Visionary: A Web Application for Eye Health andIllness Detection

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Abstract:-In an era of ubiquitous digital device usage, ignorance of self-health has caused the prevalence of eye-related health problems, affecting billions worldwide. Addressing this growing concern, this paper introduces "Visionary", a comprehensive web application designed for eye related illness detection combined with tools to manage an individual's eye health. Encompassing early detection of eye diseases and personalized recommendations, Visionary offers a solid eye health management solution. Innovative features of Visionary include a symptom guide, a personal health journal, and an eye health blog. Furthermore, Visionary has the unique capability to detect several common vision problems using a set of tests and provides users with a risk analysis report with tailored recommendations. Trial runs on a selected set of diverse user groups revealed the effectiveness of Visionary with successful vision problem detection and high accuracy during testing. In conclusion, Visionary emerges as a pivotal solution, bridging the gap in eye health management and eye related illness detection.

Keywords: *vision, management, astigmatism, acuity*

1. Introduction

As a result of the rapid digitalization of the modern world, humans are deeply entrenched in the habitual use of digital devices. Most individuals currently suffer from an increase in eye illnesses because of these behavioral tendencies. According to the World Health Organization (WHO), At least 2.2 billion individuals worldwide currently suffer from some form of visual impairment, at least 1 billion of which might have been avoided or are still unaddressed. Despite the spread of digital eye strain and the increasing prevalence of eye diseases, existing eye health management solutions are fragmented and lack comprehensive integration. There is an urgent need for a unified and customized vision health management system that can effectively alleviate digital eye strain, enable early detection of eye diseases, and provide personalized recommendations to users.

This research addresses a critical gap in modern healthcare by adopting a holistic visual healthcare management solution that meets the changing needs of people in the digital age. The practical importance of this research is that it can improve quality of life by reducing digital eye strain, enabling early intervention, and promoting informed decision-making about eye health. The theoretical significance of this study contributes to the growing field of digital health applications and emphasizes the importance of personalized recommendations and proactive management.

This research is driven by two main goals: first, to create a comprehensive website for holistic eye health management that addresses the challenges of digital eye strain and broader eye wellness. Secondly, to thoroughly evaluate the application's effectiveness and user satisfaction, paying particular attention to the ground-breaking features like the innovative eye test and risk analysis functionality. Implementing this web application will lead to increased user awareness of their eye health concerns and be able to provide personalized recommendations according to the test results to enhance user satisfaction and maintain their eye health in the best possible condition.

The study mainly concentrates on the following objectives:

- Develop a comprehensive web application.
- Enable early detection of eye diseases.
- Provide personalized recommendations.
- Increase user awareness about their eye health.
- Assess effectiveness and user satisfaction.
- Contribute to the digital health field by developing a holistic eye health management system.

The subsequent sections of this paper are structured as follows. The literature review contextualizes the research from the perspective of earlier studies on this eye management system. The methodology part addresses the development of the eye health management system and describes the assessment process in depth, including the experiment trials and case studies according to the research. The final outcomes and findings are presented in the results section, while the discussion section describes the results' interpretation and consequences as well as the difficulties this research project faced. The research concludes with a concise summary of its key contributions and outlines potential paths for future research in the domain of eye health management.

2. Literature Review

The following section contains an overview of existing research and applications that were referred to enhance the functionality and user experience of the web application addressed in this paper. The accuracy of the application scope was improved via the usage and influence of these resources. Furthermore, this section mainly focuses on the contributions of relevant research papers and articles that have both inspired and guided this project. Additionally, it explores broader studies that addressed the challenges associated with eye health management in the digital age.

The article “Work-Related Eye Injuries and Illnesses” provides a comprehensive insight into the correct protocols for conducting eye examinations and it also outlines a range of potential injuries and illnesses identifiable through those examinations [1]. Notably, the contribution of this article extends to enclose a diverse range of diagnostic approaches for illnesses which includes corneal abrasions, foreign body intrusion, blunt traumas, and chemical burns [1].

The research paper titled "Digital Eye Strain: Prevalence, Measurement, and Amelioration" investigates a prevalent optic illness named digital eye strain (DES), which is common among individuals who are extensively engaged with digital screens as a part of their daily routine [2]. Notably, this paper introduces an innovative approach to the detection of DES in individuals, including the utilization of questionnaires and objective assessments based on parameters like critical flicker-fusion frequency [2]. The insights gained from these techniques assisted in developing approaches to the detection mechanisms of the project.

A study titled “A Mobile-Based Application for Cataract and Conjunctivitis Detection” addresses the growing issue of optic health amidst other healthcare priorities [3]. This research introduces “Eye Plus” which is a mobile application that provides users the ability to perform self-administered eye tests, particularly targeting prevalent conditions like Cataracts and Conjunctivitis. This autonomous and accessible testing method addresses the lack of medical resources in rural areas. Notably, the application has a success rate of 83.3% and a potential impact on early detection of the illness. This study [3] provides a tangible example of leveraging technology to enhance eye health awareness and accessible diagnosis.

. “The Vision Problem Tester” is another mobile application for vision impairment detection and awareness, which significantly influenced this project’s inception [4]. It addresses the concerns of visual impairments by introducing “Vision Problem Tester”, a mobile application that facilitates accurate vision problem detection in addition to functionalities such as symptom checkers, an eye care professional locator, and different activities for children. Whilst being endorsed by ophthalmologists, this application successfully tackles accessibility and awareness as well as proving the effectiveness regarding optic illness detection. This study's focus on enhancing vision health awareness aligns closely with the project's goals, offering a powerful model for technology-driven solutions in improving eye care accessibility and early detection [4].

"The Vision Guard" is another mobile application that allows users to identify their vision-related issues with minimal time and effort [5]. Additionally, this application also provides a piece of good knowledge about vision problems, causes and cures, and eye exercises to overcome vision problems to maintain a healthy vision. This application is also tested and recommended by ophthalmologists. It also has been tested with 30 odd eye patients and has been able to detect vision problems up to an impressive level with higher accuracy.

3. Methodology

The project is implemented following a function-oriented approach. Frontend is developed using the react framework while the backend is built using the node JS and express JS to create the server. For the database, Mongo DB is utilized. The final version of the application is deployed as a web application which also consists of responsiveness to mobile devices.

The proposed system 'Visionary' has the capability for testing and giving user feedback for eye-related diseases such as visual acuity, color blindness, astigmatism, depth perception, and some other eye-related health conditions. Moreover, it calculates the risk factor of whether a user is exposed to eye-related health conditions based on the answers of the user. Users can experience personalized recommendations. The list of available functionalities of the proposed application is as follows:

A. A Symptom Guide

The app consists of a feature that allows users to input their symptoms in the search bar and if a symptom matches a known eye-related illness, suitable search results will be displayed. Diseases are stored in the database using data schema. A backend feature is used to add diseases to the database. All data will be fetched to the application when the application starts. When a user searches for a specific symptom, the system will execute a front-end search by iterating through the data fetched.

B. Personal Health Journal

This application allows users to create and maintain a personal health record journal where they can record their daily eye health care records such as eye care information, including obversions and dates, symptoms, medications, and other eye health-related notes. Mongoose is used to create the schema which represents a single journal record in the database. Along with the user ID, all the details will be sent to the backend by Axios when the user creates a journal entry. This user ID will also be used to display each user only their journal entries.

C. Educational Content Column

This section provides educational content to users which are related to eye health care. Through this feature, users can get advice on a range of eye care topics which will help users to recognize symptoms earlier and help to take proactive steps to maintain their eye health. A mongoose schema is created to represent each educational content object. By sending a post request using Axios from the front end, this object can be added to the system database. Read, update, and delete features can be performed on these objects as well by sending requests to relevant endpoints.

D. Eye Health Blog

The app has a section called "Eye Health Blog" that helps to take better care of the user's eyes. It provides users with information on different kinds of news, inventions, cures, practical tips, and exercises to maintain proper eye health. A single blog in the database is represented by the Mongoose schema. When the user accesses the blog section, the available blogs will be fetched to the front end using the use effect hook of the React framework. Read, update, and delete features can be performed on these objects as well by sending requests to relevant endpoints.

*E. **Eye Test and Risk Analysis***

This function covers the unique aspect of this project. The proposed function “Eye Test and Risk Analysis” includes several vision testing programs. Mainly this application aims to detect eye-related diseases like visual acuity, color blindness, astigmatism, and depth perception by using several eye-testing methods. In order to get accurate results, this application prompts the user with a specific set of questions and tasks. After a user faces these questions and tasks regarding the answers they provide, the system provides a summarized overview of their eye health and potential illness risks.

Apart from that, this application has the capability to give users a personalized recommendation based on their test results. The system automatically creates these recommendations by analyzing each test result and making the most suitable recommendations for that user. These recommendations can include eye exercises, tips for reducing digital eye strain, and suggestions for lifestyle changes. As a result of these recommendations, users can maintain their eye health in good condition.

Within this feature, the system also calculates the risk factor according to the user's results. It shows whether a user is exposed to any eye-related health conditions or not. Fig. 1 shows the proposed function “Eye Test and Risk Analysis” procedure.

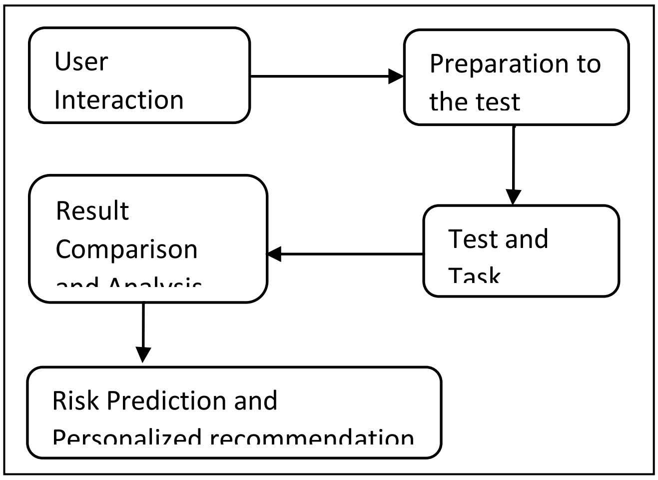

Fig. 1 The Proposed Procedure of the function.

A brief introduction to eye illness detection tasks that are included in the system are as follows:

1) ***Vision Acuity Test***

Visual acuity is the ability to detect small details. It measures how well a person sees. As a person, it is very important to check visual acuity frequently. As a result, this project contains a visual acuity checker. Users of this software can quickly assess their visual acuity.

Physically, an optician checks visual acuity by using numbers and letters of various sizes. This application “Visionary” uses a symbol similar to the letter “C” called Landolt C [6]. It consists of a ring that has a gap. Landolt C is a standardized symbol for vision testing. In this testing, users are given a Landolt C symbol, and they must recognize the gap and mark it on the corresponding ring. The program has several steps, and the Landolt C has become smaller. By using the answers provided by the user the system analyses the user’s visual acuity.

The following Fig. 2 shows the Landolt C symbol and Fig. 3. shows the difference between normal and low visual acuity.

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Fig. 2 The Landolt C Symbol [7]

Fig. 3 Difference of the Vision Acuity [8]

For this project, the vision acuity test is based on the Landolt-C chart. According to the standard, this test is done by using 20 feet. This chart contains several lines. If the patient can correctly identify the correct notations when it goes to lower levels it is considered as that person has good vision acuity.

Since “Visionary” is a web application, this vision acuity test needs to be conducted by using a computer. The test is opted for a 2 feet range and adjusts all the Landolt C symbols to accommodate that range. In Fig. 4 it shows the range and the adjustments of the symbol sizes

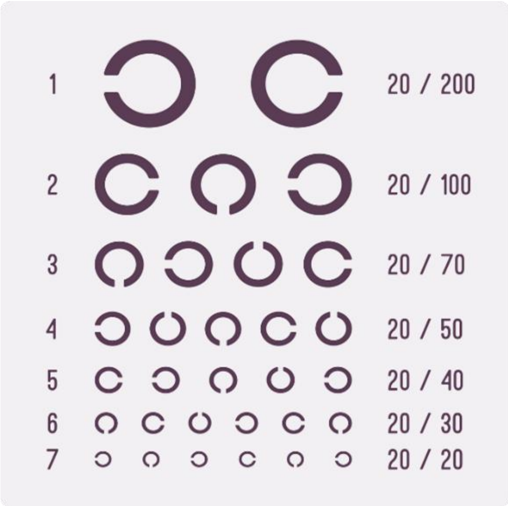

Fig. 4 Landolt C symbol sizes with range [9]

Before starting the test, the user receives user agreements and guidelines on how the test is going. When it comes to the test method, the user gets the Landolt C symbol which is divided into 8 parts. The user needs to select the correct missing part according to the rotated symbol displayed on the screen.

When a user selects a relevant part of the Landolt C symbol, it will record as a correct answer or else it will be recorded as a wrong within an array. It loops 8 times for each eye and a total of 16 rounds include in this vision acuity test. Each time the Landolt C symbol size reduced according to the Landolt C chart. Fig. 5 shows the user interface of the vision acuity test that is included in the proposed project.

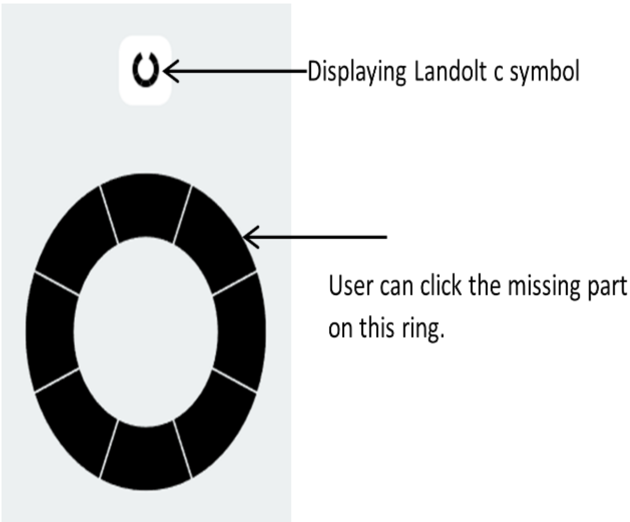

Fig. 5 Vision Acuity test UI

Once the test is done 8 times the user must switch the eyes because the user needs to cover one eye when he/she faces this test. Here it starts the test from the right eye. At the end of this test user can see the test results. To implement this test, the development team has used MERN stack, and React as the frontend framework and useful features.SVG images and CSS. Since the test has multiple phases and needs to track user answers, the "Redux Toolkit" is used within this test to accomplish this task. To make sure that every time the test goes to the next phase generates a random symbol, it uses Math.random() and Math.floor() built-in functions which come with JavaScript programming language.

*1) **Color Vision Test***

Color blindness can be considered one of the most common eye diseases in the present world [10]. Color vision is the ability to detect different colors and shapes. "Color blindness" is often used to describe color vision deficiencies. Having good color vision is and can affect many aspects of daily life, like education, exam results, and career choices.

This proposed project contains a test task to identify whether a user is affected by color blindness disease. In this system, the color vision check is based on the clinically trusted work of Dr. Shinobu Ishihara [11]. This test is called the “Ishihara test”. According to this test, normal people can identify and able to read the numbers on the color Ishihara plates, but people with color blindness cannot identify the numbers. With the help of this “Ishihara test”, the system can identify the users that have color blindness.

Fig. 6. shows the Ishihara plates and Fig. 7. shows the vision difference between a normal person and a color blindness person.

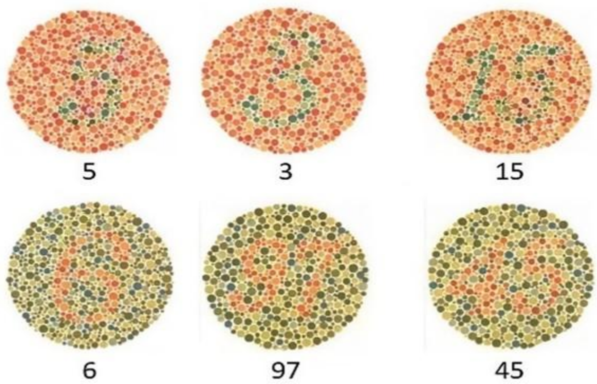

Fig. 6 The Ishihara Plates [12]

Fig. 7 Difference Between Color Vision [13]

Contrast Vision Test

The Contrast Vision test is another test that the user can do by using this “visionary” web application. As usual, this test is also implemented by using the Landolt C symbol. In order to pass this test, the user needs to identify the gap of the symbol and mark it correctly in the given ring. Step by step the contrast of the symbol is reduced, thus this test provides an initial indication of the contrast vision and helps to identify whether the user is having problems with their eye contrast vision.

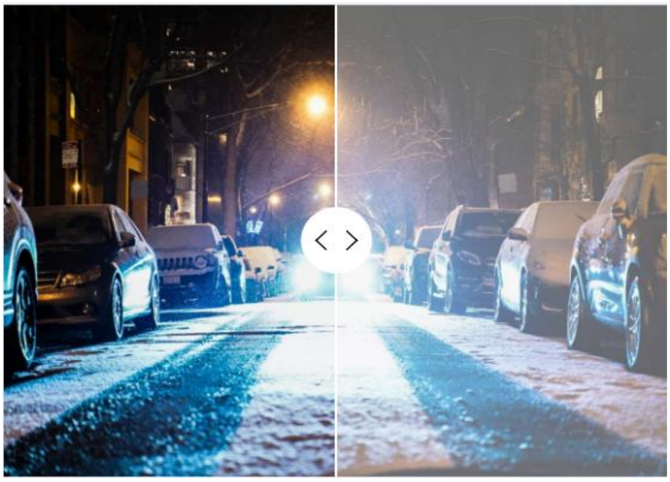

Fig. 8 Contrast Vision Difference [14]

The following Fig. 8 shows the different visions due to contrast vision issues.

As mentioned above, the Landolt C symbol is used to implement this test. The symbol prompts the user to identify and select the missing part of the ring. Within this test, the size of the symbol is fixed, instead of the contrast of the symbol by using a layer placed above the symbol. Each time the opacity of the layer changes by using the CSS properties from 0 to 1.

Rather than that, this test uses the same implementation techniques that are used to implement the vision acuity test. When the test is over all the results are sent to the database and make necessary precautions based on the user's results.

2) ***Astigmatism test***

The Astigmatism test is another test that can be seen in this proposed web application. Astigmatism is an imperfection in the curvature of the eye cornea or lens [15]. Through this, it provides a semicircle with black lines designed to appear in different shades of gray and provides questions to identify whether they can see any shades of gray or not.

Fig. 9 shows the semicircle with black lines designed to appear in different shades of gray and Fig. 10 shows the

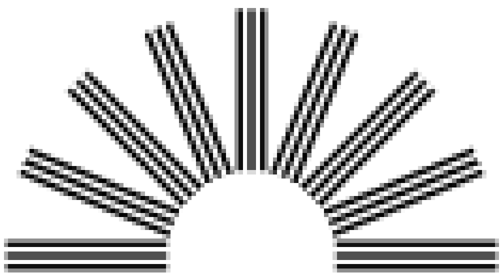

Fig. 9 Semicircle with black lines

difference between normal vision and vision with astigmatism.

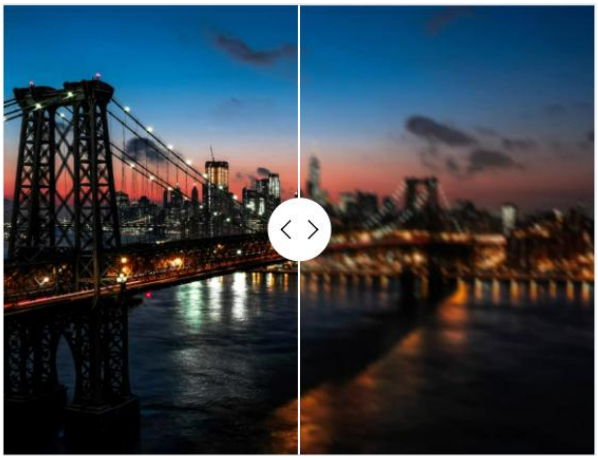

Fig. 10 Normal (Healthy) vision vs. vision with Astigmatism [16]

3) ***Field Vision Test***

Field Vision test, which can identify visual field issues, is also included in this web application “Visionary”. For the test, the system uses “Amsler Grid” [17]. It provides a grid similar to a structure with a central fixation dot and it was designed by using the Amsler test, which is used clinically to identify the vision field issues. By adding this test, users can easily recognize whether they are suffering from issues related to the field vision.

The following Fig. 11 shows the Amsler Grid and Fig. 12 shows the normal vision vs. vision with visual field defect.

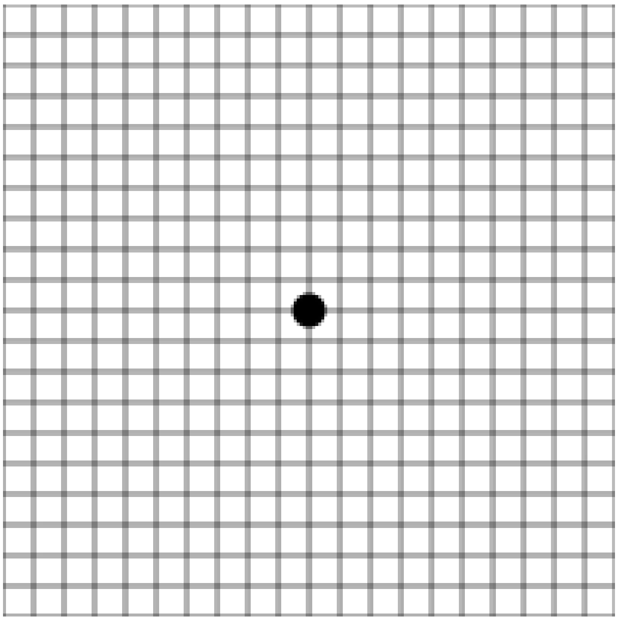

Fig. 11The Amsler Grid [18]

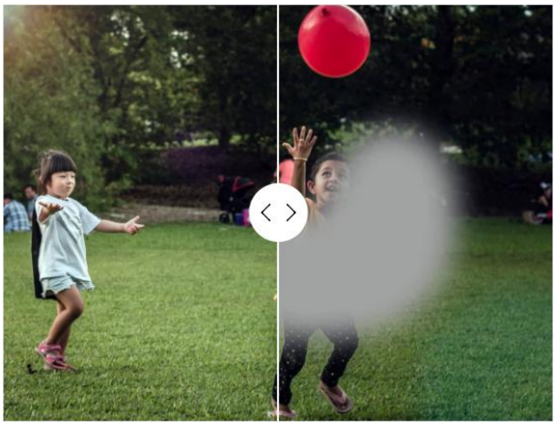

Fig. 12 Normal (Healthy) Vision vs. Vision with Visual Field Defect [19]

As mentioned above, for this test "Amsler Grid" method has been used by the development team. Withing this test, the user be able to see this Amsler grid for some time. After that, the user needs to provide answers according to what they experience within that time. Based on their experience this test helps to identify what disease their early symptoms may lead them to. Fig. 13 shows some experiences that can be experienced by patients when they are doing this test.

4. Results and Discussions

The proposed system is a web-based application that can detect eye-related illnesses and help users manage their eye health. The application includes a symptom guide, which can be used to find eye disease by providing the symptoms, an educational content column to educate users about various eye-related diseases, a personal health journal to record their previous health records, and an eye health blog to keep users updated with latest eye

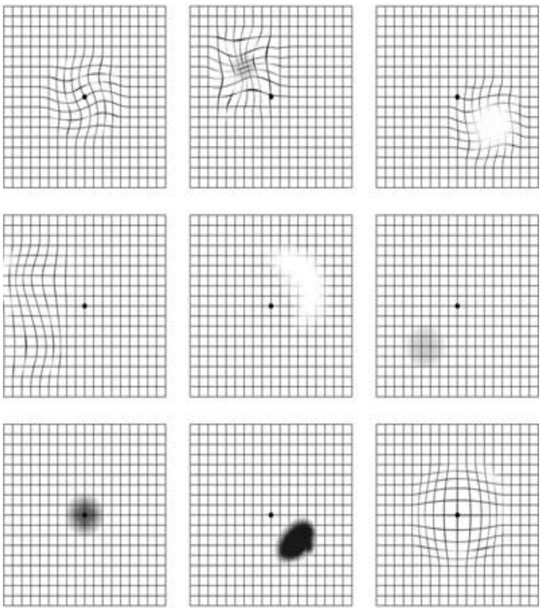

Fig. 13 Some experiences of the patients when they faced the test [20]

health-related news, diseases, cures, inventions, and tips to maintain good eye health.

The “Visionary” can detect five vision problems: Vision Acuity, Contrast Sensitivity, Color blindness, astigmatism, and field vision. All these tests are implemented by using the standard methodologies that are used in the real world. Users can diagnose their vision problems at an early stage by using the web application “visionary”. As a result, users can be treated quickly for their illnesses before it comes to a crucial stage.

Additionally, this application provides a risk analysis report according to the user's test results. Furthermore, this report includes a set of personal recommendations suggested by the application.

At present, this application has been tested with multiple individuals including eye patients and those without eye-related issues. Thus far, this application “Visionary” has been able to detect vision problems successfully at an impressive level while maintaining a high accuracy.

5. Conclusion

This research article presents the development of the eye illness detection web application called “Visionary”, an ideal solution web application for all individuals, that maintains their eye health in good condition. Researchers proposed a web application including, a symptom guide known as “Symptomology Atlas” which helps to identify eye diseases, a personal health journal that users can save their records and status, an educational content column to provide valuable information related to eye care management and section to provide eye care tips and eye-related exercises for the users.

As a special functionality, the proposed system includes a series of eye tests which are implemented by using real-world eye testing techniques. This function includes a vision acuity test, color vision test, contrast vision test, astigmatism test, and field vision test. The users can check their vision by using the aforementioned tests and can identify whether they have an issue related to eye health.

As the final output, the system can provide personalized recommendations and a risk analysis report generated by analyzing the results that users get from the above-mentioned tests.

Compared to other applications available now on the market, this web application is able to provide users with several benefits over other existing applications. The individuals who use this web application “Visionary” can gain a lot of knowledge and can healthily maintain their eye health condition by using the tests provided by the system. Thus, they can finally consult a doctor if the test results are negative.

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