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Detection of Ketosis in Bovine Using Machine Learning Techniques

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Abstract. This paper presents the different unsupervised machine learning algorithms used for Ketosis detection, based on the color characteristics taken from the Ketocheck rapid colorimetric test. The level of ketone bodies in bovine's urine is represented by three color categories, range of dark green (right ketone level), green (normal range ketone level) and yellow/orange (higher ketone level). The color image is converted into HSV color space for better color discrimination. The proposed technique enables detection of ketosis by clustering every pixel in the image using unsupervised K-means clustering and Fuzzy C Means (FCM) clustering algorithms. The results obtained have shown that K-means algorithm is faster and it also have low computational complexity. Two android application is developed. One with K-means clustering algorithm loaded in server and the other, directly programmed in android application.

Keywords: Unsupervised machine learning, ketocheck, k-means clustering, fuzzy c means clustering, and android.

1. Introduction

Ketosis or Acetonaemia is a metabolic disorder occurs in bovine (cattle) during the first few weeks of lactation. It is characterized by elevated ketone bodies level in blood or urine and low blood glucose level. In late pregnancy, the energy requirement for the growing calf is high but the cow's appetite is reduced. This problem is identified during the moderate decline in milk yield and there might be sudden drop in some cases. Some other indications are weight loss, reduced appetite, waxy firm faeces, dull coat and nervous signs, aggression, lack of coordination and excess salivation. The article in Journal of Dairy Veterinary and Animal research suggests that one of the best methods to prevent ketosis is using blood, urine or milk screening for ketone bodies detection, which is simple to implement in cattle farms [1]. In this paper, the Ketocheck rapid colorimetric test kit is used to test the urine sample of the cattle to identify the level of ketone bodies, especially β-hydroxy butyrate (BHB).It is an affordable cow-side test for BHB detection and for It is an affordable cow-side test for BHB detection and for routine monitoring of herds. It cost only about 20% of the costs involved in commercial tests [2].

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Unsupervised Machine learning (ML) is one of the best ways for predicting outcomes without being explicitly programmed and works without historical data or labeled responses. Color based segmentation for detecting different colors in the well-plate with 96 different urine sample to identify whether the bovine is infected by ketosis or not using clustering techniques. Unsupervised clustering algorithms namely, K-means and Fuzzy C means clustering are used. Android application with machine learning helps in easy access to the results of the ketosis test. Two android application is developed. One works with server containing ML algorithm and the other in which ML algorithm is directly programmed in the app.

2. Literature Review

Wolffang D. Niño Pacheco et al, developed an unsupervised K-Means Clustering algorithm to segment six different colors of tomatoes that ranges from green to red. They have used L*a*b and HSI color spaces. The algorithm randomly picks the image from the dataset and the data points are clustered [10]. Srinivas B et al, segmented tumor from the MRI Brain images using the clustering algorithms, K- Means and Fuzzy C-Means (FCM). They converted RGB images to grayscale, used cluster size 3 and concluded that FCM takes lesser processing time [5]. Tamilselvi P et al, used K-means clustering and self-organizing map (SOM) to segment the infected leaves from the healthy ones. They used different histogram techniques to preprocess the leaf images and applied K-means algorithm to cluster the leaves based on the colors. City block technique gave high accuracy [8]. Jiwen Dong et al, detected the skin area by converting RGB images to LAB color space and applied K-means clustering. The tattoo area is segmented based on the area connectivity and concluded that this approach possesses low computation complexity [4]. Himanshu Yadav et al, used K-means algorithm for segmentation. The different cluster size from 2 to 5 is used. The results show that higher the cluster size, the results are more enhanced. They tested the algorithm with colored brain images and ultrasound images and concluded that the tumor is clearly noticeable [3]. Shoichi Araki et al, used FCM algorithm to segment thermal image of occupants in a room taken by a thermoviewer [11-13]. They distinguished occupants by measuring local temperature peaks from the image and determined the number of clusters [7]. Shiling Sun et al, data samples in the image are converted to gray-scale in order to reduce complex computation and FCM algorithm is applied to segment the image [6].

3. Ketosis Diagnostic Kit

Ketocheck: The rapid calorimetric test kit is used to detect BHB in urine and is used for monitoring as cow side-test. The color of the urine changes when based on the amount of ketone bodies present. Higher the BHB in urine, the cow is surely infected. The colors that can be obtained from the test is shown in Figure 1. The respective BHB levels and results based on the colors are tabulated in Table 1. The test samples taken for processing is well-plated with 96 different urine samples which contains the three different categories of colors.

Figure 1. Color Category based on the amount of BHB in the urine

Table 1. Result Interpretation based on color changes in the urine sample

Color	BHB (mmol/L)	Result
Dark Green	0	Unaffected (-)
Green	< 2	Normal (+)
Orange/Yellow	> 2	Infected (++)

4. Materials and Methods

a. Color Space Conversion

The algorithm reads the uploaded RGB (Red, Green and Blue) image and brightens it to enhance the colors. The RGB image is converted into HSV (Hue, Saturation and Value) color model by using OpenCV library. By converting the RGB image into HSV color space, the color (Hue) is separated from saturation and illuminance. So, the HSV color space is more suitable for color-based segmentation.

b. Machine Learning techniques

K-means Clustering

The unsupervised K-means clustering algorithm makes inferences from the live data with input vectors without referring to the known or labelled outcomes. The pixels in the image are considered as data points. The color component is used to group similar data points based on the cluster size. The new data point is allocated to the cluster that is closest to it. The centroid is modified each time when the algorithm reads a new data point.

Fuzzy C Means Clustering

In Unsupervised FCM clustering algorithm, each data point in the image is assigned partially to all the clusters in the input image based on the membership value.,the input vectors are not assigned exclusively to a single cluster, but partially to all the clusters. The membership value is higher, when the data point is closer to a particular cluster and that data point is assigned to the cluster with highest membership value. Figure 2 compares the input image with the segmented image obtained from K-means and FCM clustering.

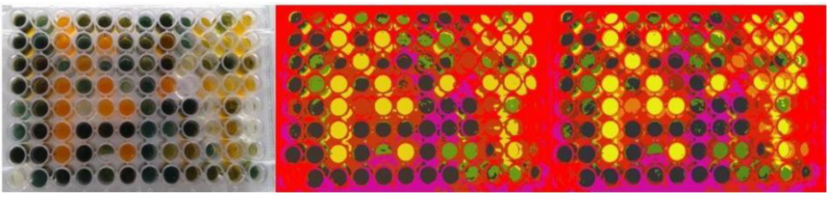

Figure 2. Input Image vs K means Output vs FCM Output

5. Android Application

Mobile application is developed using Android Studio and python frameworks to segment the samples in the well plate image. The application developed for android users is easy to use and provide instant results without having to undergo any complex screening process to identify the results.

a. On-device Machine Learning Application

The machine learning algorithm is directly programmed onto the android application. The device does not need internet access to operate the application or to view the results. Figure 3 illustrates the working of the application. The user install the application and grant permission to access media files from storage. Click 'CHOOSE IMAGE' button to select the image. Click 'KETOSIS KMEANS' button multiple times to display the clusters one after the other. The result description is also attached in the bottom of the page to identify respective category of the colors.

Figure 3. Working of On-device Machine Learning Application

a. Online Application

Online application comprises two main modules, Android app and web server. The server is developed using Python Flask Framework. The device using the application should the internet access to transfer the images to and from the server through IP address and port number. Figure 4 illustrates the working of the online application.

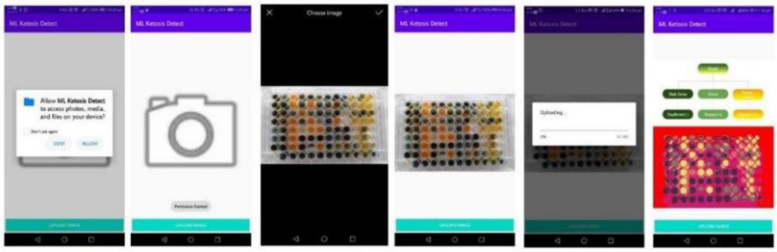

Figure 4. Working of Online android application

6. Results and Discussion

The machine learning algorithm process the RGB color image with the goal of segmenting three categories of colors. With the help of unsupervised clustering algorithm, the range of a particular color can be grouped forming the single-color cluster. For processing and examination, 15 images of a well-plate with 96 urine samples are taken. There are two clustering methods used. Cluster size 6 is fixed in K-means and FCM clustering, and it can clearly segment the three-color groups. While comparing the results obtained by working with RGB and HSV color space, clustering algorithm applied on RGB image ends up separating dark green and green as a single color. HSV color space increases the accuracy of the algorithm by enhancing the hue of the image. Although these clustering algorithms yield the expected result, one main consideration is to launch the algorithm in the android application. The faster the app works, the better the user experience will be. The K-means clustering algorithm takes no more than 3 seconds to complete, while FCM clustering takes up to 75 seconds.

7. Conclusion

The urine sample color images are taken as input and segmented into three colors. Two unsupervised machine learning algorithms are used. K-means and FCM clustering. According to the observation made, K-means clustering algorithm is faster than FCM and is implemented in the android application. The algorithm detects Infected, normal and unaffected bovine from the urine samples obtained through KetoCheck rapid test kit. The android application designed with and without server serves the user according to their internet accessibility.

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