Proposed Method of Ophthalmic Perimeter for Vision Field Testing

[1] Neha Sridhar, [2] H.S.Nishchitha, [3] Harshitha.B.L,[4] Neha C Shekar,[5] Mr.B.R.Santhosh Kumar
[1]Student, [2] Student, [3] Student,[4] Student,[5] Professor
[1] Department of Electronics and Communication Engineering,
[1] K.S.Institute of Technology, Bengaluru, India

Abstract: Perimeter is the device used to measure perimetry of the eye. The perimetry is the measurement of light sensitivity in the visual field by the detection of the presence of test targets on a defined background. Perimetry is also referred to as Visual field testing for macula region of the eye. The macula region of the eye gets worn out with age or other disorders. This is to be tested and corrected. The perimeter device used currently for testing is not easily available due its high cost and complexity. This paper tries to overcome the high cost and complexity. This is purely for testing and not correction of the defect in the macula region. The implementation is based on flashing a series of random light emitting diodes in the peripheral field vision area and the subject is made to concentrate on a single center source. The results are recorded based on the patient's response for each eye. This perimeter is used to detect and evaluate pathologies which cause constriction in the peripheral vision or that effect both peripheral and central vision.

***IndexTerms* – Ophthalmic Perimeter, Vision Field Testing, Perimeter.**

I. INTRODUCTION

Humans can obtain visual information in the visual area of the eye while keeping their sight in a fixed position. When one's head and body is in stationary position, this sum of visual perception of one eye is attributed as the "visual field". Different factors influence the size of the visual field, namely, the measurement environment, the patient's response criteria and characteristics of stimulus. The technique of measuring the bound of visual field or to evaluation of the sensitivity of the visual field system while external stimulus is applied to it is called Visual Perimetry [8]. Visual field and field of gaze are often confused. Visual field is one which permits only the eye to move with the examinees head and body kept in a stable position. Field of gaze shows an area that one can perceive by moving his/her eyes or head. Everyday visual experience includes the above mentioned combined freedom of movements, the field of view and the field of gaze represent the common expressions of the total visual performance.

Ophthalmic perimeters are devices used to measure and evaluate the area of the macula region of the eye. When the macula region is projected upon a stimuli with the help of a curved surface it will induce a response of visual sight. These perimeters can be used to determine the peripheral and central visual field and also the areas of depressed or lost vision. Ophthalmic perimeters may use mobile targets of fixed luminosity or fixed targets. The results are recorded for one eye at a time. These perimeters are used to detect and evaluate pathologies that cause constriction of the peripheral vision or that effect both peripheral and central vision.

One of the best way to test the visual field is *Perimetry*. In the field testing the identification of the field targets within a predefined space is the systematic measurement of light sensitivity. This is used for careful mapping and quantification of the visual field, mainly at the extreme periphery of the visual area.

During the examination, patients are given with the test objects of varying size or brightness and the position of the background luminance(brightness) is usually held constant. The two techniques of perimetry are static and kinetic perimetry. In kinetic perimetry the test objects are in a moving state while its brightness and size are kept constant. In static perimetry the stimuli are static while operators can vary its brightness and/or size [7]. Based on randomness. The threshold is characterized as a 50% possibility of perception at a given location in the visual field. This is represented with a central peak of sensitivity at the point of fixation [4,6].

Fig.1. This figure shows what a defect means

The left part of the Fig.1 indicates the normal vision of person whereas right part indicates the abnormal vision in which he can't see the airplane and one person which indicates the defect of eye. Defects in the visual field of the macula can be caused by a variety of diseases/disorders of the eye and brain. Not all ocular and brain disorders cause visual field defects. On the other hand, not all visual field abnormalities are indicated as significant disorders/diseases. Some defects are caused by harmless retinal scars.

II. RELATED WORK

Automated visual field (VF) testing is an important part in diagnosing and managing the patients with varying types of neurological and ophthalmological diseases [5]. The results of the visual test depend upon the patient's performance during the test procedure because of its subjective psychophysical nature. The trustworthiness of the patient during the examination can be assessed with the automatic calculations of false-positive or false-negative responses and the rate of fixation loss. It has been termed that the reliability indexes are regularly outside the recommended fixation loss and false-positive and false- negative limits. Thus, the process of interpreting the results becomes a challenging task. Hans Goldmann perimetry was the first universally standardized perimetry system which was widely exploited for conducting the visual field testing. Goldmann perimeters were characterized by the identical standardized stimuli and background level [3].

The hemispherical surface is used to perform perimetry which projects the visual field. The eye is fixed at the geometric center of the hemisphere so that the entire range of points on its inner surface are located equidistantly from an eye. While small spots of light sources act as test sources which are mapped upon the background with the surface of the hemisphere being evenly illuminated.

There are 128 LEDs which are placed in random manner on the hemispherical disc. It has a centered led at which the patient is asked to concentrate on. The paper also tells about how the patient's response is noted using the response switch. [1] Our proposed model plans to use a similar mechanism with lesser number of LEDs. Since a matrix which is in 2^x form is easier to handle, control or manipulate, we plan to use one such matrix. The number of LEDs used will be 64 since it can be spaced equidistantly upon the hemispherical disc. Also 8x8 matrix can be setup easily.

The existing perimeter device is shown in Fig.2. This device is very bulky and complex. The device is also not available at many hospitals because of its high cost. Also, the test done by this device is too expensive and affordable by everyone.

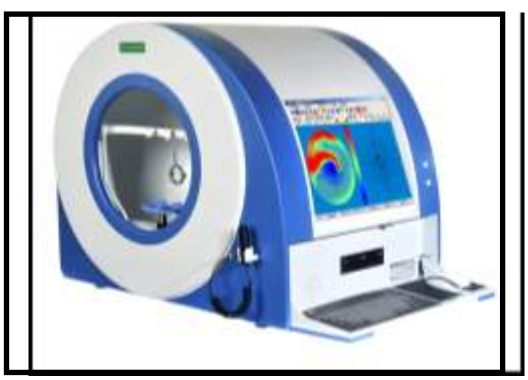

Fig 2. Diagram of Goldmann's Perimeter

Hence, we aim at reducing this high cost and making it easily accessible to the needy patients. Aa a result the cost of the test will also be reduced. The complexity is main thing which we aim to optimize in the cost of view. This is just a testing prototype and not correcting device as it only helps in detecting the faulty area of the macula.

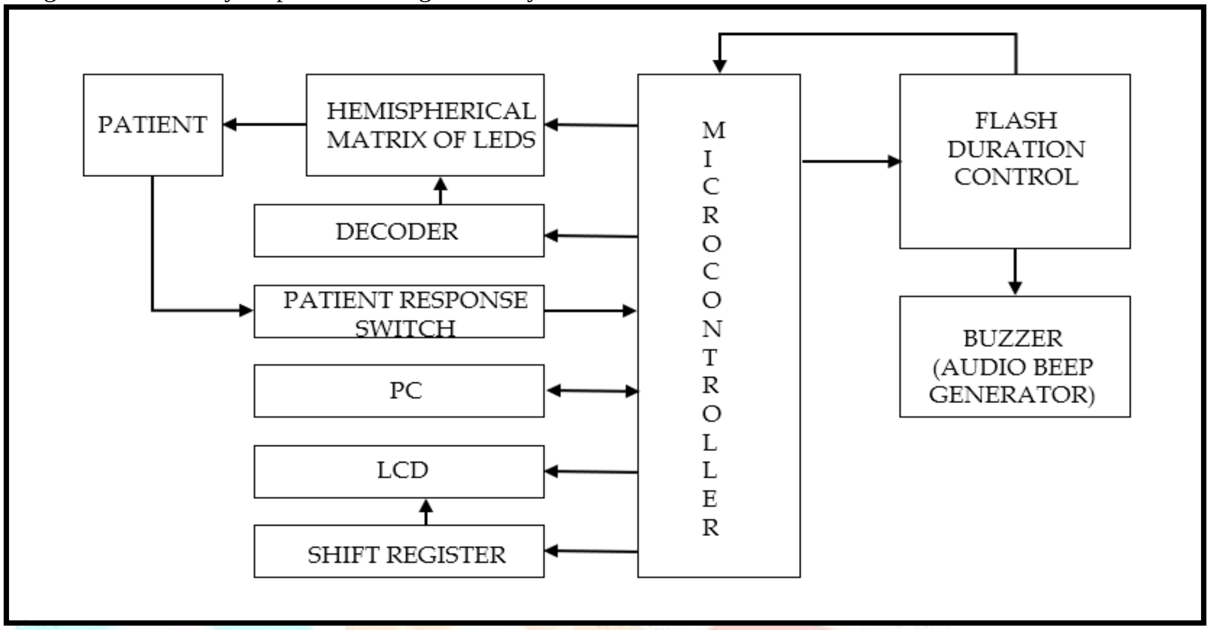

Fig 3. Block Diagram of the proposed Perimeter

III. METHODOLOGY

A. Block Diagram:

Fig 3. describes the blocks that constitute an ophthalmic perimeter. Each of these blocks is discussed in detail in the following sections.

The Hemisphere contains an 8x8 matrix. LED's are mounted in this fashion. LED's mounted are to be mounted at strategic points in 3 concentric circles. The 1st circle consists of 8 – LED's, the 2nd circle consists of 24 – LED's and the 3rd circle consists of 32 – LED's, the hemisphere consists of another light source in the center which is used as background light source. These LED's are used as Stimulus to the patient's eye. As there are 64 LED's which should be turned ON randomly one at a time. Hence, we are using LED driven circuit. The LED driven circuit consists of the shift registers and the decoders. We are using two different brightness named half and full brightness.

Patient is provided with the patient response switch when the patient see's the LED flash or stimuli he/she conveys the message to the doctor or the technician that he/she has seen the flash by pressing patient response switch one of the key of the keypad which consists of 12 keys. This message is also conveyed to microcontroller which acts as the brain of our system. The microcontroller analyses this response.

The microcontroller required for this project must be emphasizing on high integration, low power consumption, self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor (the kind used in a PC). In addition to the usual arithmetic and logic elements of a general-purpose microprocessor, the microcontroller typically integrates additional elements such as read-write memory for data storage, read-only memory, such as flash for code storage, EEPROM for permanent data storage, peripheral devices, and input/output interfaces. At clock speeds of as little as a few MHz or even lower, microcontrollers often operate at very low speed compared to modern day microprocessors, but this is adequate for typical applications. One of the controller that fits the requirements is PIC microcontroller (PIC18F series preferred).

The beep generator or the buzzer generates a short beep before the LED is turned ON, thus providing an indication of arriving stimulus. The duration of beep is around 800 milli Second. The microcontroller pulls logic high if pins for 800 milli seconds connected to switch placed between the buzzer and the ground.

The microcontroller program is needed to interact with the outside world. The program must provide input and output devices that communicate directly with a human being. One of the most common devices attached to a microcontroller is an LCD display. The LCD circuit is used to display which LED is being accessed, its brightness levels and other details.

B. Working:

To do the test, the patient sits considering a hemispheric-shaped instrument called a perimeter. The patient is asked to patch one eye and place his/her chin on the chin rest of the perimeter. The position of the chin rest is adjusted to facilitate the patient to view the complete periphery of the hemisphere. The patient is then asked to fix his/her vision through the eyepiece provided on the central fixation light. The Fig 4. shows the schematic block diagram of the hardware used for the perimeter.

A buzzer is sounded, indicating the appearance of the stimulus. The stimulus is then turned on, thus giving a flash of light for a short duration. Without shifting his/her gaze from the central fixation, the patient is asked to identify whether he/she can able to see the stimulus by pressing a response button. This response is indicated on the response indicator. These responses are mapped and the visual field is analyzed.

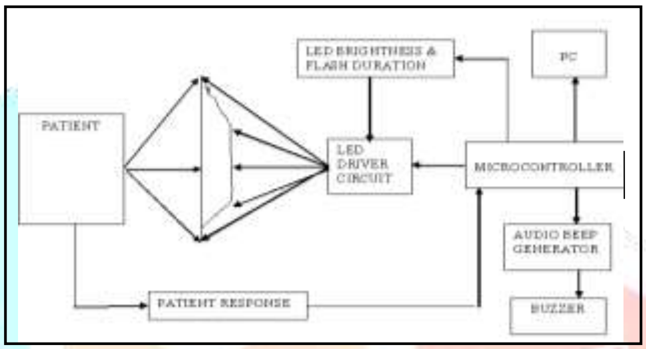

Fig 4. Schematic of hardware used for the project

C. Software:

Since we are using PIC microcontroller, programming can be done in simple C-language. This coding can be done using any of the assembly level coding tools, namely Keil uVision, C Compiler, etc. It can be checked for errors and then is dumped onto the microcontroller.

D. Testing methods:

Perimetric test can be done in three ways:

a. Manually : LED's are selected one by one manually by the doctor. Each random spot (LED) is selected by the doctor by using spot up and spot down key. Before selecting spot number, left or right eye option is selected and then spot numbers is selected. Later true or false is selected. True means flash and false means no flash of LED and go (Enter). Key is pressed which executed the selected option for that LED. Hence for next LED, selected randomly by the doctor above operations should be performed by the doctor manually.

b. By Making List : Eight LED are selected by the doctor for each eye. The software makes use of this eight LED's prepared by the doctor & converts it into a list of 32 combinations. These combinations arranged in an order which is difficult for the patient to guess which LED is going to turn on next. The 32 combination is made by making 4 combinations for each LED that is 4x8 = 32. These 4 combinations for each LED can be of half intensity, full intensity, flash or no flash that is, if we consider 1 as flash & full intensity and then '0' as no flash & half intensity.

c. Automatic : - Hence manufacturer makes a list of 8 LEDs for each eye and converts it into 32 combinations for left and right eye, which is used by the doctor or technician.

E. Results:

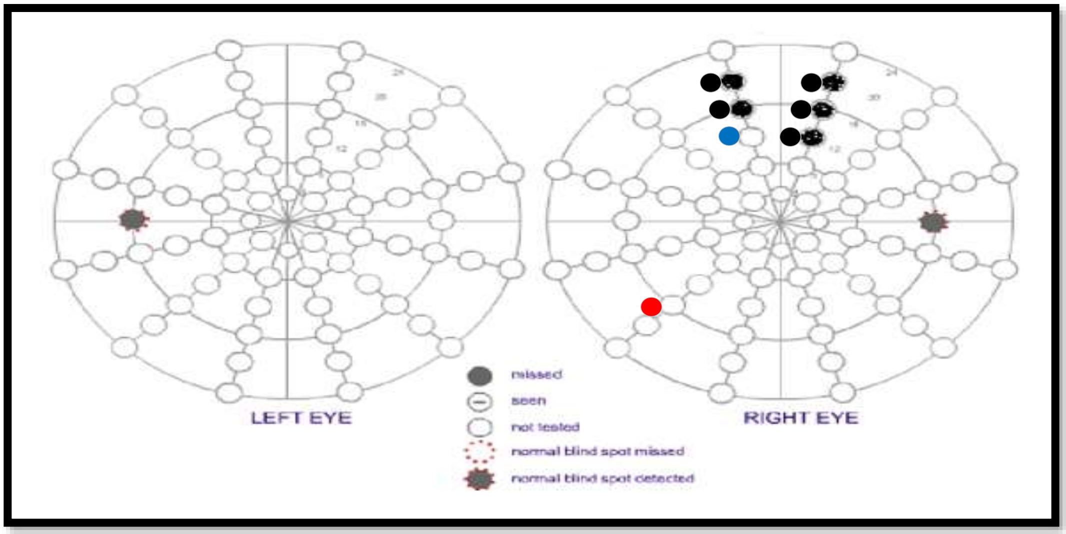

Fig. 5 Expected result representation showing defects in right eye

The result for each LED's of the list is given as:

a. Blind
b. Half vision
c. Logic fail
d. Full vision

Blind refers to the blind spot. This is displayed in the place where subject had not responded to both half and full brightness.

Half vision represents that the photoreceptor in that area is weak. This happens usually in elderly persons. This displayed when the subject response to full brightness and did not response to half brightness.

If the subject has responded to half brightness and did not respond to full brightness. This is impossible, so the name is logic fail. In this condition, the retest is done in this partial spot.

Full vision represents that the photoreceptor in that area is normal. This is displayed when the subject is responded to both half and full brightness.

The results can be differentiated by using different colors for each led used. For example, black can be used to depict blind, blue can be used to depict half blind, red can be used to depict logical fail and white for full vision.

IV. CONCLUSION

As a person's age advances retina gets degenerated and loses sensitivity. This results in many blind spots. This perimeter helps in detecting these blind spots in a more convenient way. In most equipped hospitals, this model is more complex and requires specialists or doctors to operate.

This proposed prototype hence uses less number of LED's which are connected in a matrix. Functioning is carried out by flashing random number of LED's with two levels of intensities which is more convenient to detect defects in eye. This can be operated by any normal person without the help of a technician or doctor. One can use this device and get the results. Later that can be taken to the hospital for further diagnosis. This prototype can be used as first precautionary step to test a person's eye. This model provides appropriate results like blind, full vision, half vision, logic fail.

Thus, we aim at making this prototype very efficient, economical and employable for small applications in any place.

V. REFERENCES

[1] Irina A. Gotsiridze, Giorgi T. Gigilashvili, Zviad T.Gurtskaia, "Computer Perimeter for Screening of Field of Visions and Standardization of this Method", 2015 IEEE

[2] Finnegan J. Calabro, Lucia M. Vaina, "A computerized perimeter for assessing modality-specific visual field loss", Conf Proc IEEE Eng Med Biol Soc . 2011 ; 2011: 2025–2028.

[3] Albert von Graefes, Arch. Klin. "Automatic (Octopus) and manual (Goldmann) perimetry in glaucoma."

[4] Pineles S.L, Volpe N.J, Miller-Ellis E, Galetta S.L, Sankar P.S, Shindler K.S, Maguire M.G. "Automated combined kinetic and static perimetry: An alternative to standard perimetry in patients with neuro-ophthalmic disease and glaucoma." Arch Ophthalmol. 2006;124(3):363-9.

[5] Yaniv Barkana,MD; Yariv Gerber PhD; Ricardo Mora MD; Jeffrey M. Liebmann MD; Robert Ritch. "Eye Testing Order on Automated Perimetry Results Using the Swedish Interactive Threshold Algorithm" Standard 24-2. Affiliations Arch Ophthalmol. 2006; 124(6):781-784.

[6] Schiefer U., Pätzold J., Wabbels B, Dannheim F. Conventional Perimetry, Part 3: Static Perimetry: Grid-Strategy- Visualization. Ophthalmology 2006 Feb,103(2):149-6.

[7] Johnson C.A, Keltner J.L, Lewis R.A. "Automated kinetic perimetry: an efficient method of evaluating peripheral visual field loss, Applied Optics. 1987 Apr 15; 26(8):1409-14.

[8] Traquair H.M., "Clinical Perimetry", Klimpton, London (1957S).