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# MICRO-CONTROLLER BASED AUTO-IRRIGATION AND PEST DETECTION USING IMAGE PROCESSING

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***Abstract:** Traditional wisdom relating to agriculture dates back around 12,000 years when the first plants were domesticated by humans. This system has since been evolving through accumulated experiences in dealing with situations and problems, and has been recorded and challenged down the generations. The integration of indigenous knowledge structure with scientific knowledge structure is vital to make agriculture sustainable. The significance of IT and automation in agriculture is increasing rapidly. IT have brought to the fore, new ways of doing things. There is realization that IT should be integrated with field of agriculture to be effectively used as a facilitating tool to boost its impact on the lives of farmers. Although India is the second largest irrigated country of the world after China, only one-third of the cropped area is under irrigation. Extensive care needs to be taken to oversee the ill effects of over irrigation. Abundant amount of crops gets affected due to excess amount of moisture present in the soil. The major challenge in agriculture is early pest detection. Detection of pests in the paddy fields is a major challenge in the field of agriculture, farmer relies on a combination of experience, visual inspection and he has to perform periodical surveys over a widespread plantation which is a time consuming activity and therefore effective measures should be developed to fight the infestation while minimizing the use of pesticides. This study refers to a collaboration of automation and electronics to suggest an auto irrigation system inclusive of a pest detector. The technique of image analysis is extensively applied to agriculture science to provide maximum protection to crops which can ultimately lead to better crop management and production. This study extends the implementation of different image processing techniques to detect and extract pests by establishing an automated detection and monitoring in order to minimize human efforts and errors.*

***Keywords:** early pest detection; over irrigation; automation; auto irrigation system; pest detector; Image processing.*

## 1. Introduction

India is an agriculture oriented country. Two-third of population relies upon agriculture directly or indirectly. It is not merely a source of livelihood but a way of life. It is the main source of food, fodder and fuel. It is the basic foundation of economic development. It provides highest contribution to national income. In addition to this, agriculture also provides employment opportunities to very large percentage of population. The climate conditions of our country is isotropic, still we are not been able to utilize agriculture resources. The reason behind this is the lack of rains and scarcity of water. Another cause may be unplanned use of water due to which a remarkable amount of water goes in vain. At the present era, the farmers have been using irrigation techniques in India through manual control in which farmers irrigate the land at the regular intervals. Since the process is controlled manually, the amount of water going in the soil might not fulfil the requirements which may affect the cultivation of crops. This problem can be completely resolved if we use automatic irrigation system in which the irrigation will take place only when there will be an acute requirement of water. Presence of pests and disease affect the rate of crop cultivation. It reduces crop yield in a significant amount and as a result there will be an increase in poverty, food insecurity and mortality rate. There exists a strong demand now for non-chemical control methods for pests. Currently no automatic method breathe which periodically detect the presence of pests. The current system relies on visual observation which is a time consuming process. With

 

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the advancement in image processing technology, it is feasible to create an automated mechanism for the detection of pests. In this paper, the author describes a method of acquiring images from a high resolution camera or satellite. Then the acquired image is processed by various image processing techniques to detect the presence of pests or diseases. The shape and size of the pest can also be procured by extracting the image.

## 2. Literature Survey

A lot of research has been done by the author on several papers for the identification of pests in the field. There are various methods described in the existing system which are mentioned below:

### 2.1 Video analysis and static image analysis

For detection and identification of pests, the input can be a video or a still image. Ying yang et.al.[1]use video analysis to count the number of pests. Author use various techniques such as motion estimation, multiple-frame verification etc.. Murali Krishnan et.al. [2] use cameras to capture still images of mono crops infested with coffee berry or aphids and the pest image is outshined after multiple clustering of the original image taken from the mono crop plantation using various algorithms like k-means, fuzzy c-means and Expectation-Maximization. Ganesh Bhadane et.al.[3]captured the images of the infested leaf by cameras and used computer vision techniques for automatic detection of the bio-aggressors. Image processing is done on the acquired image that undergoes various processes such as filtering, segmentation, object extraction.

### 2.2 Types of pests

Various methods exists to detect and identify different types of pests like whiteflies, aphids and borers. Whiteflies and aphids are detected on yellow sticky traps by Rupesh G. Mundada et. al.[4] using pan tilt camera with zoom features. The features like eccentricity, color, mean, standard deviation etc, are extracted and stored in the support vector machine (SVM) and these features are used for detecting and classifying whether the bio aggressors are aphids or whiteflies. Pratibha GP et. al. [5] use image processing techniques to detect borers on tomato plants. The image is captured and obtained by the system followed by RGB to grayscale image conversion. Then the image undergoes segmentation process to extract the interested area. Filtering is done by distinguishing the border and the tomato pixels so as to remove noise. The target object is extracted which is the borer. It also gives a count of the borers in the tomato.

## 3. Proposed Model

### 3.1 Automatic Irrigation System

The system is used to monitor the moisture content of the soil. It consists of an arduino board which is the heart of this system. Hygrometer is connected to arduino board which anticipates the moisture content of the which control the automated mechanism of water pump. When the moisture content of the soil overshoots threshold value, the water pump switches ON. The flow of water lowers the moisture content and as it goes below threshold value it switches off the water pump. The switching operation is controlled by a relay switch. The connections and observation table are shown in fig 1. and tab. 1 respectively.

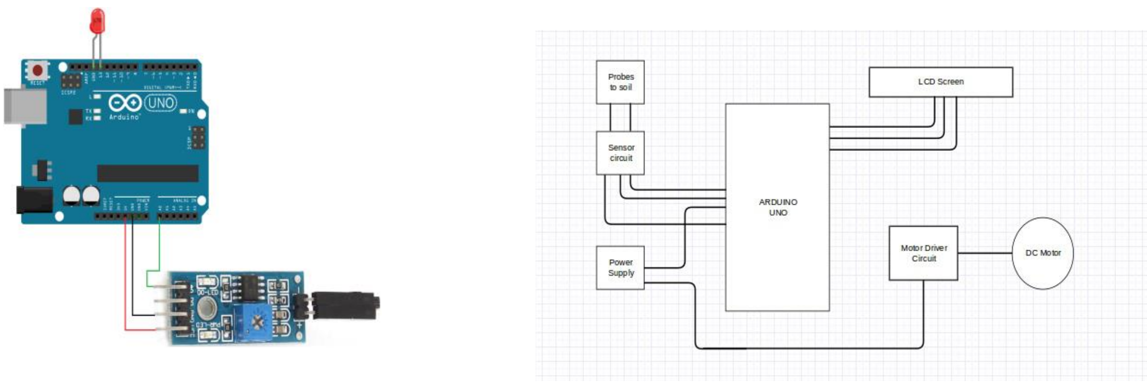


Fig.1 Block Diagram of Automatic Irrigation System

 

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| STATE | WET | DRY |
|---|---|---|
| **MOISTURE CONTENT** | 0 | 1023 |
| **THRESHOLD** | 800 | 800 |

Table 1 Analog moisture readings of Arduino

## 3.2 PEST DETECTOR

### 3.2.1 Need of early detection of pests

Early detection of pests or the initial presence of a bio-agressor is a key point for crop management. The detection of biological objects as small as such insects is a real challenge, especially when considering greenhouse dimensions.[3] Early detection of pest attack in paddy crops will help farmers control pests and save hectares of crops. For this motive different techniques are applied such as Sampling Method, Visual Observation but these methods does not provide accurate results. Hence there is a need of an automated scheme for early pest detection.

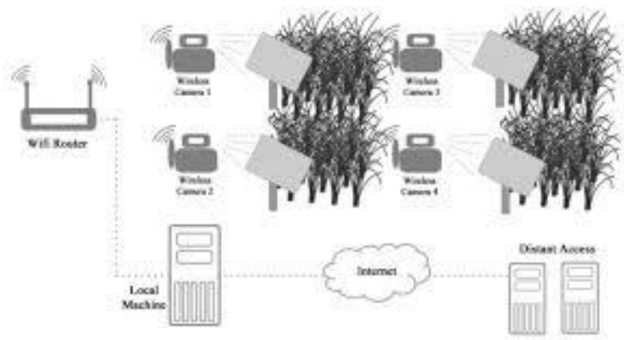
### 3.2.2 Sampling Method


There are many insect sampling techniques that can be utilized to detect pests in the air, on plants, and even on and beneath soil[6]. It initiates with the monitoring of field conditions. Once you have an idea of the field conditions and layout, farmers needs to think about an efficient sampling pattern for the field. For example, “W” or “U” shaped sampling patterns are implemented in square fields and “zig-zag” sampling patterns are more efficient in narrow fields. The more plants sampled, the more reliable the sampling data and that is why it is a time consuming process. From the sampling data various parameters such as presence, type, density can be obtained. Effective measures are taken in the last to increase the crop yield.

### 3.2.3 Image Processing

***A. Image Acquisition***

For the process of Image Processing, Image Acquisition is an important framework as without an image no processing can be done. Image can be retrieved from satellite that use a 3-D Image Acquisition technique or a network of wireless camera (protected against water projection and direct sunlight) can be set up of high resolution(1280 x 1024 pixels) which could take 10 frames per second. The image can be extracted and used for further processing.




***B. Image Preprocessing***

It involves the process of removing low-frequency background noise, normalizing the frequency of individual particle images, removing reflections, and masking portions of images. It creates an enhanced image that is more useful in processing the still image. It involves 3 main steps : a) Conversion of RGB image to greyscale image b) Resizing of the image c) Filtering of the image d) Segmentation

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*a) Conversion of RGB Image to Greyscale Image*

In RGB colour model, each colour appears in its primary spectral components of Red, Green and Blue, described by their corresponding intensities[7]. The drawback of RGB model is it occupies a large volume of space and it takes a lot of time for processing. Hence, RGB images needs to be converted into Greyscale images using formulae mentioned below :

$$I(x, y) = 0.2989\times R + 0.5870\times G + 0.1140\times B$$

Fig. 2.1 Input Image

Fig. 2.2 Greyscale Image

*b) Resizing of the Image*

Resizing is a crucial step in Image Processing. The acquired image is resized according to the requirement of technique. For this objective various methods can be used such as B linear, Bi-cubic, Nearest neighbourhood interpolation etc. The obtained images will be resized into (248 x 200 pixels) and filtered.

*c) Filtering of the Image*

Filtering is a technique for modifying or enhancing an image[8].Filtering is a neighbourhood operation, in which the value of any given pixel in the output image is determined by applying some algorithm to the values of pixels in the neighbourhood of the corresponding input pixel. A pixel's neighbourhood is some set of pixels, defined by their position relative to that pixel. There are various filters such as Low pass, High pass, Band pass, Smoothening etc. Different techniques of filtering are available such as average filtering, median filtering etc. In this study the author uses median filter technique. Median filter looks at its nearby neighbour's pixel values to decide whether or not it is representative of its surrounding pixels and replaces with the median of those values. Fig. 3 illustrates an example calculation.

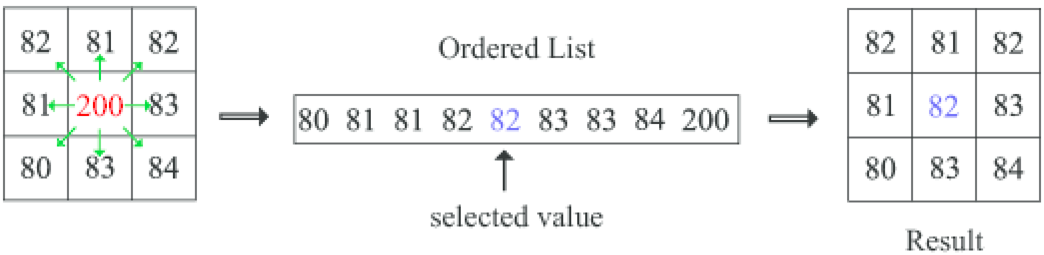


Fig.3 Calculation of Filtering process by median filtering algorithm

*d) Segmentation*

Segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyse. Image segmentation is typically used to locate objects and boundaries in images. The processing image is segmented by means of K-mean clustering algorithm.

***C. Detection of Pests in the Image***

The automated mechanism proposed by authors is very simple and efficient. It is based upon a concept of comparing the pixel values of successive captured images. Two images are used to distinguish a difference. One image acts as a reference image which has the reference pixel values and the second is the input image which is served as an input. The pixel values of input image is then compared with pixel values of reference image. If both the pixel values are same, then the output will be white (pixel value is 255) else the input pixel values will be the pixel values of output image. After the comparison being done the output image will be extracted and the input image will be served as output for next page.

$$O_{RI}(i,j) = \begin{cases} 255, & if R(i,j) = I(i,j) \\ I(i,j), & if R(i,j) \neq I(i,j) \end{cases}$$

Let us take an example of two 4 x 4 greyscale images:

$$R(i,j) = \begin{bmatrix} 170 & 170 & 170 & 170 \\ 170 & 170 & 170 & 170 \\ 170 & 170 & 170 & 170 \\ 170 & 170 & 170 & 170 \end{bmatrix} \qquad I(i,j) = \begin{bmatrix} 170 & 170 & 170 & 137 \\ 170 & 130 & 23 & 170 \\ 170 & 30 & 22 & 170 \\ 170 & 170 & 250 & 178 \end{bmatrix}$$

$$O(i,j) = \begin{bmatrix} 255 & 255 & 255 & 137 \\ 255 & 130 & 23 & 255 \\ 255 & 30 & 22 & 255 \\ 255 & 255 & 250 & 178 \end{bmatrix}$$

R(i, j) represents the reference image, I(i, j) represents the input image and O(i, j) represents the output image in the co-ordinates (i, j).

***C. Extraction of Pests from the processed image***

In this phase the output image obtained will be used to extract the co-ordinates of pests present in the field. To do so, the output image pixel values will be scanned horizontally as well as vertically. The width and height of the extracted image will be determined by using its starting and ending co-ordinates. This process consists of two steps. First, the output image pixel values is scanned horizontally which starts at the first i-direction, then the pixel values are summed up to the corresponding columns. The co-ordinate value in i-direction is incremented by one and the total pixel value in the next column is calculated. The process is repeated until reaching the last pixel value in the i-direction. As a result, the total pixel values of each column are calculated. In order to determine the ith co-ordinate where an object starts or ends within the image, each total value is compared to a certain threshold value. Second, it vertically repeats the horizontal scanning method; therefore the total pixel value in each row is calculated. Then, to determine the jth co-ordinates, the thresholding will apply where objects start or end within the image. The mathematical description is shown in the following equations. Starting at coordinates (i=0, j=0) until coordinate (i= $n_i$ , j=$n_j$ ), the total pixel value of the column and row are defined below:

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$$J_i = \sum_{j=0}^{n_j} O(i,j) \qquad I_j = \sum_{i=0}^{n_i} O(i,j)$$

$$S_i = j \quad if\ J_i \leq \lambda \qquad S_j = j \quad if\ I_j \leq \lambda$$

$$E_i = j \quad if\ J_i > \lambda \qquad E_j = j \quad if\ I_j > \lambda$$

here $\lambda$ is the threshold, $S_i$ and $E_i$ are respectively the starting and ending i co-ordinates of the extracted output image and $S_j$ and $E_j$ are respectively the starting and ending j coordinates of the extracted output image. The size of the extracted object image is $(E_i - S_i).(E_j - S_j)$.

## 4. Conclusion

The idea prevails an automated irrigation mechanism which reduces human intervention in the paddy fields. It creates a system which ensures proper irrigation. It prevents the adverse effects of over irrigation which leads to reduction in crop cultivation. This model can be successfully applied to achieve great results with most types of soil . In this research, author aims another goal of early detection of pests. It is achieved with prominent results by acquiring the images of agriculture land. The image is then filtered by applying mean filter algorithm to remove noise created by various lighting conditions. The filtered image is then segmented and processed by image processing technology to extract the information about presence of pests. The process mentioned by authors gives promising result upto a certain extent. In the future, other image processing techniques may be used to enable the detection and extraction more efficient and accurate.

## 5. Future Work

In future, the project may be extended by using WSN(Wireless Sensor Network) technology. Every sprinkler can be connected by means of WSN so as to integrate the model in acres of land. Every sprinkler acts as a sensor node and will be connected to a base network. By anticipating the requirement of pesticides in the field, significant amount of pesticides can be charged in sprinklers in liquid form to obtain the automated pesticide spray system. GSM technology can also be integrated to create an interface between user and fields.

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