DEVELOPMENTOF APLICATION CATARACT DETECTION USING TENSORFLOW API AND OPENCV LIBRARY BASED ON ANDROID

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ABSTRACT

Cataract is a clouding of the lens in the eye which leads to a decrease in vision. Cataracts are the number one cause of blindness in Indonesia, but there are still many people who forget to check their eyes regularly. In a previous study entitled "Development of Android-Based Smartphone Aplication Helps Maintain Eye Health by Utilizing Smartphone Sensors" it has been able to detect cataracts in one eye. But there is no result of accuracy identified in the study and the application still process images other than the eye. Therefor, this research will develop a cataract detection application that Tensorflow to process cataract classification. In this application it will also be developed so that it can validate the detected eye object and can detect two eyeballs in one process. This application using the OpenCV Library to crop the iris and using Tensorflow API for the classification process. From the result of testing, this application is able to detect cataracts with an accuracy of 90% success and detect eyes with an accuracy of 85% success.

1. INTRODUCTION

Cataract is the number one cause of blindness in Indonesia, according to a survey conducted by the Indonesian Ministry of Health, the prevalence of cataract sufferers is 1.5%. However, many people still forget to check eyes regularly. Routine eye examinations are important enough to actually permit eye health. so that someone can solve the problem of disease that can directly contact the doctor to take precautions and treatment before it gets worse. As we get older the eyes become more virulent and will damage various diseases, especially cataracts [1]. Cataracts are an eye disease characterized by perching of the eye lens, making vision blurry. This condition generally occurs in the elderly, and can occur in one or both eyes at once. However, cataract is not a type of infectious disease. As we get older, the protein in the lens will clot and slowly make it cloudy and foggy [2].

In a previous study entitled "Android-based Smartphone Application Development helps Maintain Eye Health by Using Smartphone Sensors" [3] was able to detect cataracts in the eye using the K-Nearest Neighbor (KNN) method. However, this study only tested one eye at a time and there are no KNN accuracy values that support the research. In this study the authors wanted to implement the Convolutional Neural Network (CNN) method using Tensorflow to get the accuracy values generated from detection trials. In this study, the author wants to use the CNN method because this method gets a lot of verification results that are quite good. One of them is in research [4] with an average rate of more than 87%. Then in research comparing CNN with Extreme Learning Machine (ELM), while CNN performance results get higher accuracy, reaching 98.04% [5]. The use of CNN on Tensorflow obtained an accuracy value of 100% which was carried out on fingerprint research [6]. In OpenCV research, circle detection results in accuracy of 95.46% [7].

The suggested solution to overcome this problem is to develop an Android-based cataract detection application. Which will use tensorflow API to validate the eye object then cropping it to get the iris and then collecting the eyes that includes cataracts or normal using the Convolutional Neural Network (CNN) method. From the solution requested, the authors hope that the cataract detection application that will be developed can overcome the existing problems. Therefore, the author wants to conduct research with the title "Development of Cataract Disease Detection Application in the Eye Utilizing the Tensorflow API and Android-Based OpenCV Library".

2. CONTENT OF RESEARCH

2.1 Cataract

Cataract is one of the damage to the eye that is characterized by turbidity in the lens of the eye. Turbidity varies depending on the level of damage due to cataracts. usually takes place slowly and causes visual disturbances. blurring even has the potential to cause blindness if the turbidity on the lens is too thick so that it blocks the path of light entry [8].

2.2 Image Processing

Image processing is a field of science that studies about how an image is formed, processed, and analyzed to produce information that can be understood by humans [9].

2.3 Image Type

The value of a pixel has a value in a certain range, from the minimum value to the maximum value. The range used varies depending on the type of color. But in general the range is 0-255. Images with such depictions are classified into integer images. Here are the types of imagery based on the pixel value [10].

2.4 Color Image

Each pixel of a color image (8 bits) is only represented by 8 bits with the maximum number of colors that can be used is 256 colors. There are two types of 8-bit color images. First, an 8-bit color image uses 256 color palettes with each palette with a specific RGB color map. This model is used more often. Second, each pixel has the following 8-bit format [10].

2.5 Greyscale Image

Gray scale images are digital images that only have one channel value in each pixel, in other words, the value of the red = green = blue part. This value is used to indicate the level of intensity. The colors are black, gray and white. The gray level here is gray with a number of black to almost white levels. The following gray scale images have an 8-bit color depth (256 gray combinations) [10].

2.6 Biner Image

Binary images are digital images that only have two possible pixel values, which are black and white. Image biner is also called a black and white image (black and white) or monochrome. Only 1 bit is needed to represent the value of each pixel of a binary image. Binary images often appear as a result of processing, such as segmentation, flotation, morphology, or filtering. [10].

2.7 Artificial Intelligence

Artificial Intelligence or artificial intelligence is also part of computer science to find out computer machines can do work like humans or maybe can be better [11].

2.8 Convolutional Neural Network

Convolutional nerves & networks are one of the machine learninq methods & to develop multilayer perceptron (MLP) which are desiqned to process two & dimensional data. CNN is included in the type of deep neural network because of its deep tissue level and is widely implemented in image data. CNN has two methods; that is, classification & use of feedforward and stages of learning using & backpropagation. The way CNN works is similar to MLP, but on CNN each neuron is presented & in two dimensions, unlike MLP, where & each neuron has a size of only one dimension.

2.9 Systems Analysis Method

Systems & development methodologies are formal & appropriate systems & development processes that define a set of methods, best practices, and activities & tools for developers and managers. Systems analysis is an individual or group that conducts development & systems, systems analysts & studies the problems and needs of a system and systems & analysis is also the person & responsible for the analysis & design of information systems.

2.9.1 *Object Oriented Programming (OOP)*

OOP (Object Oriented Programming) or better known as Object Oriented Programming is an object oriented programming paradigm. All data and functions in these paradigms are wrapped in classes or objects.

2.9.2 UML

Unified Modeling Language (UML) is a language that has become an industry standard for viewing, designing and documenting software systems. UML is used to design model a system. We can create models for all types of software applications, they can run on any hardware, operating system and network, and they are written in any programming language. Because UML uses classes and operations in its basic concept, UML is more suitable for writing software in object-oriented languages such as C ++, Java, C # or VB.NET [20].

2.10 System Testing

System testing method to determine the effectiveness of the software used, in addition to providing an opportunity for users to operate and verify reports generated through software. The system testing method consists of a white box test and a black box test [12].

2.10.1 Blackbox Testing

Tests carried out for the software interface, this test is done to show that the functions work well in the sense that the input has been received correctly and the outputs produced are correct, the integration of the extrenal data runs well.

2.10.2 User Acceptance Testing

User acceptance tests are conducted in the application to find out answers and evaluations of application users, then the calculation is done using a Likert scale where the data is analyzed by

calculating the average responses based on the score of each respondent's responses then added up.

3. RESEARCH METHODS

Research methodology is used as a guideline in conducting research so that the results achieved do not deviate from the objectives being carried out, and can be used to solve a problem. In this study the methodology used has stages that can be seen in Figure 1.

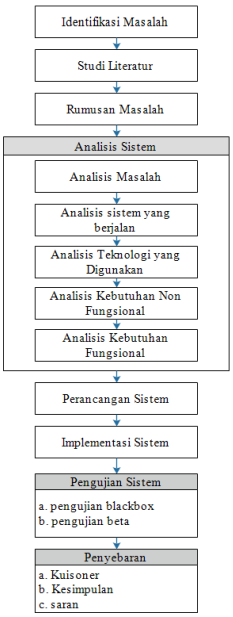

Figure 1. *Research Methodology*

3.1 Identification of Problems

This stage is the beginning of research by formulating problems that occur on the research topic. In identifying this problem, researchers analyzed and evaluated problems regarding the application of cataract detection.

3.2 Study of Literature

This stage the researcher refers from various sources both from books and the internet that is used as a reference to obtain data and theories needed to support in conducting further research.

3.3 Formulation of The Problems

This stage is to formulate the problem. This stage is very important to be done so that the formulation of the problem becomes clear because it is based on facts and data in the field and as an initial form that in scientific research it really requires solving problems through research. The formulation of this research is how to develop technology for cataract detection applications.

3.4 System Analysis

At this stage where there is a problem analysis stage, a system analysis that is running, technology analysis, nonfunctional requirements analysis and functional requirements analysis.

3.5 Software Development

The method used for software development is the waterfall pressman method. Waterfall is an example of a planning process, where all activity processes must be planned and scheduled before they are done. The process of the waterfall method includes Communication, Planning, Modeling, Construction and Deployment.

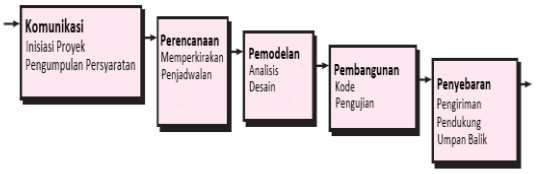

Figure 2. *The Waterfall Pressman Aplication Development Method*

3.6 Testing

The testing phase is the testing phase of software that is developed. The test that will be performed for cataract detection applications aims to test the application that has been built and observe whether or not there are deficiencies in the application. The system testing method uses the BlackBox approach and User Acceptance Testing.

4. RESULTS AND DISCUSSION

4.1 Discussion Analysis

The first problem is that other circles besides the iris can still be processed by the system which makes the system process objects other than its destination. The second problem is the detection of cataracts in the previous application for one eye at a time. The third problem is the level of accuracy that has not been identified from the results of the previous application test.

4.2 Architectural Analysis

Analysis of the system architecture built can be seen in Figure 3.

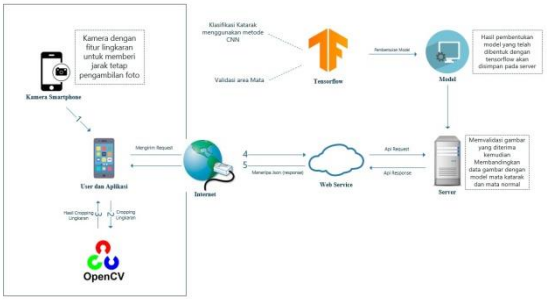

Figure 3. *System Architecture*

System architecture analysis is an analysis of architectural design in cataract detection applications. This application can detect cataracts in sufficient light conditions. The application is built based on mobile, this application serves to assist the community in detecting eye cataracts. In using this

application the user needs a smartphone as a tool to run the cataract detection application.

4.3 System Modeling

4.3.1 Analysis of Non-Functional Needs

Non-functional requirements analysis is a needs analysis outside the function of the system, this analysis consists of hardware analysis, software analysis, and user analysis.

4.3.2 Analysis of Functional Needs

Functional requirements analysis is the process of describing the activities needed by a system so that the system built runs well and in accordance with needs. System modeling is modeled using a use case diagram.

4.3.2.1 *Use Case* Diagram

Use case diagrams explain the expected functionality of a system. In the use case diagram, what the system does and the way the system works is emphasized. A use case represents the interaction between the actor and the system. The use case diagram in this system can be seen in Figure 4 below:

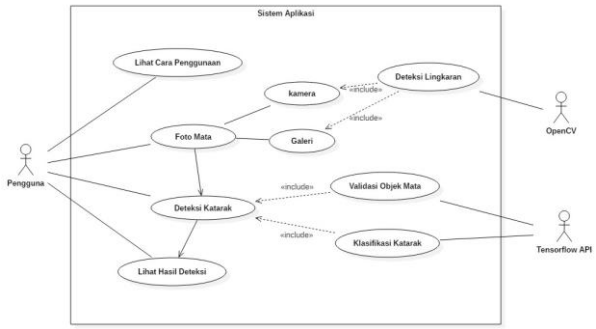

Figure 4. *Use Case Diagram*

4.3.2.2 Definition of Actor

A reactor is another person, process or system that interacts with the system to be built. Here are the several actors in the system to be built that can be seen in table 1:

Table 1. *Definition of Actor*

No	Aktor	Deskripsi
1	Pengguna	Pengguna adalah orang yang menggunakan aplikasi deteksi katarak
2	*Tensorflow*	*Tensorflow* API sebagai system yang akan memvalidasi objek mata pada aplikasi
3	*OpenCV*	*OpenCV* sebagai system yang akan melakukan cropping pada iris mata

4.3.2.3 Identification of Use Case Diagram

Here is the identification of the Use Case contained in the system to be built.

Table 2. *Identification of Use Case Diagram*

No	Use Case	Deskripsi
1	See How to use	Functionality for application users to see how to use cataract detection applications
2	Eye Photos	The functionality for application users to take eye photos that will be detected
3	Cataract Detection	Functionality for application users to detect cataracts
4	See Detection Results	The functionality for application users to see the results of cataract detection
5	Circle Detection	The functionality carried out by the system to detect and crop the iris circles
6	Eye Object Validation	The functionality of the system to validate the object to be detected
7	Cataract Classification	The functionality of the system to classify iris cataracts and normal iris

4.4 Implementation Design

4.4.1 Interface Design

Following is the main menu interface design can be seen in Figure 5.

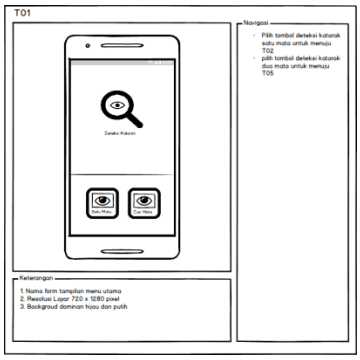

Figure 5. *Main Menu Interface*

Next is the design of the two-eye cataract detection interface can be seen in Figure 6.

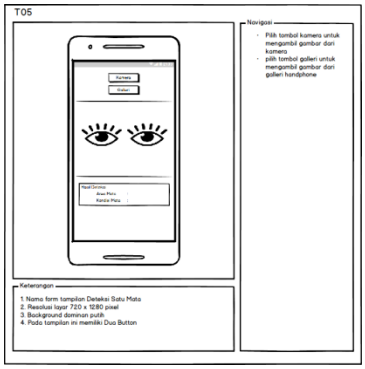

Figure 6. *Dual Eye Cataract Detection Interface*

The following is the interface design of the detection of two eyes can be seen in Figure 7.

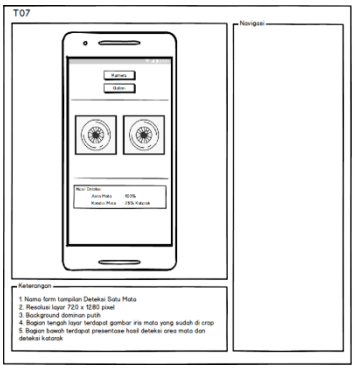

Figure 7. *Interface Detection Results Two Eyes*

4.4.2 Menu Structure Design

Following is the design of the menu structure can be seen in Figure 8.

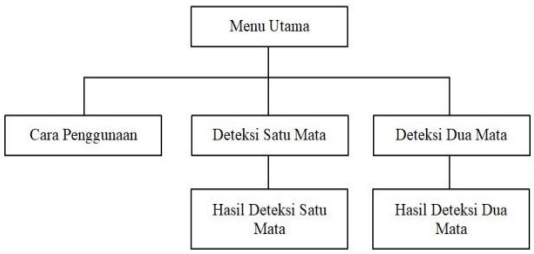

Figure 8. *Menu Structure*

4.4.3 Semantic Design

Here is the semantic design can be seen in Figure 9.

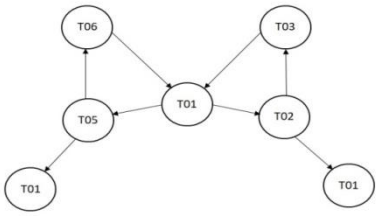

Figure 9. *Semantic Design*

4.5 Testing and Test Result

4.5.1 Blackbox Testing

The black box test focuses on the functional requirements of the software being made. The stages of functional tests that will be carried out include the black box test scenario and test cases and results.

4.5.1.1 Blackbox Testing Result

Depending on the results of the blackbox testing that has been done, it can be concluded that the system that is created works as expected. Of all the things that have been done in this test, it is expected to represent testing other functions in the system being built.

4.5.2 User Acceptance Testing

The user acceptance test is an objective test where the test is carried out directly to the user whose purpose is to determine the quality of the system in the cataract detection application that is built. User acceptance tests are conducted by investigating respondents or potential users of the application to determine the qualifications of the application user.

4.3.2.4 User Acceptance Testing Result

Based on the results of user acceptance testing conducted with an observation questionnaire, it can be concluded in the cataract detection application in the eye. The following is the recapitulation of the results of user acceptance testing.

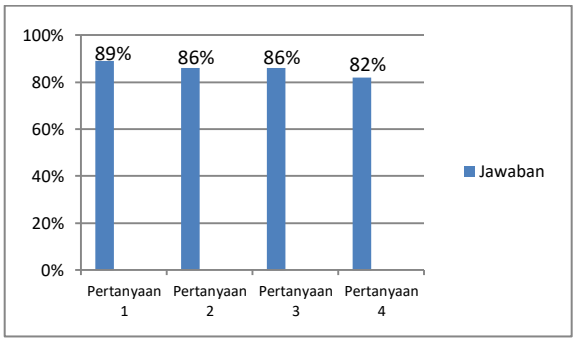

Figure 10. UAT *Test Result Graph*

5. CONCLUSION

Based on the test results obtained from the research conducted in the preparation of this thesis and referring to the research objectives that have been made, it can be concluded that:

a. *This cataract detection application in the eye can validate eye objects with an accuracy value of 86%.*
b. *This cataract detection application can assist users in making eye detection for one pair of eyes.*
c. *The CNN method implemented in the cataract detection application is able to detect cataracts with an accuracy rate of 90%.*

Based on all the results that have been achieved in the preparation of this thesis. As for suggestions that can be used as a reference for the development of cataract detection applications in the eye in the future, namely:

a. *It is expected that this cataract detection application can be developed with a history of detection, so that users can detect it routinely.*
b. *It is expected that this cataract detection application can be developed by adding other types of diseases to the eye besides cataracts.*

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