The Prevelance of Age Related Eye Disease And Visual Impairment Using Machine Learning Algorithm

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Abstract- *As people age, they are at a greater risk for many Eye diseases and conditions, but vision loss doesn't have to be a normal part of aging, early detection and treatment can help protect vision and prevent vision loss. Eye disease and vision loss affect millions of Indians including many older adults in our community. As people get older, they are at greater risk for common Eye diseases and conditions, including Age-Related Macular Degeneration (AMD), Cataract, and other Eye diseases. Many Eye diseases have no early symptoms. But the good news is that regular comprehensive detailed eye exams can help adults age 50 and older protect their vision by catching Eye diseases and conditions early, when they are easier to treat. As it cannot be cured, detecting the disease in time is important. Current tests using Intra Ocular Pressure (IOP) are not sensitive enough for population-based eye screening. Optic nerve head assessment in retinal fundus images is both more promising and superior. In our proposed method we are planning to detect various eye related diseases using machine learning algorithm. Commonly occurring disease are Age-Related Macular Degeneration, Bulging Eyes, Cataracts, CMV Retinitis, Color blindness, Glaucoma, Diabetic Retinopathy. The proposed method consists of 3 stages. 1. Preprocessing which includes image resizing, color transforms and Histogram Equalization. 2. Feature extraction using Histogram of Gradients. 3. Classification using Navies Bayes Classifier.*

Keywords- Age-Related Macular Degeneration, Bulging Eyes, Cataracts, CMV Retinitis, Color blindness, Glaucoma, Diabetic Retinopathy, ImagePreprocessing, Histogram Equalization, Histogram of Gradients, Navies Bayes Classifier.

I. INTRODUCTION

According to the National Blindness and Visual Impairment Survey in 2018, 66.2% of blindness causes in people above 50. The area of the pupil governs the amount of light that can reach the retina. The extent to which the pupil dilates decreases with age, leading to a substantial decrease in light received at the retina. A retinal disease causes the irreversible vision loss.

The prevalence of Eye disease in the world was 60.5 million in 2010, and by 2020 it is expected to increase to 10 percentages. Eye disease has to be diagnosed before it causes a significant impact on the people's quality of life.[1]

As the eye ages, certain changes occur that can be attributed solely to the aging process. Most of these anatomic and physiologic processes follow a gradual decline. With aging, the quality of vision worsens due to reasons independent of diseases of the aging eye. While there are many changes of significance in the non-diseased eye, the most functionally important changes seem to be a reduction in pupil size and the loss of accommodation or focusing capability. Increased Intra ocular Pressure (IOP) within the eye causes the damage to the optic nerve. Automated screening tool can support the early detection of Eye disease thereby preventing the irreversible loss of vision. Automated screening tool involves the extraction of local and global features from the CHUK iris dataset to detect the deformation in the retinal structures due to the presence of the Eye disease. Prevalence estimated indicates the burden of a condition (e.g., visual impairment) at a defined location at a point or period. Accurate prevalence estimates are needed to plan for availability of health care services, associated monetary costs, and quality of life connected with having the condition. Such data are also of importance in planning future studies, such as controlled clinical trials of prevention and treatment of the disease. Periodic estimates of prevalence enable the tracking of temporal trends; this is important especially in situations where new, costly interventions are being introduced. Prevalence estimates reflect disparities in vision loss and vision-threatening conditions among racial/ethnic groups as well as age, income and education groups, as well as between the sexes. In addition to these characteristics, nutritional and environmental exposures may affect prevalence's or disparities among groups. Aside from true disparities, apparent differences may be related to differences in case definition. For eye conditions this may rely upon self-reported history of a condition, findings at a clinical exam, or imaging (e.g., digital fundus photography, film fundus photography, optical coherence tomography). Variations in diagnostic procedures to define conditions (phenotypes) may further confound the ability to estimate prevalence as well as to identify temporal trends and cohort effects.

Definitional differences of conditions frequently occur among different groups of investigators, even when attempts are made to use the same characteristics and standardized protocols to classify subjects. For example, estimates of the prevalence of AMD (Age-related Macular Degeneration) may vary depending on whether size, type, and/or area of drusen or presence of pigmentary abnormalities are used to define its presence. This occurred among three population-based cohorts that used the Wisconsin Age-Related Maculopathy Grading System to classify and grade AMD lesions. Each group made modifications to the protocol. These modifications led to several systematic differences in grading fundus photographs that exaggerated differences in the prevalence of early AMD among the studies.1 Harmonization was required to achieve a uniform definition of early AMD to facilitate meta-analyses. Similar problems affect other conditions (e.g., open-angle glaucoma and cataract) because definitions and methods used to assess the conditions vary among studies.

Despite these problems, estimates, even if imperfect, are needed to describe public health and clinical burden as well as to plan for future needs. We describe estimates of prevalence of Age-Related Cataract, Open-angle glaucoma, AMD, Diabetic Retinopathy (DR), Naive Bayes classifier and visual impairment using data from several sources. We also highlight current needs to obtain data that will be used to successfully prevent visual loss due to these conditions.
Deformations in the retinal structures such as optic disc area, optic cup area, Parapapillary area, neuroretina rim area are the characteristics of Eye disease. Rajendra Acharya et al introduced a method using a combination of texture, and higher order spectra (HOS) features for detection of Eye disease from the digital fundus image. The accuracy of classification is evaluated using various classifiers such as, Sequential Minimal Optimization, Naive Bayes (NB) classifier. Suraya Mohammed et al proposed Eye disease classification using texture analysis based on Binary Robust Independent Elementary Features (BRIEF) on color fundus images. Hence, the features are extracted using Discrete Wavelet Transform (DWT) and sequential forward feature selection algorithm is used to rank the features that are fed to a feed forward back propagation neural network classifier. Machine learning techniques such as Neural Networks, Naive Bayes classifier, Nearest Neighbor, Support vector machine, has been implemented for detection and classification of Eye disease

On the next stage, we classified using Naive Bayes algorithm. Also used to classify the images, if it is defected as eye disease or normal eye. Naive Bayes algorithm has a high accuracy of 90%.

II. LITERATURE SURVEY

[1]. "Automatic visual impairment detection system for age-related Eye diseases through gaze analysis", Ai Ping Yow, Damon Wong, Haiyang Liu, Hong yuan Zhu, Ivy Jing-Wen Ong, Augustin us Laude, Tock Han Lim IEEE 2019.

Visual impairment associated with Age-related Macular Degeneration (AMD) often results in a central scotoma which is an alteration in the central vision, leading to distortion or loss of vision. Current methods for assessing visual performance such as Amsler grid and Microperimetry are typically manual and have limitations as an indicator of visual field. In this paper, we present an automated system for detecting visual impairment through gaze tracking (AVIGA). Two types of assessments namely, Impulse Stimuli Response (ISR) test and Pursuit Stimuli Response (PSR) test were implemented in AVIGA system. A Support Vector Regression (SVR)-based approach is applied on the assessment results to differentiate the severity of visual impairment. The results show that AVIGA system is well-correlated to visual acuity test (VA) and performs better in identifying presence of visual impairments in eyes, compared to Microperimetry.

[2]."Degraded Reality: Using VR/AR to simulate visual impairments", Pete R. Jones, Giovanni Ometto 2018 IEEE Workshop on Augmented and Virtual Realities for Good (VAR4Good) IEEE 2018.

The effects of Eye disease cannot be depicted accurately using traditional media. Consequently, public understanding of Eye disease is often poor. We present a VR/AR system for simulating common visual impairments, including disability glare, spatial distortions (Metamorphopsia), the selective blurring and filling-in of information across the visual field, and color vision deficits. Unlike most existing simulators, the simulations are informed by patients' self-reported symptoms, can be quantitatively manipulated to provide custom disease profiles, and support gaze-contingent presentation. Such a simulator could be used as a teaching/empathy aid, or as a tool for evaluating the accessibility of new products.

[3]. "Eye disease detection using wavelet based contourlet transform", K Nirmala ; N Venkateshwaran, C Vinoth Kumar , J Shiny Christobel IEEE 2017.

One of the leading retinal diseases which cause vision loss is Glaucoma. This paper presents the methodology to detect Glaucoma using wavelet based contourlet transform with Gabor filters. The input retinal fundus image is localized for its region of interest and enhanced using adaptive Gamma correction with weighted Distribution function (AGCWD). The blood vessels in ROI are removed using the Gabor filter and morphological operators. To the Region of Interest the wavelet based contourlet transform (WBCT) is applied to extract the features and then given to the Naïve Bayes (NB) classifiers for detecting the normal and Eye disease toes image.

[4]. "Clinical and technical perspective of Eye disease detection using OCT and fundus images", A review Madiha Naveed, Aneeqa Ramzan, Muhammad Usman Akram IEEE 2017.

Glaucoma is an eye problem that affects the retina and weakens the nerve cells that assist in visual recognition. This disease can be the cause of blindness and visual impairment if not treated earlier. Increase in Intraocular pressure (IOP) is the main cause for Eye disease presence and succession. The diameter of the optic cup within optic disc region is increased due to the excessive retinal pressure. The increased cup to disc ratio (CDR) results in the loss of optic nerve fibers that are connected to the retina by disc area. The thickness of the rim area between the disc and cup area as neuro-retinal rim (NRR) and CDR are important structural features for differentiating between a non-Eye disease tous and a Eye disease tous eye. Greater CDR is observed for Eye disease tous eye analysis because of less number of optic fibers in the rim area. The widely used parameters as CDR and NRR are used in fundus images, and cup depth and retinal layers (retinal nerve fiber layer (RNFL) and ganglion cell layer (GCL) thickness are the features calculated for Eye disease diagnosis in optical coherence tomography (OCT) imaging. The objective of the paper is to present the state of art methods for Eye disease detection that assist in the progressive development of computer-aided systems.

[5]. "Detection of Eye disease using Neuro retinal Rim information", Pranjal Das, S. R. Nirmala, Jyoti Prakash Medhi IEEE 2017.

Glaucoma is one of the most common causes of blindness in the world. The vision lost due to Eye disease cannot be regained. Early detection of Eye disease is thus very important. The Optic Disk (OD), Optic Cup (OC) and Neuroretina Rim (NRR) are among the important features of a retinal image that can be used in the detection of Eye disease. In this paper, a computer-assisted method for the detection of Eye disease based on the ISNT rule is presented. The OD and OC are segmented using watershed transformation. The NRR area in the ISNT quadrants is obtained from the segmented OD and OC. The method is applied on the publicly available databases HRF, Messidor, DRIONS-DB, RIM-ONE and a local hospital database consisting of both normal and Eye disease tous images. The proposed method is simple, computationally efficient and achieves a sensitivity of 91.82% and an overall accuracy of 94.14%.

[6]. "HOG feature based SVM classification of Eye disease toes fundus image with extraction of blood vessels", T Balasubramanian, S Krishnan , M Mohanakrishnan , K Ramnarayan Rao , C Vinoth Kumar , K Nirmala IEEE 2017.

Eye diseases at the later stages causes eye blindness, it is essential for early detection to minimize the risks and warn patients who might eventually lose their vision. The study gives an assessment on Eye disease detection using the Histogram of Oriented Gradients (HOG) Feature extraction along with SVM classification of retinal fundus image with the extraction of blood vessels using Gabor filter. Retinal fundus images are reduced in their dimension. Then the blood vessels are extracted by using Gabor filter, morphological operations and thresholding. This improves the accuracy. Textural features within the images are used for accurate and efficient Eye disease classification. The image is then given to a HOG feature descriptor. The feature sets (statistical properties) are then extracted from the HOG Features that are used for Support Vector Machine classification of Eye disease tous images.

[7]. "A stand-alone MATLAB application for the detection of Optic Disc and macula",
B. Ramasubramanian, S. Selvaperumal IEEE 2016.

Glaucoma and Diabetic Retinopathy are the leading common cause of vision loss. Optic Disc and macula are the important landmark for the detection of these retinal pathology. Even though, the manual screening of Optic Disc and macula are available, they consume more time and have more human error. Therefore, there is a need of an automated application for the reliable and efficient localization of OD and macula. This paper presents a novel and fast stand-alone MATLAB application for the segmentation of these anatomical structures. This application uses color K-means segmentation for locating macula and for detecting Optic Disc, bilateral filtering followed by Morphological operation is used. The application were evaluated on 135 Eye disease tous images collected from local eye hospital and 200 diabetic retinopathy images from DIARETDB1 and DRIVE database. This stand-alone application consumes an average computation time of 13s for macula localization and 32s for OD segmentation with a success rate of 98%. Overall, the proposed application obtain an efficient result in the segmentation of both OD and macula, which in turn helps to detect Eye disease and Diabetic Retinopathy.

[8]. "Causality-Based Attribute Weighting via Information Flow and Genetic Algorithm for Naive Bayes Classifier", Ming Li, Kefeng Liu IEEE 2019.

Naive Bayes classifier (NBC) is an effective classification technique in data mining and machine learning, which is based on the attribute conditional independence assumption. However, this assumption rarely holds true in real-world applications, so numerous researches have been made to alleviate the assumption by attribute weighting. To the best of Authors knowledge, almost all studies have calculated attribute weights according to correlation measure or classification accuracy. In this paper, Authors propose a novel causality-based attribute weighting method to establish the weighted NBC called IFG-WNBC, where causal information flow (IF) theory and genetic algorithm (GA) are adopted to search for optimal weights. The introduction of IF produces a bran-new weight measure criterion from the angle of causality other than correlation. The population initialization in GA is also improved with IF-based weights for efficient optimization. Multi-set of comparison experiments on UCI data sets demonstrate that IFG-WNBC achieves superiority over classic NBC and other common weighted NBC algorithms in classification accuracy and running time.

[9]. "Automatic Real-Time Mining Software Process Activities From SVN Logs Using a Naive Bayes Classifier", Rui Zhu, Yichao Dai, Tong Li, Zifei Ma, Ming Zheng, Yahui Tang, Jiayi Yuan, Yue Huang IEEE 2019.

The abundance of event data in current software configuration management systems makes it possible to discover software process models automatically by using actual observed behavior. However, traditional process mining algorithms cannot be applied to event logs recorded in software configuration management (SCM) systems, such as SVN, because of missing activity attributes. To address this problem, a software process activity classifier is proposed to build event-activity mapping relationships from software development event streams, revealing activity attributes and associating the activity to the original SVN log. The proposed approach extracts activity from the SVN log based on semantic features and introduces a novel technique based on a naive Bayes approach to associate event activities dynamically. The approach has been applied to two real-world software development process logs, ArgoUML and jEdit , consisting of more than 80,000 events, covering development information from 1998 to 2015. With the application of our approach to such data, activities can be extracted from event logs and a classifier can be constructed for adding activity attributes to new events. The results of the classification are evaluated in terms of precision rate , recall rate, and the F-measure . Overall, two real-world software development process logs are used to validate the method, and the experimental results show that the approach can mine software process activities from SVN log events automatically and in real-time.

[10]. "A Review on Age Related Eye Diseases and their Preventive Measures", Srilatha B JCEO 2019.

Age-related eye diseases, in many cases are not sudden but tend to develop slowly as a person age. Of the many age-related eye diseases, there are four major ones that are recognized and that can be detected and treated if a comprehensive eye examination is performed. These four age-related eye diseases are Macular Degeneration, Cataracts, Glaucoma and Diabetic Retinopathy are expected to dramatically increases if left untreated can cause serious vision loss and blindness. Populations are most at risk for developing eye disease is unaware of the factors that make them susceptible. However, there are certain common preventive measures like taking Healthy Diet, avoiding Smoking and managing Health conditions.

III. PROPOSED METHOD

The proposed method includes the following 3 processes.

1. Preprocessing
2. Feature Extraction and Selection
3. Classification

The overall flow of the proposed method is represented in Figure. The performance of the Naïve Bayes is analyzed using the feature matrix. Further, the performance of the Hog is studied for its accuracy, sensitivity and specificity values. The process of diagnosing the eye diseases is illustrated in the upcoming section

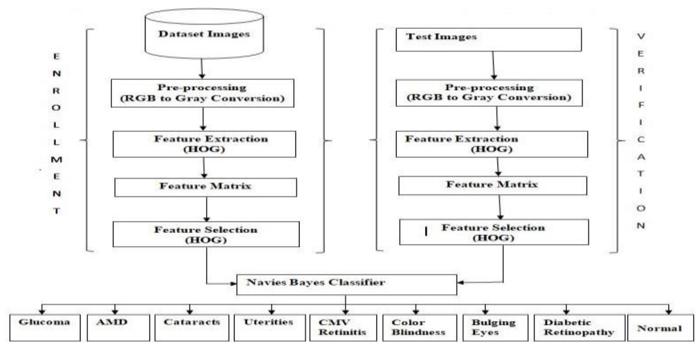


Fig 1. Architecture of proposed system

1. Pre Processing

Image pre-processing is the initial step to identify the affected eye area. Multiple steps are performed in the preprocessing phase to make the image suitable for the feature extraction process. The abnormalities in the input image are detected and preprocessed for the following purpose:

- To avoid uneven illumination
- To enhance the contrast among image background pixels and exudates
- To eliminate the noise in the input image

In this research work, the techniques used for the preprocessing phase are:

- Image resizing.
- Color transformation(RGB to Gray) and
- Histogram equalization.

1.1 Image Resizing:An image size can be changed in several ways. One of the simpler ways of increasing image size is nearest-neighbour interpolation, replacing every pixel with the nearest pixel in the output; for upscaling this means multiple pixels of the same colour will be present. Image resizing is necessary when you need to increase or decrease the total number of pixels, whereas remapping can occur when we are correcting for lens distortion or rotating an image. Zooming refers to increase the quantity of pixels, so that when you zoom an image.

1.2 Color Transformation**:** The retinal images are taken from the fundus camera in the form of RGB (Red, Green, and Blue). Grayscale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelength s. Intermediate shades of gray are represented by equal brightness levels of the three primary colors (red, green and blue) for transmitted light for reflected light. In the case of transmitted light (for example, the image on a computer display), the brightness levels of the red (R), green (G) and blue (B) components are each represented as a number from decimal 0 to 255, or binary 00000000 to 11111111.

1.3 Histogram Equalization: The use of fundus camera to capture the retinal image results in an uneven illumination. The portions near the center are well illuminated and hence it looks very bright. But the portions on the sides are less illuminated and hence looks very dark. To address this issue, the histogram equalization is used. As the regions of exudate and optic disc are much greater in intensity than the neighboring regions of the image, the histogram equalization method is used to assign the neighboring regions greater intensity.

2. Feature Extraction

The HoG features are extracted from the localized ROI. The HoG features are invariant to geometric and photometric transformation and thus used to describe the shape and edge of the structures present within the image. As HoG features are related to edge information, the optic disc deformation due to the presence of Eye disease can be depicted with these features. Deformation in the Optic disc is one of the key parameters in the detection of Eye disease. To compute the HoG features, the image is divided into small cells and the shape of the objects is obtained by counting the strength and orientation of the spatial gradients in each cell.

2.1 Histogram of Gradient (HoG) :The HoG extracts the features of the images that are present over the grid of overlapping rectangular blocks in the search window. The histogram of each block is used to describe the frequency of the gradient directions inside each block. The image is generally described by a set of local histograms. These histograms count the occurrences of the gradient orientation and they become the local parts of the images. The steps involved in calculating the histogram are:

• Computing the gradients of the image
• Constructing the histogram orientation of each cell
• Normalizing the histograms in each block of the cells

A histogram of oriented gradients (HOG) is used in image processing applications for detecting objects in a video or image, which by definition is a feature descriptor [2], proposed by Dalal and Triggs who used their method for pedestrian detection. Figure shows the block diagram and block normalization scheme of HOG feature extraction.

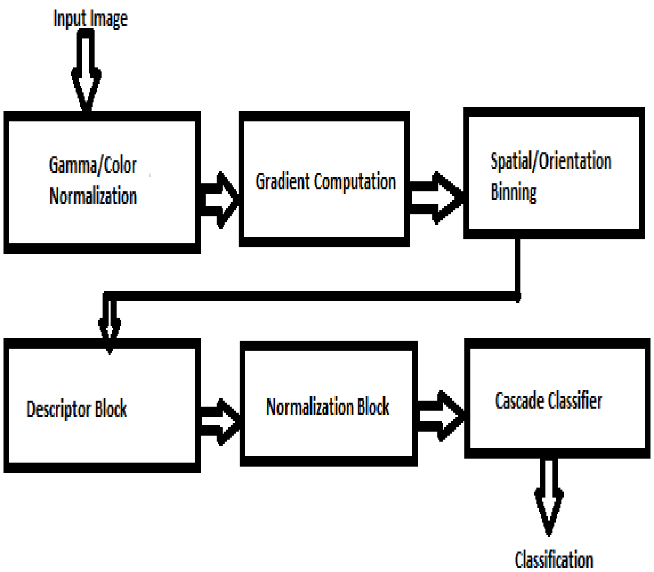


Fig 2. HOG algorithm

3 Naive Bayes Classifier

The Naive Bayes classifier is an efficient and simple probabilistic classifier based on Bayes' theorem. It is based on the Bayes Theorem. It predicts the class membership probabilities. "Naïve Bayesian classifiers assume that the effect of an attribute value on a given class is independent of the values of the other attributes. This assumption is called class conditional independence". Due to this assumption, the computation of the NB classifiers is better than the other classifiers. It is a simple model that assigns class labels from a finite set to a vector of feature values. These classifiers assume that the value of a particular feature is independent of any other feature. The advantage of naïve Bayes is that it requires only a small number of training data. With the small number of training data, the parameters can be estimated for classification. It classifies the data in two phases namely training phase and prediction phase. In training phase, using training data, the parameters for probability distributions are estimated, and in the prediction phase, for any unseen test data, the method computes the posterior probability of that sample belonging to each class. The method thus classifies the test data according to the largest posterior probability. Once the features of the training set are fed into the classifier, the probabilities of individual features P(X) being presented the outcome (i.e., the class – 'Normal' or 'Eye disease '), as well as the probabilities of each of the two classes, are calculated. The Naive Bayes method is suitable for the discrete valued attributes as well as for large size dataset, but in case of continuous valued attributes, Naive Bayes method is lacking in attribute interactions. On the other hand, the decision tree does not give good performance when the data size is very large. These limitations have been overcome by the notion of NB Tree algorithm. Proposed a hybrid algorithm called Naïve Bayes Tree, which is a hybrid approach appropriate in learning environment when various attributes are likely to be relevant for a classification task. NB Tree gives relaxation to the attribute independence assumption of the Naïve Bayes algorithm. "NB Tree is a hybrid classification technique which combines Decision Tree and Naive Bayes classification algorithms. The algorithm is similar to the classical recursive partitioning schemes except that the leaf nodes created are Naive-Bayes categorizers instead of nodes predicting a single class and the learned knowledge is represented in the form of a tree. It combines the advantage of both Decision Tree and Naïve Bayes Classification." NB Tree induces highly accurate classifiers in practice. It has been shown that NB Tree is accurate and scale up in terms of accuracy on real world datasets.

A. MEATHODOLOGY

The image is initially pre-processed and Resize, Histotrophic Equalization (HE) and on Binary Robust Independent Elementary Features (BRIEF). The HoG (Histogram of gradients)features are extracted from Collective competitive ratio and number of statistical properties is derived. The derived properties constitute the HoG features that are fed to the Naïve Bayes classifier for identifying the normal and Eye disease affected image. The classifier is trained and tested with a normal and Eye disease toes image obtained from CUHK iris dataset

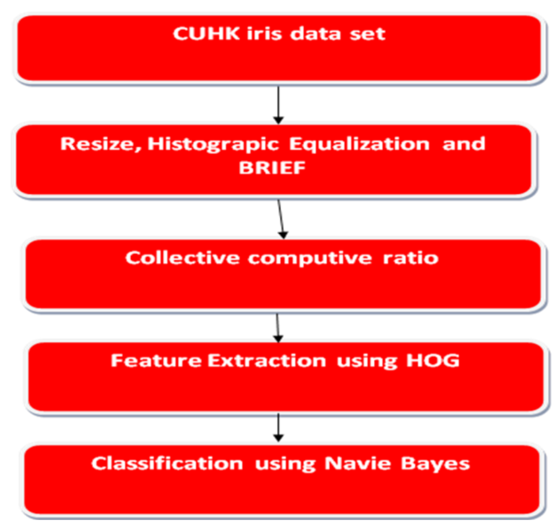


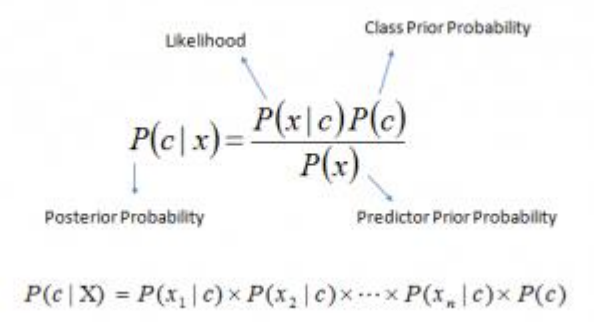
Fig. 3 Methodologies of the Proposed System

B. NAIVE BAYES ALGORITHM

It is a classification technique based on Bayes' Theorem with an assumption of independence among predictors. In simple terms, a Naive Bayes classifier assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature.

For example, a fruit may be considered to be an apple if it is red, round, and about 3 inches in diameter. Even if these features depend on each other or upon the existence of the other features, all of these properties independently contribute to the probability that this fruit is an apple and that is why it is known as ‘Naive’.

Naive Bayes model is easy to build and particularly useful for very large data sets. Along with simplicity, Naive Bayes is known to outperform even highly sophisticated classification methods. Bayes theorem provides a way of calculating posterior probability P(c|x) from P(c), P(x) and P(x|c). Look at the equation below:



$$P(c|x) = \frac{P(x|c)P(c)}{P(x)}$$

$$P(c \mid X) = P(x_1 \mid c) \times P(x_2 \mid c) \times \cdots \times P(x_n \mid c) \times P(c)$$

Above,

- P(c|x) is the posterior probability of class (c, target) given predictor (x, attributes).
- P(c) is the prior probability of class.
- P(x|c) is the likelihood which is the probability of predictor given class.
- P(x) is the prior probability of predictor.

IV. CONCLUSION

The Prevalence of Age-Related eye diseases and visual impairment using machine learning algorithm presents HoG features based Naive Bayes classifier for identifying the Eye disastrous image. The significance of HoG based feature extraction is that HoG well describes the shape and orientation of objects within the retinal image. Also, the Naive Bayes classifier has a simple representation, assumes the feature vectors are independent and requires a smaller number of training data set. The accuracy of Eye disease detection, based on the HoG feature-based classifier is shown to be better than another transform with Naive Bayes classifier. Simulation results show that the HoG feature-based classifier performs better with an accuracy of 90%. The classification model presents here may serve as pre-treatment diagnostic tool in detection of Eye disease. The robustness of the classifier may be further improved by considering larger dataset.

V. ACKNOWLEDGMENT

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