessed ultrasound image is segmented using distance regularized level set segmentation (DR-LSS), since it yields better results. It uses a two-step splitting methods to iteratively solve the DR-LSS equation, first step is iterating LSS equation, and then solving the Sign distance equation. The second step is to regularize the level set function which is the obtained from first step for better stability. The DR is included for LSS for eliminating of anti-leakages on image boundary. The DR-LSS does not require any expensive re-initialization and it is very high speed of operation. The RD-LSS results are compared with distance regularized level set evolution DRLSE1, DRLSE2 and DRLSE3. Extracted region of the kidney after segmentation is applied to Symlets (Sym12), Biorthogonal (bio3.7, bio3.9 & bio4.4) and Daubechies (Db12) lifting scheme wavelet subbands to extract energy levels. These energy level gives an indication about presence of stone in that particular location which significantly vary from that of normal energy level. These energy levels are trained by Multilayer Perceptron (MLP) and Back Propagation (BP) ANN to identify the type of stone with an accuracy of 98.6%.

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1. INTRODUCTION

There are several tests which can currently be used to diagnose kidney problem and diseases. Blood and urine tests can be performed to check for the kidney function (Tadashi Araki et al., 2015; Nobutaka Ikeda., 2015). In order to diagnose and finalize any disorders related to kidney blood vessels, patients can undergo kidney biopsy procedure. Imaging tests including intravenous pyelogram (IVP), ultrasound (Jadranka et.al and Alenka et.al, 2003), computed tomography (CT) (Alev et.al, 2010) and magnetic resonance imaging (MRI) scans. The albuminuria is also used as an early marker of kidney injury as it usually leads to the decline of renal function (Demetrius et.al, and Kelly A. Healy, 2012). Nowadays, availability of renal time US and automated biopsygun have improved the biopsy procedure to become more effective and safer through complication of bleeding still remains as one major area of uncertainty in kidney biopsy (Ngo, L. Y., Meng, O. L., Leong, G. B., and Guat, L. D., 2011). CT scan is an imaging technique that combines x-ray and computer technology for the production of cross-sectional images CT scan technique has superior sensitivity and specificity over all other modalities (Alev et.al, 2010). CT scan can be used to detect kidney stones, blockage, cysts and solid masses with more than 99% but problem with CT scan is contrast agent (John, R., 2007). US are often used as the initial imaging techniques because it can be performed safely, do not require any contrast agent and US scan is non-invasive, widely available.

Tanzila Rahman, Mohammad Shorif Uddin proposed reduction of speckle noise and segmentation from US image is discussed. It not only detect kidney region, but also enhance image quality (Anzila Rahman, T., & Mohammad Shorif Uddin, 2013). The wan Mahani Hafizah proposed kidney US images were divided into four dissimilar categories: normal, bacterial infection, cystic disease, kidney stones, based on gray level co-occurrence matrix (GLCM). From these categories doctors identify that the kidney is normal or abnormal (Wan Mahani Hafizah, 2012). Gladis Pushpa had proposed Hierarchical Self Organizing Map (HSOM) for brain tumours using segmentation, wavelets packets, and the results were correct up to maximum 97% (Tadashi Araki, MD., & Nobutaka Ikeda, 2015). Norihiro Koizumi proposed high intensity focused ultrasound (HIFU) technique, used for destroying tumours and stones (Viswanath, K., & Gunasundari. R, 2014). Bommanna Raja proposed content descriptive multiple features for disorder identification and artificial neural network (ANN) for classification and the results says that the maximum efficiency is 90.47%, and accuracy 86.66% only (Nilanjan Dey, & Sourav Samanta, 2013). The MLP- BP ANN is found as better performance in terms of accuracy having 92%, speed is 0.44 sec and sensitivity (Stevenson, et.al, Weinter, et.al and Widow, et.al, 1990). The Non-invasive combination of renal using pulsed cavitation US therapy proposed shock wave lithotripsy (ESWL) has become a standard for the treatment of calculi located in the kidney and ureter (Joge Martinez carballido, 2010). Mohammad E. Abou EI-Ghar projected location of urinary stones with unenhanced computed tomography (CT) using half-radiation (low) dose compared with the standard dose and of the 50 patients, 35 patients had a single stone while the rest of them had multiple stones(Morse, P. M, & Feshbach, H, 1953). In order to solve the local minima and segmentation problem the thord Andersson, Gunnar Lathen proposed modified gradient search and level set segmentation (Tadashi Araki, Nobutaka Ikeda, 2015). For 3D detection of kidneys and their pathology in real time, the Emmanouil Skounakis proposed templates based technique with accuracy of 97.2% and abnormalities in kidneys at an accuracy of 96.1% (William G. Robertson, 2012).