Smart Sugarcane Crop Growth Monitoring System Using IoT and Image Processing

Someshwar Terkar¹, Sushma Potdar², Saurabh Shinde³, Neha Chavan⁴, K. S. Jadhav⁵
¹,²,³,⁴Student, Department of Information Technology, Vidya Pratisthans Kamalnayan Bajaj Institute of Engineering and Technology, Baramati, India
⁵Professor, Department of Information Technology, Vidya Pratisthans Kamalnayan Bajaj Institute of Engineering and Technology, Baramati, India

Abstract: Agriculture is the most important sector of an Indian economy. Sugarcane is the main source of sugar in India and holds a prominent position as a cash crop. People uses conventional way for the farming. Conventional way requires more human power. Around 55% people in India has been engaged in agriculture but only 15% goods we get from the agriculture. Though there is a large area under cultivation, we don’t get maximum yield as well as proper price for their crops. The fact that most of our farmers have the lack of proper knowledge makes it even more erratic. A large portion of farming and agricultural activities are based on the predictions, which at times fail. Due to this, farmers have to bear huge losses. Since we know the benefits of proper irrigation and soil nutrients in the growth of sugarcane crop, such parameters can’t be ignored. Diseases occurred to the sugarcane plant can affect the yield of sugarcane. So the “Smart sugarcane crop growth monitoring system based on IoT and image processing” is one of the best way to increase crop yields and get maximum price for their crops. Also farmers can sell and purchase their yields online and they can get direct benefit without third member. This is very beneficial to farmers.

Keywords: IoT, Image Processing, Irrigation, Soil nutrients, Disease.

1. Introduction

This is the automated system in which required amount of water is given to the crop automatically and if the nutrients of the soil gets below the minimum threshold frequency then this system automatically sends the notification about that to the farmer. Also if the disease is occurred to the sugarcane plant then due to lack of proper knowledge about the disease and the required fertilizers to overcome that disease plants can get die before harvesting. And also one of the problem is that farmers do not get the preferable price for their yield. For that we are going to extract this system by image processing in which farmer can simply capture the image of the infected sugarcane crop leaf and find out the information about the disease and required fertilizers to overcome that disease. In this way we can reduce the loss in farming and increase the crop yields by implementing IoT and Image processing technology into agriculture. When IoT is implemented with the help of sensors, the sensors can sense the data continuously and notify the farmers about nutrients present in the soil and automatic irrigation system can be controlled by the farmers using mobile application. With the help of image processing farmers can capture the image of infected crop leaf and can get a brief understanding of the disease and fertilizers required to remove the disease. This system will thoroughly help farmers to increase the productivity of sugarcane crop and gain maximum profit by purchasing and selling their products online by their own without the need of any mediator. We are also going to provide the facility of online payment for the customers who are purchasing farmer’s products so the farmers get the fruitful results.

2. Literature Survey

Sachin D. Khirade, A. B. Patil [1] worked on Identification of the plant diseases is the key to preventing the losses in the yield and quantity of the agricultural product. It requires tremendous amount of work, expertise in the plant diseases, and also require the excessive processing time. Hence, image processing is used for the detection of plant diseases. Disease detection involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification. This paper discussed the methods used for the detection of plant diseases using their leaves images. This paper discussed various techniques to segment the disease part of the plant. This paper also discussed some Feature extraction and classification techniques to extract the features of infected leaf and the classification of plant diseases. The accurately detection and classification of the plant disease is very important for the successful cultivation of crop and this can be done using image processing. This paper discussed various techniques to segment the disease part of the plant. This paper also discussed some Feature extraction and classification techniques to extract the features of infected leaf and the classification of plant diseases. The use of ANN methods for classification of disease in plants such as self- organizing feature map, back propagation algorithm, SVMs etc. can be efficiently used. From these methods, we can accurately identify and classify various plant diseases using image processing technique.
P. Revathi, M. Hemalatha [2] worked on Image Edge detection Segmentation techniques in which, the captured images are processed for enrichment first. Then R, G, B color Feature image segmentation is carried out to get target regions (disease spots). Later, image features such as boundary, shape, color and texture are extracted for the disease spots to recognize diseases and control the pest recommendation. In this Research work consist three parts of the cotton leaf spot, cotton leaf color segmentation, Edge detection based Image segmentation, analysis and classification of disease.

Satish Madhgoria, Marek Schikora, and Wolfgang Koch [3] Proposed automatic pixel based classification method for detecting unhealthy regions in leaf images is presented. The algorithms have been tested extensively. Linear SVM has been used to classify each pixel. We have also shown how the results from SVM could be improved remarkably using the neighborhood check technique. The presented algorithm could well extended for other detection tasks which also mainly rely on color information, but extension to other features is easily possible. The task is performed in three steps. First, we perform segmentation to divide the image into foreground and background. In the second step, support vector machines are applied to predict the class of each pixel belonging to the foreground. And finally, we do further refinement by neighborhood-check to omit all falsely-classified pixels from second step.

Karan Kansara, Vishal Zaveri, Shreyans Shah, Sandip Delwadkar and Kaushal Jani [4] worked on Sensor based Automated Irrigation System with IOT mentioned about using sensor based irrigation in which the irrigation will take place whenever there is a change in temperature and humidity of the surroundings. The flow of water is managed by solenoid valve. The opening and closing of valve is done when a signal is send through microcontroller. The water to the root of plant is done drop by drop using rain gun and when the moisture level again become normal then sensor senses it and send a signal to microcontroller and the value is then closed. The two mobile are connected using GSM. The GSM and microcontroller are connected using MAX232. When moisture of the soil become low moisture sensor sense it and send signal to microcontroller, then the microcontroller gives the signal to mobile and it activate the buzzer. This buzzer indicates that valve needs to be opened by pressing the button in the called function signals are sent back to microcontroller. Microcontroller used can increase System Life and lower the power Consumption. There system is just limited to the automation of irrigation system and lacks in extra ordinary features.

Y. Kim, R. Evans and W. Iversen [5] worked on A remote sensing and control irrigation system using distributed wireless sensor network aiming for variable rate irrigation, real time in field sensing, controlling of a site specific precision linear move irrigation system to maximize the productivity with minimal use of water was developed by Y. Kim. The system described details about the design and instrumentation of variable rate irrigation, wireless sensor network and real time in field sensing and control by using appropriate software. The whole system was developed using five in field sensor stations which collects the data and send it to the base station using global positioning system (GPS) where necessary action was taken for controlling irrigation according to the database available with the system. The system provides a promising low cost wireless solution as well as remote controlling for precision irrigation.

3. Methodology

A. Auto Irrigation

Soil moisture sensor is connected as an input to the controller which gives moisture values from the soil. Water pump is connected at the output. Soil moisture sensor gives values ranges from 0 – 1024. that values can be converted into moisture percentage with the formula moisture percentage = (100.00 - ((analogRead(sensor pin)/1024.00) * 100.00 )). We can set the minimum and maximum threshold frequency ranges of moisture percentage required to sugarcane crop. If the moisture percentage goes below the minimum moisture frequency, then water pump get start and If the moisture percentage goes above the maximum moisture frequency then water pump get stop.

B. Soil Nutrients detection

PH sensor is connected as an input to the controller which gives PH values from the soil. PH sensor gives values ranges from 0 – 14. If the value is between 0-6 then soil is acidic and there is more than required nutrients in the soil. If the PH value...
is between 6-8 then soil is neutral and all required nutrients present in the soil. If the value is between 8-14 then soil is basic and there is less than required nutrients in the soil and needs to add required nutrients. Information about the nutrition is sent to the farmer. In this firstly analog value converted into millivolt by using the value we are getting Ph value=(analogRead(sensor pin)*5.0/1024/6 and afterwards this millivolt value will be converted into required ph value using ph value=3.5*ph value.

Fig. 3. PH Sensor Output

<table>
<thead>
<tr>
<th>PH Values</th>
<th>Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>0-6 (Acid)</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>6-8 (Neutral)</td>
</tr>
<tr>
<td>HIGH</td>
<td>8-14 (Basic)</td>
</tr>
</tbody>
</table>

4. Disease Detection

A. Image Acquisition

In this step the sample images are collected, which are required to train the system. Sugarcane leaf images are taken by using digital camera and are used for both training and testing the system. The standard jpg format is used to store these images. In this study, images are collected from different regions like Pune. Few of the images have been taken from internet. Collected images include the leaves infected by red rot, mosaic.

B. Preprocessing

The image preprocessing is done on gathered images for improving the image quality. It removes the background noise as well as to suppress the undesired distortion. In this image is first resized to size 300x300 and then thresholding is done to get all green color component. Gaussian filtering is carried out to remove noise in the image.

5. Mathematical Model: Sugarcane leaf image Feature Extraction using Global Features

A. Mathematical equations of color feature extraction method

The color distribution information can be captured by the low-order moments, using only the first three moments: mean, variance and skewness, it is found that these moments give a good approximation and have been proven to be efficient and effective in representing the color distribution of images (Stricker and Orengo 1995).

\[
\mu_i = \frac{1}{N} \sum_{j=1}^{N} P_{ij}
\]

\[
\sigma_i = \sqrt{\frac{1}{N} \sum_{j=1}^{N} (P_{ij} - \mu_i)^2}
\]

\[
S_i = \frac{1}{N} \sum_{j=1}^{N} (P_{ij} - \mu_i)^{3/2}
\]

Where, \(P_{ij}\) is the value of the \(i\)th color channel of the \(j\)th image pixel. Only 3 x 3 (three moments for each color component) matrices to represent the color content of each

C. Training and testing dataset

The dataset is divided into two sub datasets. Training data: Training dataset is derived from main dataset and it contains 75% records in main dataset of Sugarcane Disease.

Testing data: Testing dataset is of 25% records from main Sugarcane Disease dataset.

D. Feature extraction for disease identification

Color feature: As most of the color distribution information can be captured by the low-order moments, using only the first three moments: mean, variance and skewness, it is found that these moments give a good approximation and have been proven to be efficient and effective in representing the color distribution of images (Stricker and Orengo 1995).

Edge Detection: Most of the shape information of an image is enclosed in edges. So first we detect these edges in an image and by using these filters and then by enhancing those areas of image which contains edges, sharpness of the image will increase and image will become clearer.

Texture feature: Describes the structure arrangement of surfaces and their relationship to the environment, such as fruit skin, clouds, trees, and fabric. The texture feature in our method is described by hierarchical wavelet packet descriptor (HWVP).

A 170- D HWVP descriptor is utilized by setting the decomposition level to be 3 and the wavelet packet basis to be DB2.

E. Classification

SVM Support vector machines are mainly two class classifiers, linear or non-linear class boundaries. The idea behind SVM is to form a hyper plane in between the data sets to express which class it belongs to. The task is to train the machine with known data and then SVM find the optimal hyper plane which gives maximum distance to the nearest training data points of any class.
image are needed which is a compact representation compared to other color features.

B. Mathematical equations of canny edge detector method

Step 1: Smooth the image with a Gaussian filter to reduce noise and unwanted details and textures.

\[ g(m,n) = G_\sigma (m,n) \ast f(m,n) \]

Where

\[ G_\sigma = \frac{1}{\sqrt{2\pi \sigma^2}} \exp \left( \frac{m^2 + n^2}{2\sigma^2} \right) \]

Step 2: Compute gradient of \( g(m,n) \) using any of the gradient operations (Roberts, Sobel, Prewitt, etc) to get:

\[ M(m,n) = g_m^2 (m,n) + g_n^2 (m,n) \]

And

\[ \Theta (m,n) = \tau \alpha n^{-1} \left[ g_n (m,n) / g_m (m,n) \right] \]

Step 3: Threshold M:

\[ M_T (m,n) = \begin{cases} M (m,n) & \text{if } M (m,n) > T \\ 0 & \text{otherwise} \end{cases} \]

C. Mathematical equations of texture feature extraction method

According to co-occurrence matrix, there are several textural features measured from the probability matrix to extract the characteristics of texture statistics of remote sensing images. Correlation measures the linear dependency of grey levels of neighboring pixels.

\[ \rho (i,j) = \frac{\sigma_x \sigma_y}{\sigma_x \sigma_y} \]

Following figure represent the respected values output in feature extraction.

D. The mathematics of the support vector machine

We have k sub-spaces so that there are k classification results of sub-space, called CL_SS1, CL_SS2, ..., CL_SSk. Thus the problem is how to integrate all of those results. The simple integrating way is to calculate the mean value:

\[ CL = \frac{1}{k} \sum_{i=1}^{k} w_i CL_{SS_i} \]

Where \( w_i \) is the weight of classification result of subspace \( SS_i \), and satisfies:

\[ \sum_{i=1}^{k} w_i = 1 \]

The centroid of a leaf is calculated as follows:

\[ X = \frac{\sum_{i=0}^{k} x_i}{k}, \ Y = \frac{\sum_{i=0}^{k} y_i}{k} \]

Where \( (X,Y) \) represents the centroid of the leaf, \( x_i \) and \( y_i \) are x and y coordinates of the ith pixel in the infected region and \( k \) denotes the number of pixels that represent only the leaf portion. In the next step, the distance between the centroid and the pixel value was calculated. For distance, the following Euclidean distance was used:

\[ \sqrt{(x2 - x1)^2 - (y2 - y1)^2} \]

Where \( (x1, x2) \) and \( (y1, y2) \) represent the two co-ordinate values.

E. Prediction

Following steps are performed for prediction:

1. Input sugarcane leaf image
2. Image pre-processing:
   In image pre-processing actions like unwanted part removal, converting image in standard resolution, adjust brightness these tasks are performed.
3. Feature Extraction:
   In feature extraction features like color, texture is extracted from the image.
4. Classification:
   In classification image is classified with extracted feature by using SVM algorithm.
5. Predicted output:
   At the output name of the disease is generated.

6. Future scope

This work can be installed by any individual who doesn’t have the proper knowledge about farming. Also extension to this work This system can be scaled up using PIR sensor which is used to detect animals which may lead to damage or effect the crop. PIR sensor don’t detect or measure heat, instead detect infrared radiation emitted or reflected from an object. It is used to detect the movement of people, animals or other objects. They are commonly used in burglar alarms and automatically activated lighting system. When an animal passes in field, the sensor automatically triggers the detection and thereby system takes necessary actions.

7. Conclusion

In this paper we conclude that with the help of this system we can save 70%-80% water requirement and also it reduces the time and efforts of the farmer. This system can be installed by any individual who doesn’t have the proper knowledge about...
farming. It also increases rate of growth of plant. This system can detect the disease occurred to sugarcane crop and farmers can take actions accordingly. It also helps for maintain the level of nutrients in the soil. Farmers can get everything notified with the help of mobile application. And also by using this system farmer can sell and purchase their good to gain maximum profit.

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