Classification of Ultrasound Kidney disease using Texture Analysis

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Abstract:
The aim of this study to classify the ultrasound kidney disease using texture analysis image processing among adults' patients. The data of this study was collected from 200 adults' patients both gender suffering from renal disorders and referred to ultrasound department in east coast kalba hospital – Sharjah province United Arab Emirates in period from December 2017 up to July 2018.

Comparing of mean between classification function for normal, hypertensive, mild hypertensive and diabetic patients. And the mean value of each class was difference according the measurements. For normal class was higher at MLRIKD, PSVRiKD and ATLiKD measurements. For HT class was higher at BMI, CLLiKD, MLLiKD and ATRiKD measurements. FOR MHT calls the measurements were higher at WLiKD, DLiKD, EDVRiKD and PSViKD. For DM class the measurements that it was dominant at was LRIKD, DRIKD and EDVLiKD measurements.

Scatter plot generated using discriminate analysis function for four classes represents of normal, hypertensive, mild hypertensive and diabetic patients, were the classification showed that the kidney disorder was classified well from the rest of the tissues although it has characteristics mostly similar to surrounding tissue. classification score matrix generated by linear discriminate analysis and the overall classification accuracy of renal disorders 95.4%, were the classification accuracy of normal 98.6%, HT 94%, and MHT 93.8%. While the DM showed a classification accuracy of 92.9%.

Key words: Ultrasound, Kidney disease, image processing, Classification function

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I. Introduction:

Ultrasonography is a non-invasive and inexpensive investigation modality with sufficient anatomical details necessary to diagnose renal diseases without exposing the patient to radiation or contrast and hence has replaced standard radiography in our country and abroad [1-3]. All these factors promote early detection and prediction of deranged renal function tests necessary for making a therapeutic decision. Sonography identifies renal length, thickness, and echogenicity of renal parenchyma apart from its importance in detailing a dilated collecting system [4]. These details assist in identifying the extent of renal parenchymal damage and the possibility of its reversibility [5,6], and the decision to perform a renal biopsy [7,9]. According to a study, abnormal sonographic findings were seen in 67% of cases of CKD [8].

Renal length estimation by ultrasound is an important parameter in clinical evaluation of adult patient's kidney disease and healthy adult donors [9,10] and has replaced radiography as the common standard. Ultrasound is a useful, accessible, non-invasive, inexpensive method to reliably measure renal size [11]. Some renal diseases can change the morphological characteristics of the kidney seen by ultrasound. Renal size can also be a decisive factor for performing renal biopsy or avoiding immunosuppressive therapy [10]. Estimating renal size by ultrasound can be done by measuring the length, total volume or cortical thickness. The most accurate measurement of renal size is the total renal volume, which is correlated with height, weight and total body area. Renal morphology can be determined by a number of means that include measuring renal length and volume and renal cortical thickness. Renal function can also be evaluated through renal length and cortical thickness, and important clinical decisions can be made on its basis.

Therefore, serial sonographic evaluations are done to find out the progression of renal disease or its normality [12]. Although renal parenchymal volume is quite an accurate measurement in patients with end stage renal disease, measurement of renal longitudinal length is sufficient in normal patients [13].

The increasing prevalence of CKD is closely tied to the increase of at-risk populations with diabetes, hypertension, and prediabetes. Indeed, diabetes is the leading cause of CKD and a global health emergency, with
425 million individuals affected worldwide in 2017 and a projected 629 million individuals affected by 2045 [14-16]. Hypertension is the second most frequent cause of CKD, affecting nearly one-third of US adults and 1.13 billion people globally in 2015 [17,18]. The estimated population size for prediabetes was 78.5 million among adults in the United States between 2011 and 2014, and nearly one-tenth have been reported with CKD [19]. Even so, awareness of CKD and its major risk factors remains strikingly low among health care professionals and patients alike [20-22]. So, the aim of this study to classify the ultrasound kidney disease using texture analysis image processing among adults’ patients.

II. Methodology:

The data of this study was collected from 200 adults’ patients both gender suffering from renal disorders and referred to ultrasound department in east coast kalba hospital – Sharjah province United Arab Emirates in period from December 2017 up to July 2018.

Tools and equipment’s: Ultrasound system general electric GE. Transducer: highest frequency curved linear array probe possible, start with 5 MHZ and work down to 2 or 3 MHZ for larger patients with color and doppler capabilities. A high sweep speed will improve accuracy of the measurements taken to the spectral trace. The patients variables were age, gender, kidney volume and resistance index of the right and left kidneys.

Scanning Technique:

the patient should be lie supine, for the right kidney have the patient lie supine and place the probe in the right lower intercostal space in the mid axillary line. And the liver as your acoustic window and aim the probe slightly posteriorly toward the kidney. Gently rock the probe up and down or side to side to scan the interior kidney. Obtain longitudinal (long axis) and transverse (short axis) views.

For the left kidney the patient has lie supine or in the right lateral decubiti position, place the prob in the lower intercostal space on the posterior axial line. The placement will be more cephalent and posterior than when visualizing right kidney, and again rock the probe to scan the entire kidney to obtain longitudinal and transverse view.

Assessing the arteries within the kidney parenchyma to assess any alteration in the waveforms. The RI should be low resistance. The acceleration time (AT) should be < 70 msec. The probe is slowly moved superior and inferior to search for additional renal arteries. Any vessels identified must be traced to the kidney and confirm their identity. The kidneys will be atrophy with chronic renal failure and the length should be <9 cm, the RI > 0.8 cm for untreatable medical renal disease.

III. Results:

Table 1. shows the classification function that differentiates between normal, hypertensive, mild hypertensive and diabetic patients:

<table>
<thead>
<tr>
<th>Classification Function Coefficients</th>
<th>qClasses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
</tr>
<tr>
<td>BMI</td>
<td>1.383</td>
</tr>
<tr>
<td>LRiKD</td>
<td>1.976</td>
</tr>
<tr>
<td>DRiKD</td>
<td>1.320</td>
</tr>
<tr>
<td>WLiKD</td>
<td>2.227</td>
</tr>
<tr>
<td>DLiKD</td>
<td>1.970</td>
</tr>
<tr>
<td>MRLiKD</td>
<td>0.431</td>
</tr>
<tr>
<td>CLLiKDN</td>
<td>3.402</td>
</tr>
<tr>
<td>MLLiKDN</td>
<td>1.369</td>
</tr>
<tr>
<td>PSVRLiKD</td>
<td>.263</td>
</tr>
<tr>
<td>EDVRLiKD</td>
<td>-.106</td>
</tr>
<tr>
<td>AFRiKD</td>
<td>-.103</td>
</tr>
<tr>
<td>PSVLiKD</td>
<td>.143</td>
</tr>
<tr>
<td>EDVLiKD</td>
<td>.498</td>
</tr>
<tr>
<td>ATLiKD</td>
<td>-.152</td>
</tr>
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</table>
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<table>
<thead>
<tr>
<th>Classes</th>
<th>Normal</th>
<th>HT</th>
<th>MHT</th>
<th>DM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>-316.045</td>
<td>-306.301</td>
<td>-325.353</td>
<td>-346.694</td>
<td></td>
</tr>
</tbody>
</table>

Fisher's linear discriminant functions

<table>
<thead>
<tr>
<th>Classes</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>98.6</td>
</tr>
<tr>
<td>HT</td>
<td>94.0</td>
</tr>
<tr>
<td>MHT</td>
<td>93.8</td>
</tr>
<tr>
<td>DM</td>
<td>92.9</td>
</tr>
</tbody>
</table>

95.4% of original grouped cases correctly classified.

Table 2. Showed the classification accuracy of the Predicted Group Membership for the four classes using linear discriminant analysis.

IV. Discussion:

Table 1. show compare of mean between classification function for normal, hypertensive, mild hypertensive and diabetic patients. And the mean value of each class was difference according the measurements. For normal class was higher at MLRtKD, PSVRtKD and ATLtKD measurements. For HT class was higher at BMI, CLLtKDN, MLLtKD and ATRtKD measurements. For MHT class was higher at WLtKD, DLtKID, EDVRtKD and PSVLtKD. For DM class the measurements that it was dominant at was LRtKD, DRtKD and EDVLtKD measurements.

Scatter plot generated using discriminate analysis function for four classes represents of normal, hypertensive, mild hypertensive and diabetic patients, were the classification showed that the kidney disorder was classified well from the rest of the tissues although it has characteristics mostly similar to surrounding tissue. fig .1

Table 1. show classification score matrix generated by linear discriminate analysis and the overall classification accuracy of renal disorders 95.4%, were the classification accuracy of normal 98.6%, HT 94%, and MHT 93.8%, While the DM showed a classification accuracy of 92.9%.

V. Conclusion:

The aim of this study to classify the ultrasound kidney disease using texture analysis image processing among adults' patients, comparing of mean between classification function for normal, hypertensive, mild hypertensive and diabetic patients. And the mean value of each class was difference according the measurements. For normal class was higher at MLRtKD, PSVRtKD and ATLtKD measurements. For HT class
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References:

[3]. Rosansky SJ: Renal function trajectory is more important than chronic kidney disease stage managing patients with chronic kidney disease. Am J Nephrol. 2012, 36:1-0.10.1159/000339237