AN AUTOMATIC MULTI-THRESHOLD IMAGE PROCESSING TECHNIQUE FOR MUSHROOM DISEASE SEGMENTATION

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Abstract
Mushrooms are great source of nutrition, with antioxidants and medicinal values, so their consumption and cultivation is increasing day by day across the world. There is a great demand in classification of mushroom types and disease segmentation. Manual mushroom disease detection methods like electroscopes, biological and chemical take more time and not a cost effective if detection is made for large scale mushrooms. This paper presents novel attempt to detect the mushroom diseases using computer aided digital image processing method. A multi threshold image processing automatic Technique is proposed to detect and segment the mushroom diseases. It includes two main parts, one removes background in the input mushroom diseased image first to overcome uncertainty in separating diseased part and removing soil part which happens to be close in its intensities values, and other part segments diseased part on the mushroom.

Index Terms— Mushroom diseases segmentation, Multi thres old, Image processing method.

I. INTRODUCTION

Mushrooms cultivation and consumption is increasing worldwide in many countries because of its medicinal, nutritional, antioxidant, and therapeutic values [1]. A mushroom is a spore-bearing and fleshy fruit body of a fungus produced above soil or on its food source. There are many types of mushrooms, among which few are edible and the others are toxic. The edible mushrooms include Button mushroom (*Agaricus bisporus*), winter mushroom (*Flammulina velutipes*), Oak mushroom *(Lentinus edodes*), Oyster mushroom (*Pleurotus species*), Milky mushroom (*Calocybe indica*), paddy straw mushroom (Volvariella volvacea) and few more. Among different mushrooms being cultivated in India, button mushroom accounted for >73% of the total mushroom production, oyster mushroom (16%), paddy straw mushroom (7%) and milky mushroom (3%) [2]

Mushrooms are subject to diseases such as fungal, bacterial and viral. The most common diseases include wet bubble, dry bubble, cobweb and bacterial blotch. Environmental conditions within rooms can increase the rate of disease development. Table 1 shows fungal disease in mushroom [3], [4].

Disease in commercial mushroom production can severely reduce the yield and productivity. The spreading of disease makes controlling disease outbreaks more challenging. Disease control depends on the hygiene in preparing mush- room bed or soil casings and growing rooms [5]. Knowledge on disease diagnosis is needed to control the disease spread within and between crops. Manual disease detection is definitely a challenging task, as it requires good knowledge of diseases and is a time consuming process. Besides this, human errors may happen which could result in loss of mushrooms which are healthy too. So, computer aided automatic mushroom disease detection using image processing segmentation and classification Techniques are a key step to get results almost nearer to accuracy and correct estimation of diseased mushrooms.

TABLE I. FUNGAL DISEASES OF AGARICUS BISPORUS

S. No.	Diseases	Symptoms
1	Dry bubbles (Vericillium fungicola)	Onion shaped mushroom at early stage of infection, crooked and deformed mushroom at the later stage of infection.
2	Wet bubbles (Mycogone perniciosa)	Development of distorted undifferentiated mushroom tissue.
3	Green mold (Trichoderma spp)	Dark brown of greenish lesions on the pileus and stipe.
4	False Truffle (Diehliomyces microspores)	Whitish, solid, wrinkled, irregular fungal masses resembling small brains and peeled walnut.
5	Cobweb disease (Dactylium dentriods)	While mycelia patches on the casing which turn yellow to pinkish red.
6	Yellow mold (Sepedonium spp)	White mycelium turning to yellow at maturity, present in lower layers of compost or sides of bags.
7	Mat diseases	*Chrysosporium luteum* yellow brown corky layer formed at interphase of compost and casing.

Rest of the paper is organized as: Section II, reviews the work of various authors on mushroom classification and mushroom diseases detection and classification. Section III, presents the proposed algorithmic steps and related theory. In Section IV, presents and analyze experimental results, finally section V concludes the paper and future work is predicted.

II. LITERATURE SURVEY

Dilip Roy Chowdhury, et.al, in [6] to diagnosis mushroom diseases a data mining approach has proposed. This system helps in selecting highly influenced attribute or factors or symptoms of different mushrooms diseases based on ranking among the attributes. Authors generated mushroom data set from real field and mushroom growers, input data is converted to appropriate file format, then fed to Evaluator where high influential attributes were selected using data mining tool. The classification techniques used are Naïve Bayes, RIDOR and SMO and they are experimentally evaluated using Mushroom diseases dataset. Authors made a good comparative analysis and results show that Accuracy is equally good for Naïve Bayes and SMO compare to RIDOR, but Naïve Bayes is less prone to Error compared to other two classifiers techniques. Limitations are that farmer cannot use this software directly, administration collects the image from farmer then converts to appropriate file format for further processing. Directly collected images are not processed instead they converted it to feature dataset to classify the mushroom diseases using data mining tools WEKA.

Kyung Jong Kim, et.al, in [7] studied and analyzed mush- room pests and disease images using CNN-based system. This developed system consists of user interface for input and output of the system, Manager Interface for learning analytical model, Convolutional layer extracts features, ReLu act as an Activation function, pooling layer reduces the image size, fully connected layer for classifying feature vectors and Database stores pest information. The PHP-based Apache2 web environment is used to implement CNN module learning system in java class. It is observed that authors have used deep learning concept in a systematic manner, but they might have developed system for classifying poisonous and edibility but not for diseases detection in mushrooms, because the results showed in figure doesn't look like diseased mushrooms and nowhere it is mentioned what type of diseases authors have taken to test proposed system.

Er.Pratibha Goyal et.al, in [8] developed software to detect diseases and pests in white button mushrooms crop using image processing methods. A database is created in the form of coloured images for different diseases of white button mush- rooms. The user has to submit image and textural description to the server of website to get the information of diseases. The input image is assumed to be with required size and then pixel to pixel comparison is followed with data base image. When matching ratio reaches to certain required percentages level then software provides information about the disease such as casual organisms, survival of the pathogen, favorable weather conditions, amount of loss causes etc. This system is developed using ASP.net and database using SQL Server 2008. Authors have used simple image processing methods, but farmer should have computer knowledge to upload image and textural descriptions to know the disease information. It needs only image that actually matches the disease mushroom data base to detect disease in the input image i.e same camera specifications are required. A blind pixel to pixel comparison is used.

Munirah M.Y, et.al, in [9] developed a rule based system using forward chaining techniques for diagnosing oyster mushroom diseases like bacteria, mold, virus, pests and insects faced by mushroom farm owners. The entire system is divided in to Information module which includes all oyster mushroom diseases, symptoms, treatments, rules and questions. Main module includes diagnosis and admin modules. in diagnosis module user has to answer the system questions related to the mushroom condition and symptoms to identify oyster disease. In admin, six sub modules are included; they are disease, symptoms, treatments, rules, photos and general information and administrator manages the system by delete, add, and update any latest and related information of oyster mushroom disease.

This system is designed to identify the oyster mushroom diseases based on the texture based questions loaded in the system being posed to famer. Then based on the answers to the questions given by the farmer about the condition and symptoms of the crops, final decision on the diseases occurred is displayed in text form to the farmer. A mushroom farming Starter who has less knowledge on symptoms of diseases may not get right help with this system.

Daniel Eastwood, et.al, in in [10], presented biological and chemical method to detect brown cap disease in button mush- rooms. Four mushroom samples are collected from commercial farms in Ireland and United Kingdom and compared with 12 uninfected controls. Micro array analysis results in recognizing 25 transcripts of increased levels and 32 transcripts of decreased levels between uninfected and brown infected states. The virus fragments are highest in brown infected, high in white infected mushrooms and low in uninfected mushrooms. In time course analysis of colour symptom, 3 chromatic values were considered [L(brightness), a(redness), b(yellowness)], ‘b’ value is different for non-infected compared to brown and white infected. ‘L/b’ ratio shows significant difference between brown and white infected mushrooms. Chemical and biological methods need manual intervention, time taking and their accuracy may be less because only few samples are examined under the experimental process.

Ibrahim Ozer Elibuyuk et.al, in [11] detected disease agents (virus) using growth tests of mycelium on agar, double stranded Ribonucleic Acid (dsRNA) Analysis and direct electron microscopy in button mushroom. Researcher observed various symptoms of virus in mushrooms; they are elongation of stalks, thickened barrel shaped stipes, brown caps and distortions of sporophores. The presence of two ds-RNAs and observation of spherical particles in diseased mushrooms indicates virus.

Segmentation one of the important stages of image processing plays important role in mushroom disease detection, segmentation of interested object is one of trivial task, where many research works are done and applied for different field. Salem saleh Alamri, et.al. in [12] presented and compared the different threshold methods applied to satellite images. Rajeshwar Dass et.al. in [13] presented different segmentation methods applied in field of ultrasound and SAR Image processing.

There is related work and many apps are developed on mushroom types (i.e edible and nonedible) detection. It is observed from the literature that only few made an attempt to detect mushroom diseases that to pre-processed readymade data set are used instead of direct image processing. In this paper an automatic image processing method is proposed to work directly on collected images without any user interface.

III. MULTI- THRESHOLD MUSHROOM DISEASE DETECTION TECHNIQUE

The detection of the diseased part is done based on global Multi-Thresholding concept. Generally, images are captured automatically using digital cameras in real time applications, but for simulation, to test and to analyze the proposed innovatives are collected and stored in the system for further processing. In this proposed method images collected are converted to L*a*b colour space, which is suitable to segment the mushroom from background. Fixed initial threshold values are used to differentiate the background and the mushroom part. This threshold value is fixed by performing Separate histogram analysis on each channels of L*a*b color space for background and mushroom part in image. Then, the image is converted to YCbCr and Lin colour space and morphological operation is performed. Then to segment the diseased part a final threshold is applied. The diseased part can be clearly viewed by converting the image to a binary image.

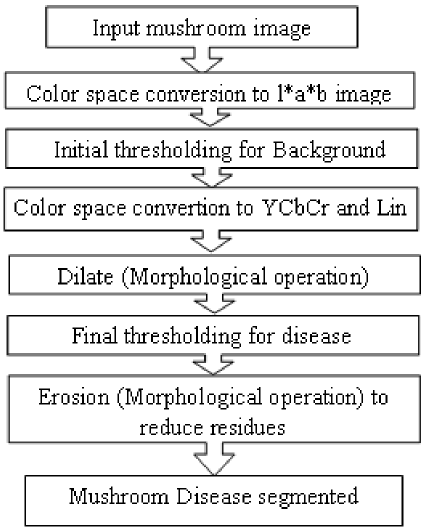


Fig. 1. Flow chart of of mushroom disease segmentation using multiple thresholding.

Finally, morphological operation is applied to extract mushroom diseased part without any residues. The proposed method flow chart is shown in Fig. 1.

The two main phases of the proposed method are background removal and disease segmentation

a. Background Removal

The background and the foreground are separated by the intensity based thresholding method. This is achieved by first converting the acquired image into L*a*b colour space [8]. It expresses colour as three numerical values, L^* for the lightness and a^* and b^* for the green–red and blue–yellow colour components respectively. RGB is converted to XYZ and then to L*a*b colour space. Corresponding equations are given by (1), (2), (3), (4), (5), (6)

$$X = R*0.4124 + G*0.3576 + B*0.1805 \quad (1)$$

$$Y = R*0.2126 + G*0.7152 + B*0.0722 \quad (2)$$

$$Z = R*0.0193 + G*0.1192 + B*0.9505 \quad (3)$$

$$L^* = 116 f\left(\frac{Y}{Y_n}\right) - 16 \quad (4)$$

$$a^* = 500\left(f\left(\frac{X}{X_n}\right) - f\left(\frac{Y}{Y_n}\right)\right) \quad (5)$$

$$b^* = 200\left(f\left(\frac{Y}{Y_n}\right) - f\left(\frac{Z}{Z_n}\right)\right) \quad (6)$$

Where

$$f(t) = \begin{cases} \sqrt[3]{t} & if \quad t > 0.008895 \\ 7.787q + \frac{16}{116} & otherwise \end{cases}$$

Here t is variable and Xn, Yn, Zn are normalized XYZ tristimulus values of the reference white point.

Histogram analysis is performed on background and foreground mushroom parts separately on each channel of L a b colour space to find the initial threshold values.

Histogram equalization is performed to improve the contrast to easy differentiation of foreground mushroom from background.

b. Disease Segmentation

The colour space conversion techniques are applied to the above background removed image following which the intensity based thresholding is carried out for the disease part extraction. First background removed image is converted to YCbCr colour space using equation (7), (8), (9).

Y=12 +(65.738R/256) +(129.057G/256) +(25.064B/256) (7)

$$Cb=128 -(37.945R/256) -(74.494G/256) +(112.439B/256) \quad (8)$$

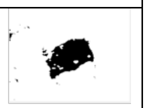
$$Cr=128 +(112.439R/256) -(94.154G/256) +(18.285B/256) \quad (9)$$

YCbCr is converted to Lin colour space for gamma correction and linearize the image; shadow regions in the image will be made darker so that it will fall into background region. Morphological operation dilation is applied to the colour space converted images for the accurate shadow removal. Then final Thresholding is applied, where thresholding values are obtained by histogram analysis on each channel of L*a*b colour space. Finally, Morphological operation erosion is applied to reduce the artifacts present in the final threshold image along with the segmented disease part.

IV. RESULTS AND DISCUSSIONS

Simulation results at each step are presented in an ordered manner for the diseases which are most prone in India such as Dry bubble, Cobweb and Wet bubble. Simulated results are shown in table II obtained in MATLAB environment to extract the diseased part from the input mushroom image using the proposed algorithm.

Table II. Stage wise Results of Multi Threshold Mushroom Disease Segmentation

Mushroom disease	**Original image**	**Image After background Elimination by local thresholding**	**RGB to YCbCr colour space and morphological operations**	**After Intensity threshold and morphological operations**
Cobweb				
Dry bubble				
Wet bubble				

The proposed algorithm takes original input image and resizes it to 256*256-pixel image shown in second column of table II. The image is then converted into a different colour space and undergoes through thresholding for background removed image shown in third column of Table. II. The background eliminated image is taken and morphological operations and followed by YCbCr and Lin colour space conversion are applied on it as shown in fourth column of the Table II. Then final thresholding is applied on YCbCr and Lin colour image to segment the disease from mushroom in the image. Further to remove the artifacts morphological operation erosion is applied and the result is shown in fifth column of the table II. Proposed methods experimental results show a good performance in segmenting Dry bubble and Cobweb diseases, but it is not able to segment completely for some input mushroom images of wet bubble disease.

V. CONCLUSION

This paper made an innovative attempt to detect the mush- room diseases using an automatic digital image processing techniques. Different image processing Techniques were applied early in the field of vegetation. In this work major cultivated mushroom ie., button is considered in the botanical platform and different segmentation technique is proposed to extract the diseased part of a mushroom from the input image. The goals of this paper it to detect the diseases using simple and effective algorithm (multi-thresholding technique) and maintain sufficient amount of accuracy.

The proposed method is able to detect budding to fully grown stage of mushroom disease. It avoids the time consumption of manual verification and human errors of manual verification, eliminates human errors and increases the gross productivity of mushroom. The proposed technique is built to segment different diseases with fixed thresholding but analysis for threshold estimation was carried out with less number of images, so accuracy in segmenting complete part of the disease on some types of mushrooms like Wet bubble is at compromising level.

In future extension of this work will be to analyze different possible mushroom diseases and classify the type of diseases, which helps the cultivator to take appropriate measures to either treat or discard the mushrooms. This technique can be improvised using neural networking or machine learning concepts in order to classify the disease kind after segmenting the disease.

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