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컬러와 혈관징후패턴 코드 생성에 의한 공막진단시스템 구현

류광렬*

Scleral Diagnostic System Implementation with Color and Blood Vessel Sign Pattern Code Generations

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ABSTRACT

The paper describes the scleral diagnostic system implementation for human eyes by using the scleral color code and vessels sign pattern code generations. The system is based on the high performance DSP image signal processor, programmable gain control for preprocessing and RISC SD frames storage. RGB image signals are optimized by PGC, the edge image is detected form the gray image converted. The processing algorithms are executed by scleral color code generation and scleral vessels sign pattern code creation for discriminating and matching. The scleral symptomatic color code is generated by YCbCr values at memory map tolerated and the vessel sign pattern code is created by digitizing the 24 clock and 13 ring zones, overlay matching and tolerances. The experimental results for performance are that the system runs 40ms, and the color and pattern for diagnostic errors are around 20% and 24% on average. The system and technique enable a scleral diagnosis with subdividing the patterns and patient database.

요 약

이 논문은 사람 눈의 공막컬러코드와 공막혈관징후패턴코드 생성에 의한 공막진단시스템 구현에 관한 연구이다. 시스템은 고성능 DSP 영상처리 프로세서를 기반으로 PGC 프로그램어불 게인제어 선처리 및 RISC SD프레임저장 메모리 등으로 구성된다. PGC는 RGB신호를 최적화하고 그래리 영상에서 에지가 검출된다. 판별 및 매칭 처리알고리듬은 공막컬러코드화 및 혈관징후패턴코드 생성을 실행된다. 공막컬러코드는 메모리 맵의 위치에서 YCbCr값을 구하고 허용오차 범위를 적용하여 생성된다. 혈관징후패턴코드는 24시간등분과 13환형등분 구역에 의해 디지털화 되고 중첩매칭과 허용오차 적용에 의해 코드화된다. 실험결과 성능에서 시스템은 40ms로 동작하고 진단오차는 컬러판별이 평균 약20%, 혈관징후패턴 매칭이 약 24%이다. 이 시스템 및 기술은 세분화와 환자데이터베이스화 하면 공막진단 의용시스템으로 사용 할 수 있다.

Key word : Scleral diagnostic system, Scleral color code, Scleral blood vessels sign pattern code.

키워드 : 공막진단시스템, 공막컬러코드, 공막혈관징후패턴코드.

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Ⅰ. INTRODUCTION

A noninvasive way of analyzing the body's health conditions by observing the major organs is getting the limelight. The iris and sclera of the human organ are the windows to the body's health pathologically and also very reflective of the mood. Through the various patterns and colors that appear in the iris and sclera, it is possible to detect underactive and overactive organs or tissues for the presymptomatic phase. One of the earliest iridologists was Ignatz von Peczely that the first iris chart was published. The first published iris analysis was credited to the physician Philippus Meyens. Bernard Jensen developed one of the most comprehensive iris charts which is still the most accurate one available today. Sclerologists, Donal R. Bamer and Leonard Mehlmauer apply to clinical practice by sclerology and to natural healing by herbal medicines.[1-3] The blood vessels that are the sclera lines in the eyes are signs of compromised health. These markings identify pathological conditions that are most clinically treatable which enables to be defined as a sickness or health. These analysis and diagnosis are based on the analogue processing by physician. Now digital image processing applies to them automatically. The iris and scleral pattern are already used to surveillance and recognize the people in the biometric field.[4-6] Thus this paper implements new scleral diagnostic system design by image signal processing with image acquisition and edge detection to discriminate the scleral colors and to create the vessels pattern code generations to detect the symptomatic treatment in real time. Also an experiment will be performed by sample images.

Ⅱ. SYSTEM IMPLEMENTATION AND SCLERAL CODES

2.1. Diagnostic System Configuration

The diagnostic system configuration is composed of live image video acquisition from human eye and preprocessing with programmable gain control (PGC), image signal processor (ISP), RISC SD memory, Color code generation and scleral vessel pattern code generation blocks as shown in Fig.1. The RGB camera works at D1 (720x480) and available at a distance. The PGC is RGB gain control to be adaptable at the surrounding circumstance in the preprocessing block with antialiasing. The ISP is based on DSP processor, 32 bit machine for multimedia image processing to communicate with edge detection and frame SD memory which is designed by RISC MPU 32 bits machine. The scleral color code generation is created by color palette on the computer. The blood vessel pattern code on the sclera area is generated by the digitized scleral zones which divided by the rings and clock zones. The final diagnostic codes are shown by the scleral diagnosis block (a) and interactive user's interface (b).

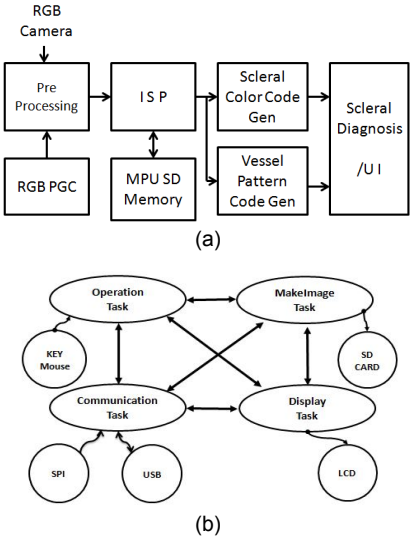


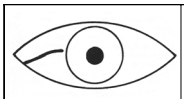
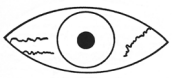
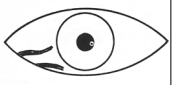
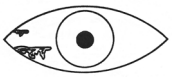
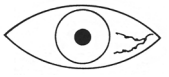
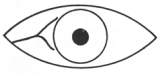
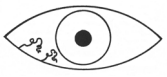
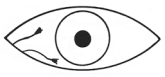
그림 1. 진단시스템 구성도
Fig. 1 Diagnostic system configuration

2.2. Scleral Features

The scleral functions protect the eye from the negative factors of the environment and provide constancy of the eye form, volume and tone. Also color and scleral vessels are changed by body's conditions and symptoms.

The scleral lines show stress and congestion of any significance, the organs or tissues where disease began, physical injury, trauma, metabolic disease, tumor development, disease syndromes, drug induced disorders, food allergies, etc. Of course, there are many other possible diagnostic capabilities. The scleral signs are index vessels, vascular spirals, trauma fork vessels, and etc as shown in Table 1. For example, an index red vessel is usually a very large thick that will come from the corner of the eye or in that area, and points the 8 clock zone in the right eye, it indicates the person is having a liver problem. If the index points at 3 clock zone in the left eye, this would be indicative of a cardiac heart problem. The scleral signs fall into indicators such as the index vessels, vascular spirals, etc or diagnostic and pathological. The true underlying cause of the pathological signs is either impeded or congested circulation or the artery wall breaking down and contorting the vessels. The scleral vessels are indicative and are very valuable as an analytical tool.

표 1. 공막혈관 징후
Table. 1 Scleral signs of vessels

		
Index vessels	Vascular spirals	Meandering Vessels
		
parallel Band	Porcelain Vessels	Stagnation Stumps
		
Spindle Vessels	Vascular Pearls	Vascular Branch
		
Glomerular Vessels	Anemic Vessels	Trauma Fork

2.3. Color Processing and Code Generation

The video processing is based on the allocated two video buffers in the DSP processor, capture and display. The capture control register of the video port is set up at the allocated address of the buffer. The video signals are converted to YCbCr 4:2:2 from the composition signal of the input RGB camera. The image data are stored in sequence like CbYCrY at DDR memory as shown in Fig.2. The stored one frame data is copied at the display buffer address which set up at the display register. The copied frame data are transferred to LCD display monitor. The YCbCr value of the coordinate im(x,y) is detected and calculated by the following equation (1) for finding color value of a sclera point.

$$\begin{aligned} Y &= buffer(720*position\,y + position\,x)*2 \\ Cb &= buffer(720*position\,y + position\,x)*4 \\ Cr &= buffer(720*position\,y + position\,x)*4 \end{aligned} \quad (1)$$

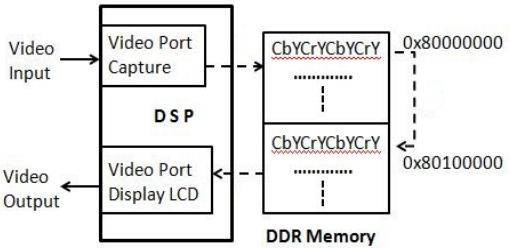


그림 2. 컬러와 비디오 메모리 흐름도
Fig. 2 Color and video memory flow

Observing the color of a person's sclera is one of the quickest ways of determining the overall health condition. The health sclera should have a bright, crisp white appearance. That is not reddish, blueish, yellowish, brownish, milky, or pale white tint of scleral surface. The tints point symptoms that reddish is local irritation, blueish: metal poisoning, yellow: cholesterol plaquing, brownish: toxic blood stream, cloudy or milky: lymphatic tophus, pale or flat: anemia. The 6 tints are selected by observing sclera of eyes. These reference scleral colors are converted to YCbCr color space and are compared with an input scleral images. The color palettes of system creates the color code k(i) as shown in Table 2. All of the others are normal that code values are 00.

표 2. 공막컬러와 코드 생성
Table. 2 Scleral color and code generation

Tint	Ref. color	YCbCr triplet	Code k(i)
Reddish		#6D67BF	01
Blueish		#A3965B	02
Yellowish		#D13691	03
Brownish		#866A9D	04
Milky		#CF827F	05
Pale white		#DB7F83	06
others	-	-	00

2.4. Scleral Signs Pattern Code Generation

The scleral signs patterns are digitized by the 13 Ring Zones from A outside to O inside and 24 Clock Zones from 1 to 24 for generating the pattern code as shown in Fig. 3. The pupil and iris are sited at O zone. While the system processing time is delayed and complicated, the ring and clock zone may be subdivided into the smaller parts to be accurate diagnosis.

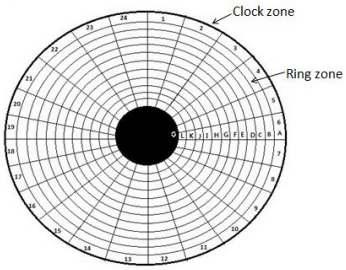


그림 3. 클럭과 링 영역 디지털화
Fig. 3 Clock and ring zones digitizing

The clock zone indicates organs that 1:cerebellum, 2: neck, 3: chest, 4: thorax, 5: upper abdomen, 6: lower abdomen, 7: pelvis, 8: lower back, 9: upper back, A: throat, B: face, and C: cerebrum of brain. The pattern codes are generated by the scleral sign pattern to detect the vessel points crossed between two zones by using overlay matching. For example, In case of index vessels in Fig. 4, the pattern code is created such as the following Table 3.

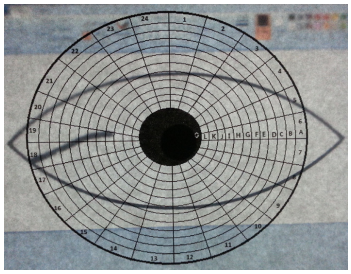


그림 4. 패턴코드 생성의 중첩매칭
Fig. 4 Overlay matching for pattern code creation

표 3. 인덱스 혈관 패턴코드
Table. 3 Index vessel pattern code

Ring zone r(k)	A	B	C	D	E	F	G	H	I
Clock zone c(j)	18	18	18	18	18	19	19	19	19

The scleral color and sign pattern code are generated by k(i), c(j) and r(k). Where index i is 1 to 6, j is from 1 to 14, and k is from 1 to 12. The equation is given in equation (2).

$$K_i C_j R_k = \prod_{i=1}^{6} \prod_{j=1}^{12} \prod_{k=1}^{24} k(i)c(j)r(k) \quad (2)$$

Thus the code format of the brown sclera and index vessel sign by color and vessel pattern code generation is coded as 04A18B18C18D18E18F19G19H19I19. This code is used to register a reference code. The complicated pattern makes the pattern code long. The reference database to all vessel signs results from the same processing as well.

Ⅲ. EXPERIMENT AND RESULTS

The system performance is based on the digital media processor which has 400MHz 32bit fixed point and 24bit RGB with live video codecs, has about 40ms to execute over all on D1 frames in real time. The PGC is examined. RGB ADC gain register is 6bit per color. The gain values set from 1 to 12 out of 0 to 63 code values as shown in Fig.4. To find out for optimal gain value, all register are reset, and the average histogram is

calculated by being repeated 80 times to the same scan position. The low level color gain is adjusted to set up on the histogram to figure out the RGB equal level values, and repeat the previous step. The measured optimal ADC gains are R:4, G:8 and B:7, and RGB values are R:1.6, G:2.1 and B:2.0 by using the gain transfer curve as shown in Fig. 5.

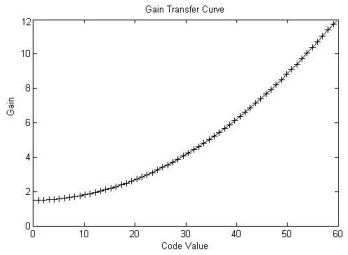


그림 5. PGC 전환곡선
Fig. 5 PGC transfer curve

The scleral edge detections are affected by reflecting illumination on tears as shown in Fig.6 about vessel indexes by using Canny edge detection algorithm.

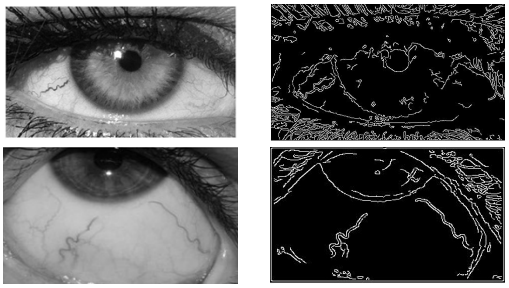


그림 6. 공막혈관 에지검출
Fig. 6 Scleral blood vessel edge detections

The scleral color detection is measured by probing up, down, left and right points of the sclera. The values are averaged over the YCbCr points as shown in Fig. 7. The measured success rate has 80% as shown in Table 4. The redish and brownish is shown as 5% lower rate because color are similar a bit. The pattern codes of scleral sign are measured by tolerances 40%, 50% and 60% on each blood vessel respectively because the scleral up and down outside are hidden a little bit. That is determined in consideration of ±10% error of 50% probability.

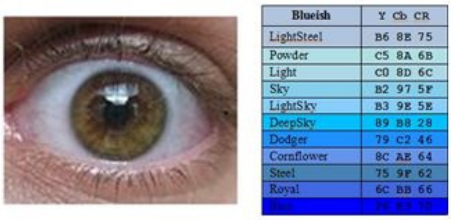


그림 7. 파란색눈과 컬러
Fig. 7 Blueish eye and colors

표 4. 공막컬러 판별율
Table. 4 Scleral color discrimination rate

Scleral color	Success(%)	Tolerance(%)
Blueish	85	40
Redish	79	
Yellowish	81	
Brownish	78	

The hidden vessels need to compensate on the pattern code. The more blood vessels are spreaded, the longer pattern code has complicated, the result values are stored to the references. The matched average rate has 76% as shown in Table 6. A sinuous vessel in the same zones is not easy finding variations on pattern code.

Ⅳ. CONCLUSIONS

The scleral diagnostic system implementation for human eyes by using the sclera color code and vessels sign pattern code generations is presented in this paper. The system is based on the high performance image signal processor and RISC frames storage. The system execution takes 40ms approximately for diagnosis. The SD frames fetch is mainly delayed to process. The gain has been adjusted by PGC, which results in enhancing the image resolution a bit at preprocessing. The scleral color discrimination rate has about 80% on 4 colors. The redish and brownish color are 5% lower relatively because of similarity. The pattern code for blood vessel sign is examined as 76% success. This result is shown to reduce the rate because of sinuosity on the ring and clock zones.

표 5. 공막혈관 패턴코드
Table. 5 Scleral bloode vessel pattern codes

Blood vessel	Pattern code
Index vessel	A18B18C18D18E18F19G19H19I19
Vascular spirals	A17A18B17B18C17C18D17D18E17E18F18
Meandering vessel	A5A17A18B5B17B18C6C17C18D6D17D18E6E17E18F6F17F18G7G8G17G18
Parallel band	A17A18B17B18C17C18D17D18D19E17E18F16F17F18F19G16G17H16H17
Porceain vessel	A17A18B17B18C16C18D16D18E16E17E18F16F17G16G18H15H18
Staguation stump	A16A19B18B19C17C18C19D17D18D19E17E18F16F17F18G17H17
Spindle vessels	A17A18B17B18C17C18D17D18E17E18F16F17F18G16G17G19H15H17H19I19
Vascular pearl	A6B6B7C6C7D7D8E7E8F7F8G6G8H6H9
Vascular branch	A18B18C18D18E18F19G18G19H18H20I16I17I21
Glonerular vessels	A16A18B16B18C16C18D16D18E16E18F16F17F18G16G18H15H16I16
Anemic vessel	A17A18B17B18C17C18D17D18E17E19F17F19G16g19g20H15
Trauma fork	A18B18C19D19E19F19G19H16H17H18H19I20I21

표 6. 패턴코드 매칭
Table. 6 Matched rate of pattern code

Blood vessel	Tolerance(%)	Success(%)	Average(%)
Index vessel	40	78	81
	50	80	
	60	85	
Vascular spiral	40	70	75
	50	76	
	60	80	
Meandering vessel	40	70	73
	50	73	
	60	76	

That needs to subdivide the each zones for solving sinuous vessel. Thus the system enables to apply to a portable medical system for examining the scleras. In the future the system is required to subdivide the zone and to apply to new algorithm to enhance the success rate of scleral diagnosis.

감사의 글

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