OPTICAL DIFFERENTIAL DIAGNOSIS PROCESS USING IMAGE ANALYSIS

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A.P

B.E

R.M.B

TABLE OF CONTENTS

LIST OF FIGURES

ARTICLE 1:

Optical Differential Diagnosis Process using Image Analysis

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***Abstract*— The human eye is a crucial component of our visual system, and regular eye exams are essential for maintaining good eye health. However, these exams can be time-consuming and expensive, mainly when performed by an ophthalmologist. A study proposes the development of an improved eye examination device that utilizes image processing and analysis technology to address this issue. The device employs the optical differential diagnosis process to provide a faster and more accurate evaluation of five commonly known eye diseases and assess healthy eyes. During the exam, the device takes and analyzes images to detect the presence of any disease or abnormalities, which reduces the time required to deliver results and provides a more convenient and cost-effective way to monitor and maintain eye health. After conducting several tests, the researchers found that the eye examination device had an overall accuracy of 92.49%.**

Keywords*—Differential Diagnosis, Eyes, Diseases, TensorFlow, Image Analysis.

I. Introduction

The eyes are the most exposed yet fragile part of our body, and their importance is priceless. However, getting an optical check-up can be expensive and time-consuming, as it typically requires the expertise of professional doctors or exceptional optic nurses to perform the initial check-up or differential diagnosis. The proposed system aims to mimic the proper and ethical procedure of optical differential diagnosis performed by ophthalmologists and optic nurses.

In recent years, experts have suggested new techniques for image analysis based on artificial intelligence (AI). These techniques can overcome the shortcomings of the traditional methods used in industrial vision systems [1]. Deep learning algorithms have revolutionized the way computers process and interpret data. These algorithms can learn and improve independently by analyzing vast amounts of information, often surpassing human capabilities in various tasks. As a result of these advancements, fields such as image and speech recognition, natural language processing, and drug discovery have made significant progress [2] [3].

Several deep-learning algorithms have shown great promise in the field of medical imaging. Experts have designed these algorithms to analyze medical images, such as retinal images, and accurately classify or detect various disease conditions. With their high sensitivity and specificity, these algorithms have the potential to greatly improve the speed and accuracy of medical diagnosis significantly, leading to better patient outcomes [4] [5] [6].

Neural networks each have unique strengths for algorithmic approaches. TensorFlow, a popular library for machine learning and image analysis, includes various neural networks and commonly employs Convolutional Neural Networks (CNNs). While it requires minimal coding, TensorFlow relies heavily on large datasets for training. TensorFlow can provide a highly accurate output when appropriately used, surpassing a single neural network [7].

Three studies from the Philippines utilized image processing techniques to create a bimodal vein recognition system using a support vector machine [8]. The procedure uses two NoIR cameras connected to a multi-camera adapter mounted on a Raspberry Pi Model 3B+, which acquires images of the dorsal and palm veins exposed to infrared light. By using a support vector machine, the study was able to classify hand veins by 97.16%. Bumacod et al. conducted another survey on a digital goniometer that enables instantaneous measurement of the elbow and knee joint angles through pictures. The statistical analysis shows a 98.25% and 98.09% accuracy for the elbow and knee joints. Linsangan et al. [10] employed geometric analysis and (k-NN) to classify skin cancer in another investigation. The researchers looked at three types of skin lesions in their study: malignant melanoma, benign melanoma, and unknown. The functionality testing was 90% accurate due to the inquiry.

Neural networks can uncover critical details from massive amounts of data. In ophthalmology, the retina plays a crucial role in vision, and image processing technology can help detect retinal health [11]. Computer-aided diagnosis (CAD) systems provide precise, dependable, and efficient glaucoma diagnosis [12]. Recent advances in computational power capabilities have allowed the implementation of convolutional neural networks (CNN), facilitating autonomous classification of glaucoma based on complex features derived from thousands of available fundus images [13] [14]. By using neural networks to detect cataracts in the human eye, this study can aid in the early diagnosis of potential cataracts, which, if left untreated, may ultimately result in blindness [15].

Related to eye illness is jaundice. Modern technology also takes precautions against this illness and involves rehearsing the implementation of non-invasive detection for jaundice [16]. The accuracy of emergencies in a differential diagnosis is also high. A late-examined patient might already have a higher level of illness [17]. Diagnosing abnormalities in the eye are typically performed by ophthalmologists, specialists in identifying eye disorders and diseases, using sophisticated equipment. However, these devices can be prohibitively expensive and inaccessible in rural areas. This lack of resources can lead people to neglect eye disorders or attempt self-diagnosis, potentially exacerbating their condition. As such, there is a need for a cost-effective and easily accessible alternative that can be made available to those living in remote areas with limited medical knowledge [18].

In conclusion, this study is a big step toward getting this technology into clinical use. As future researchers focus on the final diagnosis, the conquest of differential diagnosis continues [19].

Based on research, the proponents of this study have found that optical differential diagnosis is expensive and time-demanding. This is because an ophthalmologist conducts the initial check-up with a professional license.

This research dramatically benefits optical medical institutions such as hospitals and clinics by lowering the cost of the initial check-up, resulting in a quicker process, and doing away with the necessity for an ophthalmologist during differential diagnosis.

This research aims to create a system that can determine the level or extent of various eye conditions such as keratitis, cataracts, uveitis, glaucoma, conjunctivitis, and eyes that are considered healthy. With the development of this system, the researchers aim to provide a more efficient and accurate method of assessing the seriousness of these eye conditions, thereby facilitating effective treatment and management.

This study's range of differential diagnoses only includes conditions including keratitis, cataracts, uveitis, glaucoma, conjunctivitis, and normal vision. Additionally, the external human eye is the sole subject of this investigation. Due to differential diagnosis requirements, the data will be presented in an aggregated manner.

II. Materials and Methods

Based on the literature reviewed for this study, a systematic application is being planned and constructed. The subject patient will be examined using the personalized slit lamp, and the computer will be able to view the patient's eye. Upon a specific command, the application will capture a clear image of the patient's eye and then undergo image analysis. The result will be an output indicating the probabilities of the patient's eye disease, following the standards of differential diagnosis.

A. Conceptual Framework

Fig. 1 provides a visual presentation of the processes involved in detecting eye disease using an image captured through a macro camera. The input to the system is the image processed using a combination of TensorFlow and OpenCV. TensorFlow delivers highly accurate results by leveraging its embedded neural network known as CNN, while OpenCV is employed to extract relevant features from the image. The system outputs a list of possible eye diseases with their corresponding accuracy rate. The framework clarifies how the system's input, processing, and output components relate to one another.

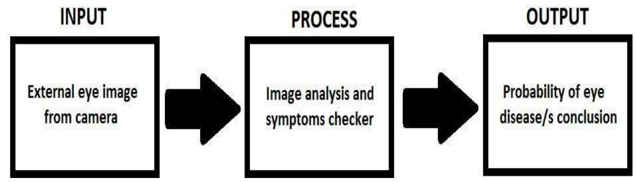


Fig. 1. Conceptual Framework

B. Software Resources

In this study, the software consists of an algorithm library of Google called TensorFlow. The core of this library now features an embedded neural network called CNN, which enables the library to perform advanced tasks such as image recognition and natural language processing with greater accuracy and efficiency. The resources implemented for computer vision will be OpenCV, a machine vision library.

C. Methods and Procedures

The algorithm and image analysis rely solely on software, computer vision, and other peripherals, such as the symptoms evaluator, to perform the necessary functions.

The software is composed of libraries, codes, and algorithms. Machine vision requires an OpenCV library, a standard library used to manifest camera captures and coding. TensorFlow's main library for machine learning provides many tools and functionalities for developing and deploying machine learning models. This powerful library will be able to give high-accuracy results with proper data sets. To implement the main algorithm for neural networks in this system, we will use CNN on top of TensorFlow and develop additional features, such as the symptoms evaluator, using Python code. The synchronized combination of each library, algorithm, and regulation will accomplish the needed functionality software-wise. Fig. 2 displays the block diagram of the CNN algorithm.

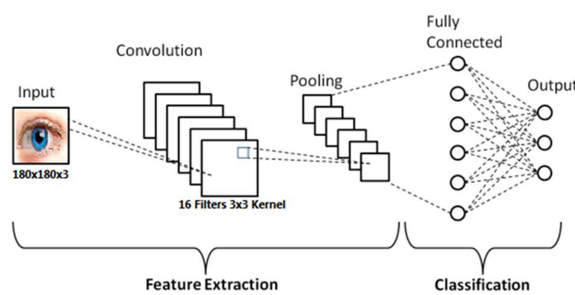


Fig. 2. Block Diagram of CNN Algorithm

The following algorithms for Kernel Convolution, Zero Padding, and Strided Convolution listed below were used in the CNN, respectively:

Kernel Convolution [eq. (1)] has f as the input image, h as the kernel, and m and n as the matrix's row and column indexes. Zero padding [eq. (2)], represented by p, has s equaled 1, with f being as filter dimension.

Where: G = filtered image
f = original image
h = kernel
m, n = matrix row and column indexes
p = amount of zero padding
f = spacial extent
n_{in} = number of input features
n_{out} = number of output features
k = convolution kernel size
s = convolution stride size

$$G[m,n] = (f * h)[m,n] = \sum_j \sum_k h[j,k] f[m-j, n-k] \quad (1)$$

$$p = \frac{(f-1)}{2} \quad (2)$$

$$n_{out} = [\frac{n_{in} + 1p - f}{s} + 1] \quad (3)$$

Fig. 3 illustrates the flow of the system's algorithm and operation. The process starts when the camera captures an image of the patient's eye, which the computer receives for differential diagnostics. The system evaluates the idea of detecting specific diseases and calculates their accuracy or probability percentage.

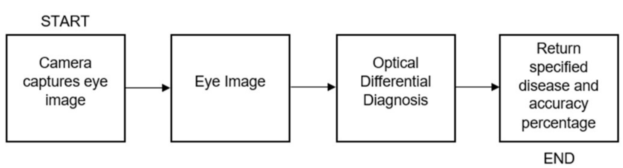


Fig. 3. System Flow

Fig. 4 shows the necessary step for diagnosing a patient with red eye, which involves conducting a patient history and eye examination to determine the cause. The patient history should include information about whether the redness is affecting one or both eyes, how long the symptoms have been present, what type and amount of discharge is current, any vision changes, the level of pain experienced, sensitivity to light (photophobia), any previous treatments received, the presence of allergies or systematic diseases, and whether the patient uses contact lenses.

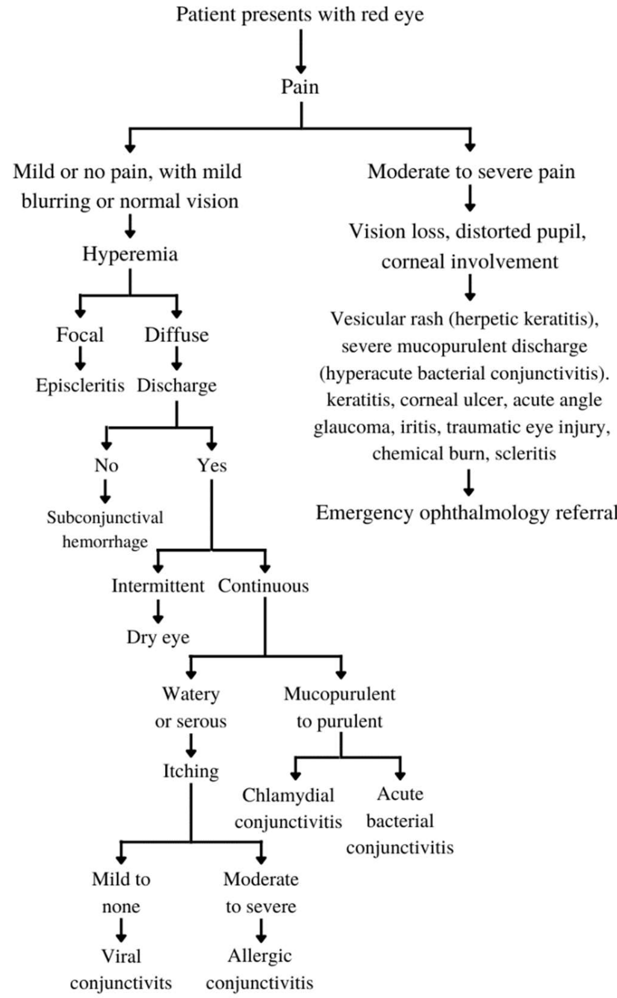


Fig. 4. Differential Diagnosis of Patient with Red Eyes
Source: Adapted from [20]

D. Step-by-step Procedure

This section illustrates the system process for the image processing procedures on the optical differential diagnosis.

1) Capturing Eye Image:

The device takes a picture of an eye, which is subsequently processed using TensorFlow and CNN algorithms. While processing the image, the system notes certain features of the picture.

2) Optical Differential Diagnosis Result:

As shown in Fig. 5, if any specific features are detected that correspond to any of the defined eye diseases, the system returns a list of possible eye diseases, which the symptoms evaluator then narrows down and evaluates. After that, the method returns the specified eye disease and its accuracy rate. The image indicates healthy eyes if the system finds no traits that could be attributed to any of the listed eye disorders.

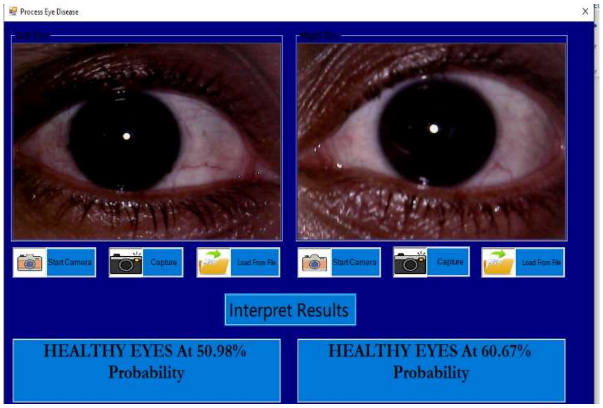


Fig. 5. Final Differential Diagnosis Result

III. Results and Discussions

This section of this study presents the findings of the image-based eye disease detection system. The system processes images of the patient's eye captured through a slit lamp examination, utilizing a combination of TensorFlow and OpenCV. The system's output provides a list of potential eye diseases and their accuracy rates, as detected by the system using the features extracted from the image. The results and discussion section highlights the performance and effectiveness of the proposed method.

A. Test Results

During the testing phase of the study, the researchers evaluated 1052 datasets and presented the results in Table 1.

A total of six different eye conditions were subjected to data collection throughout the system testing to obtain results. The accuracy rate rose because eye disease had a unique collection of data. These datasets were collected from a Kaggle online cache and eye photos provided by an ophthalmologist who prefers to remain anonymous during and after the study's implementation. Overall, the analysis accurately detected 973 out of 1052 samples, resulting in a 92.49% accuracy rate.

Table 1: Confusion Matrix Analysis

	N = 1052	PREDICTED DATA						
		K	C	U	G	Co	H	C.O
ACTUAL DATA	K	153	1	1	2	5	5	167
	C	5	160	5	5	5	3	183
	U	2	1	165	1	2	1	172
	G	2	5	3	175	5	2	192
	Co	2	3	1	3	135	2	146
	H	1	1	2	1	2	185	192
	T. A	165	171	177	187	154	198	1052
	C.A%	91.62%	87.43%	95.93%	91.15%	92.47%	96.35%	
	O. A	92.49%						

Where: N = Number of Sample
K = Keratitis
C = Cataract
U = Uveitis
G = Glaucoma
Co = Conjunctivitis
H = Healthy Eyes
T.A = Truth Overall
C.A = Classifier's Accuracy
O.A = Overall Accuracy
C.O = Classification Overall

$$Overall\ Accuracy = \frac{153+160+165+175+135+185}{1052}\ x\ 100\% \quad (4)$$

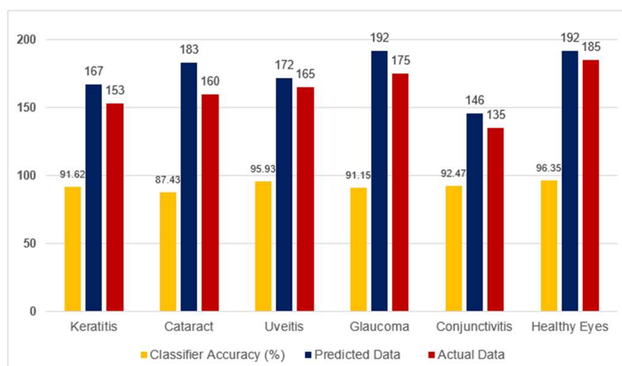
The system's overall accuracy was determined using equation 4; the system's accuracy rate is 92.49%.

B. Data Analysis

Out of the 1052 datasets tested, the results were tallied based on each eye disease's actual and predicted results.

Starting with Keratitis, 153 out of 167 samples were correctly identified, resulting in an accuracy of 91.62%. Out of 183 samples tested for cataracts, 160 were confirmed as true positives, resulting in an accuracy rate of 87.43%. Uveitis showed an impressive accuracy rate of 95.93%, correctly diagnosing 165 cases out of 172. The last two diseases, Glaucoma and Conjunctivitis, also achieved accuracy rates of 91.15% and 92.47%, respectively. Glaucoma had 175 correct identifications out of 192 samples, while Conjunctivitis had 135 accurate labels out of 146. Healthy eyes showed an accuracy rate of 96.35%, with 185 suitable markers out of 192 models. Table 2 compares the predicted and actual results of the eye disease diagnosis.

Table 2. Comparison between the predicted and actual results of each eye disease.



The blue columns show the predicted data, while the red columns indicate the actual obtained from the system. The yellow columns evaluate the accuracy of the results by measuring the discrepancy between the predicted and fundamental data.

IV. Conclusions and Future Works

This study created a system that utilizes the Optical Differential Diagnosis Process and images analysis to diagnose several eye diseases. Using a macro-lens camera, the researchers obtained more detailed images of patients' eyes for training and utilization of the system.

Expanding the number of eye diseases analyzed would be beneficial to enhance future studies. Additionally, incorporating x-ray imaging could improve disease detection, as this imaging technique may only make some illnesses visible.

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APPENDICES

APPENDIX A

Title of the Study

Automated Differential Diagnosis of Ocular Conditions Using Image Analysis Via Image Upload

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***Abstract*— This study introduces a novel eye examination device that employs image processing and analysis for optical differential diagnosis, particularly for the detection of five specific eye diseases. This device's ability to conduct remote examinations via image uploads is a standout feature. Using this approach, the device can assess patients' eye health quickly and precisely, identifying any abnormalities or diseases. The testing phase produced an impressive overall accuracy of 92.49%, indicating that our device has the potential to provide a more convenient and accurate alternative to traditional in-person eye exams.**

***Index Terms*— Differential Diagnosis, Eyes, Diseases, Glaucoma, Cataract, TensorFlow, CNN, Image Analysis, Checkup.**

I. Introduction

Optical check-ups and differential diagnoses are typically performed by professionals such as ophthalmologists or optic nurses, which can make the process expensive and time-consuming. In addition, many remote or underserved areas lack access to adequate eye testing facilities and professional care. This system aims to provide ad ethical and accurate alternative for conducting optical differential diagnoses, with the goal of increasing access to eye care in areas where it is otherwise limited [1].

Recent advances in artificial intelligence (AI) have led to the development of novel methods for image analysis, which have demonstrated superiority over traditional techniques employed in industrial vision system [2]. AI-based image processing is a burgeoning field of research, with the most effective approaches leveraging deep learning, a type of machine learning based on artificial neural networks [3][4].

Different neural networks exhibit varying capabilities, making them suitable for specialized tasks. TensorFlow is a library that includes a diverse range of neural networks, with convolutional neural networks (CNNs) as the most commonly used and fundamental component. This library is particularly effective for image analysis and machine learning but requires a significant amount of training data for optimal performance. When utilized correctly, TensorFlow has been shown to produce the most accurate results compared to any individual neural network [5].

Three studies from the Philippines have been reviewed in which image processing techniques were used to create a bimodal vein recognition system using support vector machine (SVM) [6]. In this system, two NoIR cameras are connected to a multi-camera adapter mounted on a Raspberry Pi Model 3B+ were used to acquire images of dorsal and palm veins exposed to infrared light. By using SVM, the study was able to classify hand veins with 97.16% accuracy. Another study by Bumacod et al. used a digital goniometer to measure elbow and knee joints angles through pictures, with statistical analysis showing 98.25% and 98.09% accuracy for the elbow and knee joints, respectively [7]. Linsangan et al. conducted a study in which geometric analysis and k-nearest neighbor (k-NN) were used to classify skin cancer into three categories: malignant melanoma, benign melanoma, and unknown [8]. The functionality testing of this method was 90% accurate.

Neural networks can be utilized to build a system that can extract relevant details from a vast amount of data. In ophthalmology, image processing is employed to assess retinal health, which is a crucial aspect of the eye and plays a vital role in vision [9]. Computer aided diagnosis (CAD) systems play a crucial role in providing accurate, reliable, and rapid diagnoses of glaucoma [10]. Recent advances in computational power have enabled the use of convolutional neural networks (CNNs) for autonomous classification of glaucoma based on complex features extracted from thousands of fundus images [11]. Neural networks can also be employed for detecting cataracts in the human eye, which if left untreated can cause blindness [12]. Non-invasive detection of jaundice is also possible using modern technology [13]. Early diagnosis is important for Chinese myopic eyes and for myopia, a leading cause of visual impairment affecting millions of children worldwide [14]. While deep learning and computer vision have demonstrated significant potential for disease screening, they have yet to be applied to large-scale myopia screening using ocular appearance images [15].

Based on research, the proponents of this study have found that optical differential diagnosis can be costly and time-consuming, as it requires the initial check-up to be conducted by a professionally licensed ophthalmologist. However, with this technology, it is possible to take a picture and upload it to the system for a diagnosis, even in remote areas. This allows for more efficient and convenient diagnosis.

This research greatly benefits optical medical institutions such as hospitals and optical clinics by reducing the cost of the initial check-up and speeding up the process, as well as eliminating the need for ophthalmologists during differential diagnosis. In addition to benefiting hospitals and optical clinics, this technology also help unfortunate individuals in rural areas who may not have access to professional medical care due to geographical or financial constraints. By allowing for remote diagnosis through the use of images, this technology can provide access to necessary medical care for individuals who may otherwise not have been able to receive it.

The goal of this research is to develop a system that can assess the degree or severity of eye conditions such as keratitis, cataracts, uveitis, glaucoma, conjunctivitis, and healthy eyes via image upload.

This study focuses on differential diagnosis related to conditions such as keratitis, cataracts, uveitis, glaucoma, conjunctivitis, and normal vision. It is important to note that the research is limited to the external human eye. For the purposes of differential diagnosis, the data will be presented in an aggregated form. It is also important to ensure that the images uploaded to the system are legitimate eye problems, as uploading images with unrelated issues may result in incorrect or random data.

II. Materials and Methods

Based on the related literatures reviewed for this study, a systematic application is being planned and constructed. The subject patient will be examined through the personalized slit lamp, then the computer will then be able to view the patient's eye. When a specific command is applied, the application will then capture the clear image of the patient's eye, which will then go to the imaging analysis process. A result will be the output indicating probabilities of the eye's diseases, following the standard of differential diagnostics.

A. Conceptual Framework

Fig. 1 conceptualizes the entire process; the input will the patient's data seen through the slit lamp. The data will then be manifested with the software application, hence, yielding results. The initial result will then be backed-up and strengthened in detail about the possible differential diagnosis.

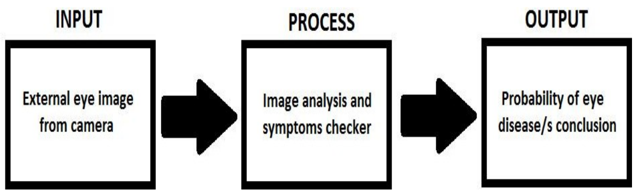

Fig. 1 Conceptual Framework

B. Materials and Resources

In this study, the hardware components will be like a compromised model of a slit lamp's oculars. This slit lamp is a device used by an ophthalmologist and optical nurses to examine the exterior and interior part of the human eye. With the oculars utilized to observe the patient's eyes more clearly.

This hardware is composed of an industrial microscope zoom magnifier macro-lens camera with a max resolution of 1280x1024 propped on top of a stand. Fig 2 shows the 3D model of the proposed device. Unlike a regular slit lamp where the ophthalmologist looks through the oculars, the industrial microscope zoom magnifier macro-lens camera takes clear, zoomed-in images of the patient's eye.

The device is connected to the computer where the visualization of the patient's eyes is seen. This setup is a standard setup of a personal computer, which consists of a system unit, monitor, keyboard, and mice. Other components of this hardware consist of bearings, screws, adjustable gears and a mixture of plastic, and metal for the body. The accomplishment of this hardware is the connection of the patient and software.

The software resources are an algorithm library of Google called TensorFlow. This library's core is now then embedded with a neural network call CNN. For computer vision, the resources implemented will be OpenCV which is a machine vision library.

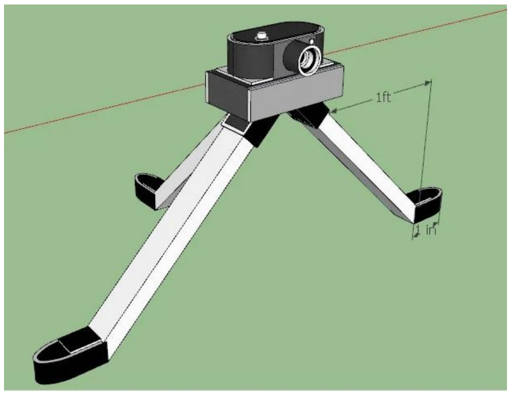

Fig. 2 3D Model of Proposed Device

C. System Flow

Fig. 3 shows the system's flow of the whole system algorithm and how it works. It starts with the camera capturing the image of the patient's eye. This data (eye image) is then sent to the computer where the differential diagnostics is done to the image. It will then evaluate if it detects a particular disease and its accuracy percentage/probability percentage.

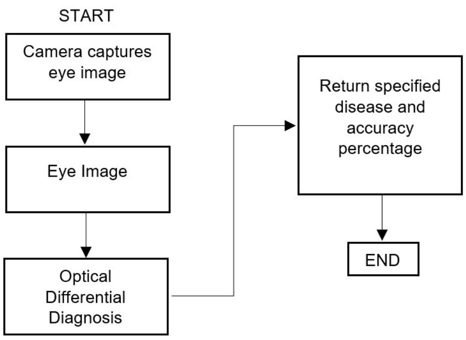

Fig. 3 System Flow

A sample flow of this differential diagnosis is illustrated in Fig. 4, used with a patient found to have red eyes.

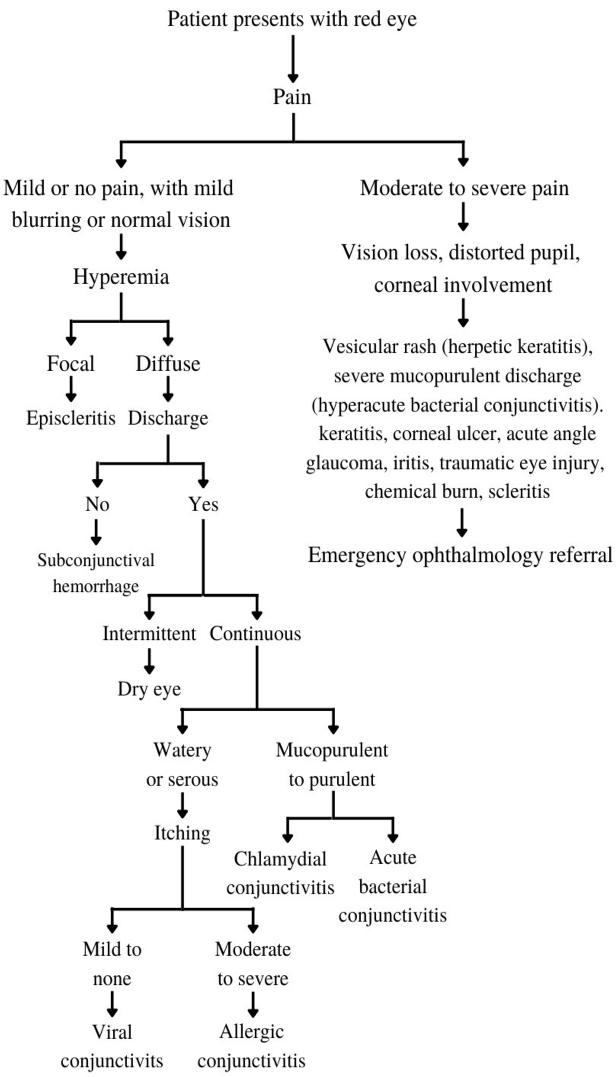

Fig. 4 Differential Diagnosis of Patient with Red Eyes
Source: Adapted from [16]

III. Results and Discussions

A. Detailed System Setup and Process

The macro-lens camera can be seen on top of the manufactured stand, this is seen in Fig. 5. This is connected to the computer, which runs the designed software.

Fig. 5 Hardware Device

The entire process starts with the hardware. When the patient is sat across the device user who will place the camera in front of one of the patient's eyes, a software command will then initialize the capturing of the image. The software will then analyse the captured image.

As seen in Fig. 6, the camera is pointed in front of one of the patient's eyes. Then through the software, the system will capture an image displaying the condition of the patient's optical organ. When the image is being processed, certain features of the image is taken note by the system.

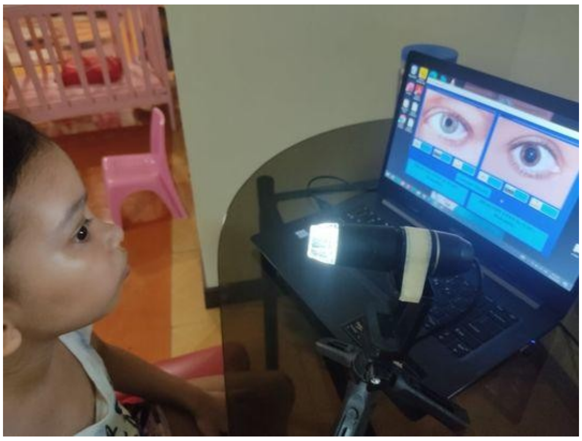

Fig. 6 Device used during testing

After yielding the result, the software will give a list of possible diseases as well as their respective probability. These diseases are now then narrowed and evaluated through the symptom's evaluator, a software feature of assessing the patient's overall and optic health. The symptoms evaluator is how differential diagnosis is implemented into the system. With the use of differential diagnosis, the visible symptoms displayed in the eye image is sorted to separate one diagnosis from another. This is to ensure that having two similar conditions does not immediately result in the same disease diagnosis, as some diseases do show similar conditions but down the line within the diagnosis, result in differing symptoms.

The device takes a picture of an eye, which is subsequently processed using TensorFlow and CNN algorithm. When the image is being processed, certain features of the image is taken note by the system, as shown in Fig. 7-a.

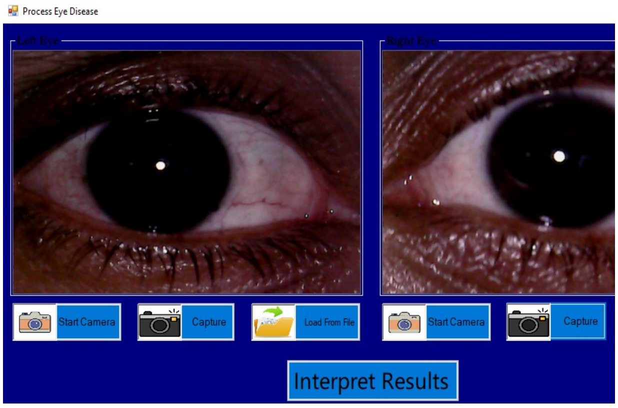

Fig. 7-a Capturing Eye Image

As shown in Fig. 7-b, if there are any particular features detected that correspond to any of the conditions of the define eye disease, the system returns a list of possible eye diseases, which the symptoms evaluator then narrows down and evaluates the conditions found in the image. After that, the system returns the specified eye disease and accuracy rate. The image is considered as having healthy eyes if the system finds no specific traits that could be attributed to any of the states of the listed eye disorders.

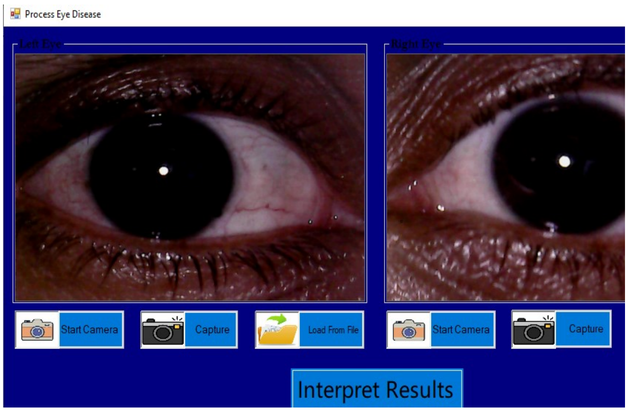

Fig. 7-b Final Differential Diagnostic Result

B. Test Results

During the testing part of the study, 1052 datasets were evaluated. The results are presented in Table 1. Using the confusion matrix formula given in Equation 1.

A total of six different eye conditions are subjected to data collection throughout the system testing to obtain the results. As the accuracy rate rises, it's because each eye disease has a unique collection of data. These datasets were collected from a Kaggle online cache and eye photos provided by an ophthalmologist who prefers to remain anonymous both during and after the study's implementation. Overall, the analysis has 973 out of 1052 samples been detected accurately, having a 92.49% accuracy rate.

	N = 1052	PREDICTED DATA						
		K	C	U	G	Co	H	C.O
ACTUAL DATA	K	153	1	1	2	5	5	167
	C	5	160	5	5	5	3	183
	U	2	1	165	1	2	1	172
	G	2	5	3	175	5	2	192
	Co	2	3	1	3	135	2	146
	H	1	1	2	1	2	185	192
	T. A	165	171	177	187	154	198	1052
	C.A%	91.62%	87.43%	95.93%	91.15%	92.47%	96.35%	
	O. A	92.49%						

Table 1. Confusion Matrix Analysis

Where: N = Number of Samples
K = Keratitis
C = Cataract
U = Uveitis
G = Glaucoma
Co = Conjunctivitis
H = Healthy Eyes
T.A = Truth Overall
C.A = Classifier's Accuracy
O.A = Overall Accuracy
C.O = Classification Overall

$$Overall\ Accuracy = \frac{153+160+165+175+135+185}{1052}\ x\ 100\%\ (eq. 1)$$

The system's overall accuracy was determined using equation 4; the system's accuracy rate is 92.49%.

C. Data Analysis

On the total of 1052 datasets tested, the results are tallied based on the actual and predicted result of each eye disease.

The classifier accuracy for Glaucoma was reported to be 91.15%, with 175 right images out of 192 images.

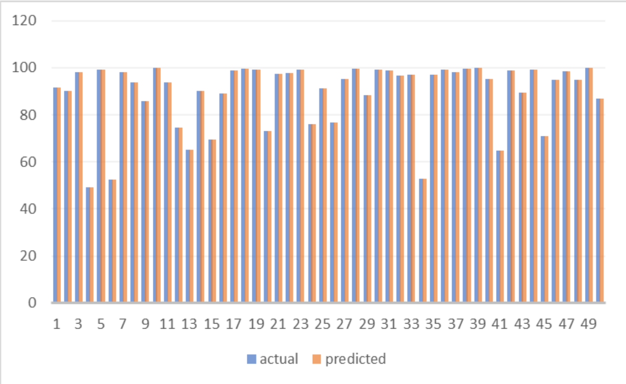

Table 2. Statistical Table for Glaucoma

In the case of Cataracts, 160 images out of 183 samples were found to be true positives, yielding an accuracy of 87.43%.

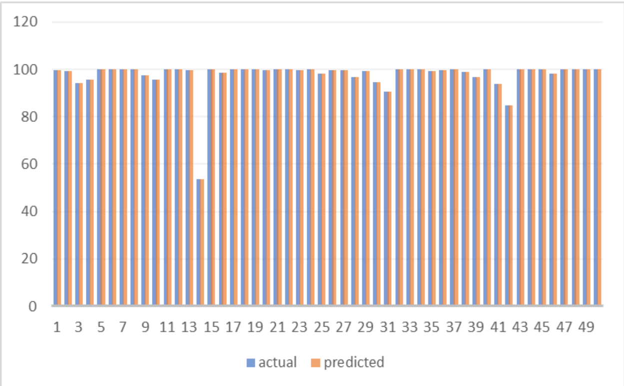

Table 3. Statistical Table for Cataract

Next is Conjunctivitis, with a reach of 92.47% with a total of 135 correct over its 172 total samples.

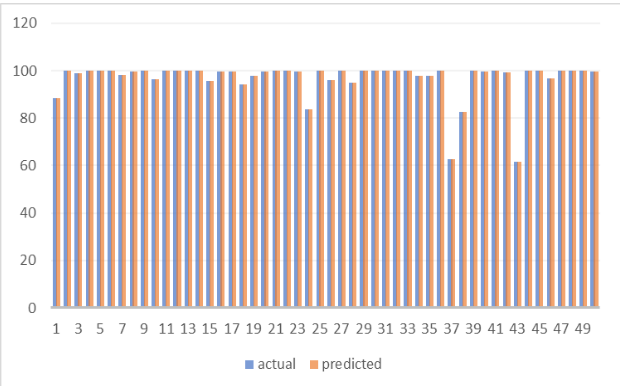

Table 4. Statistical Table for Conjunctivitis

For Keratitis, with a reach of 91.62% with a total of 153 images out of 167 samples.

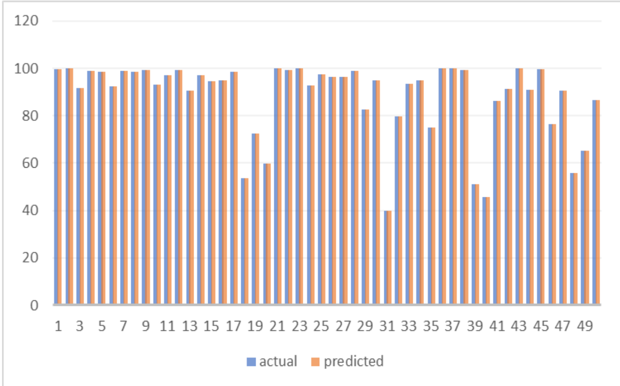

Table 5. Statistical Table for Keratitis

Next is Uveitis, with a total of 165 correct over its 172 total samples, yielding an accuracy of 95.93%.

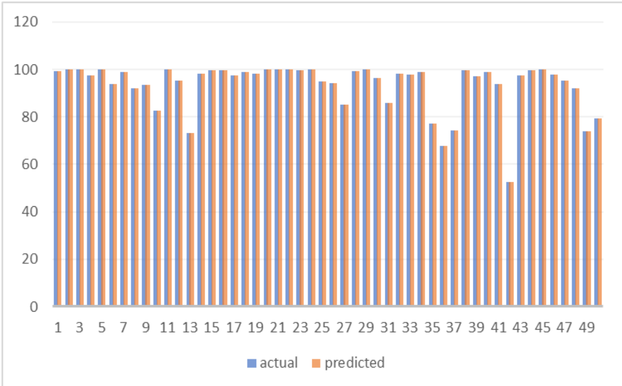

Table 6. Statistical Table for Uveitis

Healthy Eyes were found to have 185 correctly identified images out of 192, and 96.35% was the classifier accuracy reached.

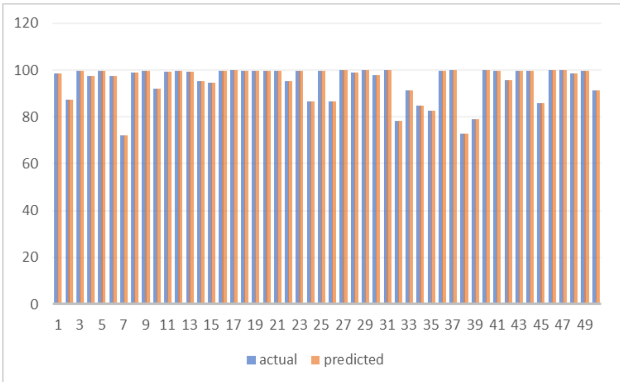

Table 7. Statistical Table for Healthy Eyes

The red lines indicate the predicted data of every result of each eye disease, as the blue lines illustrate the actual data given by the system. Horizontal line (0-100) measures the accuracy of the data. And as for vertical lines (1-50), it is the total number of the system tested during that period.

IV. Conclusions and Future Works

With this study, the creation of a system with the use of the Optical Differential Diagnosis Process and image analysis to diagnose a specified number of eye diseases was made possible. By implementing a macro-lens camera, the research was able to get a more detailed image of patient’s eyes for the utilization and training of the system.

Regarding future works, it would be better if the number of eye diseases were to be broaden. The application of x-ray imaging would also be better as an improvement for diseases to be detected, as there are some illnesses that are not visible when x-ray is not involved.

V. References

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APPENDIX B
Trade-Off Analysis

TRADE-OFF ANALYSIS

Selection Criteria	Constraints	Weight (%)	Pugh Concept Selection Matrix	Weight (%)	Design Concepts	
					Design 1	**Design 2**
	Manufacturability	**19.17**	Can be produced by existing methods	**5.84**	3	3
			Resouces are readily available	**5.45**	3	3
			Lesser production cost	**6.32**	3	3
			Easier to build/ complexity	**1.54**	3	4
	Economic	**16.20**	Is cost-efficient based on cost-benefit analysis	**16.20**	4	3
	Efficiency	**33.80**	Faster execution/transaction (compute time spent)	**15.55**	4	3
			User-friendly/less complexity in usage	**7.47**	4	3
			Accuracy in data	**10.78**	4	3
	Sustainability	**30.83**	Expected life span	**10.58**	4	3
			Performance under heavy usage	**11.20**	4	3
			Maintenance	**9.05**	4	3
			TOTAL SCORE		**40**	**34**
			WEIGHTED SCORE	100	**3.808330511**	**3.02**

COMPARISON OF ALTERNATIVES: WEIGHTS OF CRITERIA

Use the following for Concept Selection:

1	equal
2	moderate
3	strong
4	very strong
5	extreme

Use the following for Concept Scoring:

Values	Interpretation
1	*i* and *j* are equally important
2	*i* is slightly more important than *j*
3	*i* is more important than *j*
4	*i* is strongky more important than *j*
5	*i* is absolutely more important than *j*

Constraints:

A	Manufacturability
B	Economic
C	Efficiency
D	Sustainable

	A		B		C		D	
A	1	1	2	1	2	3	1	3
B	1	2	1	1	3	4	2	3
C	3	2	4	3	1	1	2	1
D	3	1	3	2	1	2	1	1

Squaring the matrix

1	2	0.7	0.3		1	2	0.7	0.333
0.5	1	0.8	0.7		0.5	1	0.8	0.667
1.5	1.3	1	2		1.5	1.3	1	2
3	1.5	0.5	1		3	1.5	0.5	1

						SUM	WEIGHT(%)
	4	5.4	3	3.3		16	**19.17**
=	4.1	4	2.2	3	=	13	**16.20**
	9.7	8.7	4	5.4		28	**33.80**
	7.5	9.7	4.1	4		25	**30.83**
						82	**100.00**

Manufacturability **19.17 %**

Criteria:

A	Can be produced by existing methods
B	Resouces are readilty available
C	Lesser production cost
D	Easier to build/s complexity

	A		B		C		D	
A	1	1	1	2	3	1	2	1
B	2	1	1	1	2	3	4	1
C	3	1	1	4	1	1	4	1
D	1	2	1	3	1	4	1	1

Squaring the matrix

1	0.5	3	2		1	0.5	3	2
2	1	0.7	4		2	1	0.7	4
3	0.3	1	4		3	0.3	1	4
0.5	0.3	0.3	1		0.5	0.3	0.3	1

						sum	weight(%)	actual weight(%)
=	12	2.4	6.8	18		21	30.4872	**5.84346553**
	8	3.5	8.3	15	=	20	28.45472	**5.453901162**
	8.5	3.3	11	15		23	32.99791	**6.324692103**
	2.4	1	2.2	4.3		5.6	8.060177	**1.54489007**
						70	100	**19.16694887**

Efficiency **33.80 %**

Criteria:

A	Faster execution/transaction (compute time spent)
B	User-friendly/less complexity in usage
C	Accuracy in data

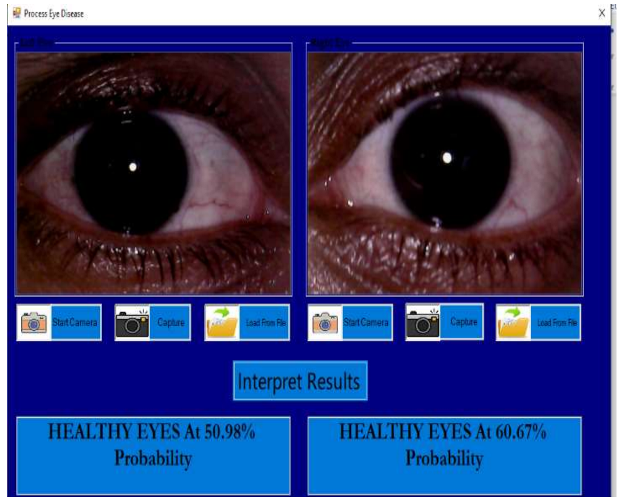
	A		B		C	
A	1	1	2	1	3	2
B	1	2	1	1	2	3
C	2	3	3	2	1	1

Squaring the matrix

1	2	1.5		1	2	1.5
0.5	1	0.7		0.5	1	0.7
0.7	1.5	1		0.7	1.5	1

					sum		weight	actual weight
	3	6.3	4.3		14		46.0	**15.54686004**
=	1.4	3	2.1	=	6.5	=	22.1	**7.471394908**
	2.1	4.3	3		9.4		31.9	**10.77788457**
					30		100	**33.79613952**

DESIGN 1 CONCEPT



The macro-lens camera can be seen on top of the manufactured stand. This is connected to the computer, which runs the designed software. The entire process starts with the hardware. When the patient is sat across the device user who will place the camera in front of one of the patient's eyes, a software will then analyse the captured image.

DESIGN 2 CONCEPT

Design 2 shows the hardware design concept of a previous research study for the optical differential diagnosis.

Design 1	Design 2
Manufacturability: The design requires a macro-lens camera. This might be an issue when it comes to availability.	Manufacturability: This design utilizes a web camera, which is much more common.
Economical: This uses a macro-lens camera. It's a good investment for getting more accurate results and which will deliver more cost-effective functionality.	Economical: Web camera might be cheaper but it will require more pictures for its quality is not as clear and focused. Which can cause in a fluctuated cost.
Sustainability: The macro-lens camera in genera is a more compact and more durable camera meant for project applications and because of its durability.	Sustainability: Using a web camera, it is not as sustainable because it is more fragile and not meant for project applications.
Ethical: The fact that an actual patient is required for a picture makes it more difficult for unethical use.	Ethical: Utilizing web camera might not get proper shots taken of the eye. There might be an ethical or validity question if rendered result is provided using this capture method.
Feature Advantages of Design 1	**Feature Advantages of Design 2**
On time capture and differential diagnosis. More accurate and recent picture can give more accurate data.	Cheaper for the short-term. And web camera is a lot easier to find retail stores.
Trade-Off Conclusion	
Design 1 utilizes a macro-lens camera that provides accurate and focused pictures for on-time capture and differential diagnosis. However, its availability might be an issue, and it requires a larger investment. Meanwhile, Design 2 uses a web camera which is more common and cheaper in the short term, but the quality of the pictures might not be as clear and focused, raising ethical and validity questions. Choosing between the two designs depends on the specific needs of the project and resources available. If accuracy and durability are crucial, Design 1 might be better despite the higher investment. If availability and short-term affordability are priorities, Design 2 might be more suitable.	

APPENDIX C
User Manual

USER MANUAL

1.0 General Information

1.1 System Overview

The system will determine the level or extent of various eye conditions such as keratitis, cataracts, uveitis, glaucoma, conjunctivitis, and eyes that are considered healthy.

This program dramatically benefits optical medical institutions such as hospitals and clinics by lowering the cost of the initial check-up, resulting in a quicker process, and doing away with the necessity for an ophthalmologist during differential diagnosis.

1.2 System References

- TensorFlow
- Python Programming Language
- Visual Basic

1.3 Organization of the Manual

This manual is divided into 4 major sections, listed, and defined below.

1.0 **- General Information**: Contains basic information about the program, such as functions performed and a description.

2.0 – **System Summary**: This section provides a general overview of the system.

3.0 – **Getting Started**: This section provides a general walk-through guide to the system, from beginning to exit.

4.0 – **Results**: This section shows the example various results that can be interpreted by the system.

1.4 Acronyms and Abbreviations

TensorFlow – an open-source framework to run machine learning, deep learning, and other statistical and predictive analytics workloads.

Python – a popular programming language. It can be used on a server to create web applications.

Visual Basic – an object-oriented programming language developed by Microsoft. Using Visual Basic makes it fast and easy to create type-safe .NET apps.

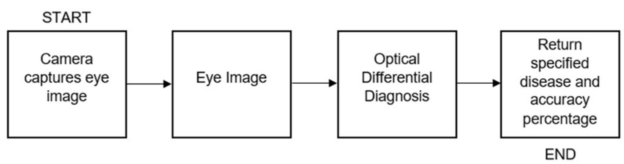
2.0 System Summary

2.1 System Configuration

The system is provided with a GUI to interact with the dataset to complete tasks such as start camera, image insertion, camera capture, and interpret result.

2.2 System Flow

Users are presented with an interface from which they can choose a specific task. The system provides an option to the user to either capture an image or load a file, which then will going to be read by the system and will provide a result.



2.3 User Access Levels

Specific user or authorized personnel may be able to operate the system.

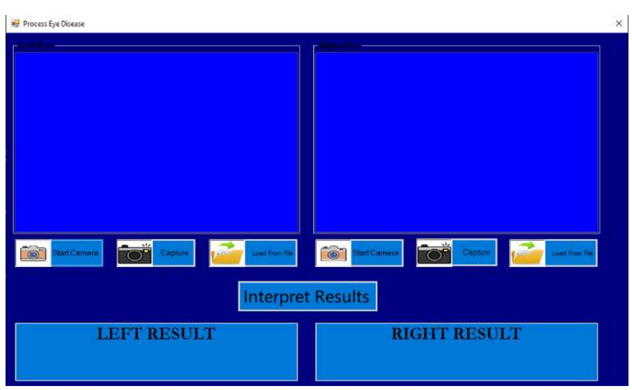
3.0 Getting Started

3.1 Click the icon.

Right click the icon and select open.

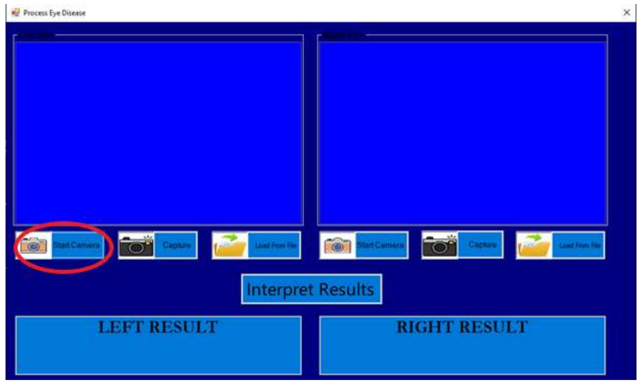
3.2 System Interface

Upon launching the icon, users are presented with the following buttons. By clicking each button, users can perform the following actions:



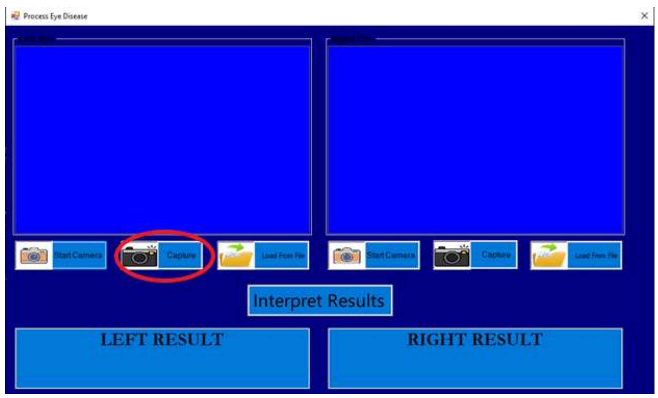
3.2.1 Start Camera

By clicking on the Start camera button, users are now able to use the external device to capture both left and right eye.



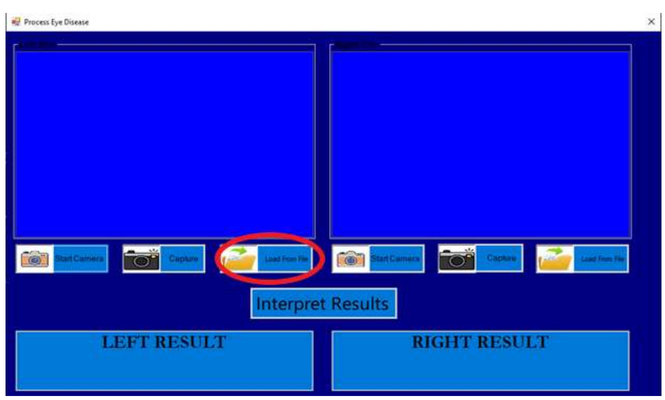
3.2.2 Capture

By clicking on the capture button, it will now capture both left and right eye image using the external device and ready to be interpreted.



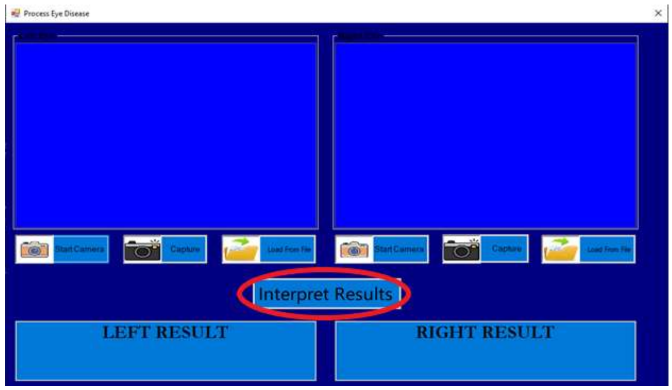
3.2.3 Load from file

By clicking on the load from file button, this is an option to insert both left and right eye image without the help of the external device.



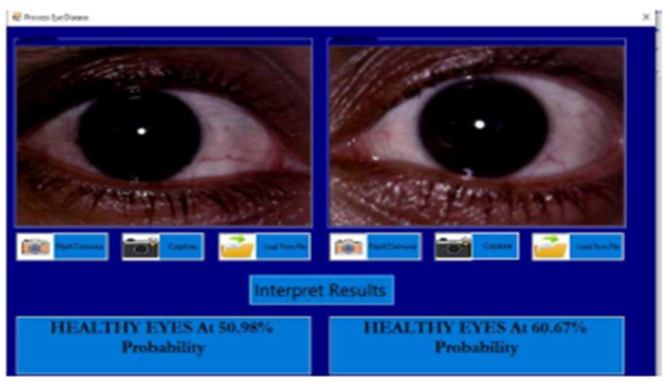
3.2.4 Interpret

By clicking the interpret button, the system now will provide a result of eye disease.



3.2.5 Result

This section shows the interpreted result of the captured eye.



APPENDIX D
Software Source Code

PROCESS CODE

```
import matplotlib.pyplot as plt
import numpy as np
import os
import PIL
import tensorflow as tf
import sys
from tensorflow import keras
from tensorflow.keras import layers
from tensorflow.keras.models import Sequential
img_height = 180
img_width = 180

#print ("File %s" % (sys.argv[1]))

model = keras.models.load_model('D:\\Kuyabenj\\Kuya\\code\\eye-disease')
class_names = ['CATARACT', 'CONJUNCTIVITIS', 'GLAUCOMA', 'HEALTHY EYES',
'KERATITIS', 'UVEITIS']
##
##sunflower_url =
"https://storage.googleapis.com/download.tensorflow.org/example_images/cat1.png"
##sunflower_path = tf.keras.utils.get_file('Red_sunflower',
origin=sunflower_url)

img = keras.preprocessing.image.load_img(
    sys.argv[1], target_size=(img_height, img_width)
)
img_array = keras.preprocessing.image.img_to_array(img)
img_array = tf.expand_dims(img_array, 0) # Create a batch

predictions = model.predict(img_array)


score = tf.nn.softmax(predictions[0])

print(
    "result:{}:{:.2f}:"
    .format(class_names[np.argmax(score)], 100 * np.max(score))
)
```

MAIN CODE

```
import matplotlib.pyplot as plt
import numpy as np
import os
import PIL
import tensorflow as tf

from tensorflow import keras
from tensorflow.keras import layers
from tensorflow.keras.models import Sequential
batch_size = 32
img_height = 180
img_width = 180

train_ds = tf.keras.preprocessing.image_dataset_from_directory(
  "./images",
  validation_split=0.2,
  subset="training",
  seed=123,
  image_size=(img_height, img_width),
  batch_size=batch_size)

val_ds = tf.keras.preprocessing.image_dataset_from_directory(
  "./images",
  validation_split=0.2,
  subset="validation",
  seed=123,
  image_size=(img_height, img_width),
  batch_size=batch_size)

class_names = train_ds.class_names
print(class_names)

import matplotlib.pyplot as plt

plt.figure(figsize=(10, 10))
for images, labels in train_ds.take(1):
  for i in range(9):
    ax = plt.subplot(3, 3, i + 1)
    plt.imshow(images[i].numpy().astype("uint8"))
    plt.title(class_names[labels[i]])
    plt.axis("off")

for image_batch, labels_batch in train_ds:
  print(image_batch.shape)
  print(labels_batch.shape)
  break

AUTOTUNE = tf.data.experimental.AUTOTUNE
train_ds = train_ds.cache().shuffle(1000).prefetch(buffer_size=AUTOTUNE)
val_ds = val_ds.cache().prefetch(buffer_size=AUTOTUNE)

normalization_layer = layers.experimental.preprocessing.Rescaling(1./255)

normalized_ds = train_ds.map(lambda x, y: (normalization_layer(x), y))
image_batch, labels_batch = next(iter(normalized_ds))
first_image = image_batch[0]
```

```
# Notice the pixels values are now in `[0,1]`.
print(np.min(first_image), np.max(first_image))

num_classes = 6

model = Sequential([
  layers.experimental.preprocessing.Rescaling(1./255, input_shape=(img_height,
img_width, 3)),
  layers.Conv2D(16, 3, padding='same', activation='relu'),
  layers.MaxPooling2D(),
  layers.Conv2D(32, 3, padding='same', activation='relu'),
  layers.MaxPooling2D(),
  layers.Conv2D(64, 3, padding='same', activation='relu'),
  layers.MaxPooling2D(),
  layers.Flatten(),
  layers.Dense(128, activation='relu'),
  layers.Dense(num_classes)
])

model.compile(optimizer='adam',

loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
              metrics=['accuracy'])
model.summary()

epochs=10
history = model.fit(
  train_ds,
  validation_data=val_ds,
  epochs=epochs
)
##
###training visualization
##
##acc = history.history['accuracy']
##val_acc = history.history['val_accuracy']
##
##loss = history.history['loss']
##val_loss = history.history['val_loss']
##
##epochs_range = range(epochs)
##
##plt.figure(figsize=(8, 8))
##plt.subplot(1, 2, 1)
##plt.plot(epochs_range, acc, label='Training Accuracy')
##plt.plot(epochs_range, val_acc, label='Validation Accuracy')
##plt.legend(loc='lower right')
##plt.title('Training and Validation Accuracy')
##
##plt.subplot(1, 2, 2)
##plt.plot(epochs_range, loss, label='Training Loss')
##plt.plot(epochs_range, val_loss, label='Validation Loss')
##plt.legend(loc='upper right')
##plt.title('Training and Validation Loss')
##plt.show()
##

data_augmentation = keras.Sequential(
  [
```

```
    layers.experimental.preprocessing.RandomFlip("horizontal",
                                                 input_shape=(img_height,
                                                              img_width,
                                                              3)),
    layers.experimental.preprocessing.RandomRotation(0.1),
    layers.experimental.preprocessing.RandomZoom(0.1),
  ]
)
model = Sequential([
  data_augmentation,
  layers.experimental.preprocessing.Rescaling(1./255),
  layers.Conv2D(16, 3, padding='same', activation='relu'),
  layers.MaxPooling2D(),
  layers.Conv2D(32, 3, padding='same', activation='relu'),
  layers.MaxPooling2D(),
  layers.Conv2D(64, 3, padding='same', activation='relu'),
  layers.MaxPooling2D(),
  layers.Dropout(0.2),
  layers.Flatten(),
  layers.Dense(128, activation='relu'),
  layers.Dense(num_classes)
])
model.compile(optimizer='adam',
loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
              metrics=['accuracy'])
model.summary()
epochs = 15
history = model.fit(
  train_ds,
  validation_data=val_ds,
  epochs=epochs
)

model.save('D:\\Kuyabenj\\Kuya\\code\\eye-disease')
##
##sunflower_url =
"https://storage.googleapis.com/download.tensorflow.org/example_images/592px-
Red_sunflower.jpg"
##sunflower_path = tf.keras.utils.get_file('Red_sunflower',
origin=sunflower_url)
##
##img = keras.preprocessing.image.load_img(
##    sunflower_path, target_size=(img_height, img_width)
##)
##img_array = keras.preprocessing.image.img_to_array(img)
##img_array = tf.expand_dims(img_array, 0) # Create a batch
##
##predictions = model.predict(img_array)
##score = tf.nn.softmax(predictions[0])
##
##print(
##    "This image most likely belongs to {} with a {:.2f} percent confidence."
##    .format(class_names[np.argmax(score)], 100 * np.max(score))
##)
```

APPENDIX E

Test Conducted Confusion Matrix

TEST CONDUCTED

During the testing phase of the study, the researchers evaluated 1052 datasets and presented the results in Table 1 and Table 2. A total of six different eye conditions were subjected to data collection throughout the system testing to obtain results. The accuracy rate rose because eye disease had a unique collection of data. These datasets were collected from a Kaggle online cache and eye photos provided by an ophthalmologist who prefers to remain anonymous during and after the study's implementation. Overall, the analysis accurately detected 973 out of 1052 samples, resulting in a 92.49% accuracy rate.

Table 1. Confusion Matrix Analysis

	N = 1052	PREDICTED DATA						
		K	C	U	G	Co	H	C.O
ACTUAL DATA	K	153	1	1	2	5	5	167
	C	5	160	5	5	5	3	183
	U	2	1	165	1	2	1	172
	G	2	5	3	175	5	2	192
	Co	2	3	1	3	135	2	146
	H	1	1	2	1	2	185	192
	T. A	165	171	177	187	154	198	1052
	C.A%	91.62%	87.43%	95.93%	91.15%	92.47%	96.35%	
	O. A	92.49%						

Table 2. Number of datasets for each classification.

Input	Training Datasets	Testing Datasets	Total Datasets
Keratitis	184 images	167 images	351 images
Cataract	212 images	183 images	395 images
Uveitis	266 images	172 images	438 images
Glaucoma	240 images	192 images	432 images
Conjunctivitis	321 images	146 images	467 images
Healthy Eyes	188 images	192 images	380 images

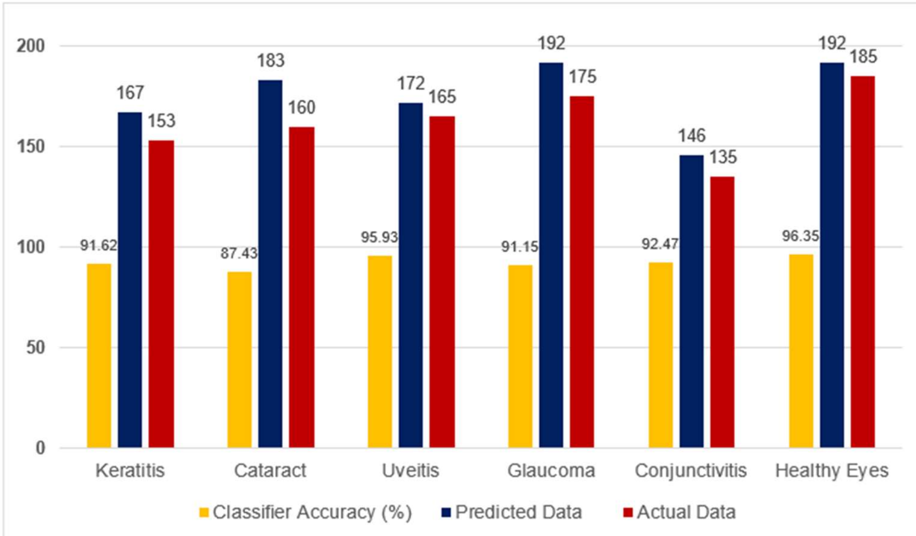
Healthy eyes have an overall accuracy of 96.35%, followed by Uveitis with 95.93%, Conjunctivity with 92.47%, Keratitis with an accuracy rate of 91.62%, Glaucoma with 91.16%, and Cataract having 87.43%. With this, the overall accuracy was calculated by dividing the sum of all accuracy rates by the total number of classifications. This resulted in the total accuracy rate of 92.49%. An arrangement of thesedata is shown in Table 3.

Table 3. Functionality test with highest accuracy reached and overall accuracy.

Input	**Result**	**Highest Accuracy Reached**	**Overall Accuracy**
Keratitis	Keratitis	99.91%	91.62%
Cataract	Cataract	99.85%	87.43%
Uveitis	Uveitis	98.94%	95.93%
Glaucoma	Glaucoma	94.03%	91.15%
Conjunctivitis	Conjunctivitis	93.52%	92.47%
Healthy Eyes	Healthy Eyes	97.19%	96.35%

Out of the 1052 datasets tested, the results were tallied based on each eye disease's actual and predicted results. Starting with Keratitis, 153 out of 167 samples were correctly identified, resulting in an accuracy of 91.62%. Out of 183 samples tested for cataracts, 160 were confirmed as true positives, resulting in an accuracy rate of 87.43%. Uveitis showed an impressive accuracy rate of 95.93%, correctly diagnosing 165 cases out of 172. The last two diseases, Glaucoma and Conjunctivitis, also achieved accuracy rates of 91.15% and 92.47%, respectively. Glaucoma had 175 correct identifications out of 192 samples, while Conjunctivitis had 135 accurate labels out of 146. Healthy eyes showed an accuracy rate of 96.35%, with 185 suitable markers out of 192 models. Table 2 compares the predicted and actual results of the eye disease diagnosis.

Table 4. Comparison between the predicted and actual results of each eye disease.



APPENDIX F
Production Cost Summary

PRODUCTION COST SUMMARY

The table shows below the overview of the production cost of the research. All the cost of each component is dependent on the receipt from various electronic online shops. These components were selected for its compatibility to our specifications and/or requirements. The researchers examine each specification before buying the components to ensure its quality.

Table 1. The Production Summary of the Study.

Product Name	Specification	Cost
Microscope Zoom Magnifier Macro-lens Camera	- Max Resolution: 1280x1024 - Pixels: ≤ 1 Mega	P 2, 750.00
Mini Desktop Tripod Support Rotation Foldable Bracket Stand Holder	- Size: 10cm*10cm*0cm/69*9*57inch	P 145.00
		Total Cost: **P 2, 895.00**

APPENDIX G
Project Cycle Plan

PROJECT CYLE PLAN

PROJECT CYCLE PLAN																
ACTIVITIES	1 August 2020				1 September 2020				1 October 2020				1 November 2020			
	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4
PLANNING																
PROGRAMMING																
COLLECTING DATA SET																
FUNCTION TESTING																
TROUBLESHOOTING																
FINAL CHECKING																
PLANNING FOR THESIS PAPER																
RRL RESEARCH																
CREATION OF ARTICLE 1 PAPER																
REVISIONS																
FINAL DEFENSE																
ACTIVITIES	1 December 2020				1 January 2021				1 February 2021				1 March 2021			
	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4
PLANNING																
PROGRAMMING																
COLLECTING DATA SET																
FUNCTION TESTING																
TROUBLESHOOTING																
FINAL CHECKING																
PLANNING FOR THESIS PAPER																
RRL RESEARCH																
CREATION OF ARTICLE 1 PAPER																
REVISIONS																
FINAL DEFENSE																
ACTIVITIES	1 April 2021				1 May 2021				1 June 2021				1 July 2021			
	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4
PLANNING																
PROGRAMMING																
COLLECTING DATA SET																
FUNCTION TESTING																
TROUBLESHOOTING																
FINAL CHECKING																
PLANNING FOR THESIS PAPER																
RRL RESEARCH																
CREATION OF ARTICLE 1 PAPER																
REVISIONS																
FINAL DEFENSE																
ACTIVITIES	1 August 2021				1 November 2022				1 December 2022				1 January 2023			
	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4
PLANNING																
PROGRAMMING																
COLLECTING DATA SET																
FUNCTION TESTING																
TROUBLESHOOTING																
FINAL CHECKING																
PLANNING FOR THESIS PAPER																
RRL RESEARCH																
CREATION OF ARTICLE 1 PAPER																
REVISIONS																
FINAL DEFENSE																

APPENDIX H

Endorsement Letter for Final Defense

ENDORSEMENT FOR FINAL DEFENSE

Date:

This is to endorse the research manuscript, entitled: "**Optical Differential Diagnosis Process Using Image Analysis**" prepared and submitted by **Alvin B. Petina, Benjie M. Ehilla,** and **Rey Mark V. Baluyot** for Final Defense. The manuscript has been evaluated by the research personnel listed below and was found to be compliant with the quality standards as provided in the UM Research Manual.

	Name of Personnel	Signature
Adviser	Engr. Hanna Leah P. Angelia	______________________
Statistician	Engr. Randy E. Angelia	______________________

Endorsed by:

ENGR. JETRON J. ADTOON, CpE
Subject Teacher

ENGR. JETRON J. ADTOON, CpE
Research Coordinator

DR. CHARLITO L. CAÑESARES, PME
Dean, College of Engineering Education

APPENDIX I

Assignment of Research Personnel

APPENDIX J

Authorization Letter

APPENDIX K
Grammarly Result

GRAMMARLY RESULT

grammarly Report: Article-1.8

Article-1.8

by Hanna Leah Angelia

General metrics

21,559	3,052	227	12 min 12 sec	23 min 28 sec
characters	words	sentences	reading time	speaking time

Score

98

This text scores better than 98% of all texts checked by Grammarly

Writing Issues

41	15	26
Issues left	Critical	Advanced

Writing Issues

15	**Correctness**
2	Confused words
1	Misspelled words
12	Unknown words

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Page 1 of 19

Approved by:

ENGR. HANNA LEAH P. ANGELIA
Thesis Adviser

APPENDIX L

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Optical Differential Diagnosis Process using Image Analysis

The University of Mindanao

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Name of author/s:

Alvin B. Petina, Benjie M. Ehilla, Rey Mark V. Baluyot

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APPENDIX M

Turnitin Report

Turnitin Report

Optical Differential Diagnosis Process using Image Analysis

ORIGINALITY REPORT

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PRIMARY SOURCES

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APPENDIX N

Approval of Final Manuscript

The University of Mindanao

College of Engineering Education
2
nd Floor, BE Building
Matina Campus, Davao
City Telefax: (082)296-

UNDERGRADUATE THESIS / RESEARCH / CAPSTONE APPROVAL OF FINAL MANUSCRIPT

Date : March 2023

Title : Optical Differential Diagnosis Process Using Image Analysis

Student-Proponents	Program
1. Alvin B. Petina	BSCPE
2. Benjie M. Ehilla	BSCPE
3. Rey Mark V. Baluyot	BSCPE

Panel Comments/ Recommendations	Previous Status	Actions Taken / Revisions	Page Reflected
Introduction: >Abstract improvement >Introduction shortening	Introduction were to long and the content were somehow messed up.	Abstract improved and introduction Shortened	1
Objective of the study improvement	Objective of the study were somehow lack of details.	Objective of the study improved	2
Materials & Method: Conceptual Framework Description Improvement	The detail about the software had a little information.	Conceptual Farmework Description Improved	2
Improve fig. 2 block diagram of CNN algorithm	Input was not an image of an eye and also too much grouping of the datasets.	fig 2 block diagram of CNN algorithm improved	2
Results and Discussion: >Correcting of formulas (IEEE standard) >Merge all single charts to one chart as an overall summary (Table 2-7) >improve overall discussions >Remove redundant images fig 5-a & 5-b	Formulas were not IEEE standard. There are separate tables for the 6 diagnosis of the eyes. Two images were included on the results and discussion.	Corrected formulas Merged single charts to one. Improved overall discussions. Removed images fig 5-a % 5-b	3

You may use additional pages as necessary

APPROVALS:

C Complied NC Not Complied	Thesis Adviser / Editor	Signature	Date
✓	Engr. Hanna Leah P. Angelia		3/10/23

C Complied NC Not Complied	Statistician	Signature	Date
C	Engr. Randy E. Angelia		3/10/23

C Complied NC Not Complied	Panel Members	Signature	Date
C	Engr. Stephen Paul Alagao		3/10/23
C	Engr. Jetron J. Adtoon		MAR 13 2023

C Complied NC Not Complied	Research Teacher	Signature	Date
C	Engr. Jetron J. Adtoon		MAR 13 2023

APPENDIX O
Curriculum Vitae of Researchers

ALVIN B. PETINA
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EDUCATIONAL BACKGROUND

Tertiary:	University of Mindanao	2014-Present
Secondary:	University of Mindanao – Ilang Tibungco Jr. College	2012 – 2014
	Philippines International School of Tabuk	2010 – 2012
Primary:	International Indian School of Tabuk	2010 – 2011

WORK EXPERIENCE:

• Cyberbacker Inc.	2022-Present
• Freelance (Upwork)	2020 – 2022
• Outsource Doers	2019 – 2020

SEMINARS ATTENDED

Vue.js Framework Webinar
October 10, 2020
University of Mindanao

Introduction to DevOps: The Game Changer of Cloud Computing
October 17, 2020
University of Mindanao

Version Control and Source Code Management with Git
October 26, 2020
University of Mindanao

Google Certification: Google Ads
June 26, 2020
Google Skillshop

SEO Expert Certified
October 3, 2020
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EDUCATIONAL BACKGROUND

Tertiary:	University of Mindanao	2015-Present
Secondary:	Sta. Ana. National High School	2000 – 2004
Primary:	Quezon Elementary School	2000 – 1995

WORK EXPERIENCE:

- RYU DATA ANNONATOR 2022-Present
- Remotasks 2020 – 2022
- TracSys. Inc 2012 – 2015

SEMINARS ATTENDED

Web Development using Laravel
November 7, 2020
University of Mindanao

Version Control and Source Code
Management with Git
October 26, 2020
University of Mindanao

Android Application
November 14, 2020
University of Mindanao

Cisco Networking
October 24, 2020
University of Mindanao

Vue.js Framework Webinar
October 10, 2020
University of Mindanao

Cloud Computing
October 17, 2020
University of Mindanao

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EDUCATIONAL BACKGROUND

Tertiary:	University of Mindanao	2014-Present
Teriary:	Hi-tech Institute of Technology	2009 - 2011
Secondary:	King's College of Isulan	2004 – 2008
Primary:	Kalawag Central Elementary School	1998 – 2004

WORK EXPERIENCE:

- Teleperformance Inc. 2022-Present
- Freelance (Remotask) 2021 – 2022
- Computer Technician 2011 – 2014

SEMINARS ATTENDED

Vue.js Framework Webinar
October 10, 2020
University of Mindanao

Introduction to DevOps: The
Game Changer of CloudComputing
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APPENDIX P
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	Benjie M. Ehilla	Course Code	**4945**
	Rey Mark V. Baluyot	Semester/SY	**2022-2023**

Name	Date Received	Signature	Date Released	Signature	Remarks
Adviser Engr. Hanna Leah P. Angelia	3/9/2023		3/9/2023		
Statistician Engr. Randy E. Angelia					
Panel 1 Engr. Stephen Paul Alagao	3/6/23		3/6/23		
Panel 2					
Panel 3 (RC/ARC) Engr. Jetron J. Adtoon	MAR 13 2023		MAR 13 2023		[illegible]
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Dean Dr. Charlito L. Cañesares					

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