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Development of an Expert System for the Diagnoses of Amblyopia

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Abstract
This work presents the design of an expert system to provide the patient with background for suitable diagnoses of an eye disease called Amblyopia. The eye has always been viewed as a tunnel to the inner working of the body. Diagnosing the disease has been difficult among some urban and rural communities because of the ignorant of its symptoms. The problem of human expertise rarely available was identified and a new system was developed so as to mimic the human expert. In the research we develop an expert system that diagnosis Amblyopia. The software was developed using PHP (Hypertext Processor 6.0) programming language and MySQL (My Structural Query Language), a rational database management system in designing the database was tested and found to have produce the expected results. The new system is flexible and can provide a platform for quick self-diagnosis for potential patients of the disease and also to guarantee a prompt healthcare to people that have Amblyopia. Diagnosis is performed via the expert system, based on patient data. The proposed system is experimented on various scenarios in order to evaluate its performance. In all the cases, proposed system exhibits satisfactory results.

Key Words: Amblyopia, expert system, expertise, Structured Query Language (SQL), Diagnose, Knowledge-based, Symptoms, Optometry, Optician, Computerization, Design, Automation, Database Management System (DBMS), Patient, Defect.

1.1 Introduction

In the current history, computers have faster footwork in the field of biomedical electronics. It has already become an important component in diverse range of medical applications. Because of this, the growth of medical field is occurring at an exponential rate [1]. Computer assisted medical diagnosis has already become a routine feature in most of the medical diagnostic centers and such systems are generally intended to support physicians, complementing their natural abilities to make judgments with the computer' s memory, reliability and processing capabilities [2].

An expert system is a software system that attempts to reproduce the performance of one or more human experts, most commonly in a specific problem domain, and is a traditional application and/or subfield of Artificial

Intelligence. A wide variety of techniques can be employed to duplicate the success of the expert, however common to most or all are the creation of a supposed " knowledge base" which uses some knowledge representation formalism to capture the subject matter experts (SME).

The evolution of expert system has laced some major areas especially in health. The Expert System mainly comprises of three stages i.e. Knowledge base, a user interface and an inference engine. Queries identified by user are inferred by the system keeping in view the knowledge base built in it. This realization has then obtained the knowledge base by inference engine. Implementation of the inference engine is determined by the knowledge base. The inference engine specifically developed on the basis of some particular guidelines and logics and it has a memory and arsenal of rules.

Computer-based methods are progressively used to enhance the performance of medical services. Artificial Intelligence (AI) is the area of computer science that focuses on creating machines that can engage on conduct that humans consider intelligent. Developing one of the systems to represent the storage facility of the knowledge of a medical doctor is as essential as any other expert system. To this end, the project, Expert System for the Diagnoses of Eye an disease called Amblyopia is a necessity.

2.1 Review of Related Literatures

Advancement of expert system in medical field has already regarded as a significant area in the application of computers in medicine. Medical expert system for management, diagnosis and treatment of diseases are gaining importance in the practice of modern medicine.

Systems which use some representation of knowledge are commonly known as expert systems [3]. Researchers are now trying to integrate data mining with expert systems. As mentioned by Saeed in thesis report [4]:

> " An Expert system is often interfaced with a data mining tool to help executives make more informed decisions. Though there are a variety of expert systems in the market, their applications consist mostly of synthesizing the data to executives so that they can make more objective decisions based on the data analyzed" .

Data mining techniques are being used for feeding knowledge to the expert system.

In healthcare environment many researchers have proposed data mining methods to fill the knowledge based of the expert systems [5]. However most of them are for the purpose of supporting diagnostic decision [6], or for finding fraud and abuse [7]

Israel conducted a series of 38 tests on a porcine eyes using two water streams and various stream velocities to investigate the safety of water streams (i.e. water toys and water part streams). As water streams flow continually they do not have a tangible mass associated with them; therefore, kinetic and normalized energy cannot be directly quantified for these cases. This study implemented the correlations from Israel to predict eye injury risk from water streams based on IOP. Globe rupture was neither predicted nor observed in this study. Risk for hyphema was predicted to be as high as 20.7%; however, because cadaver tissue cannot be properly perfused, hyphema could not be directly assessed. Risk for lens dislocation and retinal damage was less than or equal to 1.3% for all tests. [8]

Israel investigated both the correlation between IOP and kinetic energy, and the correlation between IOP and normalized energy. Intraocular pressure was measured throughout each test and normalized energy was calculated for each projectile. [8]. Overall, kinetic energy showed better correlation to IOP than normalized energy for all

points. However, when separated by projectile type, there was a higher correlation between IOP and normalized energy than between IOP and kinetic energy for both cylinders. Three separate correlation curves were presented for IOP and normalized energy, one for each projectile. Normalized energy was previously determined to have a stronger correlation with injury than kinetic energy. The correlation between IOP and normalized energy presented in this study can be used with previously developed injury risk curves based on normalized energy to determine injury risk for eye injuries in cases where projectile characteristics are unknown or incalculable.

Artificial Intelligence is used in numerous domains, like autonomous vehicles, Robotics, Natural Language Processing, Healthcare, Image Processing etc. Models developed with machine Intelligence bring better results in many work activities than human being. Looking into medical sector, eye diseases are very common and growing very fast. explanations for this can be congenital, aging and inordinate use of screens such as phones, laptops, television etc. Around the world, people are suffering from many eye diseases but some eye diseases like Amblyopia, strabismus seems so in childhood and its timely identification and appropriate treatment is very important to prevent vision loss. Deep integration of ophthalmology and Artificial Intelligence has the potential to reform current disease diagnose pattern and generate a significant clinical impact [9]. Artificial intelligence especially Deep Learning is accepted in ophthalmology to diagnose eye disorders like Amblyopia, diabetic retinopathy, glaucoma, [10]. AMD (age related macular degeneration) [10] and ROP (retinopathy of prematurity) [11] and shows very good results [11]. With the use of new diagnostic tools and techniques, very significant number of data is generated specially in the forms of illustration, that may lead to the slow in the assessment of findings but with the help of machine learning techniques, we can solve these problems and help doctors not only in identification of disease but also in monitoring. Artificial Neural Network is used for diagnosis of inherited stable night blindness and Support Vector Machine is used to analyze eye tracking for the detection of learning disabilities. With the use of source image, excessive muscle fibers activity can be detected using k- Nearest Neighbor and Support Vector Machine. From studies, it is found that Machine learning is mostly used for the detection of eye diseases in adults but for neonatal treatment many new models are required that work with pediatric dataset and give better results, [12]. If we can have an freely accessible to pediatric source of data then machine learning models can be made for the detection of eye disorders that is found in children like Amblyopia, NLDO (nasolacrimal duct obstruction) and strabismus.

Balyen *et al*. explains various AI, ML and DL techniques used in diagnosis Diabetic Retinopathy, Age related Macular Degeneration, Glaucoma. These techniques can be used in ophthalmic setting to validate the diagnosis of diseases, read images, perform corneal topographic mapping and intraocular lens calculations. Two image processing techniques are used as diagnostic systems, one is fundus digital photography and other is optical coherence tomography (OCT). Out of both OCT is mostly used because of high accuracy in diagnosing multiple retina disorders with promising results in automated image analysis, [10]. ANN helps in ophthalmology in diagnostic and treatment of many eye related diseases with high frequency, such as Diabetic Retinopathy, Age related Macular Degeneration, Amblyopia, Glaucoma, ROP (retinopathy of prematurity), age-related cataract and others with retinal vein obstruction [9]. and can be achieved accuracy between 75% to 100%. Images data set is used in this and explain three steps. First, gather a large numerous of images and then relative specialists label the distinctive lesions. After that features are extracted of a disease with the help of a program that based on marked input images. At last with the help of statistical feature of target lesions input image can be distinguished from other

types of disease. But Deep learning used in this has some limitations like high computational cost and training experience, without our involvement it cannot completely identify disease separately because it identifies a feature mechanically, it is difficult because features of a disease and parameters used for an algorithm is different with different tasks so human intervention is necessary. It is also suggested that excessive database may be outfit or less efficient so choose the database very carefully and images from an extensive demographic for higher exterior validity can be used [11].

One of the main reasons of Amblyopia is Strabismus. Deep learning Neural network is applied on strabismus dataset, gathered and classified by the ophthalmologists for the detection of strabismus. Firstly R-FCN (Region-based Fully Convolutional Network) is applied for eye region segmentation then deep convolutional neural networks is built and educate to classify the partitioned eye regions as strabismus or regular. This shows good results for telemedicine application. The big challenge for this to collect the dataset and strabismus detection with different image sizes and resolutions [11]. Although Artificial Intelligence is widely used nowadays but has some ethical challenges like transparency, bias, human values, data protection and intellectual property, social dislocation, cyber security, decision making, liability, legal and regulatory issue, [10]. While detecting many eye disorders training data sets of homogeneous populations is used in various Deep Learning techniques. With the variations in data set better results can be achieved. It is not clearly defined in any paper how we can calculate power and performance of independent data sets. The present Artificial Intelligence screening systems that are developed for adult patients and validate using images. This system is lack of stereoscopic potentials. Chang *et al*. did Pilot study which shows that an idea or concept should be understand on individual basis and also the meaning of a concept should be by predictable understanding. A big challenge in AI is to understand the exact sense of a word or concept that may be different with different situations.

Artificial Intelligence algorithms are used for detection of many eye diseases. But amblyopia is detected with very few techniques as current applications to pediatric ophthalmology have some limitations those are divergence on reference standards, lack of time-based information, poor reproducibility and comparability which can be improved in future work. Artificial Intelligence techniques those are used for the detection of AMD (Age macular degeneration), glaucoma, ROP (retinopathy of prematurity) and other retinal vein obstruction can be used for prediction of Amblyopia.

Ivana *et al* made Design of Expert System for Early Amblyopia Detection Using C4.5 Algorithm. This application is used to detect amblyopia early disease to calculate accuracy value. Based on the results of experiments conducted using 10-fold cross so that the accuracy of output system type is 80%, and the accuracy value of result output system is 93.2%. Yudi and Yessi Nofrima make the Design of Expert System Diagnosis of amblyopia Eye Disease in Human-Based Web. This application uses Inference Forward Chaining method which is able to identify by requiring a lot of data for more accurate test results. Galih Hendro Martono, M.Eng and Siti Agrippina Alodia Yusuf perform Diagnosis of Senile Cataract Disease Using a Web Based Case Based Reasoning (CBR) Method. This application is used to solve problems that look for the similarities of previous cases with new cases that yield 70% value. [13].

The medical knowledge of specialized doctor is required for the development of an expert system. This knowledge is collected in two phases. In the first phase, the medical background of eye diseases is recorded through the creation of personal interview with doctors and patients. In the second phase, a set of rules is created where each rule contains

in IF part that has the symptoms and in THEN part that has disease that should be realized. The inference engine (forward reasoning) is a mechanism through which rules are selected to be fired. It is based on a pattern matching algorithm whose main purpose is to associate the facts (input data) with applicable rules from the rule base.

Finally, the eye diseases are produced by the inference engine. This expert system defined the symptoms of diseases of the eye such as; discharge from the eye causes at morning your eyes refuse to rise. They are so swollen shut with sticky, crusty discharge; it feels like the sandman pasted your lids with glue. It can be alarming to have to pry open your eye in the morning, but eye discharge is rarely harmful and is simply part of your body' s natural defense system. Bulging eyes is the abnormal protrusion or sticking out (bulging out) of one or both eyeballs from the eye socket. [14].

Bulging Eyes are also known as Proptosis or Exophthalmos and could be a sign of a serious medical condition. [14]. Bulging eyes should receive immediate attention. Bulging of a single eye, especially in a child, is a very serious sign and should be evaluated immediately if the two eyes are misaligned and aim at different targets, two non-matching images will be sent to the viewer' s brain. When the brain accepts and uses two non-matching images at the same time, double vision results. Double vision is dangerous to survival, so, the brain naturally guards against its occurrence. In an attempt to avoid double vision, the brain will eventually disregard one of the mismatching images. That is, the brain will ignore one eye. Dropping eyelid affects only the upper eyelid of one or both eyes, (ie) it is when the upper eyelids droops downward. [15]. The droop may be barely noticeable, or the lid can descend over the entire pupils. Drooping eyelid can occur in both children and adults, but happens most often due to aging.

2.2 Rule Based Learning Apprentice Systems

A rule based expert system integrated with a studying module has been termed as rule based learning apprentice system. Rule based learning apprentice system began in late 1970s and early 1980s. Institutionally many learning apprentice systems have been developed. Some of them are described below; All sequential earlier programs influenced the design of the latter programs. MYCIN was a famous early based expert system developed over five or six years in the early 1970s at Stanford University. It was written in INTERLISP as the doctoral dissertation of Edward Shortliffe under the direction of Bruce Buchanan, Stanley N. Cohen and others. It focused the use of judgmental rules that has some uncertainty factor. MYCIN was developed to capture the knowledge of medical experts in infectious blood diseases and detect bacteria causing severe infections, such as bacteremia and meningitis, and to recommend antibiotics with the dosage adjusted with patient' s body weight. The name MYCIN derived from the antibiotics themselves as many antibiotics have the suffix " -mycin" . Post-Operative Expert Medical System (POEMS) [16] is a general diagnostic decision support system, which provides assistance to doctors to reach a diagnostic decision. Once a diagnosis has been reached, it can also recommend possible treatments after considering their suitability and side effects for the patient. It collects patient data by interactively querying for it, or letting the user enter relevant data. Patient data and symptoms are used by the system to produce a list of possible diagnosis candidates (diseases or complications), sorted according to their severity and likelihoods. User can further query the system about recommended treatments. User can also ask to discriminate the diagnosis candidates to isolate the diseases.

POEMS was developed to give adversary and decision support to less experienced staff. (i.e) for junior doctors and other supporting medical staff (Nurses) involved in providing patient care. It has data consistency checking options

and explanation mechanism. The data consistency checking module lets the user enter all relevant data of the patient. It will prompt for any missing critical information which might play a crucial role in diagnosis process. The explanation module allows the user to explore the reported diagnosis candidates and their supporting features in order to fully understand the system' s diagnosis. POEMS is basically a frame based system, with some rules included for specific purpose.

Sabyasachi, analyzed data science as a field of science that deals with various aspects including data management and analysis, to extract deeper insights for improving the functionality or services of a system (for example, healthcare and transport system). He also analyzed data for decision support and automation possibilities using business rule transformations technique. They proposed a method for business rule transformation to executable instructions in data analysis software. Their proposed transformation techniques pull the business rules out of software system code and use them for automated decision making [17].

Pisoni, proposed hybrid architecture, a combination of a rule based and case based reasoning system. The idea of his research is to use rules to generate a diagnosis on a fault and to use cases to handle exceptions to the rules. The cases are represented using an object-oriented approach to support abstraction, re-use and inheritance features. Problem with all of the systems mentioned above is that their implementation environment is different from conventional computing environment. Normal conventional computing environment consists of tools like Java, VB, C^{++}, SQL, Oracle, ASP etc. while these systems were developed in AI specific tools like OPS-5, LISP, Prolog, KEE etc. another problem is that their learning module is manually driven, thus requiring excessive human intervention [18].

2.3 Apprenticeship Learning Techniques

Apprenticeship Learning is a kind of learning from demonstration techniques where the reward function of a Markov Decision process is unknown to the learning agent and the agent has derive a good policy by observing an experts demonstrations [19].

Learning apprentice systems is a well-established area of applied Artificial Intelligence. Historically many systems have been developed which have learning module integrated with main system. The learning system watches all the actions performed by a user and learns from the various examples presented by the user. Learnt examples are later on used by the system to provide enhanced problem solving ability.

Hence, performance of an expert system having an integrated learning module enhances with the passage of time and uses. A general learning apprentice system applied to area of turbine modeling. The system learns different types of concepts to enhance domain knowledge. i.e, modeling knowledge and knowledge of matching response outputs. Learnt knowledge is used by the inference engine for future problem solving.

Bruzda presented an interview of syndromic surveillance system. The system uses an innovative explanation based approach for modeling diseases and their symptoms. The system is also capable learning non-symptom predictors of causes, such as a majority of the patients who exhibit anthrax attended a football game. They explained the working of their Causal Reasoning Engine (CRE). CRE uses explanation based framework by Bayesian network data model. CRE is found to be accurate when compared with other diagnosis approaches [20]. Wang extended EBL to Probabilistic Explanation Based Learning (PEBL) and used it to solve two issues. The first one is the

multiple explanation problems, which is concerned with choosing the explanation to be generalized for examples having multiple proofs. The second problem is that of generalizing from multiple examples, another issue that received quite some attention in traditional explanation based learning. Similarly Based Learning (SBL) is focused on detecting similarities in a set of positive examples or dissimilarities between positive and negative examples. All SBL methods use some sort of inductive bias to identify the inductive jump that they must take to define a new concept [21].

Data Mining Based Learning Methodology in recent past, data mining technology has emerged as new form of learning. New algorithms have been developed, and existing algorithms, such as AQ [22], RULES, have been modified and implemented to extract knowledge or useful information for huge volumes of data stored in relational database or in data warehouse. This form of learning is advance form of all old learning techniques and seems to prevail in future as data in the world is increasing at an exceptional rate. This research uses data mining algorithm for extracting production rules from data stored in a data warehouse. Architecture of POEM developed by POEMS has a hierarchical knowledge base along with a dynamic temporal modeler and an active data collection methodology. Temporal modeler takes care of temporal changes in the knowledge base. Active data collection methodology allows the expert to set a policy for the junior doctors to follow. Another features implemented in POEMS is an incremental diagnostic engine which incrementally computes the likelihood of different diagnosis candidates as new patient data in entered. [16] Taken from Nkuma, POEMS' s architecture. The Data Qualifier module represents the data abstraction stage in the conceptual model. It handles all the data collection and its transfer to an internal qualitative representation. The investigative represents the investigative and remedial-actions stage in the conceptual model and handle all the querying tasks related to data collection. The intermediate modules in the architecture represent the candidate diagnosis generation stage in the conceptual model, and include:

(i) Internal representation of patient data i.e. the Current Model
(ii) Knowledge Base,
(iii) Temporal Modeler
(iv) Diagnoser
(v) Diagnosis Filter

The patient data provided to the system is a collection of attribute values, often termed findings or manifestations. These may consist of symptoms reported by the patient or signs observed (or examined) by the doctor or staff. They can also consist of laboratory findings and results of various tests. [16]

2.4 Developments in Expert Systems

Steps in Developing an Expert System

Step 1: Identify problem domain

- The problem must be suitable for an expert system to solve it.
- Find the experts in task domain for the expert system project
- Establish cost-effectiveness of the system.

Step 2: Design the system

- Identify the ES technology
- Know and establish the degree of integration with the other systems and databases.

- Realize how the concepts can represent the domain knowledge best.

Step 3: Develop the prototype

- Acquire domain knowledge from the expert
- Represent it in the form of IF-THEN-ELSE rules.

Step 4: Test and Refine the prototype

- The knowledge engineer uses sample cases to test the prototype for any deficiencies in performance.
- End users test the prototypes of the expert system.

Step 5: Develop and complete the expert system

- Test and ensure the interaction of the expert system with all elements of its environment, including end users, databases, and other information system.
- Document the expert system project well
- Train the user to use expert system

Step 6: Maintain the system

- Keep the knowledge base up-to-date by regular review and update.
- Cater for new interfaces with other information systems as those systems evolve. [23]

Although ANN and Genetic Algorithms (GA) provided many useful techniques for improving the effectiveness and efficiency of problem solving, expert systems and developments in related topics made it possible to address many down-to-earth problems. Expert system technology is the first truly commercial application of the research and development work carried out in the AI field. The first successful expert system DENDRAL, developed by Fiegenbaum, demonstrated a focused problem-solving technique which was not characterized in AI research and development. The program simulated an expert chemist' s analysis and decision-making capability. A number of expert systems in different domains, such as geological exploration, medical diagnosis etc., were developed using the concepts presented by Fiegenbaum in DENDRAL. There was apprehension among the AI community to accept expert systems as AI programs, since they used specific knowledge of a domain to solve narrow problems. Development of practical applications using the techniques of expert systems accelerated with the introduction of two new concepts, viz., scripts and frames.

2.4.1 Development Process of Expert Systems

Some of the practical concerns of developing knowledge-based expert systems are:

1. When should the knowledge based expert systems be used, and

2. How to identify potential application areas and plan for the development of knowledge-based expert systems considering staffing, funding, time and hardware requirements [24]. Expert systems development can be divided into four stages: problem selection, prototype development, migration from prototype to expert system and deployment of the expert system [25].

2.5 Biology of Human Optometry.

The eye is made up of three layers;

1. The outer layer called the fibrous tunic, which consists of the sclera and the cornea

2. The middle layer responsible for nourishment, called the vascular tunic, which consists of the iris, the choroids and the ciliary' s body

3. And the inner layer of photoreceptors and neurons called the nervous tunic, which consists of the retina.

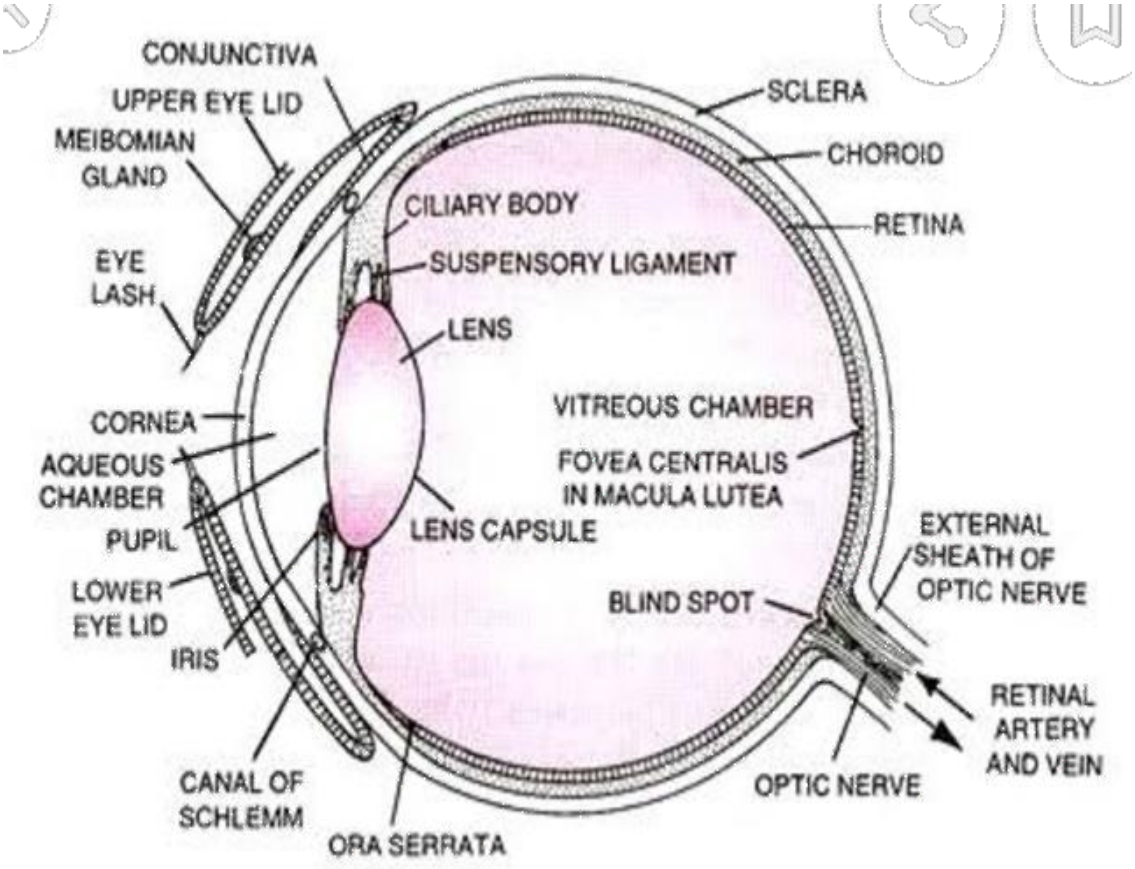

Figure 2.1 Structure of Human Eye (onlinesciencenotes.com)

The eye also contains three fluid-filled chambers. The volume between the cornea and the iris is known as the anterior chamber, while the volume between the iris and the lens is known as the posterior chamber; both chambers contain a fluid called aqueous chamber (aqueous humor). Aqueous humor is watery fluid produced by the ciliary' s body. It maintains pressure (called intraocular pressure or IOP) and provides nutrients to the lens and cornea.

Aqueous humor is continually drained from the eye through the canal of schlemm. The greatest volume, forming about four-fifths of the eye, is found between the retina and the lens called the vitreous chamber. The vitreous chamber is filled with a thicker gel-like substance called vitreous humor which maintains the shape of the eye. Light enters the eye through the transparent, dome shaped cornea. The cornea consists of five distinct layers. The outmost layer is called the epithelium which rests on Bowman' s membrane. The epithelium has the ability to quickly regenerate while Bowman' s membrane provides a tough, difficult to penetrate barrier. Together the epithelium and Bowman' s membrane serve to protect the cornea from injury. The innermost layer of the cornea is called the endothelium which rests on Descemet' s membrane. The endothelium removes water from cornea, helping to keep the cornea clear. The middle layer of the cornea, between the two membranes is called the stroma and makes up 90% of the thickness of the cornea.

2.5.1 Three Different Types of Eye Care Practitioner

1. Optometrists: These are eye care professionals who provide primary vision care ranging from sight testing and correction to the diagnosis.

2. Ophthalmologists: This is a medical doctor who specializes in eye and vision care.

3. Opticians: This is a technical practitioner who designs, fits and dispenses lenses for the correction of a person's vision. Opticians determine the specification of various ophthalmic appliances that will give the necessary correction to a person's eyesight.

2.5.2 Amblyopia

Amblyopia is a reduced vision in one eye caused by abnormal visual development early in life. Amblyopia is characterized as an " abatement of visual sharpness for which no causes can be distinguished by the physical assessment of the eye, brought about by vision hardship or unusual binocular interaction" .

Types of Amblyopia:

1. Deprivation Amblyopia develops when different types of eye diseases prevent light from reaching retina, during critical period, it prevents the proper formation of visual circuit. it could be due to media opacity, optic nerve defect or movement disorder (nystagmus). Examples are congenital cataract, blapharoptosis, nystagmus disorders, optic nerve coloboma and hypoplasia, retinal disorders, persistent fatal vasculature, cotneal opacities involving visual axis.

2. Anasometropia Amblyopia is a severity of amblyopia, is incrementally recognized also with isometropia for both eyes, instead of the perfection of refractive mistake itself.

3. Strabismus Amblyopia is a discrepancy of one eye with lack of eye concurrency. Thus, the eyes don't get similar image, driving the graphic framework to adjust to this change.

Steady strabismus creates more serious visual hardship than unusual strabismus [26]

a. Mixed Amblyopia: when two factors are liable for amblyopia advancement, its called mixed amblyopia. Integration of anisometropic and strabismus amblyopia is common, especially in temporarily affiliative esotropia, microtropia and monofixation syndrome [27]

b. Reverse Amblyopia: Invert amblyopia is a repercussions of correction of the sound eye with fixing or atropine throughout amblyopia diagnosis of the first amblyopic eye. The kind of amblyopia and its honesty antagonistically influence visual eagerness as well as binocularity, make a distinction affectability, grinding sharpness, and focal versus unexpected attachment.

Symptoms of Amblyopia:

i. An eye that wanders inward or outward

ii. Eye that appear to not work together

iii. Poor depth reception

iv. Heat tilting

v. Squinting or shutting an eye

vi. Abnormal results of vision screening tests

2.6 Summary of Literature Review and Knowledge Gap

In the literature reviewed, to diagnose patient is based on the expertise (doctor) operating directly through manual system diagnoses and other health care work with inference forward chaining method to detect an eye disease called amblyopia using C4.5 algorithm, the researcher develop a system to diagnose eye disease called Amblyopia using Inference Backward Chaining method which is able to identify by requiring a lot of data for more accurate test results and it is a also goal-driven method.

Several previous studies Ivana *et al* made Design of Expert System for Early Amblyopia Detection Using C4.5 Algorithm. This application is used to detect amblyopia early disease to calculate accuracy value. Based on the results of experiments conducted using 10-fold cross so that the accuracy of output system type is 80%, and the accuracy value of result output system is 93.2%. Yudi and Yessi Nofrima make the Design of Expert System Diagnosis of amblyopia Eye Disease in Human-Based Web. This application uses Inference Forward Chaining method which is able to identify by requiring a lot of data for more accurate test results. Galih Hendro Martono, M.Eng and Siti Agrippina Alodia Yusuf perform Diagnosis of Senile Cataract Disease Using a Web Based Case Based Reasoning (CBR) Method. This application is used to solve problems that look for the similarities of previous cases with new cases that yield 70% value.

3.1 Research Methodology

A methodology is a system of procedure and principles used in a specific " school" of a design area of work. It is a body of methods, procedures and guidelines by those who work in a discipline or participate in an enquiry. In other words, it is a set of design methods; it helps in building a system project strategy because it gives the outcome list of process and sub-processes required in developing a system.

The research technique used in this research is rule based systems.

There are many methodologies for software development; some of the more popular software development methods include Rapid Application Development, Structured System Analysis and Design Methodology, Integrated Methodology, the Prototype and others. Prototyping is the development methodology used in developing this system. System which require user to fill out form or go through different screens before information is processed can use prototyping adequately to give the correct look even before the actual software is developed. Prototyping addresses these issues with an iterative or spiral process, in which a straightforward model is continually refined toward the desired end. Fundamentally, prototyping comprises of a series of stages in which a model is discussed and refined by the stakeholders, and afterward implemented by the developers. The stages are shown in the diagram below.

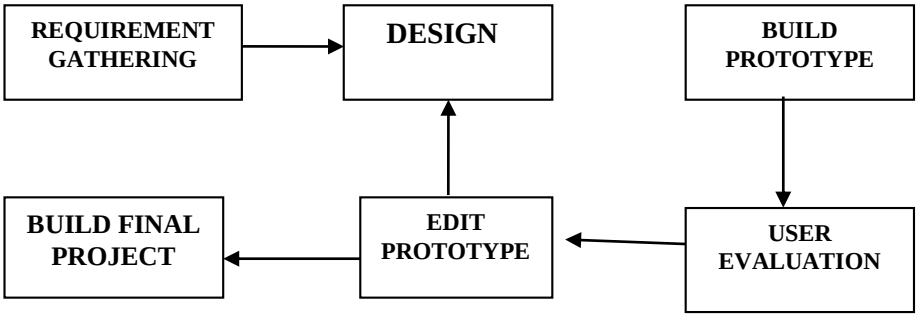

Figure 3.1 Prototype Model (researchgate.net)

3.2 Method of Data Collection

This part of the study portrays methods used in collecting data use in carrying out the project, the instruments and procedure for the data collection.

1. **Interview**: At this point the researchers interviewed most eye patients, and lots of information was gathered about the eye patient registration.
2. **Observation:** From personal observation, information about the eye patient registration system at the Kogi State University Teaching Hospital was deduced.

3.3 System Architecture

This characterizes the basic knowledge of building the system in a health organization. The fundamental operation of the system, starting from the doctor' s contact to where the ophthalmologists give information is described in the following diagram.

Here, the doctor interact with the user interface with the intention of using the system to diagnose patients, the user interface then consult the inference engine for data retrieval processing and recovering of information from the knowledge base or the working memory. The knowledge base however is updated by the ophthalmologists so as to enhance the credibility of the expert system.

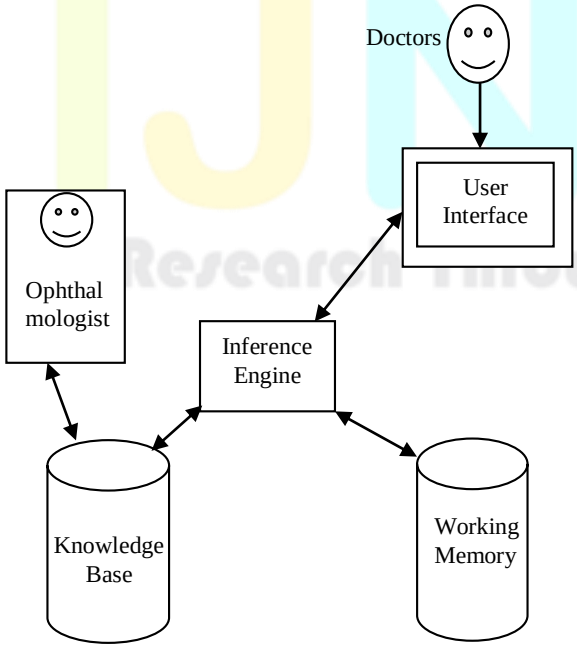

Figure 3.2 System Architecture. (researchgate.net)

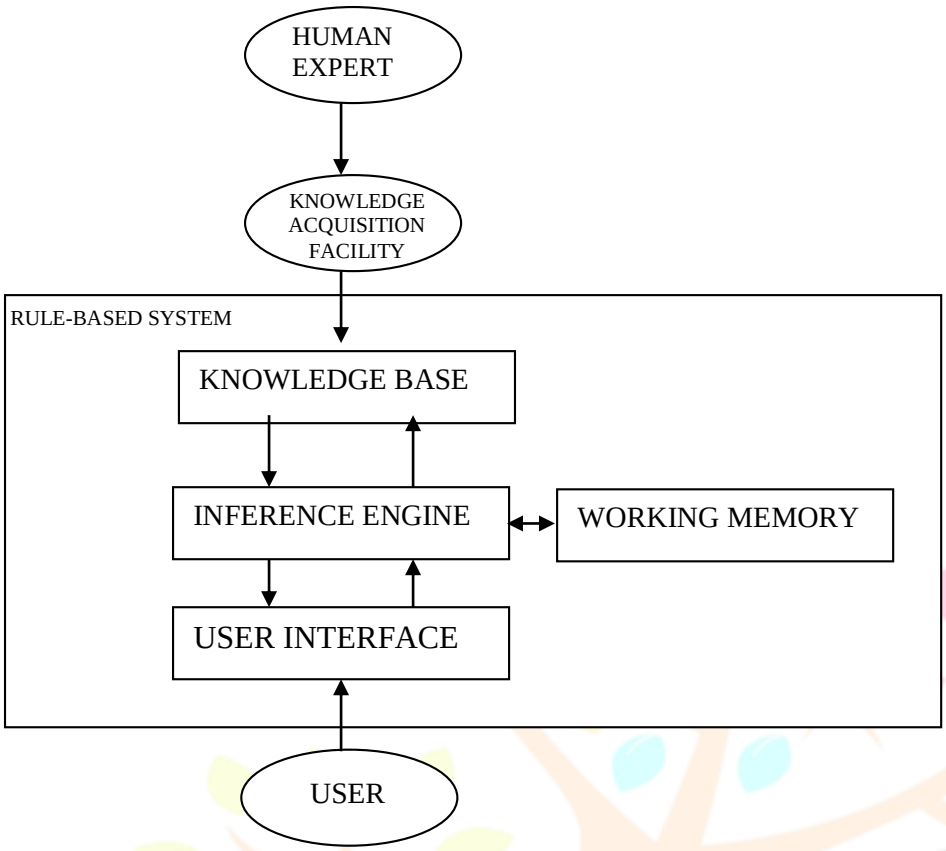

Figure 3.3 Components of an Expert System (techvidvan.com)

3.4 Analysis of the Existing System

The existing system of medical diagnosis entails the use of an inference forward chaining method to detect an eye disease called cataract using C4.5 algorithm. The process uses a down-up approach (bottom to top), it start from an initial state and uses facts to make a conclusion. The process of forward chaining may be time-consuming. It may take a lot of time to eliminate and synchronize available data. The proposed system will help directly to solve the problem of such delay in attending to the patients.

3.4.1 Weaknesses of the Existing System

The major weakness of the existing system is that the explanation of facts or observations for the system is not very clear. The former uses a data-driven method that arrives at conclusions efficiently. The process start with new data and facts.

3.5 Analysis of the Proposed System

The proposed eye diseases-diagnosis system is an expert system which main purpose is to carryout diagnosis of an eye disease called Amblyopia using inference backward chaining method.

This system is design in such a way that the user will switch on the offline server (Xamp server) before proceeding to click on the application, and the user must be a registered Admin with the username and password. The user

clicks on 'Diagnosis' and enters the patient' s data and then select the symptoms displayed based on the patient' s experience or report, then click " Start Diagnosis" and print out the Diagnosis result. In this case, communication between the user and the system is done through the user interface which was implemented in English Language. The user interface is represented as a menu which displays the symptoms of amblyopia to the user. The expert system seeks and utilizes relevant information from their human users and from available knowledge base in order to make recommendations. The diagnosis of the eye disorder is initially based on the symptoms that the person is experiencing, the appearance of the eyes, and the results of an examination. The medical knowledge of a specialized doctor is required for the development of an expert system; this knowledge is collected in two phases. In the first phase, the medical background of amblyopia is recorded through the creation of personal interview with doctors and patients. In the second phase, a set of rules is created where each rule contains the 'IF' part that has the symptoms and 'THEN' part that has the disease that should be realized.

The proposed system performs many functions. It will conclude the eye disease diagnosis on Amblyopia based on answers of the user to specific question that the system asked. The questions provide the system the explanation for the symptoms of the patient that helps the expert system to diagnose the disease by inference engine. It stores the facts and the conclusion of the inference of the system and the user for each case in the data base. It processes the data base in order to extract rules, which complete the knowledge base. The weaknesses of the existing system is been taking care of because the proposed system does not consume mush time and the explanation of facts or observation for the new system is very clear and goal-driven unlike the existing system.

3.5.1 Benefits of the Proposed System

From the observation and analysis of the proposed system, it is clear that the advantages exhibited by the proposed system entails the following:

1. To make diagnosis easy and fast
2. To ease the work of medical personnel
3. it makes it easier to deduce inferences
4. To complement the manual diagnosis of eye disease and to reduce time consumption.
5. Correct solutions can be derived effectively if pre-determined rules are met by the inference engine.
6. To educate patient about the risk factors of eye disease and ways of avoiding it.

3.6 Research Flow

This describes the way the whole research was conducted starting from the very start to the end. The diagram (figure 3.5) below shows that the research started by consultancy of the ophthalmologists and gathering of information, and ended at the conclusion and finalizing of the whole research work by documenting and tiding up its environment. The research start with expert consultancy and move to doctor' s awareness and also to data analysis follow by the rules implementation. User interface follows in the process and then the system body coding, before the final testing and conclusion. The following diagram (figure 3.5) shed light to the research flow.

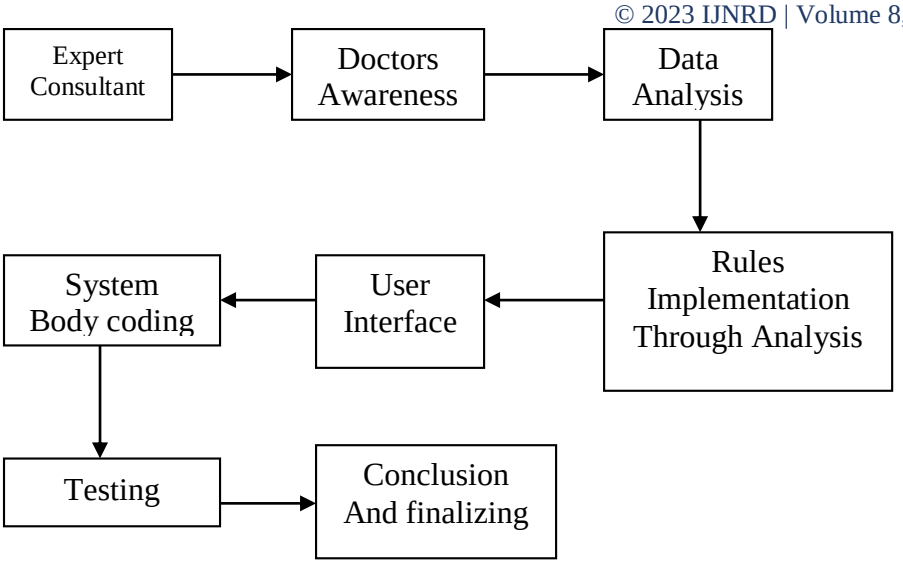

Figure 3.4 Research Flow (techvidvan.com)

4. Results and Discussion

4.1Amblyopia

Amblyopia is a reduced vision in one eye caused by abnormal visual development early in life. Amblyopia is characterized as an " abatement of visual sharpness for which no causes can be distinguished by the physical assessment of the eye, brought about by vision hardship or unusual binocular interaction" .

Types of Amblyopia:

1. Deprivation Amblyopia develops when different types of eye diseases prevent light from reaching retina, during critical period, it prevents the proper formation of visual circuit. it could be due to media opacity, optic nerve defect or movement disorder (nystagmus). Examples are congenital cataract, blapharoptosis, nystagmus disorders, optic nerve coloboma and hypoplasia, retinal disorders, persistent fatal vasculature, cotneal opacities involving visual axis.

2. Anasometropia Amblyopia is a severity of Amblyopia, is incrementally recognized also with isometropia for both eyes, instead of the perfection of refractive mistake itself.

3. Strabismus Amblyopia is a discrepancy of one eye with lack of eye concurrency. Thus, the eyes don' t get similar image, driving the graphic framework to adjust to this change.

Steady strabismus creates more serious visual hardship than unusual strabismus [11].

a. Mixed Amblyopia: when two factors are liable for amblyopia advancement, its called mixed amblyopia. Integration of anisometropic and strabismus amblyopia is common, especially in temporarily affiliative esotropia, microtropia and monofixation syndrome [12].

b. Reverse Amblyopia: Invert amblyopia is a repercussions of correction of the sound eye with fixing or atropine throughout amblyopia diagnosis of the first amblyopic eye. The kind of amblyopia and its honesty antagonistically influence visual eagerness as well as binocularity, make a distinction affectability, grinding sharpness, and focal versus unexpected attachment.

Symptoms of Amblyopia:

i. An eye that wanders inward or outward

ii. Eye that appear to not work together

iii. Poor depth reception

iv. Heat tilting

v. Squinting or shutting an eye

vi. Abnormal results of vision screening tests

4.2 System Design

This is the process of defining the modules, architecture, interfaces and data for a system to satisfy specified requirements. It could also be seen as the application of system theory to product development. The purpose of the system design is to provide sufficient detailed data and information about the system and its system elements to enable implementation consistent with architectural entities as defined in models and views of the system architecture. In order to achieve the completion of a system, the following elements were put into consideration.

1. Architecture: This model defines the structure, behaviour and more views of a system. We can use flowcharts to represent or illustrate architecture.

2. Modules: These components handle one specific task in a system. A combination of the modules makes up the system.

3. Components: They are made up of modules. The component provides a particular function or group of related functions.

4. Interfaces: This is the shared boundary across which the components of a system exchange information and data flow.

5. Data: This is the management of the information and data flow.

Major tasks performed during the system design process are:

1. Initialize design definition: this stage involves the following; plan for and identify the technology that will compose and implement the system element and their physical interfaces, determine which technologies and system element have a risk to become obsolete, or evolve during the operation stage of the system. Plan for their potential replacement, document the design definition strategy, including the need for and requirements of any enabling systems, products, or services to perform the design.

2. Establish design characteristics: This phase consist of;

i. Define the design characteristics relating to the architectural characteristics and check that they are implementable.

ii. Define the interface that were not defined by the system architecture process or that need to be refined as the design details evolve.

iii. Define and document the design characteristics of each system elements.

3. Assess alternatives for obtaining system elements: This phase consists of;

i. Assess the design options.

ii. Select the most appropriate alternatives.

iii. If the decision is made to develop the system elements.

iv. Rest of the design definition process and the implementation process are used, if the decision is to buy or reuse a system element.

v. The acquisition process may be used to obtain the system element.

4. Manage the design: This phase consists of;

i. Capture and maintain the rational for all selections among alternatives and decisions for the design.

ii. Architecture characteristics.

iii. Assess and control the evolution of the design characteristics.

4.3 Input Form Design

Input Design

Data and storage are considered to be the heart of any information system. It is necessary therefore to present data to the computer in a way which provides easy conversation into its own electronic pulse-based forms. This is achieved by supplying data using inputs devices such as keyboard, which converts it into machine sensible form and also produces output through monitor and printer.

These forms are built in such a manner that users can select from the options the kind of eye disease case they might want to diagnose. In the form always the user will have to answer the question the expert will ask him based on the history and symptoms of the medical case. The answer is either "Yes" or "No"(ie. Mark [√] which means Yes and no mark which mean No). Again, the form has a provision for the user to learn more about Amblyopia disease. Diagnosis on this form is done in a way that each question you answered " Yes" scored certain percentage depending on the degree of relevance the symptom is to amblyopia disease. At the end of each diagnosis, the extents of disease in proportion are shown. This form also has a link to the database. As you keep responding to question of the expert, database content will be retrieved.

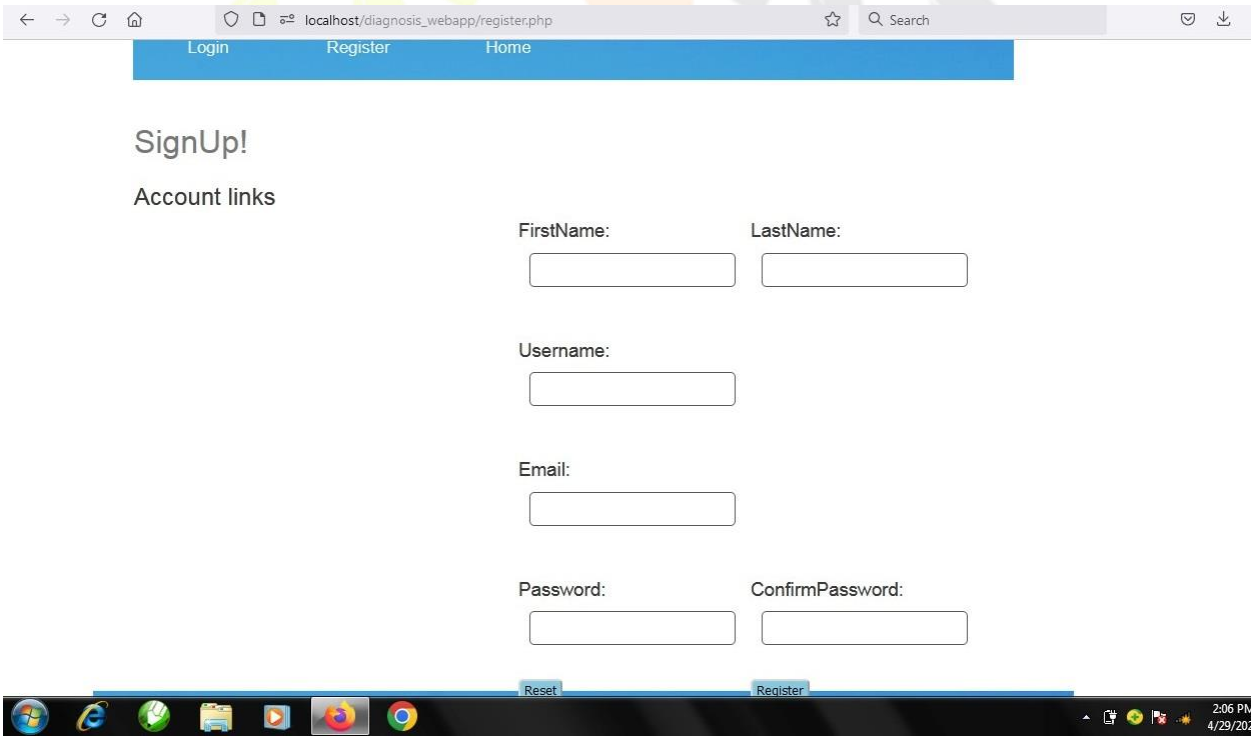

Figure 4.1 Admin Registration Form

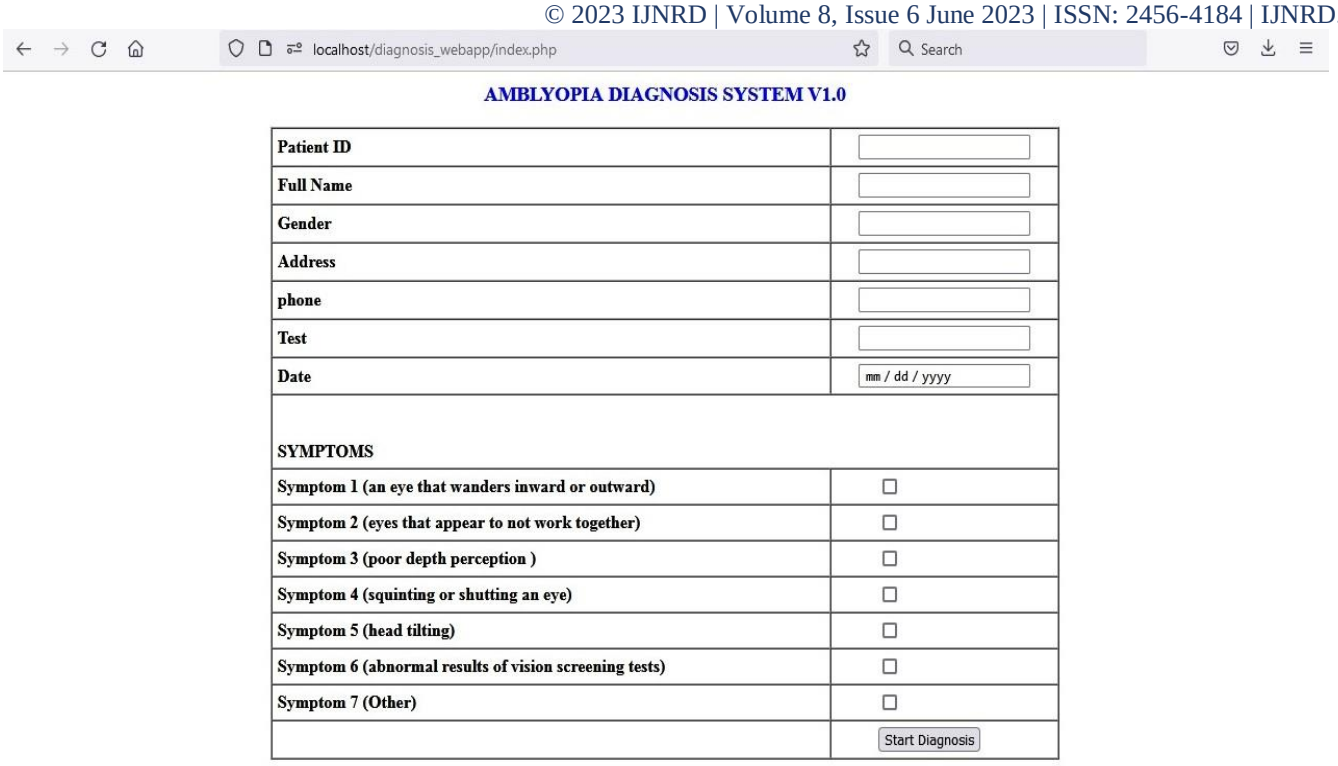

Figure 4.2 Patients Registration and Diagnosis Form

4.4 Output Specification

The output design is based on the inputs. The report generated gives a meaningful report to the eye patients. The following are some of the output display.

Patients dashboard: the dashboard display information about the diseases by the patients.

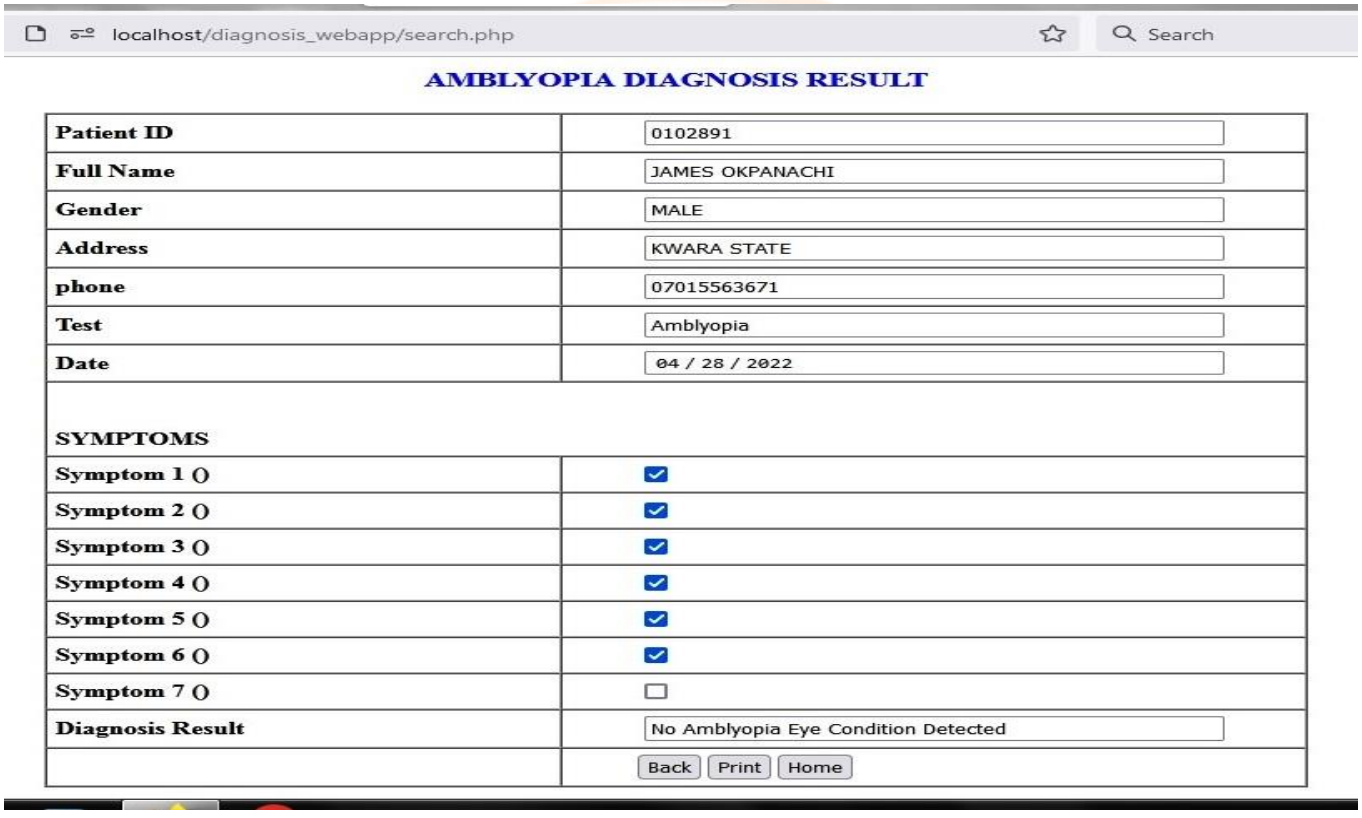

Figure 4.3 Patients Test Result

4.5 Database Design

Database design is the process of producing a detailed data model of a database it can also be seen in a layman term as the location where all data relating to the effective functionality of the program are stored. In designing a database, the first step is to outline entities. The various forms of information that are saved in the database are called ‘ entities’ and they exist in four kinds; human (persons), things, events, and locations. Everything you could want to put in a database fits into one of these categories. The following table illustrates the database design of this project work.

4.6 Data Collection

Table 4.1: Showing Allocated office space

S/N	Column Name	Data Type
1	Space No. (Number)	Int
2	Space Unit (Number)	Varchar (30)
3	Employee ID (Number)	Varchar (30)
4	Employee Name (Text)	Varchar (50)

Table 4.2: Showing Available office space

S/N	Column Name	Data Type
1	Space No. (Number)	Int
2	Space Unit (Number)	Varchar (30)
3	Space size (Number)	Varchar (30)

Table 4.3: Showing office space request

S/N	Column Name	Data Type
1	Patient ID (Number)	Int
2	Patient Name (Text)	Varchar (50)
3	Gender	Varchar (30)
4	Patient Address	Text
5	Phone number	Varchar (50)
10	Test	Varchar (30)
11	Date	Varchar (30)

Table 4.4: Showing Staff Record

S/N	Column Name	Data Type
1	Employee ID (Number)	Int
2	Employee Name (Text)	Varchar (50)
3	Employee Unit (Number)	Varchar (30)
4	Gender	Varchar (30)
5	Email	Varchar (50)
6	Qualification	Varchar (20)
7	Nationality	Varchar (20)
8	State	Varchar (20)
9	Phone number	Varchar (20)
10	Address	Text
11	Date	Varchar (50)
12	Space Allocation	Varchar (50)

Table 4.5 Showing database of users

S/N	Column Name	Data Type
1	Name (Text)	Varchar (50)
2	Email	Varchar (50)
3	Password	Varchar (20)

4.7 Database Specification

If information must be stored, then there is obviously a need for database (a collection of data or files that kept in sequential and in secured order for reference purpose).

The database was designed with MYSQL.

The database contains information of the entities of the patients diagnosing system. It organizes and manages the information to obtain the report required to support the application relational database where a common field related to different tables of data to each other.

Programming Language Platform

The new system was implemented using PHP 6.0 programming language. This is because the programming language has the following advantages to developers:

i. Speed: it is a fast in loading website

ii. Ease of use: it is easy to use PHP to program, even for individuals who are new to programming can easily pick up the programming language and learn to use them within a short while.

iii. Stable: a lot of bugs have been discovered for over 22years and the bugs have been fixed quickly by the team of developers. Which make the programming language very stable.

iv. Strong Library Support: another advantage in using the PHP hypertext preprocessor is the use of modules that are functional. We do not have to start to develop the modules from the scratch as they have already been created.

v. Cross-Platform: PHP is an application that can be burn on several platforms. The importance of this is that you do not have to worry about the operating system the user is using, as you will be rest assured that the code will still run properly and smoothly.

vi. Open Source: The programming language is been created and developed by a huge number of PHP developers. The implication is that there is a lot of extension library as well, support community creation.

vii. It produces a user friendly graphic user interface.

Software Specification

Minimum of the following operating system

i. Microsoft Windows XP Home and professional Edition (Professional Service Pack 2,3)

ii. PHP 4.5

iii. MYSQL 3.0

iv. Apache 2.2

v. XAMPP 5.5.3 or higher.

5. Conclusion

The work described in this paper looked at how an expert system is used to diagnose eye disease called Amblyopia. The work was successfully developed using PHP programming language, a user-friendly programming language, and the package was tested and improved upon which yielded an eye diagnosing system on Amblyopia.

The application of expert systems in medicine is very interesting and has created considerable importance systems of diagnosis which goes a long way to make Hospital work effective. An attempt to accomplish this work has taken care of the delay in consulting eye diagnosis on amblyopia from the human expert. The proposed system can help doctors and patients in providing decision support system, interactive training tool and expert advice. The system constitutes part of intelligent system of diagnosis of eye disease called Amblyopia. The article presented an expert system for medical cases. This expert system provides greater diagnostic accuracy. It is a potential tool to diagnose the eye problems, if those are detected at earlier period, the patient can be saved from impairment.

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