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Potential Detection Application of Nodular Melanoma on Melanocytic Nevi Image Based on Android

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Abstract*: Nodular melanoma is a deadly rare type of skin cancer. Nodular Melanoma has characteristics asymmetrical shape, border irregularity, nonhomogeneous or has several color variations and the diameter is more than 6 millimeters. Nodular melanoma has a physical form similar to melanocytic nevi, therefore nodular melanoma can be detected from melanocytic nevi spread throughout the body. This research aims to detect nodular melanoma through melanocytic nevi by utilizing the android system in order to ease the user by using camera smartphone in detecting cancer. This application uses image processing and feature extraction of the ABCD method to process images with decision tree c4.5 classification method to detect potential of nodular melanoma diagnosis from melanocytic nevi image. The ABCD method is a medical method used to detect the possibility of skin cancer using 4 parameters including asymmetrical shape, border irregularity, color and diameter. Decision tree c4.5 is classification method that using entropy and gain to make rules of decision tree. The image data test is obtained from the results of the android-based smartphone camera shooting and from medical record. Output of this application is a diagnosis condition of melanocytic nevi is healthy or nodular melanoma potentially. The accuracy of this application is 97.5%.

***Index Terms*: Nodular Melanoma, Android, Image Processing, Smartphone, ABCD.**

I. INTRODUCTION

Melanocytic nevi is a pigmentation disorder of the skin in the form of spots on the surface of the skin that has a blackish or brownish color. In general, melanocytic nevi are benign and have been present since birth. The shape and condition of melanocytic nevi in each person is different.

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The condition of a melanocytic nevi can indicate a person's skin health condition. This is what has not been widely known and is often ignored by society. One deadly disease that has a physical form similar to melanocytic nevi is nodular melanoma skin cancer. Nodular melanoma is a type of melanoma skin cancer. Melanoma is a type of deadly skin cancer that attacks the cells of melanocytes that produce skin-forming pigments [2].

Nodular melanoma is characterized by nodules or lumps. Symptoms of nodular melanoma begin with a condition that is not common in the melanocytic nevi [2]. In health, this unusual condition is known as ABCD [6]. ABCD is a method for detecting the potential of cancer in the physical condition of the skin by using the parameters Asymmetry, Border, Colors, Diameter [6]. The ABCD method can be used in image processing to detect the nodular potential of melanoma digitally. Image processing is the process of transforming images in the form of computation [7]. By implementing the ABCD method as feature extraction in image processing, information can be obtained whether the melanocytic nevi image is healthy or has potentially nodular melanoma. In 2019, it is estimated that there will be 96,480 new cases of melanoma in the United States and 7,230 deaths from this disease [5]. Age of sufferers of this disease is between 20 - 65 years old [2], at this age range is also an android smartphone user who uses smartphones in various daily activities. So from that this application was made to make it easier for every android user to check the condition of their melanocytic nevi and care more about the condition of the skin.

II. RELATED WORK

Many research on the detection of melanoma uses image processing using dermoscopy images [9]. Existing research produces good detection results, but requires dermoscopy images for accurate results [8], to get dermoscopy images requires third party tool that is dermatoscope. In the ABCD method, the calculation of diameter parameters is still manual by using total dermatoscopic value or TDV [10]. Research on automated malignant melanoma detection using MATLAB [4] provides a solution by applying a value of total dermoscopic score or TDS. TDS is defined by TDS = A*1.3 + B*0.1 + C*0.5 + D*0.5, with a maximum score of 8.9, where: A = Asymmetry (0-2 points), B = Border (0-8 points), C = Color (0-6 points), D = Diameter or Differential structures (0-5 points).

A high ABCD score means that the lesion is more likely to be a malignant melanoma if TDS > 5.45 [10]. The MATLAB solution is pretty good but still desktop-based, which makes users to have a personal computer or laptop. Deep learning ensembles for melanoma recognition in dermoscopy images [3] research provides very accurate accuracy. The problem is deep learning is using image to compare of healthy melanocytic nevi image and nodular melanoma, this method is color based by utilizing color histograms and neural networks to train image dataset. Even though according to dermatologists the detection of the potential for melanoma must see the condition of ABCD from melanocytic nevi.

III. METHOD

The method used in this system is the ABCD method in feature extraction and the c4.5 decision tree method to classify feature extraction results into diagnostic results. The ABCD method has 4 parameters, namely asymmetrical shape, border irregularity, color and diameter.

A. *Asymmetrical Shape*

The form of a benign melanocytic nevi is symmetrical which means it has a side that can fit together if it is halved and folded, while nodular melanoma has an asymmetrical shape which means it has a different side when it is halved and folded.

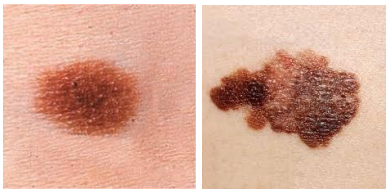

Fig.1 Melanocytic Nevi (left) and Nodular Melanoma (right) []

By applying the calculation of moment of inertia and asymmetry index, we get a value that distinguishes between asymmetrical or symmetrical forms of an image [1]. First determine the origin in the Cartesian coordinate. This point is set at the center of mass (G) of the area of a wound (L), where L is defined as a binary function z (I, j) = 1, if (I, j) ∈ L, besides it is 0. Then, look for the value of the quadratic inertial moment I (φ) of a wound image (L) that corresponds to any axis passing through the center of mass (G).

$$I(\varphi) = \sum_{(i,j)\in L} D_{\varphi}(i,j) \quad (1)$$

Information:

I(φ) = moment of quadratic inertia

$D_{\varphi}(i,j)$= Distance between pixels (i, j)

From the results of the moment the quadratic inertia gets the major and minor intersection axes. Then the next value of the asymmetry index.

$$AI = \frac{1}{2}\sum_{k=1}^{2} \frac{\Delta Ak}{A_L} \quad (2)$$

Information:

k = n main axis

ΔAk = non-overlap area when the object is folded

AL = the area of the object

Based on the calculation of the asymmetry index with 160 image dataset, nodular melanoma has AI value more than 0.099.

B. *Border Irregularity*

Melanocytic nevi have regular border which means that the periphery of nevi is clearly seen due to the consistency of color, whereas nodular melanoma has an irregular border which means that the margins of melanoma are not clearly caused by color inconsistencies in the melanoma so border is not clear.

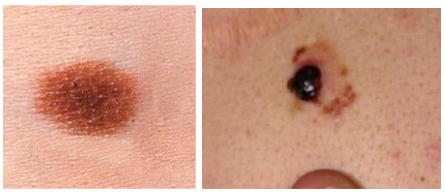

Fig.2 Melanocytic Nevi (left) and Nodular Melanoma (right) []

The calculation of border parameters is using sum of absolute differences to the calculated the irregularity and regularity image.

$$SAD = \sum_{i=0}^{n}(Gb(x,y) - G(x,y))^2 \quad (3)$$

Information:

SAD = sum of absolutes differences

Gb (x, y) = gaussian blur matrix;

G (x, y) = gaussian kernel matrix

Based on the calculation of sum of absolutes differences 160 image dataset, nodular melanoma has value more than 0.7.

C. *Color*

Melanocytic nevi have a homogeneous color such as blackness and brownish, while nodular melanoma has a variety of colors, such as blackish blue.

Fig.3 Melanocytic Nevi (left) and Nodular Melanoma (right) []

The color parameter calculation is the same as the border, except that nodular melanoma which has a non-homogeneous color has a value greater than 0.3.

D. *Diameter*

Diameter of melanocytic nevi is less than 6 millimeters, while nodular melanoma has a diameter of more than 6 millimeters.

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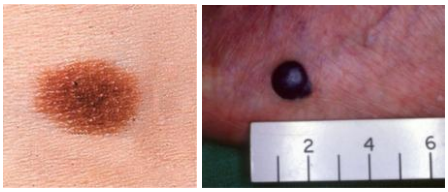

Fig.4 Melanocytic Nevi (left) and Nodular Melanoma (right) []

Calculation of diameter parameters is done by applying the reference object method, that is by using certain objects as a comparison of the size of a particular object.

In this system use coins with a diameter of 23 mm as an object reference. The calculation is done by calculating the Euclidean distance of the reference object first and then calculating the pixels per

metric and after that compared the diameter of the reference object with melanocytic nevi.

$$d = \sqrt{(x_{(i)} - x_{(i)})^2 + (y_{(i)} - y_{(i)})^2} \quad (4)$$

Information:
d = Euclidean distance
x = x axis
y = y axis
i = coordinate

$$P(x) = \frac{d}{Dim} \quad (5)$$

Information:
d = Euclidean distance
P(x) = pixel per metric
Dim = Diameter real coin object reference

$$Dim(A) = \frac{d}{P(x)} \quad (6)$$

Information:
Dim(A) = diameter object detection
d = Euclidean distance
P(x) = pixel per metric

The reference object method in diameter calculation is useful for the solution to the problem of the difference in the size of millimeter distance in pixels.

E. *Decision Tree C4.5*

Decision tree c4.5 is a classification method that uses rules in determining predictive results. The rules in this method are determined by tree formation, the tree value is obtained by calculating the gain value and the highest value as the main root [11].

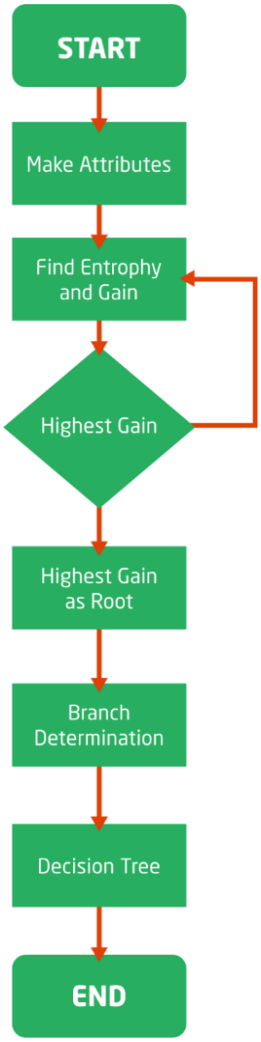

Fig.5 Decision Tree C4.5 Flowchart

Making rules in the decision tree starts with making an attribute based on the output of the feature results from the feature extraction ABCD. The result attribute is 4, namely shape, border, color and diameter, each of these attributes is tested by looking for entropy and gain values. Entropy is a value for measuring the homogeneity or homogeneity of a data set. Higher entropy will be owned by more heterogeneous data, and conversely homogeneous data will have smaller entropy. formula of entropy:

$$Entropy(S) = \sum_{i=1}^{n} -pi\ log_2 pi \quad (7)$$

Information:
S = Case Set
N = Number of Partitions in S
Pi = Proportion of Si to S
Formula of gain:

$$Gain(S,A) = Entropy(S) - \sum_{i=1}^{n} \frac{|S_i|}{|S|} * Entropy(S_i) \quad (8)$$

Information:
S = Case Set
A = Attribute
N = Number of partition attributes A
| Si | = Number of Cases on the partition to - i
| S | = Number of cases in S

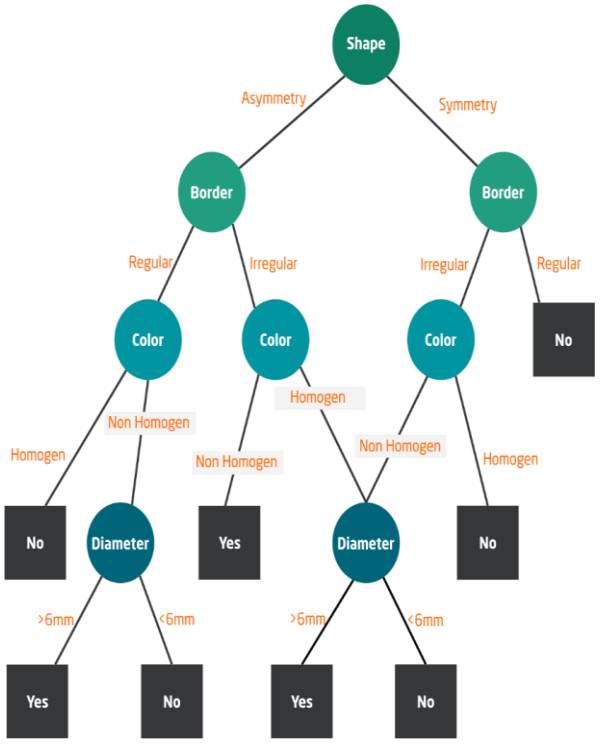

Fig.6 Decision Tree C4.5 System

Based on calculations and interviews from skin specialists, dr. Widiati Sp. KK, the result of the decision tree is if the image has 3 or 4 parameters from ABCD, namely asymmetry shape, border irregularity, color non homogeneous and diameter more than 6 millimeters, then the image has the potential to be nodular melanoma and if the image has 2 or less ABCD parameters, then the image is healthy melanocytic nevi.

IV. IMPLEMENTATION

This application is built by using android studio to create user interfaces and classification results, while for image processing and feature extraction using python.

Python files that contain feature extraction are stored on servers that using Ubuntu operating system. For storing images and connecting between servers and android, this system uses firebase. So images taken from the camera smartphone are uploaded to firebase and then sent to the server for feature extraction.

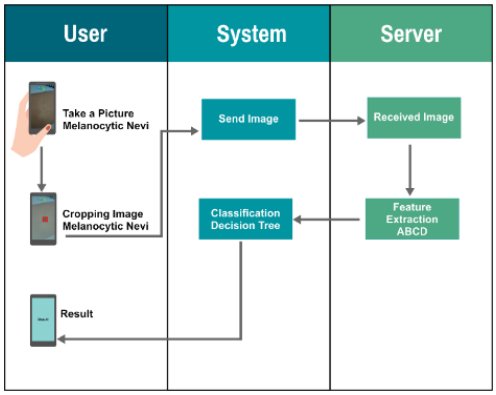

Fig.7 General Description of System

The results of feature extraction are then sent to Firebase and forwarded to Android for classification.

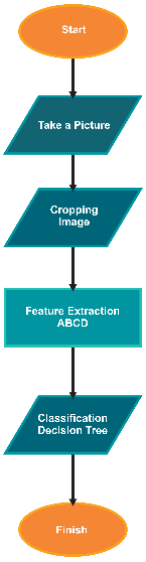

Fig.8 Image Processing Flowchart

The image processing process begins with taking a melanocytic nevi image with a smartphone camera. Then the captured image is cropped by the user and uploaded to firebase. Furthermore, the image is taken again by including the reference object in the form of a coin with a diameter of 23 mm and uploaded to firebase. Firebase that has saved 2 photos of the input will send it to the server for feature extraction. The first photo will be checked asymmetric, border and color, while the second photo will be checked in diameter. The image will be asymmetrical if it has an AI > 0.09, irregular value if SAD > 0.7, non-homogeneous value if SAD > 0.3 and value is true if dim(A) > 0.6. Determination of this value was obtained from 160 images dataset with details of 120 melanocytic nevi images and 40 nodular melanoma images that have been validated by dr. Widiati Sp. KK. The results of extracting features from the server are in the form of strings and sent to firebase and proceed to android for the classification process. The C4.5 decision tree classification system that is on android then processes the shipment from firebase.

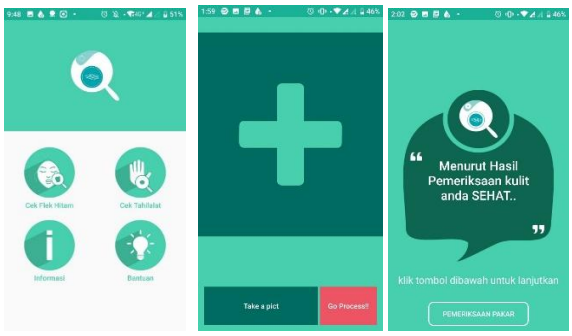

Fig.9 User Interface and Result in this Application

For testing the system uses 160 images dataset. Calculation of accuracy as follows:

$$Accuracy = \frac{Number\ of\ detection\ image}{number\ of\ image\ dataset} \quad (9)$$

Information:

Accuracy = value of accurateness in percent
Number of detection images = 156
Number of images dataset = 160

Table 1. Result Classification

Dataset	The Number of Dataset	Right percentage	Accuracy
Melanocytic Nevi	120	97,5%	97,5%
Nodular Melanoma	40	97,5%	

Based on the test results, this application correctly diagnoses 156 images of 160 total images dataset. The accuracy of this application is 97.5%. The test results have also been validated by dr. Widiati Sp. KK so guaranteed accuracy.

V. CONCLUSION

The potential detection application of nodular melanoma based on android running as expected and can perform image processing and feature extraction as well as a diagnostic classification of the potential for nodular melanoma from melanocytic nevi images with an accuracy rate of 97.5%. This application can help people to detect potential of deadly skin cancer, namely nodular melanoma and care more about skin health.

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AUTHORS PROFILE

Muhammad Alhakim A student who just graduated in 2019 at Telkom University school of electrical engineering majoring in computer engineering. Started to become a researcher since 2018 and only began to publish research results in 2019. His education took place in kindergarten at TK Tunas Harapan in North Aceh and graduated in 2002. Then he continued his junior high school education at PT Pupuk Iskandar Muda Middle School and graduated in 2008. While taking high school education moved to East Java to become a student at 1 Manyar Public High School and graduated in 2014. He pursued undergraduate education at the Telkom university and became a student majoring in computer engineering. During being an active student, he became a practicum assistant for object-based programming courses in 2017 to 2018. He is also active as a researcher in a software engineering and application laboratory with a focus on research in the fields of android, ionic, html, augmented reality and image processing. Also active in community service activities, one of which is national level is in the Citarum River. In 2019, he was also a committee in several RISTEKDIKTI cooperation activities and the directorate of research and community service, as well as IEEE activities with Telkom University. Areas of expertise and interests include, mobile software, android, image processing, video processing, artificial intelligence, data mining and internet of things.

Tito Waluyo PurboyoA lecturer at the Telkom university school of electrical engineering majoring in computer engineering. Has been a permanent lecturer at the Telkom university since 2014 until now. Active teaching in physics and multimedia systems. His education history took physics education at Bandung Institute of Technology and earned a Bachelor's degree in Science at Bandung Institute of Technology in 1998. Then continued his undergraduate education in civil engineering at Gadjah Mada University and obtained a Bachelor of Engineering degree from Gadjah Mada University in 2001. After getting two bachelor's degrees, he returned to Bandung to take a master's degree in mathematics at Bandung Institute of Technology and got a master's degree in mathematics at Bandung Institute of Technology in 2009. After graduating, he continued his doctoral education at Bandung Institute of Technology and in 2015 succeeded completed doctoral education at Bandung Institute of Technology with a doctor. Already active as a researcher starting in 2010 until now. Also published as many as 30 papers and all of them were recorded in Scopus. In Scopus it is noted that h-index is 4 with total citations of 38 out of 32 documents. The areas of expertise and interest include computer engineering, cloud computing, network security, MATLAB, probability theory, algebra, discrete mathematics and computational physics.

Casi Setianingsih A housewife and also a lecturer at the Telkom university school of electrical engineering majoring in computer engineering. Has been a permanent lecturer at the Telkom university since 2015 until now. Active teaching in artificial intelligence courses, operating systems and writing scientific papers and proposals. In addition to being a lecturer, he has also been part of the research center team at Telkom University since 2018.

His education history takes telecommunications engineering education at the telecommunication university and gets an engineering degree in 2012. Then he continues his master's education at Bandung Institute of Technology in Electrical Engineering and earns engineering master's degree at Bandung institute of technology in 2015. Already active as a researcher from 2015 to the present. Already published as many as 72 papers recorded on the Google Scholar and also published as many as 29 papers recorded on Scopus. In Scopus, it is recorded that h-index is 4 with a total citation of 31 out of 20 documents, whereas in Google Scholar, there is a record of h-index of 4 with total citations of 39. Areas of expertise and interests include artificial intelligence, image processing, video processing, neural networks, machine learning, embedded systems, computer science, and genetic algorithms.

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