THE VISION GUARD

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ABSTRACT

The Vision Guard is an idea to help people detect most of their vision impairments accurately without consulting a doctor. With the busy day to life style, now a day's most of the people do not get much time to focus on their health issues specially issues related to the five senses. It has been found out that about 180 million people of the world population is suffering from vision problems. Inability to detect the vision problems at an early stage has been the main reason for such large number of population to suffer from vision impairments. This paper proposes a mobile application which allows people to identify their vision related issues absolutely free with a minimal amount of effort and time. In addition to detecting vision problems, the application also provides a good knowledge about vision problems, causes and cures, and eye exercises to overcome vision problems and to maintain a healthy vision. Vision Guard is available in one of the most commonly used global languages: English. The proposed application has been tested and recommended by ophthalmologists. At present it has been tested with 30 odd eye patients and has been able to detect the vision problems up to an impressive level with a higher accuracy.

Keywords—vision; mobile; vision testing; android application

INTRODUCTION

The human eye is a fragile organ, which must be treated with care since the human vision is the most important sense out of the five senses [8]. The mass usage of technology such as computers, laptops, tablets, mobile phones and televisions in work places and houses will work as a catalyst to invoke eye diseases significantly. Not only adults, even some infants and small children suffer from eye diseases due to various reasons. In both cases, the vision problems should be identified in their early stages in order to medically treat them. Otherwise, it may worsen the vision of the eye and eventually cause total blindness. But, with the busy life style of the modern men and women, time has become a limiting factor for the well-being of a person. People often make the mistake of caring less about the issues related to their eyes. Also, due to the busy life style of parents, neediness to keep track of children's vision health is mostly neglected by the most parents. This will lead to serious vision problems in the future. In addition to that, due to high costs associated with vision tests, people try to skip periodic vision checkups, which is a must-do to maintain a healthy vision. Also, the lack of knowledge about vision problems among people will lead to a large population of visually impaired people. According to [7] 180 million people of the world population are suffering from vision problems. The Vision Guard is a fully functional mobile phone application developed to overcome the above-mentioned problems regarding vision health. It mainly focuses on identifying vision problems at their early stages conveniently without

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the need to spend money or time for travelling. As a result, any person can test their vision using this application without having to meet a doctor periodically. It also provides interesting games for kids below 8 years old that will help to detect whether they are suffering from any vision problems. Finally, it will provide a good knowledge about vision problems, causes and cures while providing eye exercises to overcome vision problems and to maintain a healthy vision. Any person in any part of the world will have the ability to use this application as it will be available in one of the most commonly used global languages - English.

LITERATURE REVIEW

There are limited number of mobile applications that are available for personal use. Most of the applications available gives inaccurate results and supply very little useful features. Also these few available applications only detect limited vision problems. The following five literature reviews attempt to demonstrate and support this hypothesis.

One of the main vision applications available in the market is Vision Test and it provides four main features which are eye tests, quiz, optician finder and eye advice. The main benefit of this mobile application is that it has considerable number of features apart from eye tests. But when consider the availability of the eye tests it only provides tests for four vision problems. In optician finder it doesn't give accurate results. The main disadvantage in this application is the lack of features and the targeted users being limited to adults only. As a result the amount of users who can benefit from this application is limited.

Healthy Vision is another popular vision application available. In this application it supplies three main features which are eye exercises, eye tests and questions and answers about few vision problems. One of the main benefits of this application when compared with other available applications is effective eye exercises that can be used for both adults and children. But one main downside is that the eye tests provided by this application is largely inefficient. It only provides images of impaired vision for each vision problem whereas if the user was suffering from a certain vision impairment he/she will not be able to recognize which vision impairment they are suffering from the images provided by the application.

ICARE Vision Test is another vision mobile application that is available in the market which provides vision tests and information regarding very few vision problems. Even though this application provides six vision tests, the user friendliness of ICARE Vision Test is very poor. In ICARE also the main issue is the lack of features such as eye exercises. Also the target users of this application is limited to adults only.

Another vision application revealed by the literature review is B2 Eye Test. This application provides vision tests, a survey and a quiz. The main disadvantage of this application is the user friendliness of considered vision tests and lack of features.

When consider about similar vision applications Vision Check Up is an additional vision application where we can find in the market. In Vision Check Up it provides user three different vision tests which are distance vision, near vision and color vision. Similarly to other above mentioned applications Vision Check Up also lacks the user friendliness which is must have in order to produce a quality application to the user.

All five mobile vision applications mentioned under literature review are limited to English language. Therefore the usefulness of these applications to large number of local citizens of Sri Lanka is very low.

Table 1 shows a comparison of the features between the existing applications and the Vision Guard.

TABLE 1. COMPARISON OF THE FEATURES BETWEEN THE EXISTING APPLICATIONS AND VISION TESTER

Features \ Apps	Vision Guard	Healthy Vision	Central Vision	ICare	Vision Test	Vision Check Up	B2 Eye Test
Tests for Hyperopia	✓			✓	✓	✓	✓
Tests for Astigmatism	✓			✓	✓		
Tests for Color Blindness	✓			✓	✓	✓	✓
Tests for Depth Perception	✓						
Tests for Macular Degeneration	✓	✓	✓	✓			✓
Tests for Contrast Sensitivity	✓	✓		✓			
Tests for Strabismus	✓						
Kids games for Contrast Sensitivity	✓						
Kids training game for Strabismus	✓						
Symptom Checker	✓						
Nearest doctor and optician finder	✓				✓		
Quiz related the health of the eye	✓						✓

METHODOLOGY

The Vision Guard is categorized into two main parts.

As the main category it provides the capability of identifying seven vision problems. It also includes training exercise for some of these vision problems which are recommended by ophthalmologists.

As the other category this application provides some useful additional features for the users to make this application more beneficial for them.

Following is the description of the aforementioned features of this application.

A. *Macular Degeneration*

Macular Degeneration is one of the most common eye disorders that ultimately causes vision loss mostly of people over age sixty. This condition occurs due to the deterioration of the central portion of the retina, which is known as the macula.

A person with early stage of macular degeneration has an impaired and blurred vision. A person with mature stage of macular degeneration has blind spots in the center of his vision field.

Fig. 1. Stages of Macular Degeneration Vision

In Vision Guard, Amsler grid test is used to provide initial testing on macular degeneration. Using the feedback of the user for questions based on Amsler grid, application determines the macular degeneration status of the user.

B. *Depth Perception*

Depth Perception is the visual ability to see in three dimensions. A person with depth perception problems cannot see the world in three dimensions which causes the inability to recognize the distance among objects. At present depth perception problems are recognized as a frequent vision problem among people, which is highly disturbing a person's life.

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Fig. 2. Depth Perception

There are two levels provided in this application on testing for depth perception conditions of adults. As the first level, there is a simple interface and set of activities for the user. Once the user has followed these activities there are questions asked from the user to determine the depth perception status of the user. This is the basic test for depth perception testing in Vision Guard. As the advanced test there are three dimensional images displayed for the user. Seeing these images with the aid of a stereo glass users has to provide the feedback for the application and based on this feedback application detects whether the user has a depth perception condition.

In addition to detect depth perception condition of the children, there is a game with three dimensional images included in Vison Guard. Once a child perform this game with the aid of a stereo glass, based on the result application will predict the depth perception condition of the child.

C. *Strabismus*

Strabismus is a visual condition which declines to align both eyes together in focusing on an object. The eye which does not align properly when focusing is known as the lazy eye. This is a common vision problem among children which should be detected before age of eight years in order to cure using exercises to the fovea of the lazy eye.

Fig. 3. Healthy eyes and Strabismus

Strabismus is a condition that can be cured without complex medical treatments only if it is recognized before age of eight years. Therefore this application provides a simple test using the flashlight of the phone and camera preview to detect strabismus condition of a child. User should capture an image of child's eyes which clearly display the flashlight reflection on each eye. Once a proper image is captured, from the list provided user has to select the similar image. This test should be performed by the user according to the instructions provided. Based on the image

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selected by the user on how child's eyes perform on the test, application will predict the strabismus condition of the child.

D. *Visual Acuity*

Hyperopia or Farsightedness is a condition in which distant object can be seeing clearly, but near objects are unclear and blurred. This is a common vision problem among elders.

Fig. 4. Vision of a person with Hyperopia

In order to determine the visual acuity of the user, this application provides a simple test which is based on a standard testing for visual acuity. Once user perform this test, application will provide a threshold value of user's visual acuity. This application also provides an interesting game for children to detect the visual acuity condition.

E. *Color Blindness*

Color Blindness is a genetic condition that causes the inability to see a certain range of colors in the color spectrum. A person with color blindness has trouble seeing primary colors or mixture of primary colors.

Fig. 5. Vision of a person with Color Blindness

This application uses Ishihara test to detect color blindness status of the user. There are set of Ishihara testing plates displayed and user and has to identify the number displayed in each plate. Based on how the user perform this test, application will determine the color blindness status of the user. It is recognized that Ishihara test provides a standard measure of color blindness.

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F. Astigmatisms

Astigmatism is caused by deviations from spherical curvature. This condition causes distorted images due to the inability focusing light rays to a common point.

Fig. 6. Correct vision and Astigmatism vision

In Vision Guard, Astigmatism of the user is detected using standard charts or dials. Once user observe these charts, application will request for user feedback on how he or she saw the lines in these charts. Based on the user feedback application determines whether the user is having Astigmatism condition.

G. Contrast Sensitivity

Contrast Sensitivity is the measure of how a person's eye is sensitive to the contrast between objects and their background. It is difficult for a person with poor contrast sensitivity to separate objects from its background which has a low contrasting effect.
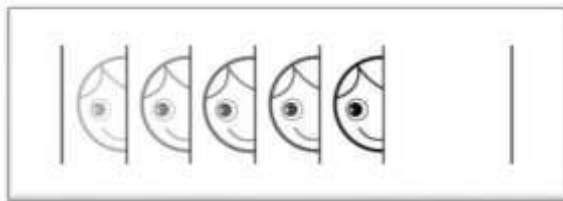

Fig. 7. Different levels of Contrast

This application detects contrast sensitivity of user by using images with different contrast levels. User has to observe these images and select the similar image from this list provided. Based on how the test is performed, application will provide a description and a chart which describes contrast sensitivity condition of the user.

In addition, to detect contrast sensitivity of children there is an interesting game with images of different contrast levels provided in Vision Guard application.

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This application also includes:

A. *Symptom Checker*

The application provides a list of symptoms to be selected by the user. The application will then provide the defect or eye disease the user might be suffering from according to the symptoms selected by the user. This feature will help to detect other vision problems in the eye apart from the main defects that were identified from the tests included in the application. Therefore, this application will be a complete eye care system for the user.

B. *Vision Improving Exercises*

To improve the vision of users and to cure some of the aforementioned vision problems there are some eye training exercises provided in this application. Each of these exercises are recommended by ophthalmologists in order to improve a person's vision. There are set of instructions provided for the user to follow these exercises. In addition to the regular exercise this application includes a lazy eye training game for children with strabismus. This game is also supervised and recommended by ophthalmologists to improve the vision of the lazy eye in order to cure the strabismus of a child.

C. *Magnifying glass*

This application provides the facility to magnify reading content which improves the readability of the content.

Any person from anywhere in the world will be use this application as it will be available in one of the most commonly used global languages: English.

D. *Nearest doctor and optician finder*

Finding the nearest opticians and doctors basing on the location of the user is included with the software. Using the GPS, the system will track the user's current location, and based on that it will display nearest opticians and hospitals. Once the user selects a hospital, it will display the available ophthalmologists in those hospitals along with their consulting dates and time.

RESULTS AND DISCUSSION

The proposed application is able to accurately detect six vision problems: Astigmatism, Hyperopia, Color Blindness, Depth Perception, Macular Degeneration, and Contrast Sensitivity. Using standard methodologies and technologies. It also includes training exercise for some of these vision problems which are recommended by ophthalmologists. It allows users to diagnose their vision problems at an early stage so that they can be treated quickly before becoming critical. It also provides attractive games for kids for easy detection of their vision problems.

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In addition, Vision Guard also provides the facility to find the most suitable doctor or optician nearby. It displays the names of the nearby specialized doctors relevant to a particular vision problem along with the location of the hospital or clinic and will also provide the specific times that a doctor is available in a given hospital.

The Symptom Checker provides a list of symptoms to be selected by the user and the application provides the defect or eye disease with details user might be having according to the symptoms.

The proposed application is unable to detect myopia because it is not possible keep the phone in a larger distance in order to take the tests. Also it is unable to detect convergence insufficiency. In order to detect convergence insufficiency both the pupils of the user should be detected within a short distance of 6 cm by the phone camera which is practically impossible.

The Vision Guard has been tested and recommended by ophthalmologists. At present the application has been tested with 30 odd eye patients and has been able to detect the vision problems up to an impressive level with a higher accuracy..

CONCLUSION

For people to maintain their healthy vision a mobile based vision testing applications are very beneficial since they can easily save money and time spent for vision tests regularly. This application provides many useful features such as vision tests for adults, vision games for kids, doctor and optician finder and availability in three languages. Even though there are existing vision applications most of them fail to deliver a useful application like the Vision Guard. By using this mobile application the user can stay updated with his/her vision status. For future improvements of Vision Guard mobile application can be implemented with additional vision tests which are not currently included.

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