

Image-Baesd Detection of Kayser-Fleischer Ring in Patient with Wilson Disease

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Abstract - In the paper the authors propose an image processing algorithm for detection of Kayser-Fleischer ring in eye cornea. This is a common symptom of a rare genetic disorder known as Wilson Disease. This pathology is cause of a malfunction in the copper excretion from the organism. So copper accumulates in tissues being responsible of oxidative processes in the organs affected. Copper deposit in the cornea is visible as a goldenbrown, sometimes orange or greyish, pigmentation called Kayser-Fleischer ring. So it is considered a diagnostic sign of Wilson disease more than ever in individuals with neurological disorders. The proposed algorithm is based on an image processing approach. In detail, eye image is analyzed by means of a segmentation algorithm to detect the Kayser-Fleischer ring. The proposed screening method is non-invasive and automated. The innovative diagnostic tool aims to improve accuracy of actual methods used in practice. So the described technique reduces possible interpretation errors and assists doctor to diagnose the pathology.

I.INTRODUCTION

Wilson disease is a genetic pathology due to a decreased copper excretion from the organism. Copper is taken by food and, in appropriate doses, it is necessary for normal growth. Copper is carried inside the cells by a transporter protein. When the levels of copper in the liver are higher than normal, the protein is not able to bind to it. As a consequence, its excretion is made difficult. Copper accumulation throughout the body is cause of its deposition in several tissues (liver, brain, kidney, cornea). So it is cause of oxidative damages in the organs. Individuals affected from Wilson disease suffer from chronic liver disease, hepatic and renal failure, haemolytic anaemia, and about half individuals have even neuropsychiatric problems. This rare disease can be inherited from parents both carrying the genetic defect. The risk regards both girls and boys and the frequency is about a case every 40000 births. The origin of pathology is due to mutation of a specific gene. One of every 100 people may have a copy of the defected gene without developing any symptom. If a child inherits the gene from both carrying parents, he/she may be affected from Wilson disease. First clear signs of the disorder appear usually between the ages of 5 and 20 years. Symptoms concern mainly the liver and the brain, 1, 2. So the common features that lead to diagnose Wilson disease are liver failure and neuropsychiatric symptoms. Moreover, many individuals

This paper presents the results of an objective and quantitative study of two segmentation algorithms. One of the algorithms is the color set back-projection which is well known and can be found in many related studies. This method was implemented and tested on a wide variety of images including medical images and has achieved good results in automated detection of color regions from an image. The second method chosen is an original algorithm and its novelty relies on: the hexagonal structure being used in the unified framework for image segmentation, the use of maximum spanning trees for determining the set of nodes representing the connected components, and an efficient procedure for extracting the boundary of visual objects from connected components representing salient objects of an general.

The term digital image refers to processing of a two dimensional picture by a digital computer. In a broader context, it implies digital processing of any two dimensional data. A digital image is an array of real or complex numbers represented by a finite number of bits. An image given in the form of a transparency, slide, photograph or an X-ray is first digitized and stored as a matrix of binary digits in computer memory. This digitized image can then be processed and/or displayed on a high-resolution television monitor. For display, the image is stored in a rapid-access buffer memory, which refreshes the monitor at a rate of 25 frames per second to produce a visually continuous display.

II. THE IMAGE PROCESSING SYSTEM

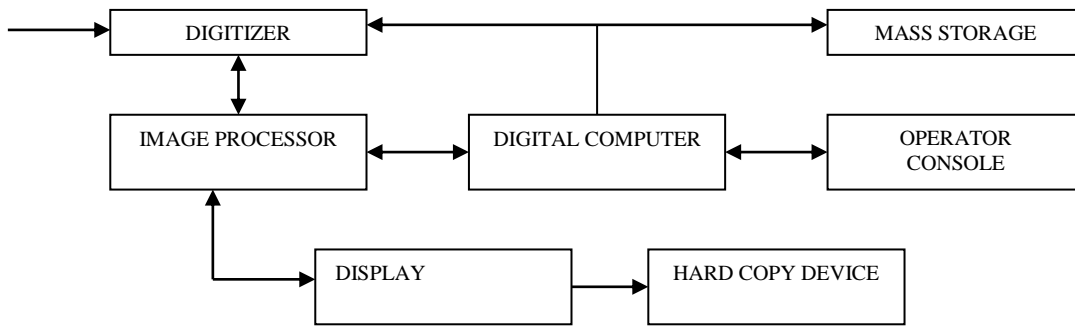


FIG 1. BLOCK DIAGRAM FOR IMAGE PROCESSING SYSTEM

As detailed in the diagram, the first step in the process is image acquisition by an imaging sensor in conjunction with a digitizer to digitize the image. The next step is the preprocessing step where the image is improved being fed as an input to the other processes. Preprocessing typically deals with enhancing, removing noise, isolating regions, etc. Segmentation partitions an image into its constituent parts or objects. The output of segmentation is usually raw pixel data, which consists of either the boundary of the region or the pixels in the region themselves. Representation is the process of transforming the raw pixel data into a form useful for subsequent processing by the computer. Description deals with extracting features that are basic in differentiating one class of objects from another. Recognition assigns a label to an object based on the information provided by its descriptors. Interpretation involves assigning meaning to an ensemble of recognized objects. The knowledge about a problem domain is incorporated into the knowledge base. The knowledge base guides the operation of each processing module and also controls the interaction between the modules. Not all modules need be necessarily present for a specific function. The composition of the image processing system depends on its application. The frame rate of the image processor is normally around 25 frames per second.

III. IMAGE PROCESSING FUNDAMENTAL

Digital image processing refers processing of the image in digital form. Modern cameras may directly take the image in digital form but generally images are originated in optical form. They are captured by video cameras and digitalized. The digitalization process includes sampling, quantization. Then these images are processed by the five fundamental processes, at least any one of them, not necessarily all of them.

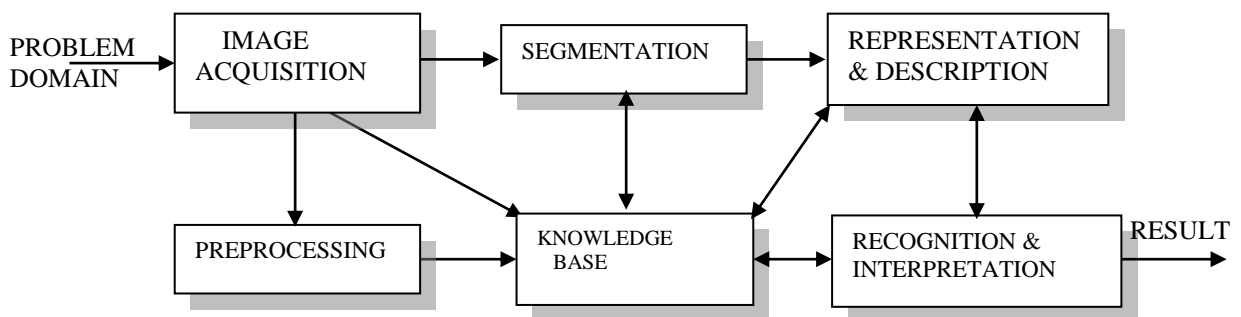


FIG 2. BLOCK DIAGRAM OF FUNDAMENTAL SEQUENCE INVOLVED IN AN IMAGE PROCESSING SYSTEM

IV. IMAGE PROCESSING TECHNIQUES

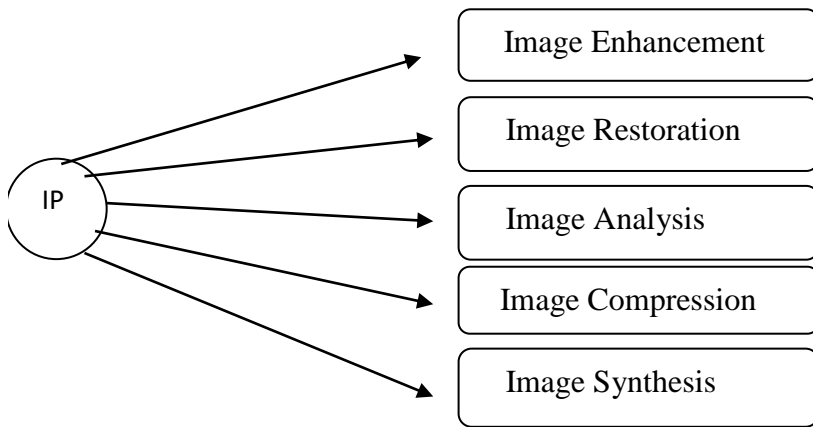


FIG 3. IMAGE PROCESSING TECHNIQUES

➤ IMAGE ENHANCEMENT

Image enhancement operations improve the qualities of an image like improving the image’s contrast and brightness characteristics, reducing its noise content, or sharpen the details. This just enhances the image and reveals the same information in more understandable image. It does not add any information to it.

➤ IMAGE RESTORATION

Image restoration like enhancement improves the qualities of image but all the operations are mainly based on known, measured, or degradations of the original image. Image restorations are used to restore images with problems such as geometric distortion, improper focus, repetitive noise, and camera motion. It is used to correct images for known degradations.

➤ IMAGE ANALYSIS

Image analysis operations produce numerical or graphical information based on characteristics of the original image. They break into objects and then classify them. They depend on the image statistics. Common operations are extraction and description of scene and image features, automated measurements, and object classification. Image analyze are mainly used in machine vision applications.

➤ IMAGE COMPRESSION

Image compression and decompression reduce the data content necessary to describe the image. Most of the images contain lot of redundant information, compression removes all the redundancies. Because of the compression the size is reduced, so efficiently stored or transported. The compressed image is decompressed when displayed. Lossless compression preserves the exact data in the original image, but Lossy compression does not represent the original image but provide excellent compression.

➤ IMAGE SYNTHESIS

Image synthesis operations create images from other images or non-image data. Image synthesis operations generally create images that are either physically impossible or impractical to acquire.

V. WILSON DISEASE AND KAYSER-FLEISCHER RING

Wilson disease is a recessive genetic disorder affecting several organs of body. Copper, taken by means of food, is not properly excreted with urine and faeces. So it accumulates in the organism tissues. Different symptoms have been observed. It affects mainly liver in about 40% of individuals with the disease. Neurological disorders concern about 35% of patients. Additional renal and endocrine pathologies are possible consequences of copper overload in the organism. When acute liver disease occurs and the treatments do not improve clinical condition, the liver transplant may be necessary. It is suggested in presence of acute cirrhosis and fulminant hepatitis. Neurological and psychiatric disorders include dystonia, ataxia, muscular rigidity, in co-ordination, speech abnormalities, depression, personality changes.

Therapies allow copper overload to be reduced by regulating the copper intake and excretion. In this way the amount of free copper in the blood is normalized. Symptoms are usually improved. Such treatments are adapted to the clinical condition of the patient and can take several months.

VI. IMAGE SEGMENTATION

An image can be considered as a set of measurements in two-dimensional 2-D or three-dimensional 3-D space. In 2-D digital images, each measurement is a pixel. Therefore a 2-D image is a set of pixels sorted in a matrix $M \times N$. Segmentation process partitions the image into several non-overlapping segments or subsets of pixels which have a specific common visual feature,

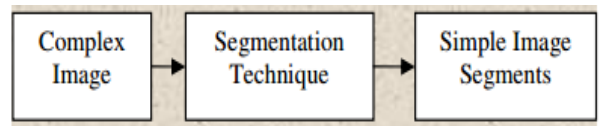


Fig 4. Image Segmentation Process

VII. HARDWARE REQUIREMENTS

The necessary hardware regarding private PC that comprises configuration as specified as follows:-

1. Processor: Intel core i5.
2. Disk capability: 1GB for MATLAB only.
3. RAM: 2GB.

VIII. SOFTWARE TOOL USED

The necessary program regarding private PC that comprises configuration as specified as follows:-

1. Windows 7(64-bit) operating system.
2. MATLAB v12.

IX. CONCLUSION

Wilson disease is a rare recessive disease due to copper accumulation in the organism. Copper toxicity is cause of failures of several body organs. It is cause primarily of liver disease and psychiatric/neurological disorders. The ophthalmologic evaluation of Kayser-Fleischer ring is a basic and non-invasive diagnostic tool for the pathology diagnosis. Kayser-Fleischer ring is present in almost all patients with advanced disease and neurological/psychiatric disorders. It is a visible brownish-yellow ring located in the Descemet's membrane of the cornea, due to copper deposits. A K-F ring detection algorithm has been proposed in order to detect the presence of such symptom. The algorithm is based on a image segmentation method. It starts from eye image and makes an automated diagnosis on the pathology. The aim of the present work is to provide a noninvasive screening tool for physicians, reducing occurrences of false-negative diagnoses.

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