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Research Article

A Study of Early Disease Prediction Using Iridology and Datamining Techniques with Special Reference to Nafld

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ABSTRACT

The human iris is a window of healthy human organs. Utilizing iris for disease prediction constitutes iridology. The iris shows variation in its color, texture, shape, and pattern when disease starts to emerge. If an investigation of iris is done, it's possible to predict the disease at the very early stage and save human life. Iridology is typically used as a CAM for examining in many western and European countries. Practitioners of iridology use digital versions of iridoscopes and digital iris cameras to examine the iris, and based on their observations, they recommend remedies to address perceived health issues. Our idea is to use iridology methodology to predict deadly NAFLD. The reason for choosing NAFLD is that nearly 25% of the world population is affected by it, and most of the population is unaware of this disease. Since the lung is a self-regenerating organ, NAFLD is unpredictable and diagnosed only at the later stage of disease where surgery or lung transplantation is the treatment for the patient, which is expensive and survival of the patient is not guaranteed. As iridology reflects the healthy condition of the organs and as NAFLD does not show visible symptom till later stage, iridology will be the best method for its early prediction and treat the person economically with knifeless treatment and guarantees the patient survival with simple medication, regular exercise, and a change in diet. This paper summarizes the methodologies used for various disease early prediction with better accuracy using iridology and also shows that there is more research scope for predicting NAFLD using iridology.

Keywords: Iridology, disease prediction, alternative medicine, data mining techniques, and machine learning algorithms.

INTRODUCTION

Iridology

The role played by the eye in the prediction and diagnosis of disease is very vital. This diagnosis is possible by analyzing certain features and changes in the eye. Changes in the health condition are reflected in the eyes because of the collection of blood vessels and nerves. The human iris is a window of healthy human organs. The methodology of using eyes for disease prediction constitutes iridology. Iridology is used to diagnose disease states or pre-disease states of a human organ. It is a CAM [3] [8]. A person practicing iridology is called an iridologist. Iridologist does diagnosis by analyzing iris color, pattern, and pigmentation [6]. Disease diagnosis is performed based on the ideology that a particular sector of the iris relates to a certain organ, and changes in a particular sector of the iris indicate changes in that organ.

Iridology is a practice that claims to diagnose and assess health conditions by examining the patterns, colors, and other characteristics of the iris (the colored part of the eye). It is based on the belief that each part of the body corresponds to a specific area of the iris and that changes in the body can be detected by observing changes in the

iris. Although iridology is considered pseudoscientific by the medical community, it continues to be practiced by alternative medicine practitioners around the world.

Place of Origin and Early History

Iridology dates back to three millennia to the Egyptians and Greeks, who relates the eye and health. For this, there is archaeological evidence in the tomb of Tutankhamon; silver plates containing intricate images of the iris were found (1400–1392 B.C.). [10]. As though it is an ancient methodology, it is framed as a health study only in 19th century. A Hungarian homoeopath Ignaz von Peczely, while treating an owl with a broken leg, observed the changes in the owl's eye corresponding to its body part. This makes him explore it on the human, and he was recognized as “Father of Iridology." He proposed "iris diagnosis," which is that specific areas of the iris corresponded to specific organs and body systems, and he compiled his findings in “Discoveries in the Realm of Nature and the Art of Healing." For diagnosis of disease, he designed an iridology chart in 1881. In the late 19th century, Swedish herbalist Nils Liljequist, because of illness he discerned a change in the color of his own eye and observed his iris after medication, which led him to explore this methodology.

EVOLUTION OF IRIDOLOGY

In iridology’s early stages, the foundation is laid by Hungarian Ignaz von Peczely by doing groundwork and release iridology chart. In the same period, a Swedish Nils Liljequist contributed his work to enhance the features of the iris chart. Europe and North America had the impact of iridology during the 20th century. Many Europeans and North American contributed to the refinement of the iris chart and did exact markings showing the link between the iris sector and a specific organ and its healthy condition. Dr. Bernard Jensen, a popularized iridology in the USA, is the one who developed an iris chart, which is widely used for diagnosis. He integrated iridology with naturopathic practices [8].

The methodology used for disease investigation by iridologists involves the following steps:

1. Iris Observation

For iris observation, visual inspection and photography are used. Visual inspection of the iris is done by using magnifying glass, a flashlight, slit lamp, or iridoscope [10]. In the photography method, they use specialized cameras to take the photograph of the eye with high resolution. Iridologists look for various features, including colors, textures, patterns, markings, and structural irregularities, which indicate various health conditions of the organ.

2. Iris Mapping

Iridology charts, or iris charts, are used for mapping. To make the mapping process effective, the iris is frequently separated into zones or sectors, each of which corresponds to specific organs, systems, or parts of the body which is represented in Figure 1.

Figure 1: Iris Chart

The iris chart in Fig. 1 is a graphical representation that divides the iris of the eye into zones or sectors, each of which is believed to correspond to specific organs, systems, or parts of the body [8]. Left and right eyes symbolize the left and right of human body parts.

3.Sign Interpretation

The iridologist focuses on iris markings, color variations, shape, and structure for interpreting them to the particular disease. In iris markings, they focus on spots, rings, or fibers that represent specific health issues. A dark spot seems to be an area of interest, while a light spot is normal and is not included for further analysis. Iris color change means confer insights for toxin buildup or deficiency. They also assess for changes in iris shape and structure, which they relate to health changes.

4.Diagnosis

Iridologists make diagnoses about the person's health based on the observed patterns from sign interpretation. Based on their analysis, iridologists may offer recommendations for improving health and addressing any identified imbalances. These recommendations may include dietary changes, lifestyle modifications, supplements, herbal remedies, or other alternative therapies.

5.Follow-up

There is a follow-up to keep track of changes in the iris, which indicates the improvement in health. Follow-up is recommended by the iridologist.

Recent Method for Iris Analysis in Iridology

Earlier days, iridologists examined iris manually or with some tools for analyzing iris. Due to technological advancement, image analysis is done using the image mining process. Data gathered for iridology examinations includes high-resolution images of the iris along with patient demographics, medical history, lifestyle factors, and other relevant information. The image data undergoes the following steps, as explained in [7].

Image Pre-Processing

Remove any noise or artifacts from the images to ensure better analysis accuracy. Median Filtering, Gaussian Filtering, Bilateral Filtering etc. are some of the algorithms used for image preprocessing. Figure 2 exhibits the many technological techniques that are available for iris pattern analysis.

Filtering an Image

Different techniques used for visual editing by graphic designers and program editors are used to alter the image's pixel density to transform it into its desired shape.

RGB to Grayscale

Grayscale conversion of an image is needed to reduce computer complexity. By holding the brightness in the course of metamorphose, the hue and saturation are eliminated.

Image Detection

The object-detection method is used by computer vision to locate objects in images. There are various data mining methods available to recover an object. Here, an iris picture ought

to be discernible. It combines localization and categorization in the majority of applications.

Image Segmentation

Segmentation in iridology refers to splitting the iris into multiple zones or areas, each of which is believed to symbolize a distinct body part or organ [21]. The heart, liver, kidneys, and other bodily parts are represented by these zones. It is thought that experts can assess the condition of related organs or systems by looking at specific iris regions. For example, a particular

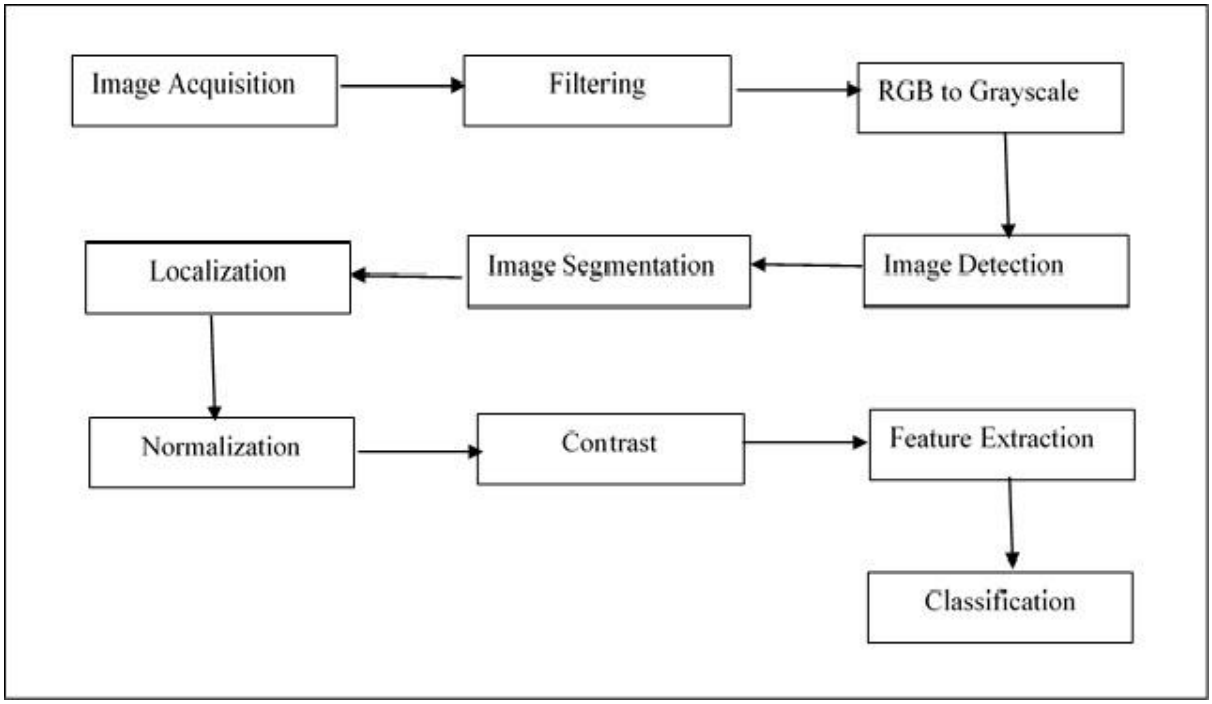


Figure 2: Steps for Using Computer-Aided Iridology to Disease Diagnoses

marker in a certain iris segment may be considered indicative of a cardiac problem [8]. After detection, the whole image is fragmented or masked so that only the necessary parts are analyzed and not the full image. The iris image-segmentation technique makes an innovative attempt to normalize the image while maintaining the exact resolution.

Localization

Localization is the process of defining a bounding box around ROI. Finding ROI is aided by predicting different coordinates.

Normalization

The practice of trying to identify differences in healthy iris swatch is known as normalization in iridology [2]. Practitioners claim that a couple of differences in iris pattern are associated with specific health issues [3]. To do this, one must compare the observed features of the iris with a iris swatch that are believed to be healthy. Variations in this reference pattern are thought to indicate possible health problems.

Contrast Enhancement

The process of improving an image's contrast quality involves adjusting the intensity variation in the image. High-performance image-enhancement methods significantly increase system efficiency.

Feature Extraction

The physical characteristics of the iris, including its colors, pattern, line, pigmentation, and further more distinguishing markings, are referred to as features in iridology. For example, some coloration or differences in the iris fibers may be construed as indicators of possible health problems. Iridologists usually use characteristics as the foundation for their assessments and diagnoses. Different practitioners may interpret the same aspect differently, leading to variations in their assessments.

Classification

In order to identify and diagnose the diseases that a person is suffering from, the most pertinent features that aid in identification are found after feature extraction and applied to classification algorithms such as DT, NB, SVM, k-NN, Neural Networks, etc. [21].

Table 1 Displays a comprehensive list of the acronyms used in this paper.

CAM	Complementary and Alternative Medicine	k-FCV	k-Fold Cross-Validation
CDE	Canny Edge Detection	HC	Hierarchical Clustering
IBS	Irritable Bowel Syndrome	SVM	Support Vector Machines
DMA	Data Mining Algorithms	GLCM	Gray-Level Co-Occurrence Matrix
ARMA	Association Rule Mining algorithms	HMM	Hidden Markov Module
DT	Decision Trees	PCA	Principal Component Analysis
NAFLD	Non-Alcoholic Fatty Liver Disease	FCNW	Fully Convolutional Neural Network
RF	Random Forest	DL	Deep Learning
IKDIS	Iris-Based Kidney Disease Identification System.	ICKIS	Intelligent Iris-based Chronic Kidney Identification System
GBM	Gradient Boosting Machines	IP	Image Processing
FPGA	FP-Growth Algorithm	ANN	Artificial Neural Networks
KMC	K-Means Clustering	OLD	Obstructive Lung Diseases
LR	Logistic Regression	CAD	Coronary Artery Disease
HDT	Hyperbolic Decision Tree	K-NN	k-Nearest Neighbours
NBC	Naive Bayes Classifier	GRBF	Gaussian Radial Basis Functions
AA	Apriori Algorithm	DNNM	Deep Neural Network Model
ROI	Regions of Interest	FSA	First-order Statistical Analysis
WT	Wavelet Transform	GLRLM	Gray Level Run Length Matrix

LITERATURE REVIEW

Innumerable works has been accomplished related to iridology based various disease prediction using many data mining techniques and machine learning algorithms.

Innumerable works have been accomplished related to iridology based various disease prediction using many data mining techniques and machine learning algorithms.

Dabeluchi N et al. [8] identified that the unique characteristics of the iris are connected by nerves from various organs, which help in understanding psychological conditions and organ conditions.

Shah D et al. [19] found that KNN has the highest accuracy score for teart disease prediction, which is a leading cause of death worldwide, and requires accurate early diagnosis and prompt management. Researchers use data mining and machine learning techniques to analyze complex medical data and predict heart disease. They use a dataset from the Cleveland database of UCI patients, including 303 instances and 76 attributes.

Ferdi Ozbilgin et al, [3] proposed a non-invasive methodology for predicting CAD using iris images was proposed which transforms images of iris into rectangular format, and WT, FSA, a GLCM, and a GLRLM are used for feature extraction. SVM predicts CAD with an accuracy of 93%.

Yohannes C et al, [22] developed a computer vision and machine learning system that uses iridology to analyze eye iris features. The system uses CED principal component analysis and Backpropagation Algorithm of ANN. The 110-data system achieved an accuracy of 95.45% in testing, demonstrating the importance of early detection and prevention.

Nilam upasani et al, [4] developed a novel model for diagnosing heart abnormality using iridology, which contains target capture, pre-processing, auto-cropping, ROI, and categorization done using a thresholding algorithm. The

precision of the system ranges from 80 to 83%, but error occurrences are there because of ineffective cropping or segmentation, potentially leading to erroneous heart area segmentation.

Kadamati Dileep Kumar et al, [23] proposed the model, which uses a hybrid approach of combining SVM and CNN for iris-based cardiac dysfunction detection. The model's performance is examined using several evaluation metrics and discovered that it performs better in terms of accuracy.

Sruthi K et al, [10] found that iridology works well with deep learning algorithms to diagnose Type II Diabetes Mellitus. 178 willing participants provided near-infrared images of their iris, which the researchers used to develop an algorithm utilizing a FCNW to classify them into Type II DM and nondiabetic or healthy categories. The AlexNet classifier demonstrated a higher classification accuracy of 95.85%.

Aminah R et al [25] use five different classifiers along with feature extraction methodology GLCM to separate diabetic from non-diabetic. The findings are validated and assessed by confusion matrix and k-FCV, and the accuracy achieved is 85.6%.

Sanjeev Kumar Punia et al, [9] developed an Iris Healthcare system that is based on Kiosk and suggests a desktop PC application that uses the Iris to identify these illnesses. The procedure begins with taking a left eye picture of the patient and performs intermediate operations such as cropping, pre-processing, auto-cropping, measuring ROI of heart and pancreas, extracting features, and results classification. The process is run through thirty-two distinct training digital data sets, and the outcome is classified as either normal or abnormal.86.36% and 90.91% of accuracy is obtained for heart and diabetes, respectively.

Padmasini N et al, [13] suggested that kidney failure can be prevented by early detection of abnormalities in the kidneys brought on by Type 1 or Type 2 diabetes. With the use of iris photographs and iridology charts, diagnose any abnormalities in the kidney caused by diabetes mellitus. Normal and abnormal cases are classified using RF and 83.33 % accuracy is achieved.

Shabdiz M et al [1] proposed a method for visual query language based on the GRBF and HDT to search points on the iris. The impact of COVID-19 on diabetic patient iris is considered and finds similarities between symptoms for conditions. An indication of a novel disease pattern is assessed during the time interval of disease and virus mutation. For assessing iris zone matching is achieved by Delaunay triangulation. For a clustered set of signs, the optimal technique is utilized for community discovery, and K-NN reduces error.

Onal M.N. et al [11] implemented a hybrid approach combining DL and IP, which was presented in a study to diagnose diabetes based on iris pictures and allow for more objective evaluation. The pancreatic region is automatically extracted from the iridology chart, and the iris boundary is detected for the pancreatic area using convolutional neural networks from the image of the eye. The approach yielded an 80% accuracy and 83.33% f1 score performance when paired with VGG-16 architecture.

Seo, J. B et al, [18] say that according to traditional Korean medicine, the iris is a structure that symbolizes the unique qualities of the human body. Dementia induction in brain disorders is predicted using deep learning algorithm and 91% accuracy is achieved.

Ur Rahman et al, [12] extract GLCM, GLRLM, and statistical characteristic features from extracted from iris image used to predict OLD. Ten types of classifiers with voting methods are put to test and metrics are assessed to found 97.6% accuracy.

Atul Bansal et al, [24] develop an automated pre-diagnostic tool for OLD that uses a two-dimensional Gabor filter and SVM to predict OLD at an earlier stage with an accuracy of 88.0%, which helps an individual to maintain health through breathing exercise, regularizing other physical exercises, and quitting smoking.

Rehman H.A. et al [16] developed a diagnostic system. IKDIS was developed using a DNNM for early diagnosis and early intervention of kidney dysfunctionality. The system achieves accuracy of 86.9% on analysis of 49 patients.

Muzamil S et al, [21] implemented ICKIS, which uses a GPU-based supercomputing system that implements deep neural network that takes an iris image as input and achieves 96.8% accuracy in predicting chronic kidney disease.

Divya, C.D. et al, [14] use an adaptive histogram to isolate the picture of the eye from the captured image. By SVM, iris image is differentiated and identified. A white Gaussian filter is utilized for extracting features of iris images, and

it is utilized as a descriptor for the extracted feature. The occurrences of magnitude and orientation of gradient are determined by the descriptors in specific regions of an iris image. Next, transform the iris picture into a grayscale picture so that the final image is consistent. Rectangular shape conversion of an image is done and assembled using HMM. The end step is to diagnose the iris HMM's edge of picture. Out of 100 test samples, the classifications identified are 43%, 22%, 15%, 13%, and 17% of normal, diabetic, kidney stones, kidney failure, and chronic kidney failure respectively.

Rehman, M.U. et al, [17] captured the iris image using an infrared camera, which is made of lens with sensor of thermal nature and digital electronics. The lens uses unique forms of 22 physiological and 33 iris properties to focus on the sensor with infrared energy. 11 separate classifiers were merged to create a classification model for a non-invasive system, and the outcomes were compared using cross-validation methods. The five metrics of accuracy were used to analyze the system's overall performance. It achieves 98% accuracy in diagnosing chronic liver disease.

Madhouse Z et al, [19] develop a computer model for early diagnosis of diseases in the brain, back, pelvis, abdomen, and chest using fuzzy logic. Five fuzzy models were built using iris image preprocessing, with an accuracy rate of over 98%. These models are suitable for doctors and the public to help them understand their health.

Avhad, V. V. et al [2], proposed a deep learning-based method for high accuracy and low cost, using data from the diabetes-iridology dataset and advanced methods like attenuation-based U-net and adaptive Residual Squeeze and excitation network (ARSEnet). The method outperforms others in terms of accuracy, precision, specificity, recall, and f1 score, with an accuracy rate of 97.02% for prediction of ocular diseases, such as dry eyes, conjunctivitis, blepharitis, and glaucoma, are prevalent and cause redness, pain, and blurry vision.

Carrera E.V. et al, [26] implemented an iridology-based computer assisted diagnosis system for the early identification of gastrointestinal disorders that uses machine learning and image processing techniques to recognize gastrointestinal illnesses in iris photos. Using 100 iris scans, the system's evaluation demonstrates accuracy and predictive capability of 96% and 99%, respectively. This study demonstrates the diagnostic potential of complementary and alternative medicine approaches for gastrointestinal illnesses.

Datamining techniques employed in iridology analysis

Datamining is the process of searching for new knowledge from a given data set. It can perform clustering, classification, association, prediction, and analysis. Clustering in iridology involves grouping of observed characteristics of iris, such as color, iris texture, or structural features [14]. The algorithm commonly employed for clustering is KMC. K clusters are created from the data based on similarity metrics like Euclidean distance. Classification is used to categorize iris images into different classes or groups based on specific features associated with certain diseases. DT, RF, SVM, and k-NN algorithms are used [9]. Associations uncover relationships between iris features and disease outcomes, identifying potential risk factors or indicators for disease development. AA, FPGA, and ARMA can be used for association. Prediction is used to forecast the likelihood of individuals developing certain diseases based on their iris characteristics. LR, NBC, ANN, and GBM algorithms are used. Analysis analyzes the patterns and clusters within iris data, providing insights into disease phenotypes or subtypes. Algorithms like KMC, HC, and DBSCAN are employed for analysis.

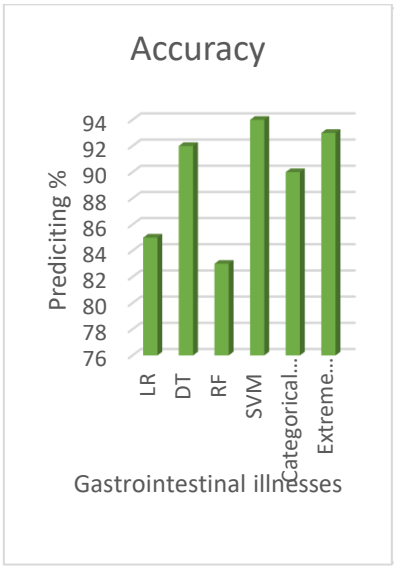
Table 2 A comparative study of various algorithms in literature review.

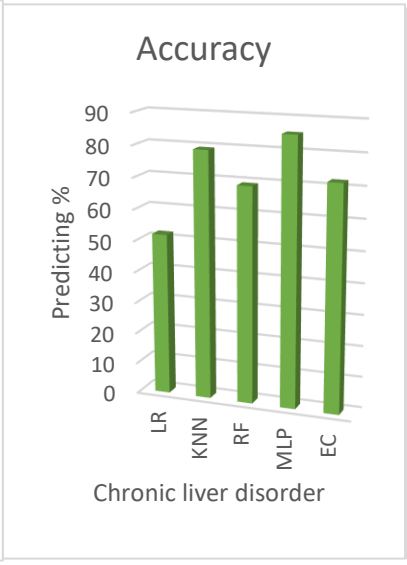
S.No	Disease	Algorithms Used	Best Predicting Algorithm	Accuracy
1	Coronary Heart Disease	NB, DT, K-NN, RF, SVM.	K-NN	93%
2	Diabetics Type1 and Type 2	BTM, SVM, Adaptive Boost Model, Generalized Linear Model, Neural Network Model, RF.	RF	95.85%.

3	Obstructive Lung Diseases (OLD)	NB, DT, K-NN, RF, SVM, Regression Model, Median Tree, Subspace K-NN, Cubic SVM, Quadratic SVM.	RF	97.6%
4	Stone Kidney, Kidney Failure	Watershead Algorithm, SVM, NB, DT, Hidden Markov Model.	Hidden Markov Model.	96.8%
5	Chronic liver disorder	J48, SVM, RF, Multi Layer Perceptron, K-Means, F-Tree.	F-Tree.	98%
6	Gastrointestinal illnesses	Logistic Regression, DT, RF, Categorical boosting, Extreme Categorical boosting.	Extreme Categorical boosting.	96%

Result Analysis for Review of The Study

To visualize the optimal accuracy of predicting algorithm for every condition that has been researched and tabulated, a comparing chart has been constructed and presented as Figure 3,4,5,6,7 & 8.





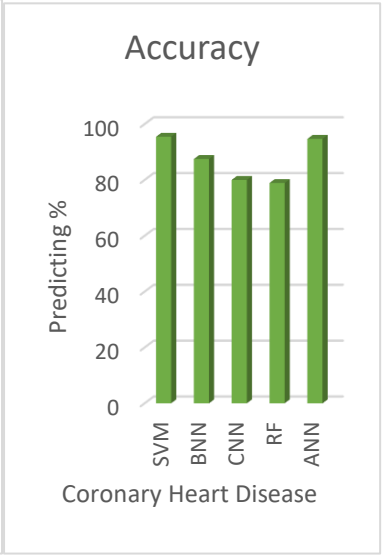


Figure 3: shows that MLP achieves 85.5% accuracy, while LR achieves 51.92 and k-NN is 79.35%. When utilizing iridology to predict chronic liver disease, RF is 69.23% and EC is 72.11%. The most accurate method for predicting chronic liver disease is MLP.

Figure 4: Demonstrates that the SVM algorithm achieves 94% accuracy in predicting gastrointestinal disorders using iridology, while the LR algorithm achieves 85%, DT achieves 92%, RF achieves 83%, Categorical Boosting achieves 90%, and Extreme Categorical Boosting achieves 93%. When it comes to predicting gastrointestinal disorders, SVM has the highest accuracy.

Figure 5: Demonstrates that when it comes to predicting cardiac illness using iridology, the SVM algorithm achieves 95.45% accuracy, whereas BNN achieves 87.5%, CNN achieves 80%, RF achieves 78.9%, and ANN achieves 94.7%. When it comes to predicting coronary heart disease, SVM has the highest accuracy.

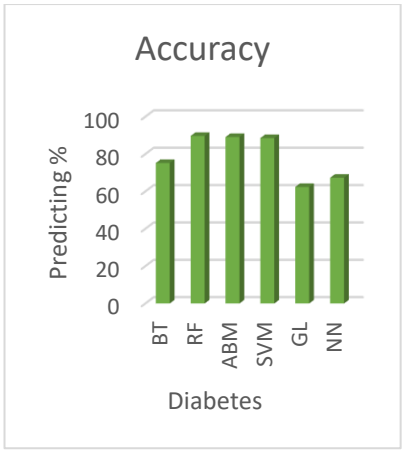


Figure 6: Demonstrates that when utilizing iridology to predict diabetes, the RF algorithm achieves an accuracy of 89.66%, whereas ABM, SVM, GL, and NN achieve 89.1%, 88.54%, and 67.29%, respectively. The most accurate method for predicting diabetes is RF.

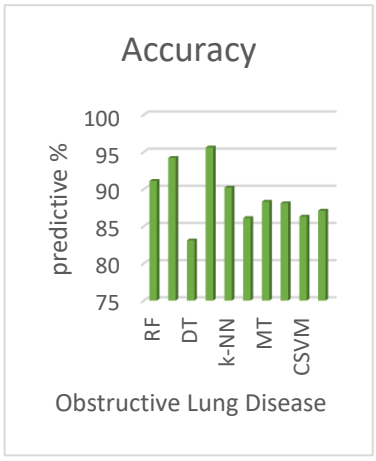


Figure 7: Demonstrates that the SVM algorithm achieves 95.6% accuracy in predicting OLD using iridology, whereas the RF algorithm achieves 91.1%, the DT algorithm achieves 83.1%, the k-NN algorithm 90.2%, the LR algorithm 86.1%, the MT algorithm 88.3%, the SKNN algorithm 88.1%, the CSVM algorithm 86.3%, and the QSVM algorithm 87.1%. The most accurate method for forecasting OLD is SVM.

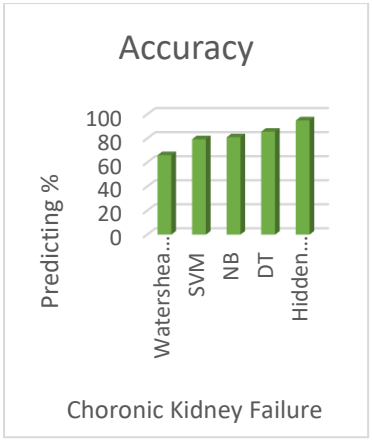


Figure 8: Indicates that the Hidden Markov Model predicts Chronic Kidney Failure utilizing iridology with a 95% accuracy rate, compared to 66.07% for the Watershead Algorithm, 80.98% for the NB, and 85.6% for the DT. The most accurate model for predicting chronic kidney failure is the Hidden Markov Model.

IMPLICATION OF STUDY

From the above review, it is transparent that iridology is involved in identifying diseases of the human in various parts of the body. Table 1 depicts the algorithms used for disease prediction and the algorithm providing best predicting with its accuracy percentage.

From the above table, it is found that certain algorithms perform best under certain values of input. It is also suggested that the best result of prediction is achieved by combing the algorithms.

From the review, it's found that there are very few contributions in liver disease prediction. As though there is a contribution, it is for chronic liver disease, which does not concentrate on symptomless NAFLD.

It is also found that about 25% of adults worldwide suffer from NAFLD that progresses from steatosis to cirrhosis, hepatocellular cancer, and NASH [6]. NAFLD is the accumulation of fat on liver which does not exhibit any symptoms. If a person is affected by NAFLD, it takes nearly 20 years for the liver to reach the cirrhosis stage. At this stage it exhibits symptoms, and the symptom is observed only through the scanning process. In this stage also liver will function. So the person will not feel any difference in the daily routine. As though it is affected, it does not show any symptoms until it completely stops functioning, or nearly 95% of the liver is affected because the liver can regenerate itself. When 95% of the liver is affected, transplantation of the liver or liver surgery is the only available treatment, which is very expensive. This has a lot of side effects on the person's health, and for recovery, it takes more time. The survival of the patient after transplantation or surgery is not guaranteed. Besides the complexity of the disease, a great deal of ignorance exists among people regarding NAFLD [14].

It is found that a healthy liver is used by the human body for nearly 500 organic purposes. A malfunctioning of a liver, the consequences might be fatal. The chance of survival might be increased with early detection and treatment [4].

The idea is to implement iridology in NAFLD prediction since iridology believes that change in the organ is reflected in iris immediately. For diagnosing disease, using iridology does not involve a scan process or biopsy, which has its own side effects and pain. Iridology captures the iris image using a tool similar to the one commonly used by ophthalmologists which is painless and does not have any side effects. It is very economic. Since the disease is predicted very early, treating the person and survival of the person are guaranteed.

CONCLUSION

Iridology is a method used to predict diseases in the human iris, which shows variations in color, texture, shape, and pattern. By examining the iris, early detection and treatment can save lives. Iridology is commonly used as a CAM for examining the iris in western and European countries. The idea is to use iridology to predict deadly NAFLD, which affects nearly 25% of the world population, and there is a lack of awareness. NAFLD is unpredictable and diagnosed only at later stages, leading to expensive surgery or lung transplantation. Iridology can be the best method for early prediction, ensuring patient survival with simple medication, regular exercise and diet changes.

Lipid disease prediction is limited, with only a few contributions made to chronic liver disease. About 25% of adults worldwide suffer from NAFLD, which progresses from steatosis to cirrhosis, hepatocellular cancer, and NASH. A healthy liver is used for nearly 500 organic purposes, and early detection and treatment can increase the chance of survival. Iridology captures the iris image using a painless, painless tool similar to ophthalmologists' tools, making it an economic and effective method for early disease prediction.

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