Designing an Android-Based Burn Rate Pattern Detection Application Model

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Abstract

In the medical area, the role of computer in pattern recognition of a disease is very much needed. It can be help for making treatment decision by first knowing the pattern of the disease. One of this model is the initial pattern recognition of burns that experienced by patients. Detecting the initial pattern of burn rates on the body will help the medical team immediately make decisions regarding patient burn level. To detect the initial pattern of burn rates, the appropriate method is to use the fisherface algorithm. This algorithm is used because of the ability to extract important information in imaging burn patterns on the body through the calculation of the average vector matrix and the covariance matrix in the pattern imaging database. In the process, the fisherface algorithm will generate an eigenface which is used for pattern recognition. Eigenface is the basis for calculating the burn patterns value on the body which represent the individual values for one or more pattern images of the burns on body. The using of fisherface and eigenface enable us to detect the degree of burns. The computational process will help in determining the degree of burns on body through facial recognition software.

Keywords
burns, fisherface, eigenface, pattern recognition, android

1. Introduction

The development of science in all fields in the current era of globalization is very fast (especially in the IT field). This development makes a lot of work done by humans replaced by computerized systems that are cheaper and optimal, but still reliable. The medical world has not been spared from the rapid development of information technology. Currently there are many medical devices that implement computers in their equipment, including electrocardiogram (ECG machines) and so on, which function to assist medical decision making. In the medical world, many cases of burns are handled. These burns have many causes, including hot fluids (water, oil, sauce), fire (fuel, kerosene, LPG (Liquefied Petroleum Gas)), electricity (PLN (Indonesia's National Electricity Company), lightning), chemicals (acids, alkalis, cosmetics), and radiation for example (sun, radiotherapy, explosion).

To overcome all these problems, the initial detection of the level of burns on the body will be carried out automatically where the system will send a notification message when the patient's body is detected. The body burns pattern recognition becomes a solution for now. In its implementation, in general, the patterns recognition of the body burn is carried out through a camera or webcam to capture a person's body image, which is then compared with the burn pattern image on the body previously stored in the database.

This study makes an application to detect the initial pattern of burns on the body using the fisherface method and Android-based MATLAB software. The scope of this research is limited to recognizing the pattern of burn rates on the patient's body at the time of taking the body. The application for detecting levels of burn rates on the body is built only to confirm the level of burns to the body and data storage media in the form of MySQL. The lighting environment for capturing the image of the burn pattern on the body must be bright with a light intensity value of more than 150

Lux. The distance between the body and a webcam or similar camera is approximately 50-70 cm to get an image of an ideal body burn pattern with the body facing the camera. And a better light coloring system is the grayscale color system, provided that each RGB color consists of 24 bits, each of which has 8 bits for Red, Green, and Blue.

2. Research Literature

2.1 Pattern Detection

Pattern detection or commonly known as pattern recognition has a basic principle, namely quoting the unique information possessed by the pattern, then it is encoded and compared with the results of the previously performed decode (Suprianto, et al, 2013). Besides that, each pattern is represented in a linear combination of eigenface (Suprianto, 2013). The eigenface method is how to decompose relevant information from an image of a pattern on the body, then into the most efficient set of codes and compare the body pattern code with a database containing various body patterns that have been coded similarly.

2.2 Burns

Burns are heat trauma caused by hot water or steam, electric current, chemicals, radiation and lightning hitting the skin, mucosa and deeper tissues, causing damage or loss of the outer skin (Noer, et al, 2006). There are many causes of burns, including hot fluids, fire, electricity, chemicals, and radiation which can also be one of the causes of skin burns. The consequences of burns are very dangerous, including skin damage (ulcus marjolin), infection (sepsis), loss of electrolytes and protein, kidney failure, respiratory failure (ARDS), gastric disorders (curling ulcer), blood damage (anemia, DIC).), and others. The rate of burns caused by burns can be seen in Table 1 (Tintinalli, 2010).

Table 1. Burn Rate and Effects

Level	Skin Layer	View	Texture	Prognosis	Example
Superficial (Degree I)	Epidermis	Red, without blisters	Dry	Healed well, can cause skin cancer if continuously exposed to sunburn	
Superficial (Degree IIa), affecting some layers of skin	Extends into the superficial dermis (papillary) layer	Red, with obvious blisters. Pale pressed.	Moist	Localized infection or cellulitis, usually without scarring	
Deep enough, hit some layers of the skin (Degree IIb)	Extends into the deep dermis (reticular) layer	Yellow or white. Less pale. Maybe blister.	A little dry	Scarring, Wrinkles (may require excision and skin grafts)	
The entire skin layer (Grade III)	Extends throughout the dermis layer	Stiff and white or brown, Not pale	Rough	Scarring, wrinkling, amputation (early excision recommended)	
Degree IV	Extends throughout the skin, and into the underlying fat, muscle	Black; charred with eschar	Dry	Amputation, significant functional impairment, and in some cases death	

Level	Skin Layer	View	Texture	Prognosis	Example
	and bone layers.				

Based on Table 1, this study will focus on the degree (degree) caused by burns suffered by the sufferer. The degrees that will be the initial detection of burns are Grade I, Degree IIa, Degree IIb, Degree III, and Degree IV. This degree of detection will be measured by imaging the new incoming image and then matching it to the image that is already stored in the database.

2.3 Fisherface Method

Body recognition systems such as case studies for student attendance apply the fisherfaces algorithm because the fisherfaces method can handle variables in lighting conditions, and so on (Rada, 2017). While another research found that this method tries to find a linear subspace that maximizes the separation of the two pattern classes according to Fisher Criterion (fisher criteria weight) (Putra, 2017). This can be obtained by minimizing the distance within-class Sw distribution matrix and maximizing the distribution matrix distance between-class Sb simultaneously to produce maximum fisher criterion.

Everything depends on the type of body recognition, the required features can be local characteristics of the body such as nose, eyes, mouth, etc., as well as global characteristics of the body (all parts of the body) (Fandiansyah, 2017). Fisherface method uses all parts of the body as data in its introduction. For the output data to be analyzed, namely the results of body recognition that are recognized by the system in the form of labels from labeled images, the accuracy of the body recognition process when carried out with a test scenario, and the time required for the recognition process on mobile (Saragih, 2007).

The stages of the fisherfaces calculation process can be explained as follows (Sugihartono, 2018):

a. After obtaining the facial data from preprocessing, the data is converted into a vector matrix and the result will be a matrix, then the results from the vector matrix then form a class.
b. The next step is to normalize the input face image to the average value of the training set (average face, Ψ),
c. Then look for the average value of each class against the projection value.
d. In the next stage, looking for a scatter within class matrix with the intention of finding the distance between classes and looking for a scatter matrix between classes with the intention of finding the distance within the class itself.
e. Then look for the covariance value which is the input from the scatter between class matrix values multiplied by the inverse of the scatter within class matrix. Next, look for the eigenvector and eigenvalues.
f. After obtaining the eigenvalue value, then sorted from largest to smallest corresponding to the eigenvector index and then projected against the normalized value as a projection matrix, and
g. The data from the projection matrix is used as input in classifying with the aim of finding the neighborhood value and finding the closest minimum value.

2.4 Literature Review

Face recognition using Haar cascade classifier and fisherface algorithm discusses the illumination normalization technique which is useful for improving image quality so that facial images can be recognized properly and have high accuracy. The cascade classifier algorithm and fisherface algorithm produce an accuracy rate of 90.9% (Sugihartono, 2018).

Another research aims to detect and recognize a person's face using the LBP cascade and fisherfaces methods. As a result, the application of the fisherfaces algorithm for facial recognition systems for the presence of students using an Android-based smartphone got excellent results with an accuracy rate of 93.33% (Putra, 2017).

The results of implementing the algorithm in the application were tested based on the experimental design made. Through the experimental design, what will be tested is the speed and accuracy of the application in terms of detecting visual hacking. The result of this study, the facial recognition algorithm is successful implemented and successfully detected threats visual hacking in testing by design experiments and 5 scenarios, with velocity times 2,7003 seconds of detection and 94% facial recognition accuracy (Alexander, et al, 2017).

Based on the test results in research it was obtained 13 successful tests and 2 failed tests. This failure is caused by a significant difference between the test image and the proper training image. The prototype facial recognition system with the PCA algorithm and Euclidean distance is designed to correctly recognize 13 out of 15 test face images. The accuracy rate of this prototype is quite good, which is 86.67% (Tommy, 2017).

Most of their research emphasis was only on the accuracy of recognition accuracy, both facial recognition and other recognition, and how fast the process was required. It is inversely proportional to this study which identified the level (degree) of the pattern caused by burns on the patient's body.

3. Research Methodology

The development model used in pattern recognition using the fisherface method is a prototype model. The following is an explanation of the stages in the Prototype development model:

3.1 Collection of Requirement

The initial stage in system planning from the development of an implementation system for early detection of burn rates in patients with the fisherface Method is as follows:

a. The data needed in this pattern recognition is in the form of burns on the body for the program's training mode to be run.
b. Work plan or work schedule.
c. Project team involved in system planning

3.2 Building a Prototype

Researchers used a pattern recognition mode for body burns that would be entered from each person. And then the results of the training generate data from each burn patient. In training the shooting process in bright lighting, this can affect body detection taking. The patterns recognition of the body burn is processed at the pre-processing stage, then the unique information contained in the patterns recognition of the body burn will be extracted its features. Then the data will be used when testing so that the test results will come out.

3.3 Prototype Evaluation

This evaluation is carried out by the user whether the prototype that has been built is in accordance with the wishes. If it is appropriate, then step 4 will be taken. Otherwise prototyping is revised by repeating steps 1, 2, and 3.

3.4 System Coding

The prototype that has been made will be translated into Python version 27.

3.5 System Testing

After the system has become a software that is ready to use, it must be tested first using a Black Box.

Body image recognition method used is fisherface, with body image detection in an input image using the Haar-Like Feature method. The data sample that can be used is in the form of real-time image capture using a webcam and provides solutions to these problems using the python27 programming language.
The research steps carried out can be seen in Figure 1.

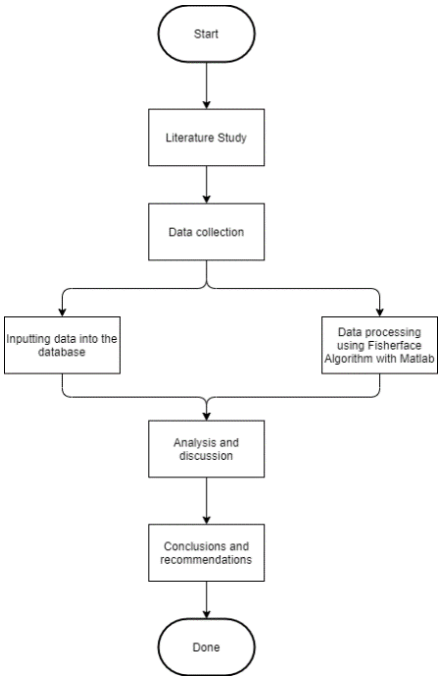

Figure 1. Research Steps

The research location chosen was the capital city of Bangka Belitung Islands Province, Pangkalpinang City. Pangkalpinang City was chosen because this city was once recorded as the city with the most lightning strikes during heavy rains. Lightning strikes are an indicator of the causes of burns in humans. Wounds caused by lightning strikes can be as high as level 4 in burns level or severity. Not only that, there are tin mining around Pangkalpinang City. Tin mining can also because fires caused by the heat of the liquid to melt tin.
In this study, the system analysis technique used is to find background information on the case study. This analysis process is useful for providing alternative forms that are proposed as a problem-solving technique.

4. Result

The development model used in pattern recognition using the Fisherface method is a prototype model. The following is an explanation of the stages.

4.1 Analysis and Design

The screen design for the main menu on Android consists only of the welcome Splash Screen, and then goes to the burn pattern image capture page. The main menu screen design can be seen in Figure 2.

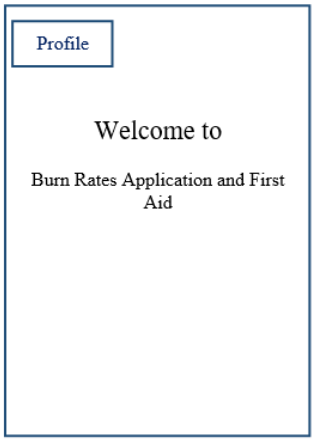

Figure 2. Main Menu Screen Design

The screen design consists of an image space using a cell phone or smartphone camera media. For more details, the image capture menu screen design can be seen in Figure 3.

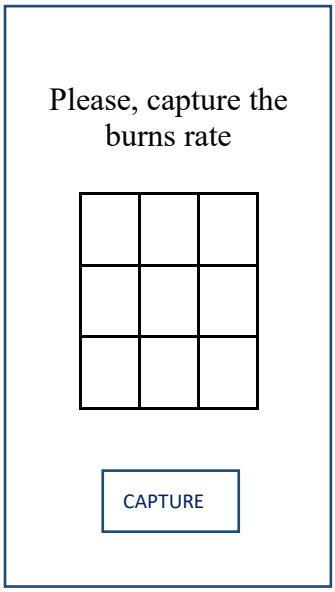

Figure 3. Image Capture Menu Screen Design

Screen design results of burn information can be seen in Figure 4.

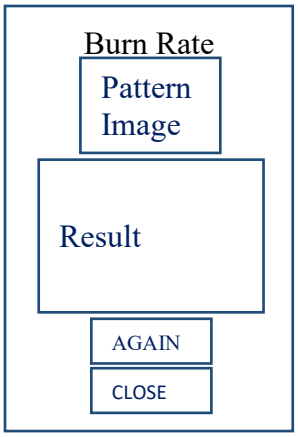

Figure 4. Burns Information Screen Design

4.2 Design and Application Development Stage

The design and prototype manufacturing stages can be seen in Figure 5.

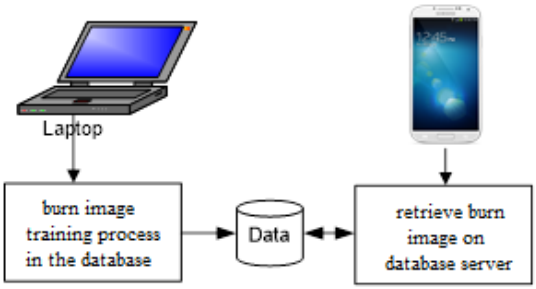

Figure 5. Design and building of a burn recognition system prototype

In Figure 5, it consists of 3 (three) processes, namely the training process, the testing process, and training data input to recognize or identify the level of burns experienced by patients.
As for the design of the burn recognition system on mobile devices, it can be seen in Figure 6.

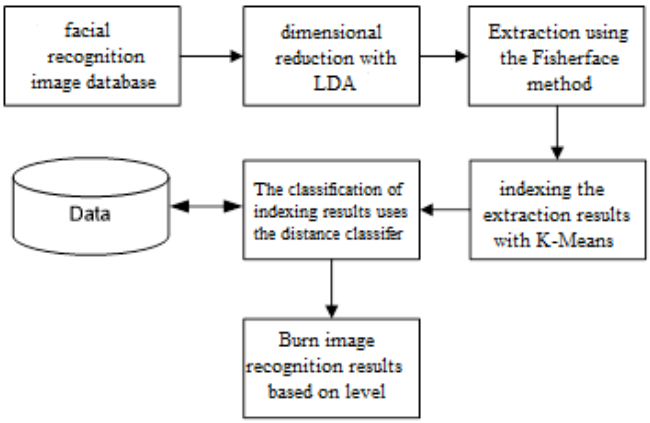

Figure 6. Burn recognition system design on mobile

From Figure 6, the K-Nearest Neighbor (KNN) algorithm can also be entered, which functions to find groups of objects in training data that are closest (similar) to objects in new data or training data. In addition, to assess system performance, the Bray Curtis Distance method will be used. This method was chosen because the performance processing time is faster than other methods in measuring the object recognition process.
After the screen design is made, the application must be implemented to accommodate all the information retrieval processes about the level of burns and their handling. The main menu in the application can be seen in Figure 7.

Figure 7. Main Menu Application

On the image capture menu, there is only one “CAPTURE” button that functions to capture burn images, and one shooting area to match the position of the burn pattern during shooting. For more details, see Figure 8.

Figure 8. Image Capture Menu

The burn information menu contains information about the results of taking images of burn patterns. The information displayed includes the results of taking the image or the image of the burn pattern, information about the detected burns that result from taking the burn and its treatment, the button again and the exit button. For the button again when the picture is not right or not bright and bright. As for the exit button, end all processes, and exit the application. For more details, you can see the burn information menu in Figure 9.

Figure 9. Display Burns Information Application

4.3 Database Design

The design of the database is done to make a match between taking pictures in the field with the data that has been stored, so that learning occurs in the database itself. The data needed when matching included the category of wound, thickness of the wound, color image, and type to determine the burns degree suffered by the patient on a mobile basis. The database here uses MySQL and XAMPP. For more details, see Figure 10 for the structure of the burn database.

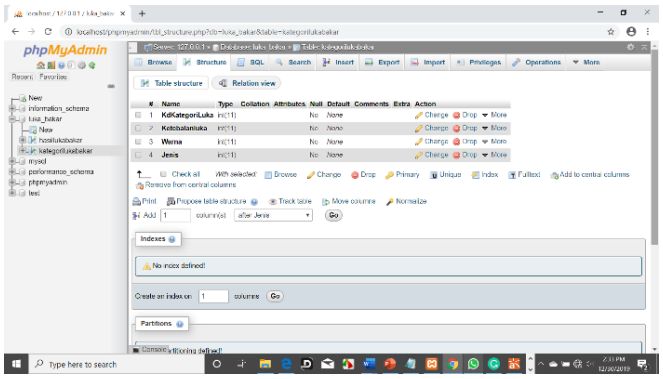

Figure 10. Burns Database Structure

4.4 Algorithm Analysis Phase

The algorithm analysis stage is preprocessing and then processed into the fisherface method. At the preprocessing stage, the incoming pixels have various intensities. Due to this diversity of pixels, the task of preprocessing is to limit the intensity of the input. Once limited, you can then convert the image to grayscale. This is done to simplify the image model that is entered into the database and new data. The formula for converting an incoming image to grayscale can be seen in equation 1.

$$f_0(x,y) = \frac{f_i^R(x,y) + f_i^G(x,y) + f_i^B(x,y)}{3} \quad (1)$$

The lowest intensity value is represented by black, and the highest intensity value is represented by white. After that, enter the thresholding image stage, due to changing the grey degree image into a binary or black and white image. For more details, the use of the fisherface method can be seen in Figure 11.

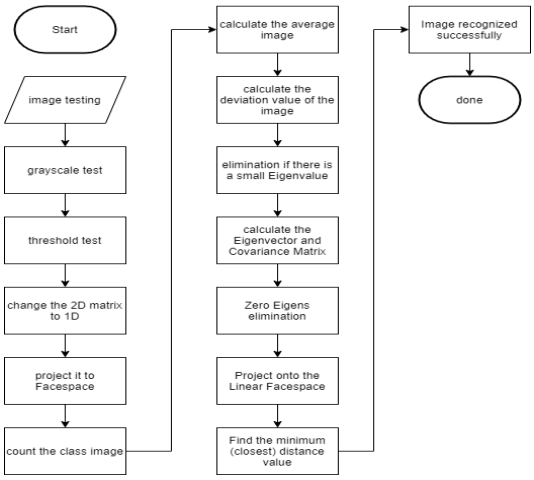

Figure 11. Flow chart of the stages of the process of image recognition burns using the fisherface method

The combination of a mobile phone and burn level image recognition in patients using the fisherface method can be seen in Figure 12.

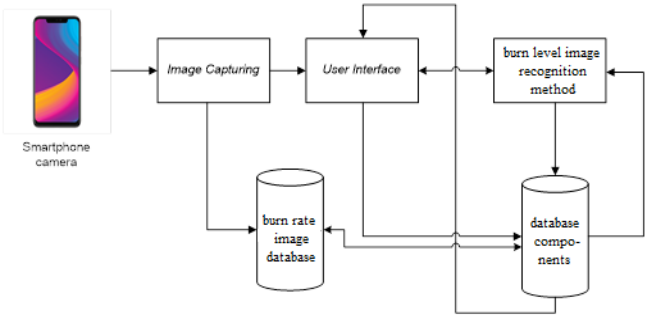

Figure 12. The relationship between smartphone function and burn rate image processing using the fisherface method

As for the system development tools or analysis and design tools used to support the software development process in this study is Unified Modelling Language (UML). The various UML diagrams used as a system development aid in this study include:

a. Use Case Diagram

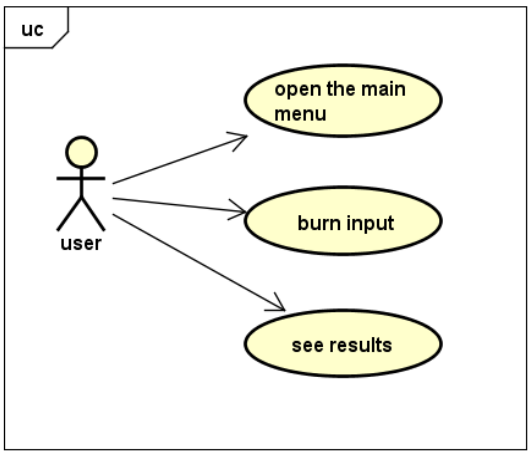

Figure 13. Use case Burns Detection Diagram

Actors in the implementation of this research are humans, which is how the admin can add data, notification settings, send notifications, record data and capture body image objects from the camera phone as training data. As for the use case diagram, it can be seen in Figure 13 before.

b. Sequence Diagram

In this study, using a Sequence Diagram to describe the sequence in body recognition, especially the level of burns. The sequence diagram used consists of the main menu sequence diagram, body data training sequence diagram, and body burn recognition sequence diagram.

c. Activity Diagram

In this study, using an Activity Diagram to describe the pattern recognition activity of the level of burns in this study consisted of an Activity Diagram of the main menu, an Activity Diagram of training on burn rate pattern data, and an Activity Diagram for pattern recognition of burn rates.

4.5 Application and System Testing

System testing is carried out using black box testing to find errors in system functions and the entire menu on the interface. This study uses Blackbox testing with Graph-based method. There are two focuses of functional testing, namely the system's ability to recognize the burns images with good lighting and good resolution. The test graph is as shown in Figure 14. Furthermore, the system's ability to recognize burns images with blurry image quality and dark lighting is tested as shown in Figure 15.

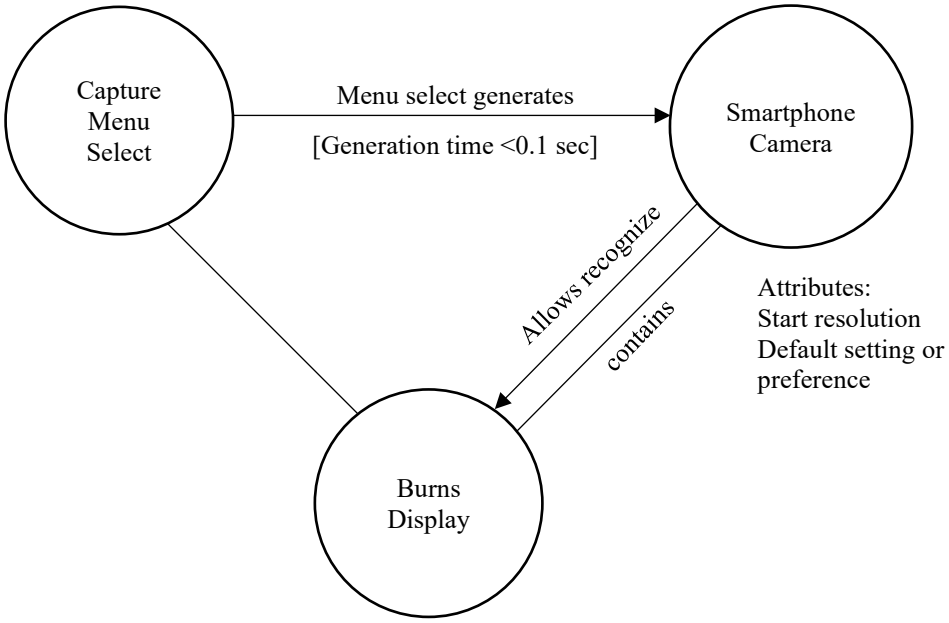

Figure 14. Graph-based Diagram for Clear and Bright Images

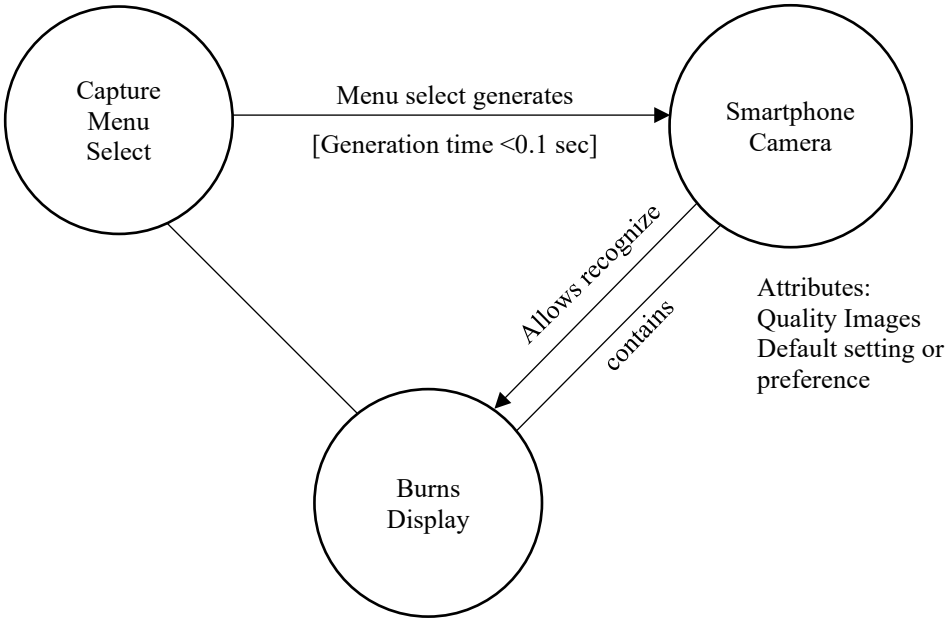

Figure 15. Graph-based Diagram for Blurry and Dark Images

The results of the test are shown in Table 2 where for good resolution images and good lighting results, the system is able to recognize the image well. In addition, for blurred images with dark lighting, the system rejects the image because it is considered bad quality.

Table 2. Black Box Testing Results

No.	Testing Scenarios	Expected results	Test result	Conclusion
1.	Capture burns image patterns	Clear and bright	According to expectations	Valid
2.	Capture burns image patterns	The system will reject blurry and dark images	According to expectations	Valid

From the results of table 2, it is known that all test scenarios carried out through Black Box testing are declared valid. This is then followed; the application can be used in the field.

5. Conclusion

Based on the results of the research that has been done, it can be concluded that the application of detecting the burns degree in patients can be used in the field. In addition, the algorithms embedded in this application can run properly. For the suggestion, it can be proposed further development such as the addition of an emergency call feature in the application, especially for burns degree 2B (partial thickness) and burns degree 3 (full thickness).

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