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System Development for Aflatoxin Inspection in Cereal Using Ultraviolet Light

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***Abstract*—This paper presents system development for aflatoxin inspection in cereal using ultraviolet light. The proposed system consists of conveyer belt, ultraviolet lamp, webcam, electronic circuits, interface card, and computer. The image processing is employed to detect aflatoxin contamination. K-means clustering and thresholding techniques are used for inspection of aflatoxin contamination in cereal. Two set of corn kernels samples were used to verify the proposed system. The experimental results show that the proposed system can detect aflatoxin affectively and suitable for raw material screening in food production.**

***Index Terms*—aflatoxin inspection, ultraviolet light, image processing**

I. Introduction

Cereals are an important source of energy and protein for humans and livestock. Major cereals are made from corn, wheat, rice and barley around the world. The major problem is the infection of the aflatoxin. The disease caused by aflatoxin, include liver cancer, hepatitis, cirrhosis, encephalitis, etc. The toxicity and disease depends on conditions of food intake, age, sex, hormones, and the amount of aflatoxin entering the body [1], [2]. The techniques widely used in reseach for aflatoxin detection are Liquid chromatography, Thin-Layer Chromatography (TLC), High Performance Liquid Chromatography (HPLC), Laser-Induced Fluorescence (LIF) screening method, Ion mobility spectrometry, Fourier Transform Near Infrared (FT-NIR) spectrometry, Adsorptive stripping voltammetry, etc. [2]-[6]. The methods mentioned depend on laboratory test which requires specialists, high cost, and long period. Therefore, they are not practical for application in the detection of aflatoxin in cereals in agricultural or food products. Therefore, this paper develops a system for aflatoxin inspection in cereals. The proposed system uses ultraviolet light and image processing techniques to detect aflatoxin contamination in cereals in manufacturing and improve the quality of products made from cereals.

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II. The Proposed System

The proposed aflatoxin inspection system is separate into two parts, the image acquisition system and the image processing system as shown in Fig. 1.

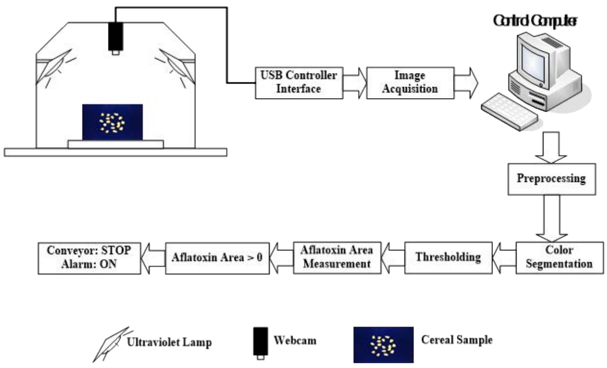

Figure 1. Block diagram of proposed system for aflatoxin inspection in cereal using ultraviolet light.

A. The Image Acquisition System

The image acquisition system consists of conveyer belt, ultraviolet lamp, webcam, electronic control circuits, interface card and computer. Conveyer belt is used for moving cereal samples into detection box. The ultraviolet lamp is used to expose ultraviolet light wave length about 340 nm to cereal samples. The webcam is employed for image capture. The computer is used to control the system and analyze image captured by the webcam. A digital image of cereals samples is captured and stored in the computer before analyzed by the proposed algorithm. The detail of image acquisition system can be described as:

1) A webcam with resolution of 16 megapixels, transmission rate of 60 fps with USB interface for image capture.
2) A computer for storing and analyzing the aflatoxin contaminate in cereal.
3) Two ultraviolet lamps (ultraviolet lamps) with illuminate the spectrum of 340 nm.

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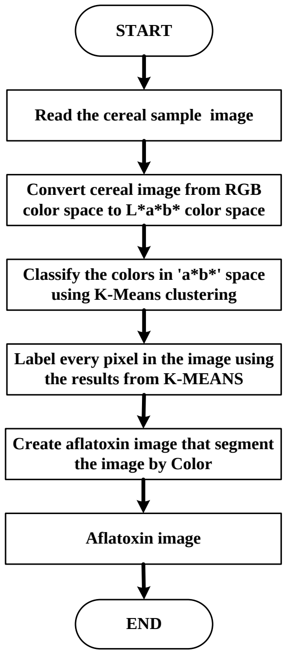
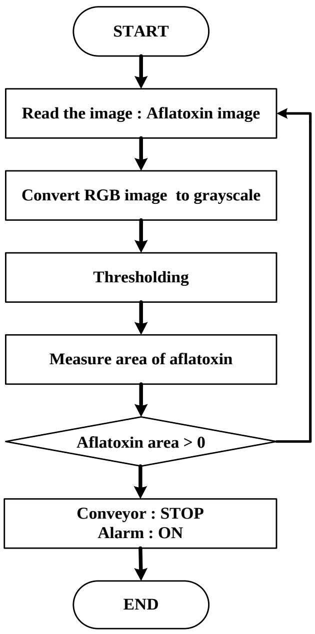
4) A wooden box with interior of box painted black to minimize background light and the two ultraviolet lamps and webcam are attached inside.

B. *The Image Processing System*

Images of sampled cereal from the image acquisition system are processed by using image processing. The image processing is separate into two parts as shown in Fig. 2 for the first part color-based segmentation using K-Means clustering is used to separate the areas contaminated by aflatoxin from cereals sample [7]-[9]. For the second part the thresholding method is used to calculate area of contaminated by aflatoxin.



(a) Color segmentation process for separating the areas contaminated by aflatoxin.



(b) Thresholding process for calculating area of contaminated by aflatoxin.

Figure 2. Image processing process of the proposed system.

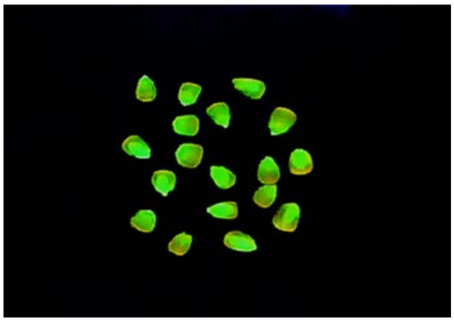
III. Experimental Results

To verify the performance of the proposed system, two samples of corn kernels, corn kernels with no aflatoxin contamination and corn kernels with aflatoxin contamination, are used in the experiment. Fig. 3 and Fig. 4 show the two samples after illuminated by fluorescent light and ultraviolet light, respectively.

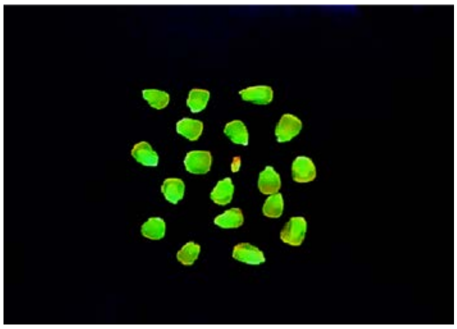
(a) No aflatoxin contamination

(b) Aflatoxin contamination

Figure 3. Corn kernels with no aflatoxin contamination and with aflatoxin contamination when illuminated by fluorescent light.



(a) No aflatoxin contamination



(b) Aflatoxin contamination

Figure 4. Corn kernels with no aflatoxin contamination and with aflatoxin contamination when illuminated by ultraviolet light.

The results show that images of aflatoxin in the corn kernels when illuminated by ultraviolet light are more contrast when compared to the images of aflatoxin in the corn kernels when illuminated by fluorescent light. Then, the images of the corn kernels illuminated by ultraviolet light are processed for aflatoxin detection by using algorithm in Fig. 2. The results of image processing of the proposed system are shown in Fig. 5 and Fig. 6.

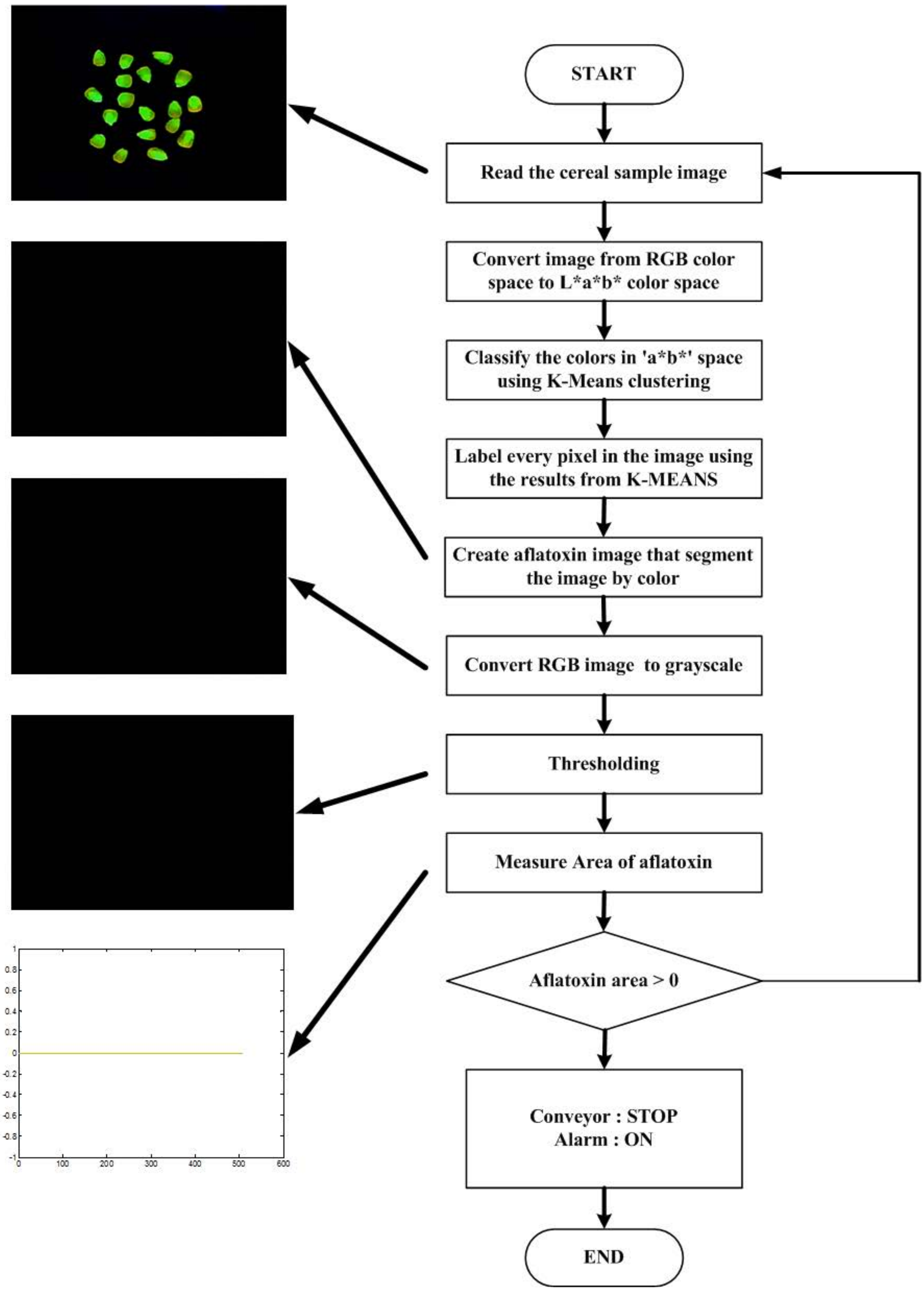


Figure 5. The results of image processing for the corn kernels with no aflatoxin contamination.

The last plot in Fig. 5 and Fig. 6 show the values of each pixel after thresholding step. The values of the pixels are zero when no aflatoxin contamination or one when aflatoxin is detected on that pixel. The results for all pixels in Fig. 5 are zero which means that the corn kernels sample does not contain aflatoxin. Fig. 6 shows the results of image processing process of the proposed system in case aflatoxin contamination. The last plot in Fig. 6 shows that there are some pixels, the 259th to 264th pixels, that contain aflatoxin contamination. The output signal from the image processing steps is used to control conveyer belt and alarm to user via interface card.

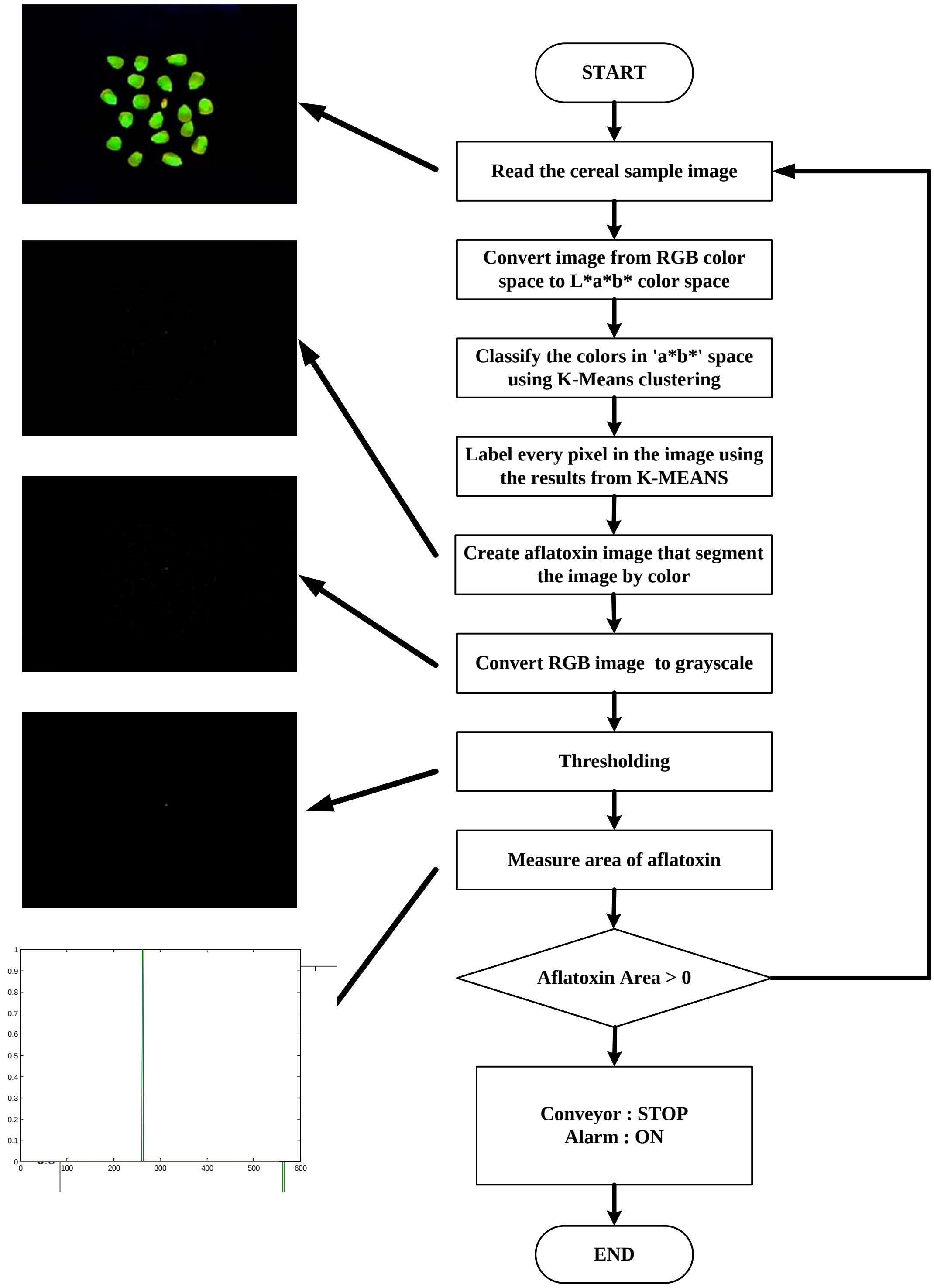


Figure 6. The results of image processing for the corn kernels with aflatoxin contamination.

IV. Conclusion

This paper presents a system for detecting aflatoxin by using ultraviolet light and image processing techniques. The techniques used to process the images are K-means clustering and thresholding techniques. Two set of corn kernels samples were used to verify the system. One set of the samples contains aflatoxin contamination and the other set does not contain aflatoxin contamination. The experimental results show that the proposed system can effectively detect aflatoxin contaminate. The advantages of the proposed system over the methods usually used in manufacturing are that the system can process at high speed with low cost. As a result, the proposed method is practical for raw material screening in food production.

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