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Deep learning based chronic kidney disease detection through iris

To cite this article: H A U Rehman *et al* 2021 *J. Phys.: Conf. Ser.* **2020** 012047

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Deep learning based chronic kidney disease detection through iris

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Abstract. Kidney is an important organ in human body as it maintains the nutrients and fluid balance in our body. It is extremely beneficial if its dysfunctionality is diagnosed at an early stage. Iridology provides a pathway to examine the kidney disease through iris images. Therefore, in this work we proposed the Iris-based Kidney Disease Identification System (IKDIS). The IKDIS would aid in identifying abnormalities through iris images an input which would be followed by application of deep neural network model for assessment. This type of diagnostic system without involving any instruments for assessment of human body organs is much popular these days. The data of 49 patients gives promising results of IKDIS, achieving overall accuracy of 86.9% during the experiment.

1. Introduction

In the recent years, the combination of image processing and machine learning has been widely used to solve real-life problems in which medical image analysis and surveillance are on the top of the list [1], [2], [3]. From the last two decades, alternative medicine and early diagnosis are the main demands in health care system to provide quality health services and also to save from many complications [4]. Iris diagnosis (iridology) has been extensively used for examining the patient's health. The Iris of the human eye plays a pivotal role in observing the health condition while reviewing the possible disturbances of the internal body organs[5].

Figure 1 shows the different regions that are associated with various human body organs[6]. A mark, pattern or spot may appear in result of any weakness or damage of the organ[7]. These iris-patterns can help us to identify the corresponding/affected organ[8]. Figure 2 shows the seven zones in the iris around the pupil [8], [9]. In case of unhealthy stomach, the changes may appear near the pupil in the iris. On the other hand, unhealthy kidneys may be detected through the changes at the bottom edge of iris.

In the human urinary system, kidneys play an important role to eliminate the waste products from human body. Any disorder in the kidneys may lead to diabetes, hypertension, urological, acute renal function and cardiovascular issues as some of major fatal problems[10],[11].

In this proposed work, an Iris-based Kidney Disease Identification System (IKDIS) is developed. The IKDIS will perform early assessment of kidney disorder based on iridology chart and artificial intelligence (AI) algorithm. The AI algorithm will classify the subject body either healthy or unhealthy.

The motivation of this work is to provide useful online practical system to determine results in cost-effective, quick and painless way.

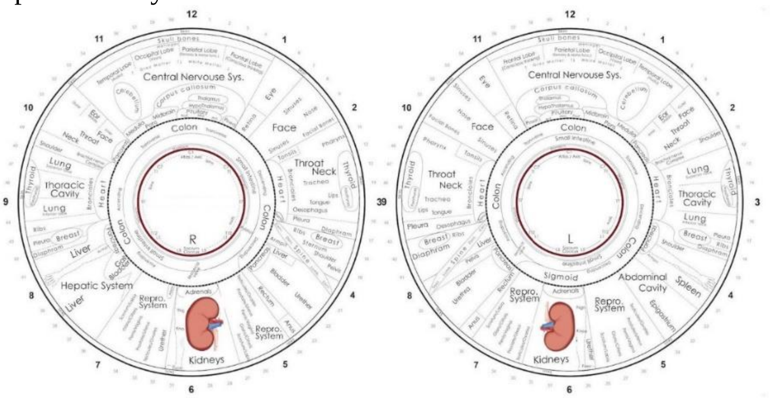


Figure 1. Iridology chart [19].

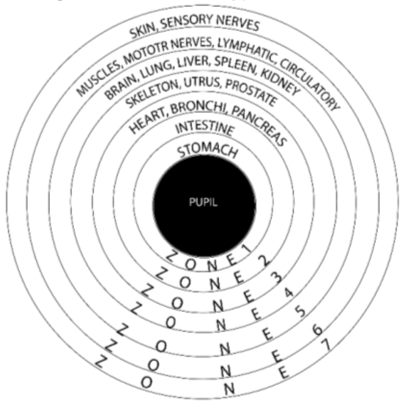


Figure 2. Seven zone of Iris.

2. Related works

Several research works have been conducted on human eye to identify and diagnose various diseases which is known as iridology. Hussain et al [6] proposed a unique approach, which consist of iris image collection, pre-processing, segmentation, feature extraction and a neuro-fuzzy interface system (ANFIS) to identify and distinguish between the normal or chronic kidney diseases. They examined total of 340 patients which were classified into 168 patients with healthy kidneys and 172 patients suffering from kidney disease. The proposed system showed overall 82% accuracy for normal and kidney failure individuals respectively.

Sara Amerifar et al [3] have done research work on CASIA iris image database to diagnose chronic kidney disease. They used Hussain et al [6] analysis for geometrical enhancement and CHT to detect circular shape. Their results indicated 82% and 93% accuracy for Chronic Renal Failure (CRF) and non-CRF subjects respectively.

Agus Prayitno et al [12] implemented their research on kidney complications mainly caused by diabetes. Iris Region of Interest (ROI) images were taken from 47 patients with the help of Dino-Lite Ver. 2.2. They used colour constancy and independent component analysis to analyse the broken tissue in the ROI iris images. 76% accuracy indicated that 31 individuals among 47 patients have kidney complications.

Adhi et al [13] diagnosed the last stage of kidney CRF with the implementation of machine learning. Hemodialysis patients and healthy persons were classified based on broken tissues in iris. To examine the broken tissues, the authors used watershed method for feature segmentation. Support Vector Machine classification showed overall 87.5% accuracy of the experiment.

Several other research has been done using iridology. For example, Rossi Erwin et al [14] worked on digestive problem, Jamal et al [15] detected diabetes, Samant and Agarwal [9] also diagnosed diabetes, Anna et al [16] found lung abnormalities, Hernandez et al [17] worked on Alzheimer's disease, and last but not least, Permatasari et al [18] presented a method to evaluate heart condition.

3. Iris based kidney diagnostic system

3.1. Kidney pathology

The assessment of various disease pattern and its features can be easily determined by the help of iridology chart shown in figure 1. The region of interest (ROI) for kidney disease in right and left eye are at position 5.35–5.95 (252–268) and 6.05–6.60 (272–288). A long solid black line, one or more and large or small open lesion and change in colour of the iris tissues are the main symptoms of the kidney disease. Figure 3 shows the after effect of the kidney disease in the iris images.

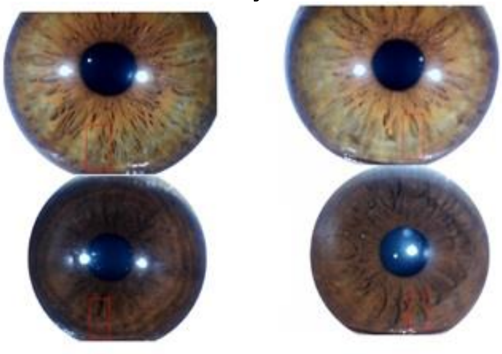


Figure 3. Marks and pattern showing kidney problem in (a) right eyes (b) left eyes [19].

3.2. Experimental setup description

The hardware setup used for this research is based on Core i7-7700HQ CPU @ 2.80 GHZ, with 512 GB SSD, 2 TB HDD, 32GB RAM and Nvidia 6 GB GTX1080 GPU. The IKDIS system uses Linux based operating system where it is easy to program artificial intelligence frameworks like Tensorflow, KERAS etc.

4. Results and discussions

4.1. Dataset

The Iris dataset were taken from the Surgical Section I, Bahawal Victoria Hospital, Pakistan. The dataset is fully verified and endorsed by famous ophthalmologist working in the same hospital after labelling work. The Iris dataset consisted of total 49 patients suffering with chronic kidney disease.

4.2. Performance analysis and architecture of proposed network

The experimental process of the proposed research used a Convolutional Neural Network (CNN) model implemented from scratch to introduce the transfer learning technique with max-pooling function. To train CNN model, various libraries were used. Among these libraries, KERAS was widely used because of its user friendly environment such as adding, dropping layers and max-pooling function in CNN.
The architecture of proposed CNN is consisted of total of five layers in which three are convolution layers and remaining two are dense layers. The detailed description of these layers are given below.
L1: Layer one of the CNN model contains 24 filters with a 3*3 strided max-pooling function and (224x224x3) input size.
L2: The second layer of Model contains 36 filters with a 2*2 strided max-pooling function with same input size (224x224x3).
L3: Layer three of the model contains 48 filters without involving max-pooling function with input size (224x224x3).
L4: Fourth layer of the Model is first dense layer with 60 hidden units. To reduce the overfitting problem, dropout rate 0.5 was used.

L5: Layer five is second dense layer which is also the last layer with softmax activation function.
The remaining important parameters are the usage of Rectified Linear Unit (ReLu) as an activation function in the first four layers whereas Softmax was used for the last layer. Fixed learning rate 0.01 was used with the Stochastics Gradient Descent (SGD) optimizer for the training of the model.
Figure 4 illustrates the validation accuracy versus training accuracy. To analyse the performance of the proposed model, CNN trained on iris images and showed 86.9% accuracy.

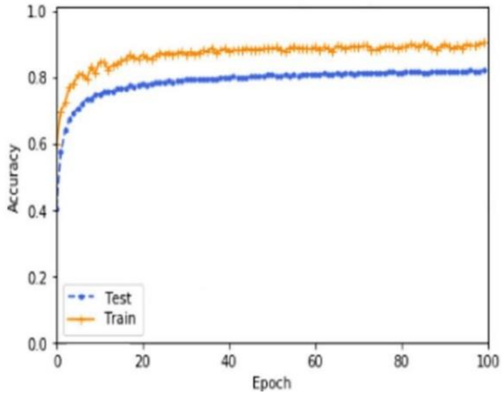
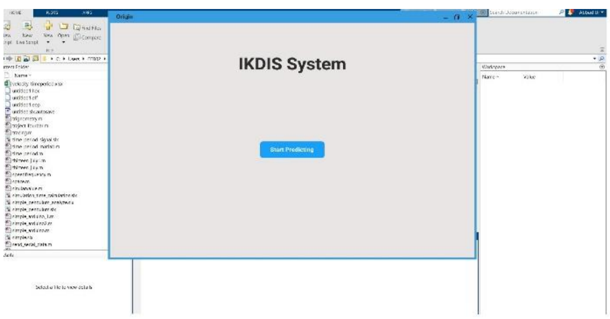


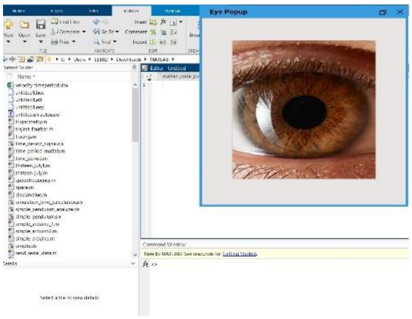
Figure 4. Proposed CNN model performance with max-pooling function.

4.3. Health assessment demo

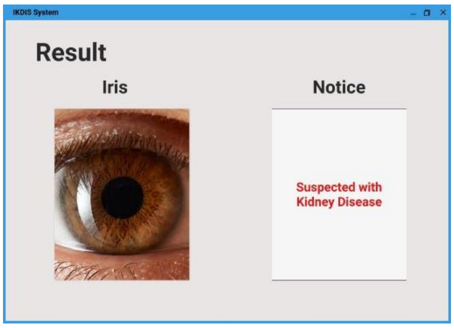
The kidney health assessment demo is presented in this section. At the first step, the system taken iris image with the help of handheld iris camera. Then, the system applied deep learning algorithm to find any marks, line or pattern in the ROI region. At the final step the system determines the result and provide the health notice shown in Figure 5.



(a)



(b)



(c)

Figure 5. Health assessment system graphical user interface (GUI)
(a) main screen (b) image obtained (c) health result

4.4. Comparison with existing result

Table 1 showed the comparison of the proposed study with others existing studies.

Table 1. Comparison summary.

Author	Method Used	Accuracy(%)
Hussein et al [6]	2-D Gabor Transform and ANFIS	82
S. Amerifar er al [3]	Circular Hough Transform Algorithm	82
Prayitno et al [12]	Iris Localization	76
Proposed Method		86.9

5. Conclusion

In this study Iris-based Kidney Disease Identification System is proposed to diagnose dysfunctional kidneys based on machine learning algorithm and iridology. This type of alternative medical diagnostic system recognizes discrepancies in iris texture and aids the medical staff to identify the disease at early stages. In future, new CNN architecture will hopefully be developed and applied to detect kidney problem more efficiently and with high accuracy.

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