Diagnosis of Long Sightedness Using Neural Network and Decision Tree Algorithms

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Abstract. Long-sightedness occurs provided the eyes don't concentrate properly on the retina that is the delicate illuminated portion at the back of the eyes. It influences the capability to recognise nearby items. Numerous researches have been conducted on eye disease, but the outcome hasn't been 100% accurate. What motivated the development of this system was that most people are not aware of the warning signs of the disease as a result of negligence, ignorant, and time constraint involved in awaiting an ophthalmologist for diagnosis or detection. Therefore, this study examined the diagnosis of long-sightedness using three algorithms which include Neural Network, Decision Tree, and Back Propagation, and this led to the development of an Expert System. Backpropagation and Decision tree algorithms were employed to train the Neural Network. A decision tree was implemented using a knowledge extraction rule to classify and categorise the disease based on the patient's symptoms. The C# programming language was used for the system implementation, and MySQL was used for the database. The outcome of the developed system explained how the sickness was identified so eradicating the impenetrability in the Neural network only, and finally, the plan was tested after development.

1. Introduction

Compared to the nose or mouth, eyes are more prominent features in humans. In image processing, eye detection is a subfield of object detection. Methods for eye detection have been commonly used in many fields, such as drowsiness detection for intelligent vehicle systems [1, 2, 3], eye gaze tracking devices [4, 5, 6], human-interaction [7, 8, 9], and automated face detection and recognition systems.

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Hyperopia is the term derived from the Greek word where hyper means "over", and ops mean "sight." Thus, as the name suggests, the person suffering is unable to see closer objects, resulting in blurred vision, but the distant objects are visible and familiar. When the condition becomes worse, the objects become blurry at all distances [11]. Long-sightedness affects the capacity to see things close by. You may recognise faraway objects; nevertheless, smaller items are typically out of sight [12]. This mostly affects adults over 40, but it could affect individuals of any age range, even children and infants. The long-medical name is hyperopia, or hypermetropia [12].

Long-sightedness happens because the eye cannot adequately concentrate light on the retina (the light-sensitive layer at the back of the eye) and this can also be because the eyeball is too short, the cornea (transparent layer at the front of the eye) is too thin. Eventually, the lens inside the eye cannot adequately concentrate. Which causes these problems sometimes are not obvious, but they are rarely a symptom of some underlying disorder [12]. Long-sightedness can often result from the genes you inherited from your parents, or from the lenses in your eyes getting stiffer and less focused as you get older [12]. Long sight happens when light from close objects in time to reach the retina is not fully brought to view. The focal point would be behind the retina if the light could get that far. During an effort to concentrate the light on the eye-mechanism called accommodation-lens is trying hard to adjust its thickness (becomes fatter or more rounded off). Those with long sight, however, cannot wholly compensate and so the light does not focus on the retina, and the vision is blurred. This happens because the eyeball is too short, the cornea is too flat (and therefore the light rays bend less), or the lens cannot get around enough (and thus loses power) [13].

An ongoing review of 1,000 grown-ups show that about half, for example, 49% stress moreover losing their sight than about losing their memory and portable hearing assistant [14]. However, practically 30% showed that they don’t get their eyes checked. A great many people are ignorant of the notice indications of eye sicknesses and criteria that could cause harm and visual deficiency if not treated soon enough. Due to these (pro in eye sicknesses are not many, failure to pay for the required administrations), late recognition of vision issue, and substantial loss of vision is experienced. Negligence to visit the clinic and as well as the time constraint in which the patient will have to wait before meeting an ophthalmologist, as a result of this, most patients decide not to visit the clinic if any of the symptoms arise.

Another problem is that of dependence on the ophthalmologist [14]. The ophthalmo-logical disorder causes near-vision loss, but natural far-sightedness is known as hyperopia or farsightedness. Although most term babies are born with this disease, they typically correct themselves by five years of age. It can still be present in up to 10 per-cent of the adult population [15]. Therefore, this study aimed to diagnose or detect Long Sightedness using three algorithms which include Neural Network, Decision Tree, and Back Propagation which led to the development of an Expert System and this can achieve by capturing and gathering symptoms of Long Sightedness from a medical practitioner (s), designing the requirement of the system using the three methods by using the charged signs. The plan was implemented employing C# programming language and MySQL for the database, and lastly, the system was tested after development.

2. Literature Review
2.1 Overview of Hyperopia

Hyperopia is more common in Native Americans and African Americans as well as in Pacific Islanders' descendants [15]. Individuals who are young and have adequate function reserves may have no symptoms. Many beyond this age group will have difficulties, that is to say, the very young and ancient populations [15]. Asthenopia is a common condition, along with headaches, blurred vision, eye pain, and occasionally double vision. Some symptoms and signs include red eyes with decreased binocularity and increased crying [15]. Farsightedness results from a deficiency in the refractive
properties of the eye, resulting in light accumulation at one stage behind the retina. Many affected people may have an eyeball too short in length, or corneal shape or lens pathology [15].

2.2 Testing Hyperopia
Through a variety of standardised examinations, a comprehensive eye exam may be used to diagnose hyperopia [15]. During these tests, an ophthalmologist may examine the eye and perform muscle integrity, cut, refraction, visual field, and visual acuity testing procedures to better assess the condition. Retina examination is called ophthalmoscopy or a fundoscopy [15]. The ophthalmoscope allows the retinal, auditory, and choroid discs to be examined. Muscle integrity is accomplished by observing eye movement responses against a moving target. Refraction tests help assess how much light bends the lens and cornea [15]. They also help to recommend the correct lenses for force. The slit lamp is used to magnify and illuminate the frontal eye region, which includes lashes, eyelids, iris, cornea, lens, and fluid chambers. Perimetry or visual field inspection is used to identify possible defects. In contrast, visual acuity is tested on a chart at a standard distance from the patient, using characters of various sizes [15].

2.3 Neural Network
Artificial neural network (ANN), generally called Neural System (NN), is a calculation that was initially spurred by the objective of having machines [16, 17, 19, 20] that can mirror the cerebrum. A neural system comprises an interconnected gathering of verifiable value information that is expected to prepare the methods [21, 27-29]. This dataset incorporates an info vector and a known yield vector. Every single one of the sources of info and yields is speaking to a hub or neuron. What's more, there is at least one concealed layer. The goal of the learning stage is to change loads of the associations between various layers or hubs. In the wake of setting up the learning tests, in an iterative methodology, an example will be encouraged into the system and artificial neurons. They are physical cell frameworks fit forgetting, putting away data, and utilising experiential information [22].

2.4 Decision Tree
Decision tree (DT) refers to a choice aid system which employs a tree-diagram or option prototypical and its probable outcomes, plus outcomes of coincidental, asset investment, and utility [23]. Showing a measurement is one method. Selection trees are typically used in the analysis of tasks, specifically in the study of preference, to support an approach intended towards achieving an objective. Another application of tree of choice is an articulate tool for evaluating contingent probabilities [24]. Learning the decision tree is a technique generally employed in knowledge discovery. The intention is to make a prototype that envisages an objective variable estimate based on a few data variables [24]. Within hub corresponds to one of the factors of information; for each of the possible forecast of that input variable, there are edges for young people. The leaf speaks to an approximation of the objective variable, given the estimates of the factors of knowledge spoken to by the way from the root to the leaf. There has been a lot of researches in this field of study, but just a few were discussed in this section.

Muharram [25], presented a new way of diagnosing eyesight related issues for people with vision problems. The paper provided a method to analyse the eyesight problem in the vision of Myopia (Short-) or Hypermetropia (Long-) and to identify the issue (if it is found) by taking measurements of eyesight distance (SPH) and deviation (CYL). Whenever the measurements of SPH or CYL are in the normal range, there was no issue for a physician to diagnose. Still, when each measure was out of the normal range, it was more difficult for a physician to diagnose and took more time to determine. Due to the importance of eyesight in human anatomy, the authors designed an approach for the diagnosis of this problem using ANN and SVM to detect the performance of the methods and to help the physician make the correct decisions on time.

Yu, Tang, Lin, Wang, Schmidt, Guo & Liang [26], provided a hybrid eye-model. Two classifiers were implemented in the model: Convolutional Neural Networks (CNN) and Support Vector Machines (SVM). An eye adjustment mesh (EAM) was designed to delete the most significant portion of the
non-eye imageries and hold fewer candidate eye images to boost detection rapidity in the scheme. The CNN after that functioned to directly extract various latent eye characteristics as a trainable function extractor. Ultimately, instead of using the CNN classification method, the qualified SVM categoriser was used for eye confirmation. Experiments to apply the model were performed on the databases of BioID, IMM, FERET, and ORL face.

3. Material and Methods
This study involved detecting Long-sightedness using Neural Network and Decision tree for diagnosis, which was implemented using a backpropagation algorithm. The system was also tested and evaluated. The research work comprises of two phases to fulfil the objectives of the present study, and this includes:
   i. Method of collecting data
   ii. Adaptation of Backpropagation Algorithm in Neural Network.

It was deduced that the newly developed system was able to provide a solution to the existing ones and the hybridisation of the three algorithms made the system per-formed accurately and effectively. The system also produced achieved high performance that is the system was able to accomplish individual proficient, Dependability which means the developed scheme was reliable and durable. The plan was also understandable, user friendly, consistent, accurate, and correct.

4. Findings and Discussion
The acceptance of one or more of the recommendations specified after the analysis of the previous and existing systems was followed by the design of the accepted new system. This design was based on the facts gathered or collected during the research process. The purpose of this design was to produce a specification that will enable the wholesome, practical, and accurate implementation of the new system—this de-scribed the general structure of the system and its functionalities during its implementation and evaluation.

4.1 Procedure Design
This entails a description of the program design and specification of the proposed system. This research was carried out with the use of the backpropagation and decision tree; the algorithms were used to get the best possible solution. The input for the system was the system design requirements, and the output of the course was specified, and all the conditions were stated.

The requirements for detecting Long-sightedness demand that a capable programming language is utilised; hence, the programming language used was C++ which was used for the front-end; MYSQL for the database. The programming language was preferred so that the system can be distributed much more efficiently across all platforms; this enhanced the usability of the system. The program can run on a computer with very little memory space, and any laptop provided met the technical requirements of the system. It supported the modification and upgrade of the system.

4.2 System Modules
   i. The Patient Registration Module is the part of the system that takes care of accepting data from the user. This module agrees with the input data and uploads them to the database.
   ii. The Administration Module: is the part of the system that deals with the admin to login to the system to be able to view the disease or add more symptoms if there is a need to.
   iii. The Self Diagnosis Module: is the part of the system that deals with the self-diagnosis of patients or users of the system. And this is done after registering one's self then. Proceed to diagnose.
   iv. The Detecting Module: is the part of the system that does the first work on the response generated to the system. This module detects Long Sightedness, checks the way the data inside the system are structured, and then checks to see that the data are of common types.
This module is essential to ensure, to a large extent, that the input the user is attempting to feed into the system will not break the system, hence, serving as a form of security to the system.

v. The Password change Module: is the part of the system concerned with changing of existing password to a new one. If the patient or user willingly wants to change his/her password, such a person can do that in this module.

4.3 Steps involved in Operation of the System
a. Click the start button on the desktop and locate visual studio 2012 and launch
b. Open the program from the menu
c. The user of the system is required to supply data and store it in the database.
d. The user can decide or willingly change their password after the account has been created.
e. After that, the user can proceed to self-diagnosis by clicking the icon tagged "self-diagnosis".
f. The user can provide answers to questions been generated as per what has been replied will prompt the type of next question been asked. That is why a decision tree is being used.
g. Once the question session is over, the Decision tree procedures accomplish speedily. They are capable of managing a massive quantity of archives with a considerable amount of areas with foreseeable feedback areas. Henceforth, the response is generated within a stipulated time.

The program started by displaying a login page as in Fig. 1 which included a signup page for a new user, the system generated a "username" when the user signs up, which was then used to login into the system together with "password".

![Login Page](image)

**Figure 1. Login Menu**

The user of the application added the first name, last name, phone number, email address, sex, marital status, username, and password as in Fig. 2, then clicked "sign up" to store the record into the database. The system generated a username that was used for logging in.
Fig. 2. Registration Menu

Fig. 3 shows the user requirement to click the "Self-Diagnosis". The question and answer pop up where the user clicks "YES" if the answer to the question is yes and "NO" if the answer is no.

Fig. 3. Question and Answer Menu Interface

When the questions had been answered, then system diagnosed the user as shown in Fig. 4. The answers provided by the users made the system to map the expected output to the dataset trained with and gives the desired result to the patient.
Fig. 4. Diagnosis Result

Fig. 5 shows when the questions been asked which have been trained with, had been answered, and then the system doesn't find the symptoms totally with the oriented sign, then the system diagnosed "you don't have hyperopia".

Fig. 5. Diagnosis Result 2

Fig. 6 shows the module that deals with a user to change his or her password. The changed password overrides the existing one in the database before. After the change of password, the patient after that continually uses the changed password. Fig. 7 shows the patients’ details database structure, and the datasets for the long-sightedness disease symptoms are shown in Fig. 8.
Figure 6. change of patient password to a new password

Figure 7. The database structure of patients’ details.

Figure 8. The disease symptoms datasets
5. Conclusion and future Work

Hyperopia also is known as long-sightedness is a typical kind of refractive blunder where removed articles might be seen more plainly than close objects. The side effects of hyperopia fluctuate from individual to individual could include cerebral pain, eye fatigue, and squinting, hazy vision, particularly for more immediate articles (National Eye Organization NEI). It is a state of the eye wherein light is engaged behind, rather than on, the retina. A neural system comprises an interconnected gathering of verifiable value information that is expected to prepare the designs. The choices of trees were utilised for the extraction of rules from prepared neural systems. The extricated rules clarified the order and arrangement of various eye sicknesses as per indications. This study is a prototype implementation of an expert system for definitive, diagnosis of eye problem disease such as hyperopia also known as Long Sightedness. The knowledge domain was gotten by extensive consultations with knowledge experts (ophthalmologists) in the field of eye consultation and also from numerous literature reviews. The expert system was developed from scratch using the C# programming language environment and MySQL for the database.

Future Work

There is more than thirty eye disease across the globe; this study only addresses one of these diseases, using C# programming language and MYSQL as a database. Other algorithms, such as machine learning and deep learning algorithms, can be implemented for diagnosis and detection of long-sightedness diseases. A system that will be able to refer a patient to a medical practitioner can be developed in the future and also a hardcopy of diagnosis result or report that could be shown to an ophthalmologist can be involved. The knowledge domain of the System for Long Sightedness Diagnosis should be upgraded to include other eye problem diseases such as myopia, glaucoma and so on. The field of medicine and science is an ever-growing, so there is a need to furthermore research on various eye problems because sight is much more critical. Once it is lost, it won't be easy to regain most, especially for a lower-class citizen. Therefore, it would be necessary to scale up the system to cater for new developments. There should be favourable conditions for further studies and the development of expert systems in different eye problems areas. As a result of this, people will be aware of what is needed to be done to keep their sight.

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