INTERNATIONAL JOURNAL OF RECENT TRENDS IN ENGINEERING & RESEARCH
Impact Factor 4.101 ISSN -2455-1457
RECENT ADVANCES IN ELECTRONICS & COMMUNICATION ENGINEERING (RAECE-2K17)

Hardware Based Implementation and Detection of Glaucoma

B.MOUNIKA
Student, ECE Department
Nalla Narasimha Reddy
Group of Institutions

SNEHA TALARI
Assistant Professor, ECE Department
Nalla Narasimha Reddy
Group of Institutions

***Abstract*— Glaucoma is one of the second driving eye sicknesses on the planet, if not treated appropriately may cause perpetual visual deficiency. Glaucoma is one the irreversible process. There are no particular evidence for this infection, it is seen by loss of side vision. Glaucoma is a moderate dynamic degeneration of retinal ganglion cells (RGC) and their axons, bringing about a particular appearance to the optic nerve head (ONH), regularly called measuring. Because of measuring, the glass zone increments and causes loss of side vision. Typically uncommonly prepared clinicians physically review the funds pictures in a tedious way. In this unique circumstance, we are attempting to build up some novel calculations for programmed discovery of eyes influenced with glaucoma utilizing picture preparing separating and change procedures and actualize the same on equipment utilizing DSP Texas Instruments (TI) DM3730 construct framework in light of chip (SOC) minimal effort, low power single board PC framework or utilizing LABVIEW based NI interfacing framework. The product that will be created by us could be inserted on the equipment to test the solid and unfortunate funds pictures for the recognition of glaucoma. Programmed glaucoma screening utilizing a TMS320C6416DSK DSP board is the equipment that could be considered for usage purposes. The calculations that could be created can be executed on retinal pictures in VERILOG HDL utilizing Xilinx ISE, MATLAB and MODELSIM. TI based pack or NI based unit (any one) is the equipment device that is considered for execution purposes.**

***Keywords*—Glaucoma, RNFL, Image, Eye, Disease .**

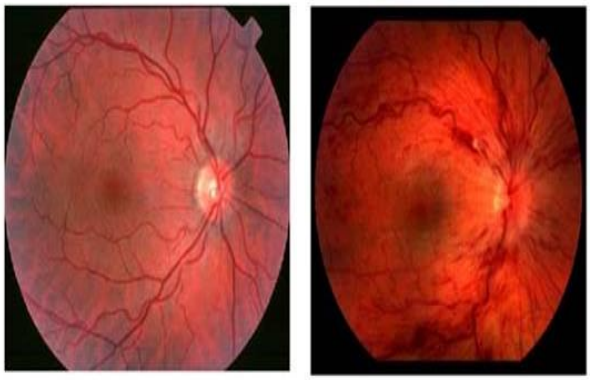
I. INTRODUCTION

In this part, a quick evaluate of the concepts regarding the glaucoma disorder, its kinds, how it is able to be detected, and so on… is being presented.

A. Overview of Glaucoma

Glaucoma damages the optic nerve which leads to permanent blindness. It cannot be cured, so detecting the sickness in time may be very important. Glaucoma is one of the most extreme eye illnesses in line with the number of blindness causes in India and western international locations and is the second one maximum main eye disorder. An appropriate time are the severe obligations for the ophthalmologist. This in advance detection of deadly diseases has been proposed using superior picture processing, evaluation and popularity strategies. This nation of art techniques had already been assisted docs in diverse fields which include earlier detection and analysis of illnesses, medical selections, remote sensing surgeries and so forth. In quick to mention, glaucoma is a continual eye sickness in which optic nerve is regularly damaged & slowly starts off evolved to motive sight loss.

Through the years glaucoma starts off evolved to affect your facet/peripheral imaginative and prescient and slowly works its manner to the middle if left undetected. in keeping with global fitness company (WHO), Glaucoma is the second one leading purpose of imaginative and prescient loss; that contributes to approximately 5.2 million instances of blindness (15% of total blindness cases said) and may doubtlessly affect ~eighty million human beings inside the subsequent decade. to date, there may be no cure for glaucoma. Fortunately, it's also a sluggish progressing situation, and if it is detected early, it could be dealt with successfully. Early detection is the important thing for preventing sight loss. it's far characterized by means of the modern degeneration of optic nerve fibers and leads to structural modifications of the optic nerve head, which is called optic disk, the nerve fiber layer and a simultaneous useful failure of the field of regard. Progression of the sickness ends in loss of imaginative and prescient, which takes place gradually over a long-time period.



(a) (b)

Fig.1 : Enlarged view of normal & affected eye with glaucoma (a) Normal non-glaucoma eye (b) Neo-vascular glaucoma affected eye

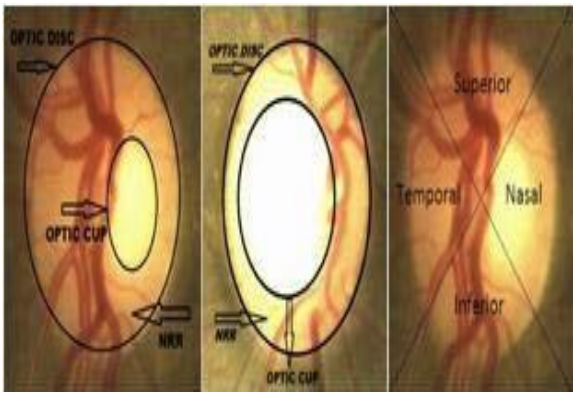


Fig. 2 : Normal Disc, Glaucomatic Disc, ISNT Quadrants

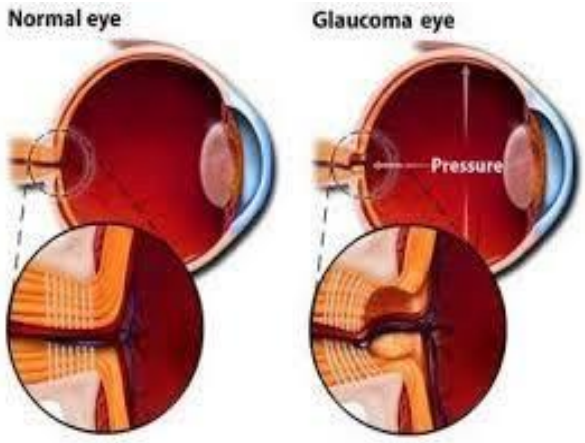


Fig. 3 : Medical image of normal and affected eye

Glaucoma can't be cured, yet its movement can be backed off by cure. Therefore, recognizing glaucoma in time is critical in any case, numerous glaucoma sufferers are unmindful of the sickness until it has achieved its unrivaled level. In India, there are presently an expected 12 million people tormented by glaucoma, the overall population of whom are undiscovered by methods for 2020, this is anticipated to be sixteen million. on record that glaucoma advances with few signs or signs and the vision misfortune from glaucoma is irreversible, screening of individuals at high peril for the turmoil is imperative. The refinement among the ordinary eye and the influenced eye is appeared in the Fig. 1 - three individually. The Fig. four - five recommends the amplified perspective of the standard eye and the influenced eye with glaucoma close by the optic plate.

II. ANATOMY OF THE NORMAL EYE

A life structures of human eye is roughly a round organ and is appeared in the Fig. 4. The defensive external layer of the eye is known as the sclera. Alternate segments of the eye are areas, for example, cornea, focal point, iris, and the retina. The retina is the light-touchy tissue that lines within the eye. The optical components inside the eye center a picture on to the retina of the eye, starting a progression of compound and electrical occasions inside the retina. Nerve strands inside the retina send electrical signs to the mind, which then translates these signs as visual pictures. Retina is roughly 0.5 mm thick and spreads the inward side at the back of the eye. The focal point of the retina is the optical circle, a round to oval white range measuring around 3 mm2 (around 1/30 of retina territory). The mean breadth of the veins is around 250µm. The fundamental retinal segments numbered in Figs. 4 and 5 could be recorded as

A) Advanced temporal blood vessels,

B) Superior nasal blood vessels,

C) Fovea,

D) Optic disc,

E) Inferior temporal blood vessels and

F) Inferior nasal blood vessels.

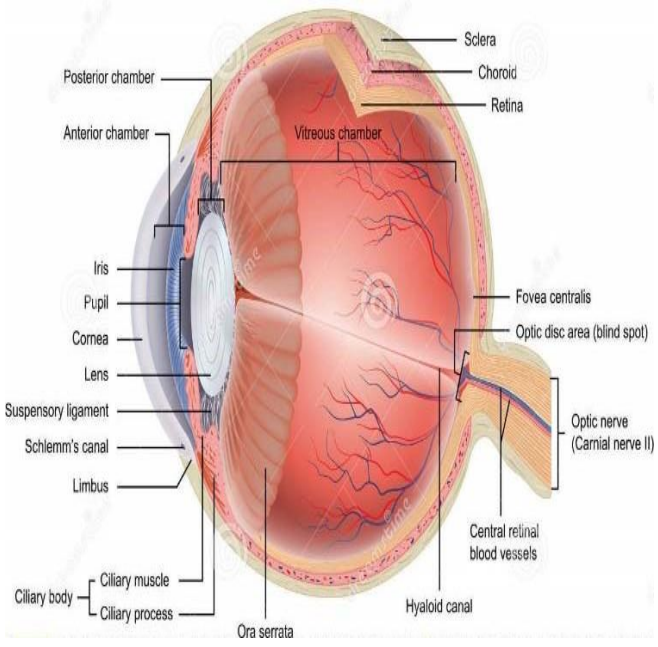


Fig. 4 : Anatomy of eye / retina

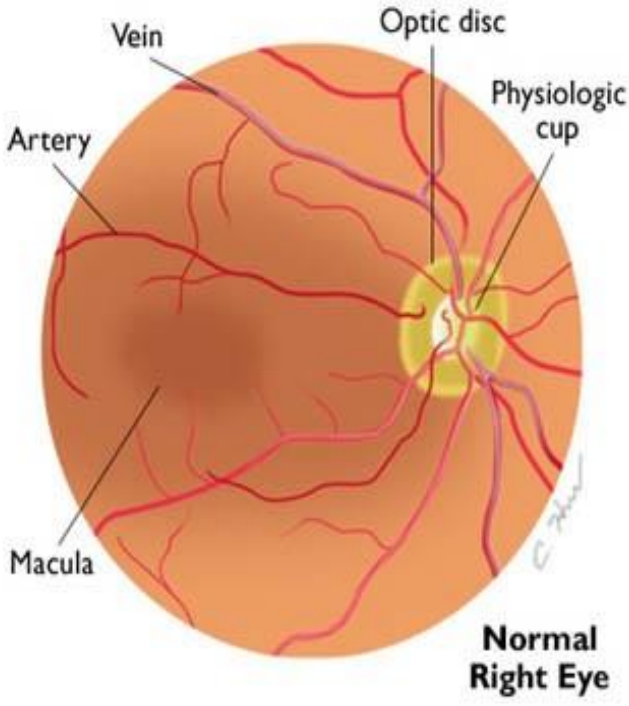


Fig. 5 : Enlarged view of the retina with optic disc

The cup-to-disc ratio is a measurement utilized in ophthalmology and optometry to evaluate the progression of glaucoma. The optic disc is the anatomical area of the attention's blind spot. it's far the place wherein the optic nerve and blood vessels input the retina. The optic disc can be flat or it is able to have a certain amount of ordinary cupping. but glaucoma, which is due to an boom in intra-ocular pressure, produces extra pathological cupping of the optic disc. The pink rim of disc consists of nerve fibers. The white cup is a pit without a nerve fibers. As glaucoma advances, the cup enlarges until it occupies most of the disc vicinity. The cup-to- disc ratio compares the diameter of the 'cup' part of the optic disc with the entire diameter of the optic disc. The hole represents the cup and the encircling region the disc. If the cup fills 1/10 of the disc, the ratio might be zero.1. If it fills 7/10 of the disc, the ratio is zero.7. The everyday optic disc cup-to- disc ratio if less than zero, three and extra than 0.3 cup-to-disc ratio additionally implies glaucoma. however, cupping by itself isn't indicative of glaucoma; alternatively, an growth in cupping as the patient a while also is a trademark for the reason of glaucoma.

III. TYPES OF GLAUCOMA

In this area, distinctive sorts of glaucoma are talked about as beneath. These are set apart by an expansion of intraocular weight (IOP) or weight inside the eye. Open-Angle Glaucoma: It is the most well-known type of glaucoma, representing no less than 90% of all glaucoma causes and is brought about by the moderate stopping up of the waste waterways, bringing about expanded eye weight it has a wide and open edge between the iris and cornea it grows gradually and is a long life condition its manifestations and harms are not taken note. Open-edge implies that the edge where the iris meets the cornea is as wide and open as it ought to be Open-edge glaucoma is likewise called essential or ceaseless glaucoma.

Point Closure Glaucoma: It is a less basic type of glaucoma and is brought on by blocked waste trenches, bringing about a sudden ascent in intraocular weight it has a shut or restricted edge between the iris and cornea Develops rapidly it has side effects and harm that are normally exceptionally recognizable Demands prompt therapeutic consideration. It is additionally called intense glaucoma or tight edge glaucoma. Not at all like open-point glaucoma, edge conclusion glaucoma is a consequence of the edge between the iris and cornea shutting.

Typical Tension Glaucoma: It is likewise called as low strain or ordinary weight glaucoma. It is a type of glaucoma in which harm jumps out at the optic nerve without eye weight surpassing the ordinary range(10-20mmHg).

Intrinsic Glaucoma: This sort of glaucoma happens in children when there is off base or inadequate improvement of the eye's seepage waterways amid the parental period. This is an uncommon condition that might be acquired. It is additionally alluded as youth glaucoma, pediatric or childish glaucoma. It is generally analyzed inside the primary year of child life.

Essential Glaucoma : The essential glaucoma is basically because of increment in the Intra Ocular Pressure (IOP). The locales influenced are Optic container, Optic Nerve Head, Neuron retinal Rim and Retinal Nerve Fiber Layer.

Auxiliary Glaucoma : Secondary glaucoma (SG) emerges because of certain convoluted conditions like genuine eye harm, tumor, diabetes, and so on. Neo-vascular glaucoma is a sort of auxiliary glaucoma which is a resultant of Diabetic Retinopathy.

Neo-vascular glaucoma : Neo-vascular glaucoma is brought about by the unusual development of fresh recruits vessels on the iris and over the eye's waste channels. Neo-vascular glaucoma is constantly connected with diabetes. It never happens all alone. The fresh recruits vessels obstruct the eye's liquid from leaving through the trabecular meshwork bringing about an expansion in eye weight.

Shed Glaucoma : happens when a flaky, dandruff-like material peels off the external layer of the focal point inside the eye. The material gathers in the point between the cornea and iris and can stop up the waste arrangement of the eye, bringing on eye weight to rise.

Pigmentary Glaucoma: happens when the color granules that are in the back of the iris break into the unmistakable liquid delivered inside the eye. These small shade granules stream toward the seepage channels in the eye and gradually stop up them, bringing on eye weight to rise.

A short survey of the different sorts of glaucoma was examined in the past segments. In this unique situation, we will discover the CDR for sound and unfortunate pictures alongside the foundation of a few connections between different parameters.

In the accompanying areas, we give a short survey about the recognition of glaucoma is managed alongside equipment execution of the same.

IV. LITERATURE SURVEY

Glaucoma disorder in humans is considered as one of the vital illnesses which impacts the anxious structures & may additionally cause the loss of vision. Glaucoma damages the optic nerve which consists of visual facts to the brain. The mind can apprehend the items in the foreground and inside the history or at a sure distance with the help of eyes. The damage to the optic nerve results in everlasting blindness or to loss of vision. So, detection of glaucoma plays an crucial function in an effort to save you the lack of imaginative and prescient.

It is often, however now not always, related to expanded strain of the fluid in the attention. The nerve damage entails lack of retinal ganglion cells in a function sample. there are numerous one of a kind sub-varieties of glaucoma but they could all be considered as a type of optic neuropathy. Raised intraocular pressure is a tremendous threat component for growing glaucoma (above 22 mm Hg or 2.nine kPa). One person can also develop nerve damage at a enormously low pressure, even as every other individual may have high eye stress for years and yet in no way increase harm. Untreated glaucoma ends in permanent damage of the optic nerve and resultant visual field loss, which can progress to blindness. Currently, ophthalmologists use three techniques to locate glaucoma, viz.,

- One is the evaluation of expanded stress inside the eye ball.
- 2nd is the assessment of odd imaginative and prescient.
- The 1/3 approach is assessment of the damage to the head of the optic nerve.

The diagnostic criteria for primary glaucoma include

- intraocular pressure dimension,
- optic nerve head assessment,
- retinal nerve fibre layer and
- visual view illness.

Huge research is being accomplished on the secondary glaucoma troubles within the global @ diverse research centres until date. a number of researchers have worked on the subject up to now, a number of them have benefits & a number of them dis-blessings. A quick exhaustive evaluation of the same work executed in the relevant selected field through exceptional authors w.r.t. glaucoma is summarized as follows.

Hardware implementation of enhancement of retinal fundus photo using Simulink becomes finished by using V. Krishna Sree & P. Sudhakar Rao in their IEEE paper. picture enhancement is essentially enhancing the interpretability or notion of information in snap shots for human visitors and supplying 'higher' enter for other automated picture processing strategies. The most important goal of photo enhancement is to adjust attributes of an picture to make it more suitable for a given assignment and a selected observer. The work accomplished by way of them addressed the implementation of photo enhancement algorithms like brightness manipulate, contrast adjustment and histogram equalization on FPGA that have grow to be a competitive alternative for high-performance digital signal processing packages. With the arrival of cell embedded multimedia gadgets which are required to carry out quite a number multimedia tasks, mainly photograph processing tasks, the need to layout green and high performance image processing structures in a brief time-to-market time table desires to be addressed. consequently, the photo enhancement algorithms applied in hardware have emerged as the most viable solution for enhancing the overall performance of photograph processing systems. Their proposed work gave the implementation of green picture enhancement algorithms on area programmable gate array (FPGA) the use of Matlab & Simulink.G.C. Sekhar et al. expressed that optical disc (OD) size in Ocular high blood pressure(OHT) sufferers is smaller compared to number one Open attitude Glaucoma (POAG) sufferers and normals. The horizontal and the vertical diameters were measured.

S.Sekhar et al. used Hough remodel to locate OD. To find the contours of OD, a place of interest (ROI) is located from the binary photograph obtained after pre-processing. Morphological operations are used to calculate the importance gradient for part detection.

Mahdad Esmaeili et al. efficient OD localization and segmentation are important obligations in automated retinal screening. in this digital curvelet transform (DCUT) of the enhanced retinal photo is taken and its coefficients are changed primarily based on the sparsity of curvelet coefficients to get probable place of OD.

Rudiger Bock et al. proposed a singular automated glaucoma detection gadget wherein, Glaucoma chance Index calculation includes three steps: pre-processing to dispose of the disorder unbiased versions from the enter picture, feature Extraction by precept issue evaluation (PCA) to convert the pre-processed enter records to feature and compact illustration, and a two stage probabilistic SVM classifier to generate the Glaucoma hazard Index.

R. Chrastek et al. writer on this paper offered a method for optic nerve head segmentation and its validation. The technique is based on morphological operations, Hough rework, and an anchored energetic contour model.

SIvan Culjak et al, in their paper described many laptop imaginative and prescient algorithms to make a reader acquainted with OpenCV and provided many simple and famous pc imaginative and prescient algorithms, together with many key references for an interested reader to pursue in addition information.

Slavomir Matuska et al, in their paper supplied simple algorithm for image processing, focusing for their CPU time consumption in Matlab and OpenCV. results confirmed that OpenCV is quicker than Matlab in a few set of rules from four to 30 times and in case of erosion algorithm up to 100 times. alternatively, Matlab environment is relative really and pleasant to apply, and provides diverse type of characteristic and set of rules. It isn't vital to care about reminiscence allocation and reminiscence leak in Matlab, however it's miles very essential project in OpenCV. This allocation and liberating memory inserts traces into the code. Matlab wishes for smoothing algorithm 2 lines, however OpenCv wishes five strains to put in writing source code with the equal capability.

The experimental outcomes display that, the segmentation module and the function extraction module require extra time. The thought to attain a combined implementation of the gadget so as to increase the performances enforce the step which has the extra time execution in hardware using VHDL language even as the alternative elements in C++. The authors additionally proposed to apply co-design technique to enforce the whole algorithm.

Jaeyoung Kim, Heesung Jun implemented realtime photograph processing program the use of Open CV library for Apple's iPhone4 clever mobile smartphone. The entire image processing software can do various operations inclusive of thresholding, adaptive thresholding, edge detection and contour detection. handy user interface became advanced the use of goal-C and also applied augmented fact software on iPhone4.

Shifeng Hu et al proposed a motive force fatigue eye functions detection algorithm primarily based on OpenCV image processing and computer imaginative and prescient development platform. those algorithms localize eye-vicinity and locate its nation based on hard to accurate thought, and might localize eye pupils in eye-open nation accurately.

Hiroki Sugano Ryusuke Miyamoto defined a parallel implementation of morphological processing optimized for cell Broadband Engine. Authors implemented numerous optimization techniques suitable for cell structure along with more than one SPEs (Synergistic Processor element), SIMD (single coaching multiple records) operation, doubles buffering, and loop unrolling. with the aid of this implementation, three.2 GHz cell the usage of two three.6 GHz SPEs can erode a 1024x768 pixel image via a five × 5 pixel rectangle kernel in 0.601 milliseconds.

Shen Khang Teoh et al supplied of their paper provided paintings on enforcing a human tracking gadget on each Intel based totally computer platform and embedded systems to optimize the algorithms for high overall performance. The algorithms are benchmarked at the Intel platform processor and Beagle Board xM primarily based on low-electricity Texas devices (TI) DM3730 ARM processor. features and library in Open CV which advanced with the aid of Intel enterprise turned into applied for constructing the human monitoring algorithms.

In majority of the paintings achieved by using the various authors supplied within the preceding paragraphs, there have been sure drawbacks / hazards / lacunas consisting of attention of only one or parameters, and many others. a lot of them have not considered dangerous photographs, noise results have been no longer considered, usage of fractional CDR was taken into consideration, SNR turned into now not taken into consideration, and many others….. Couple of these drawbacks are going to be considered in our assignment paintings with multiple parameters & new algorithms are going to be evolved which will be proven through effective simulation consequences through Matlab/LabVIEW &hardware kits DSP..

OBJECTIVES OF THE PROJECT WORK

The main objective of our project paintings is to develop a few algorithms for

- The prognosis & detection of glaucoma by using developing sophisticated algorithms using unique sorts of transformation techniques &
- To compare them for their satisfactory performance for glaucoma detection by using locating out the performance indices.
- Cases may be considered on this venture paintings, i.e., for healthy photographs & bad images (affected with glaucoma & harm).
- Hardware implementation of glaucoma detection the use of dsp kits / fpga kits.
- Using matlab / labview as a device to acquire this implementation technique.
- Important aim is to simulate and enforce the advanced algorithms the use of verilog hdl & the tool decided on for implementation may be (spartan-3e) from xilinx.

The above noted objective of our dissertation work can be executed the usage of the subsequent steps :

- gathering snap shots of human eyes (both healthful and bad) the usage of suitable photograph taking pictures gadgets…..a massive quantity of samples (statistics base of picture series) from diverse assets from hospitals & photo databases.
- coaching of preferred image statistics bases the use of kingdom-of-art strategies.
- performing photo pre-processing (segmentation, enhancement), processing, and evaluation and application of mathematically evolved equations in spatial & frequency domains.
- finding the ROI the use of distinct IP techniques.
- Use of filtering & transformation techniques to get a first- class picture

- Simulating the equal the use of Matlab/LabVIEW
- Implementation the use of hardware kits.

Hardware kits used : The hardware kits which can be going to be used for the assignment work is DSP card with CCS-Code Composer Studio & the countrywide instruments Kits / FPGA Spartan kits for the experimentation purposes / Xilinx Spartan Kits.Software tool used : The software program device that is used for the venture work is Matlab 14 with Simulink modeling for simulation functions & the picture Processing tool field or LabVIEW with NI software or VHDL language.

VI.MOTIVATION / PROBLEM STATEMENT DEFINITION

The motivation for sporting out the mission work is depicted in this phase at the side of the trouble announcement. medical doctors are finding problems in the sooner detection of the inflamed location in case of eye because the glaucoma disease is the 2nd most affected disease inside the global to which many human beings are falling victims. on the equal time it's miles a very high-priced method to locate the sickness using the modern-day gear due to which we are developing a methodology for detection such that it's miles low-cost by means of all the sections of the society, also it may be detected on the early level & prevention can be taken. consequently in continuation, with zeal of this work, we're providing some novel methodologies for detection of glaucoma with the aid of growing some software program algorithms the usage of a few forms of transformation strategies & filtering techniques in Matlab/LabVIEW & subsequently imposing the same the use of hardware (VLSI techniques) in FPGA, the hassle eventually, being described as "Simulation, development of bio-medical image processing algorithms of eyes affected with glaucoma & hardware implementation using VLSI techniques.

VII.PROPOSED METHODOLOGY

The proposed methodology that may be utilized in our project work is presented in this section (may also exchange in due path because the task progresses). The proposed method that may be adopted inside the present undertaking work is depicted within the Fig. 6 in a totally enormously abstracted way with diverse blocks in the vertical & horizontal fashion.

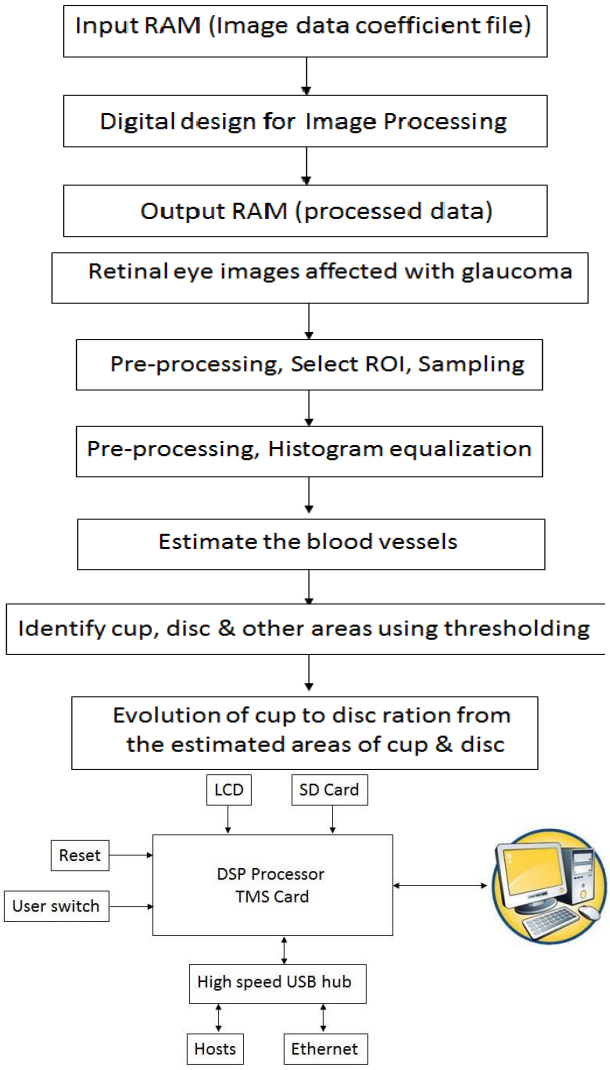


Fig. 6 : Block-diagram of the proposed hardware implementation methodology

The proposed set of rules may be developed for the detection of glaucoma the usage of the regions of cup and disc & may be used for the evaluation of glaucoma. finally, the algorithm may be initially applied on LabVIEW platform (or using DSP board or the usage of Verilog HDL Spartan Xilinx kits to enable the algorithms on hardware through LabVIEW software getting transformed to C codes). subsequently, those C packages could get replaced with Open CV programs as the unmarried board computer system operates on open supply Linux platform & gazing the experimental consequences. finally, the end result will be acquired and can be presented inside the very last stage, which could finish the effectiveness of proposed technique that is going to be evolved by way of us.

VIII. POSSIBLE OUTCOME / EXPECTED RESULT

The final results of this project work has got wide utility in the sooner detection of eye affected with glaucoma the use of nation of art of picture technology with hardware implementation the usage of FPGA / DSP / SPARTAN / VHDL / XILINX kits. this is one of the technique in which very much less human interaction giving rise to rather hygienic technique & making the device identification absolutely automatic. The predicted effects or the final results of the assignment paintings might be summarized as follows.

Glaucoma may be detected the use of transformation strategies using different sorts of filters.

- observation of the hardware experimental outcomes for validation functions.

IX.APPLICATIONS

The work done in this project may be evolved w.r.t. rural community with much less skilled medical doctors even in the subject of eye analysis affected with severe ailments. it is able to additionally be used in public locations like in malls, in order that the individual who is affected with glaucoma can be detected at once, precaution can be given in order that the proper diagnosis may be completed at the sooner stage to keep away from loss of vision.

X.CONCLUSIONS

A quick review of the paintings related to the mission undertaken became depicted in the preceding sections inside the shape of introduction, observed by way of literature survey. The goals of the project paintings turned into also explored & arrived at the definition of the trouble that needed to be tackled with. technique is proposed in the form of a block diagram to solve the above described trouble using Matlab/LabVIEW/Xilinx kits and implementation the use of hardware tools along with DSP / FPGA kits so that it will arrive at the expected outcomes.

REFERENCE

[1] Khan, Fauzia, et al. "Detection of glaucoma using retinal fundus images."Biomedical Engineering International Conference (BMEiCON), 2013 6th. IEEE, 2013.

[2] Kavitha, S., S. Karthikeyan, and K. Duraiswamy. "Early detection of glaucoma in retinal images using cup to disc ratio." Computing Communication and Networking Technologies (ICCCNT), 2010 International Conference on. IEEE, 2010.

[3] Babu, TR Ganesh, and S. Shenbagadevi. "Automatic detection of glaucoma using fundus image." European Journal of Scientific Research 59.1 (2011): 22-32.

[4] Murthi, A., and M. Madheswaran. "Enhancement of optic cup to disc ratio detection in glaucoma diagnosis." Computer Communication and Informatics (ICCCI), 2012 International Conference on. IEEE, 2012.

[5] Tan, N. M., et al. "Mixture model-based approach for optic cup segmentation."Engineering in Medicine and Biology Society (EMBC), 2010 Annual International Conference of the IEEE. IEEE, 2010.

[6] Hatanaka, Yuji, et al. "Automatic measurement of cup to disc ratio based on line profile analysis in retinal images." Engineering in Medicine and Biology Society, EMBC, 2011 Annual International Conference of the IEEE. IEEE, 2011.

[7] Yin, Fengshou, et al. "Automated segmentation of optic disc and optic cup in fundus images for glaucoma diagnosis." Computer-Based Medical Systems (CBMS), 2012 25th International Symposium on. IEEE, 2012.

[8] Morales, Sandra, et al. "Automatic detection of optic disc based on PCA and mathematical morphology." IEEE transactions on medical imaging 32.4 (2013): 786-796.

[9] Cheng, Jun, et al. "Superpixel classification based optic disc and optic cup segmentation for glaucoma screening." Medical Imaging, IEEE Transactions on32.6 (2013): 1019-1032.

[10] Aquino, Arturo, Manuel Emilio Gegúndez-Arias, and Diego Marín. "Detecting the optic disc boundary in digital fundus images using morphological, edge detection, and feature extraction techniques." Medical Imaging, IEEE Transactions on 29.11 (2010): 1860-1869.

[11] Liu, J., et al. "Automatic glaucoma diagnosis from fundus image." Engineering in Medicine and Biology Society, EMBC, 2011 Annual International Conference of the IEEE. IEEE, 2011.

[12] R. C. Gonzalez, R. E. Woods, and S. L. Eddins, Digital Image Processing using MATLAB. New York: Pearson Prentice Hall, 2004.

[13] High Resolution Fundus Image database https://www5.cs.fau.de/research/data/fundus-images/

[14] Opticdisc.org Database http://www.optic-disc.org/library/normal- discs/page7.html

[15] DRIONS-DB: Digital Retinal Images for optic Nerve Segmentation Database

[16] http://www.ia.uned.es/~ejcarmona/DRIONS-DB.html

[17] Donald L and Robert T, "Reproducibility of retinal nerve fiber thickness measurements using the stratus OCT in normal and Glaucomatous eyes"Visual science, July 2005, vol.46.No.7

[18] J. Liu, D.W.K. Wong, J.H. Lim, H.Li, N.M. Tan, Z. Zhang, T.Y. Wong, R. Lavanya, "ARGALI-An automatic cup to disc ratio measurement system for glaucoma analysis using level-set image processing", 13th Int. Conf. on Bio-Medical Engg. (ICBME2008), 2008. http://cvit.iiit.ac.in/projects/mip/drishti-gs/mip-dataset2/Home.php

[19] Praveen Vanaparthy, Sahitya G., Krishna Sree, Dr. C.D.Naidu, "FPGA implementation of image enhancement algorithms for biomedical image processing", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, An ISO 3297: 2007 Certified Organization, ISSN (Print) : 2320 – 3765, ISSN (Online): 2278 – 8875, pp. 5747 – 5753, Vol. 2, Issue 11, November 2013.

[20] International Conference (BMEiCON), 6th. IEEE, 2013.

[21] R. C. Gonzalez, R. E. Woods, and S. L. Eddins, "Digital Image Processing using MATLAB", New York: Pearson Prentice Hall, Prentice Hall, ISBN 0-13-094659, 2004.

[22] High Resolution Fundus Image database https://www5.cs.fau.de/research/data/fundus-images/

