Diabetes and Heart Disease Identification System Using Iris on the Healthcare Kiosk

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Abstract. Data reported by World Life Expectancy said, as many as 9.89% of Indonesia's population died due to suffering from heart disease and as much as 7.18% due to suffering from diabetes. The heart and pancreas are very important organs for the human body. The heart has a function to flow blood to all parts of the body. While the pancreas is the organ responsible for regulating insulin levels. Organs in the human body can also be damaged so that it can inhibit the work process of these organs. Damage to the pancreas causes diabetes. To find out whether a person has diabetes or heart disease, it is necessary to carry out time-consuming and expensive laboratory tests. In this study, we propose an identification system for diabetes and heart disease using irises on Healthcare Kiosk. The method used in detecting diseases of the body through the iris is called iridology. This identification system will be in the form of a desktop application that can be used at Healthcare Kiosk. The stages carried out in this study were photographing the patient's left eye using a special camera called an Eyeronec, target-based cropping, preprocessing, auto-cropping using integral projection, auto-cropping to remove sclera, taking pancreatic and heart ROI, feature extraction and classification. Auto cropping shows results 60% successful, 33% scant, and 7% failed. The classification process was carried out by training 31 training data that was labeled normal or abnormal by iridology experts. In this study, the system testing accuracy was 83.87% for diabetes and 80.65% for heart disease.

1. Introduction
Diabetes is a disease that lasts a long time or is chronic and is characterized by high blood sugar (duplicates) levels or above normal values. Glucose which accumulates in the blood due to not being absorbed by body cells properly, can cause various disorders of the body’s organs. If diabetes is not well controlled, it can cause various complications that can endanger the lives of sufferers. Many complications of the disease can attack the body due to uncontrolled blood sugar. One of them is a problem in the aye that can cause vision problems to blindness. This happens because long-standing uncontrolled blood sugar causes damage to the blood in the eye.

The heart has a function to pump blood through blood vessels with a size of about 9 - 13 cm. The heart is located in the middle compartment of the chest, behind and slightly to the left of the breastbone. Even though it weighs only 7 to 15 ounces, the heart is one of the giant muscles in your body. Every part of the heart has a difference function, but all parts must work equally well to keep blood moving through tour body. Heart disease is a condition when the heart is disturbed. The form of the disorder itself can vary. There is interference with the heart's blood vessels, heart rhythm, heart...
valves, or disorders due to congenital birth. Information has not been evenly distributed to the regions [1].

According to data from the Ministry of Health of the Republic of Indonesia conducted by the 2014 Sample Registration System (SRS) survey in Indonesia showing coronary heart disease is the second highest cause of death after stroke, which is 12.9% of all the highest causes of death in Indonesia. In Indonesia, Riskesdas data shows that there was an increase in the prevalence of diabetes in Indonesia from 5.7% in 2007 to 6.9% or around 9.1 million in 2013. Data Sample Registration Survey in 2014 showed that Diabetes is the largest number of causes of death 3 in Indonesia with a percentage of 6.7%, after stroke (21.1%) and coronary heart disease (12.9%) [2]. The cause of the disease is due to unhealthy lifestyles, consuming lots of sugar, eating foods that contain lots of oil, lack of sports activities, heredity, obesity, to rarely or almost never check with a doctor.

Problems that arise due to lack of our understanding as lay people related to diabetes and heart disease. To get valid and scientific information we must check with a doctor for medical check-ups and tests in the laboratory. In one medical check-up in a laboratory, hospital or other health institution, you must pay a lot of money. It also makes it difficult for poor people to get health services and get information about health for themselves. Therefore it is necessary to have a system of identification of diabetes and heart disease that the examination media uses iridology as an alternative without having to pay quite expensive for medical check-ups. The disease identification system will later be connected to the HealthCare Kiosk device for its identification process.

This research aims to build a system that helps in the detection of normal health of a person using iridology in Healthcare Kiosks. The software will capture iris images using iridology directly. This software helps in terms of giving information to the user whether the user has diabetes and heart disease or not. With this software it will be easier for users to find out their health condition through the iris and as a form of early identification system.

This research will be able to facilitate the parties, the public can utilize the identification system located in the HealthCare Kiosk to be able to obtain early information about health condition analysis without having to conduct medical check-ups to laboratories, hospitals or other health agencies. In the medical world, it helps to minimize the prevalence of diabetes and heart disease in Indonesia, making it easier for medical workers to make early prevention to the community.

2. Overview of Iridology

In iridology, it is assumed that all the conditions of organs in the human body can be read through the iris. That's because every organ has a complicated nerve connection to the iris. Each eye, right and left has 60 parts that represent certain organs. The organs on the right side of the body will be represented on the right iris. Similarly, organs on the left side of the body will also be represented by sectors on the left iris.

Iridology was first introduced in a book called ChiromaticaMedica published in 1665. Theodore Kriege, the author, does not describe the exact term iridology. As development progressed, Bernard Jensen introduced this method for detecting poisons in the body. Now, he is known as the father of modern iridology[3].

The Iridologist found that the iris has seven topographies that describe the condition of the body's organs. If the organ is damaged, irregular or abnormal, the iris representing the organ will show a different sign than the normal iris [4].

Each part of the iris represents a certain organ in the human body. For pancreas that has a relationship with diabetes mellitus, it is placed in the left eye at 03.50 - 04.20. This region is placed in the second outer circle after the pupillary area. Figure 1 shows the region of the pancreas and heart area in the left iris. As for the heart, it is placed in the left eye at 02.20 - 03.10.
3. Design System

General description of the research design in this study can be seen in the following figure 2:

Figure 1. Pancreas Area and Heart Area

Figure 2. Design System

Figure 2 shows a general description of the final project that will be done. In the design system in figure 2 there are 5 processes that must be done. The explanation of the system design is as follows:
1) Image Acquisition

Image acquisition is the initial stage to get digital images. The aim is to determine the data needed and choose the method of recording digital images. In this application system design, the acquisition process will be carried out using an eyeronec camera as a tool to record images. The recorded image is an input image that will be processed as test data.

![Capture iris using eyeronec](image)

**Figure 3. Capture iris using eyeronec**

In Figure 3, show the result of taking picture from eyeronec camera. This study used iris with dark brown color as a dataset. Iris is taken using the Eyeronec camera on a desktop application. The technique used to take the iris is explained as follows:

1. Dataset is a picture of the left eye that represents the organs of the pancreas and heart.
2. User need to take pictures of the eyes of patients using the eyeronec camera.
3. The user must place the central point contained in the eyeronec application with the user's iris.
4. To get the maximum image, the user must take an iris image as precisely as possible with the center of the coordinates in the center of the pupil and the position of the eyes straight ahead.

2) Preprocessing

Preprocessing is the step to improve the quality of input image. This stage can increase the likelihood of success in the next processing stage. Important things to do such as improving quality (contrast, brightness, etc.), eliminating noise, image improvement, transformation, and determining the part of the image to be observed. This preprocessing is planned to do median filter, color detection, cropping and integral projection to improve image quality.

3) Feature Extraction

Feature extraction is needed to find features from iris images. This feature is useful for classifying whether the iris has a heart or diabetes disorder. Feature extraction aims to measure the quantitative magnitude of the features of each pixel, for example averages, standard deviations, coefficient of variation, Signal to Noise ratio (SNR), and others. From the measurement of each pixel, a calculation can be done to obtain the ratio of values (pixel ratio) needed as a further step to help the classification stage.

4) Classification

Classification is the division of things according to classes, or it can also be interpreted as a process of grouping objects based on the characteristics of similarities and differences. Ratios obtained in each image data after the extraction process will be classified. Threshold for the classification process is obtained by calculating the average black and white ratio from the training data. If you have found a threshold then if the white ratio is identified when the result is less than the threshold then it will be classified as "Normal" while if it exceeds the threshold it will be classified as "Abnormal".
5) Output

After going through the classification process which is the process of grouping extraction results according to classes, then the next step is to enter the output stage. The output will contain the results of identification on the iris, which is between normal or abnormal (not normal). Normal means that the user does not have diabetes or heart disease, on the contrary if it is abnormal then it has disease.

In the research, the authors were inspired and referenced from many previous studies relating to the same background. In Table 1, it contains a list of related researches that the author made as a reference in the course of this research. The author, will also include one of the related studies that the author made as a reference work on this research. The following is a summary of previous research and a list of related research used by the author:

| Researcher                  | Title                                                                 | Method                          |
|-----------------------------|----------------------------------------------------------------------|---------------------------------|
| Riyanto Sigit et al. (2015) | Development of Healthcare Kiosk for Checking Heart Health [5]        | Monte Carlo and artificial neural network method |
| Hau T. Ngo et al. (2014)    | Detection Resource-Aware Architecture Design and Implementation of Hough Transform for a Real-time Iris Boundary Detection System [6] | Hough Transform                    |
| Piyush Samant et al. (2018) | Machine learning techniques for medical diagnosis of diabetes using iris images [7] | Soft Computing                   |
| Firdaus Nuzulan             | Diagnosis of Diabetes and Cholesterol through Iris Eyes Using a Webcam [8] | Backpropagation                 |
| Lintang Indah Permatasari et al. (2016) | Detection of Cardiac Disorders Using Computerized Iridology with SVM Classification Method [9] | SVM Classification            |
| Aditya Afgan et al. (2016)  | Applications Detection of Heart Through the Eye Iris-Based Mobile [10] | Threshold                       |
| Almas Salsabil et al. (2017) | Applications Detection of Diabetes Through the Eye Iris-Based Mobile [11] | Threshold                       |
| This Study                  | Diabetes and Heart Disease Identification System Using Iris on the Health Care Kiosk | Threshold                       |

4. Experimental Study

In this chapter we will discuss the results of system testing and analysis of results. System testing covers the whole stages of the system architecture, such as the results of auto-cropping, feature extraction, and classification. Test results will be analyzed. The ultimate goal of the experiment and analysis was to detect pancreatic abnormalities to recognize diabetes mellitus and recognize heart disease through iris using an eyeronec camera and calculate the level of accuracy.

Table 2 contains the calculation results from the black and white ratio from the training data that got from the previous research. In table 2 it is divided into two diseases, diabetes and heart disease. Which shows the result of "normal" identification. In table 3 will contain the results of the calculation of the ratio of black and white from the "abnormal" training data. The training data that I use in the two tables below are from almas [11] and afgan [10] research.
### Table 2. White and Black Ratio of Normal Eyes

| No | Image     | Diabetes | Heart |
|----|-----------|----------|-------|
|    |           | Black Ratio | White Ratio | Black Ratio | White Ratio |
| 1  | Mob-cam 242 | 0.788    | 0.212    | 0.793    | 0.207    |
| 2  | Mob-cam 668 | 0.846    | 0.154    | 0.787    | 0.213    |
| 3  | Mob-cam 638 | 0.751    | 0.249    | 0.713    | 0.287    |
| 4  | Mob-cam 570 | 0.762    | 0.238    | 0.749    | 0.251    |
| 5  | Mob-cam 535 | 0.853    | 0.147    | 0.808    | 0.192    |
| 6  | Mob-cam 462 | 0.71     | 0.29     | 0.67     | 0.33     |
| 7  | Mob-cam 404 | 0.557    | 0.443    | 0.708    | 0.292    |
| 8  | Mob-cam 380 | 0.682    | 0.318    | 0.653    | 0.347    |
| 9  | Mob-cam 343 | 0.753    | 0.247    | 0.718    | 0.282    |
| 10 | Mb-almas 1  | 0.819    | 0.181    | 0.888    | 0.112    |
| 11 | Mb-almas 2  | 0.86     | 0.14     | 0.767    | 0.233    |
| 12 | Mb-almas 5  | 0.82     | 0.18     | 0.741    | 0.259    |
| 13 | Mb-almas 13 | 0.802    | 0.198    | 0.739    | 0.261    |
| 14 | Mb-almas 16 | 0.802    | 0.198    | 0.782    | 0.218    |

Average of Diabetes:
- Black Ratio: 0.772
- White Ratio: 0.228

Average of Heart:
- Black Ratio: 0.751
- White Ratio: 0.249

### Table 3. White and Black Ratio of Abnormal Eyes

| No | Image     | Diabetes | Heart |
|----|-----------|----------|-------|
|    |           | Black Ratio | White Ratio | Black Ratio | White Ratio |
| 1  | Mob-cam 116 | 0.541    | 0.459    | 0.605    | 0.395    |
| 2  | Mob-cam 742 | 0.733    | 0.267    | 0.67     | 0.33     |
| 3  | Mob-cam 471 | 0.642    | 0.358    | 0.647    | 0.353    |
| 4  | Mob-cam 301 | 0.739    | 0.261    | 0.78     | 0.22     |
| 5  | Mb-almas 3  | 0.624    | 0.376    | 0.826    | 0.174    |
| 6  | Mb-almas 4  | 0.751    | 0.249    | 0.652    | 0.348    |
| 7  | Mb-almas 6  | 0.693    | 0.307    | 0.831    | 0.169    |
| 8  | Mb-almas 7  | 0.768    | 0.232    | 0.744    | 0.256    |
| 9  | Mb-almas 8  | 0.65     | 0.35     | 0.661    | 0.339    |
| 10 | Mb-almas 9  | 0.755    | 0.245    | 0.665    | 0.335    |
| 11 | Mb-almas 10 | 0.721    | 0.279    | 0.743    | 0.257    |
| 12 | Mb-almas 11 | 0.679    | 0.321    | 0.825    | 0.175    |
| 13 | Mb-almas 12 | 0.733    | 0.267    | 0.846    | 0.154    |
| 14 | Mb-almas 14 | 0.751    | 0.249    | 0.77     | 0.23     |
After doing the calculations to determine the average white and black ratio of diabetes and heart disease. Next is determining the threshold of each disease to classify as normal or abnormal. Table 4 shows the threshold value of Diabetes, then subsequently calculating the threshold value of heart disease. In table 5 shows the threshold value of heart disease.

**Table 4. Threshold of Diabetes Diseases**

| Ratio | Average | Threshold |
|-------|---------|-----------|
|       | Normal Data | Abnormal Data |   |
| Black | 0,772     | 0,696     | 0,734 |
| White | 0,228     | 0,304     | 0,266 |

**Table 5. Threshold of Heart Diseases**

| Ratio | Average | Threshold |
|-------|---------|-----------|
|       | Normal Data | Abnormal Data |   |
| Black | 0,751     | 0,737     | 0,744 |
| White | 0,249     | 0,262     | 0,256 |

After getting number of threshold, this study calculate the accuracy of the identification with training data. At table 5 shows the level of compatibility of diabetes data between the identification results from the application with the training data that we have. The higher the percentage of accuracy obtained, the better.

**Table 6. Diabetes Accuracy Result**

| No | Image     | Target | Ratio     | Result |
|----|-----------|--------|-----------|--------|
|    |           |        | Black     | White  |        |
| 1  | Mb-almas 1| N      | 0,819     | 0,181  | N      |
| 2  | Mb-almas 2| N      | 0,86      | 0,14   | N      |
| 3  | Mb-almas 5| N      | 0,82      | 0,18   | N      |
| 4  | Mb-almas 13| N    | 0,802     | 0,198  | N      |
| 5  | Mb-almas 16| N     | 0,782     | 0,218  | N      |
| 6  | Mob-cam 242| N     | 0,788     | 0,212  | N      |
After getting the level of accuracy of diabetes data, the next step is to calculate the accuracy of heart disease data [12]. In Table 6 shows the level of compatibility of heart disease data between the identification results of the application with the training data that we have. The higher the percentage of accuracy obtained, the better.

**Table 7. Heart Accuracy Result**

| No | Image       | Target | Ratio          | Result |
|----|-------------|--------|----------------|--------|
|    |             |        | Black  | White  |        |
| 1  | Mob-cam 242 | N      | 0,793  | 0,207  | N      |
| 2  | Mob-cam 668 | N      | 0,787  | 0,213  | N      |
| 3  | Mob-cam 638 | N      | 0,713  | 0,287  | AB     |
| 4  | Mob-cam 570 | N      | 0,749  | 0,251  | N      |
| 5  | Mob-cam 535 | N      | 0,808  | 0,192  | N      |
| 6  | Mob-cam 462 | N      | 0,67   | 0,33   | AB     |
| 7  | Mob-cam 404 | N      | 0,708  | 0,292  | AB     |
| 8  | Mob-cam 380 | N      | 0,653  | 0,347  | AB     |
| 9  | Mob-cam 343 | N      | 0,718  | 0,282  | AB     |
| 10 | Mb-almas 1  | N      | 0,888  | 0,112  | N      |
|   | Mb-almas 2 | N  | 0.767 | 0.233 | N   |
|---|------------|----|-------|-------|-----|
| 12| Mb-almas 16| N  | 0.782 | 0.218 | N   |
| 13| Mb-almas 3 | N  | 0.826 | 0.174 | N   |
| 14| Mb-almas 6 | N  | 0.831 | 0.169 | N   |
| 15| Mb-almas 7 | N  | 0.744 | 0.256 | N   |
| 16| Mb-almas 11| N  | 0.825 | 0.175 | N   |
| 17| Mb-almas 12| N  | 0.846 | 0.154 | N   |
| 18| Mb-almas 14| N  | 0.77  | 0.23  | N   |
| 19| Mb-almas 15| N  | 0.81  | 0.19  | N   |
| 20| Mb-almas 17| N  | 0.841 | 0.159 | N   |
| 21| Mob-cam 116| AB | 0.605 | 0.395 | AB  |
| 22| Mob-cam 742| AB | 0.67  | 0.33  | AB  |
| 23| Mob-cam 471| AB | 0.647 | 0.353 | AB  |
| 24| Mob-cam 301| AB | 0.78  | 0.22  | N   |
| 25| Mb-almas 5 | AB | 0.741 | 0.259 | AB  |
| 26| Mb-almas 13| AB | 0.739 | 0.261 | AB  |
| 27| Mb-almas 4 | AB | 0.652 | 0.348 | AB  |
| 28| Mb-almas 8 | AB | 0.661 | 0.339 | AB  |
| 29| Mb-almas 9 | AB | 0.665 | 0.335 | AB  |
| 30| Mb-almas 10| AB | 0.743 | 0.257 | AB  |
| 31| Mb-almas 18| AB | 0.624 | 0.376 | AB  |

Accurate percentage: $\left(\frac{25}{31}\right) \times 100 = 80.65\%$

Error percentage: $\left(\frac{6}{31}\right) \times 100 = 19.35\%$

5. Conclusion
In this paper, we conclude:

1. This research proposes application to detect diabetes and heart disease through iris using healthcare kiosk.
2. To classify data into normal and abnormal. The learning process produces a white threshold ratio of 0.266 for diabetes and a white threshold ratio of 0.256 for heart disease. This means that if the patient exceeds the threshold or threshold it will be classified as abnormal.
3. The reason why the results of automatic cutting fail is because of the uneven lighting when taking pictures and the position of shooting that is not precise.
4. The level of accuracy in testing the identification system is: 83.87% for diabetes and 80.65% for heart disease.

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