WSN CONTROLLED SMART GREEN HOUSE INSECTES MONITORING THROUGH IMAGE PROCESSING USING PYTHON

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Abstract:- **This paper describes the monitoring of insect through their behavior and population and also from the analysis of the parts of the plant (leaf, stem, flower, fruits) using image processing toolbox of python. Earlier there is a need of human inspectors who uses adhesive trap and visit fields for inspecting the pest insect and plant condition. This work is time taking, costly and consumes more labor force, and it would be fruitful for the farmer to have affordable system that does the same task automatically. In a result the amount of fertilizer is advised to the farmer from the comparative analysis of the healthy part and infected part of the plant by the agricultural doctor.**

Keywords: **crop pest control, image processing, wireless sensor networks, ZigBee, python.**

I. INTRODUCTION

Agriculture is the main aspect of the civilization because our basic needs are fulfilled through it. Now a day, farmers are facing many agriculture related problem. The production from the agriculture field decreases due to the environmental change and the increment of level of pest insect. The better yield from the field can be obtained by the continuous monitoring the agriculture site with the help of camera and wireless communication. After the information get retrieved from the field, we calculate the insect count and recognize the area of infected part of the plant leaves, fruit, stem and flower through image processing and inform the farmer through call/message about the crop health condition.

The timely monitoring of the agricultural field helps to protect the plant from the pest insects. The timing and number of chemical and biological treatments are taken on the basis of the pest insect population and the external morphology of the plant. The external morphology of the plant describes about the outward appearance (shape, structure, color, pattern size). The early detection of the pests and the change in color and pattern of leaves, flower and fruits helps to treat the plant successfully. In the past, the monitoring of the agriculture field is done by the human operator. The insect population level is continuously monitored during crop season by means of adhesive trap spread through the field at appropriate spatial density where odorous baits such as sex pheromone and color appearance are used to attract the insect. Such type of survey needs high labor and time consuming operation. Human survey is unlike to be conducted frequently and often yields non satisfactory result.

The rapid development in the imaging device and the wireless communication could give a large contribution in the automatic monitoring of pests. The wireless networks of sensors are used to access the remotely situated adhesive traps. The number of insects on adhesive traps and leaves of the plant approximate the level of damage in agricultural area. In the process of monitoring the agricultural field through remote sensing, there is a set of stations combined of master node and sensor nodes. There are many ways of employing the structure of remote sensing. In the first case, there is sensor node which acquires the image and does the image processing, and finally transmit the result to the master node. Such type of networking is expensive because of need of more hardware and power capacity. In the second case, there is sensor node which does the simple function of acquiring and transmitting of the images through the wireless network to the master node where the processing of image is done through image processing toolbox of python and necessary action is taken according to the retrieved information from the images.

This paper [1] presents trap cropping. A trap crop is a plant that is added to the garden or agricultural field to attract the pests away from the main crop. A trap crop acts as a breeding crop for the pest. When the pest increases, the

predators also increases then the hungry predators start eating them and this is the natural method of controlling the pests. Also the images of trap crops are used for the insect count in the farm.

Image sensor network platform [3] is developed for testing transmission of images over ZigBee networks. The transport layer functionalities such as fragmentation and reassembly are performed at the application layer since this network does not have fragmentation support. This paper deals with layer of ZigBee architecture and image format which can be supported for transmission. It concludes that images are encoded into multiple quality layers are more error resilient and high PSNR is maintained. Therefore, it is more suitable image compression format in low rate image sensor network applications.

II. SMART GREEN HOUSE

Green house is a closed room covered with glass where unseasonal crops can be also grown by maintaining its temperature, humidity, water level, moisture in soil, light, and may be controlled by a computer to optimize conditions for plant growth..These structures range in size from small sheds to industrial-sized buildings. This project has been implemented in the green house so that there is continuous monitoring on plant condition. Greenhouses allow for greater control over the growing environment of plants. Depending upon the technical specification of a greenhouse, key factors which may be controlled include temperature, levels of light and shade, irrigation, fertilizer application, and atmospheric humidity.

III. SYSTEM DESIGN METHODOLOGY

A. System Description

The sensor network used here is based on the zigbee communication protocol (IEEE 802.15.4 standard). The implementing network architecture consumes moderate energy. The peer to peer communication is implemented in our design. The network architecture consists of master node and sensor node. The master node is hosted inside PC and a set of sensor node. The sensor node acquires the image and transmits it to the master node. There is no any image processing mechanism in the sensor node. The master node coordinates the network and sends the request for shooting the picture to the sensor node. The collected images are sent to the PC.

The image processing mechanism is done in the PC and the necessary information such as insect count and color of leaves, flower and fruit are inspected by the human operator. The physical quantities that are measured here is represented by images, so the complexity of the device increases. Each node must consist of camera, a radio transceiver and a microcontroller to manage image capturing and transfer.

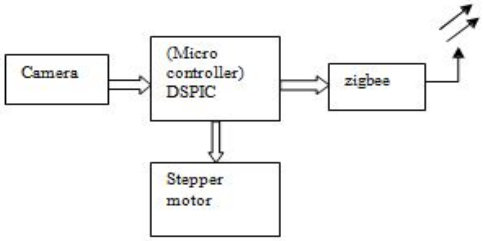


Fig: Transmitter section

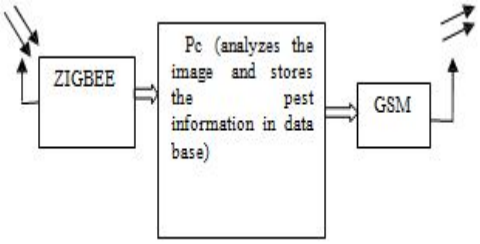


Fig: Receiver section

In this project, camera associated with the sensor node is interfaced with the microcontroller DSPIC30F3011. The model of camera is LS-Y201 which is link sprite's new generation camera module. The resolution of the camera is high and uses serial port for capturing the image. This camera takes the picture according to the light of the environment. The camera works via RS-232 connection to the microcontroller.

Fig: LS-Y201

B. Specification of Camera

- VGA/QVGA/160*120 resolution
- Support capture JPEG from serial port
- Default baud rate of serial port is 38400
- DC 5V power supply
- Size 32mm X 32mm
- Current consumption: 80-100Ma

C. Required Component Details

ZigBee is a IEEE.802.15.4 based specification for a suite of high level communication Protocols used to create personal area networks with small, low power digital radios. The technology defined by ZigBee specification is simpler and less expensive than other Wireless Personal Area Network (WPAN) such as Bluetooth, Wi-Fi. The application of it includes wireless light switches, electrical meters within home displays, traffic management system and other consumer and industrial equipment requires short-range, low rate wireless data transfer. The transmission distance of device is 10-100 meters line of sight because of low power consumption depending on power output and environmental characteristics. It can transmit data over long distances by passing it through a mesh network of intermediate devices. This network is secured by 128 bit symmetric encryption keys. The defined rate of ZigBee is 259 kbps which is suitable for intermediate data transmission. A ZigBee device has low latency and operates in Industrial, Scientific and Medical radio bands: 2.4 GHz. ZigBee network supports star, tree, mesh networking. DSPIC30F3011 is 16-bit high performance risc C.P.U. The microcontroller is implemented with enhanced flash memory having low power consumption with less cost. The operating frequency is 7.35 MHz. GSM is used to transmit the message to the farmer. There are three phases of communication between microcontroller and camera. They are connection, configuration and download phase. In connection phase, the channel is synchronized. In the setup phase, the type of image and packet size is defined. In the download phase, camera transmits the packet composing the whole image. The image is saved in the flash memory. The flash memory would have read/write operations to make data transfer efficient. The size would be in blocks of 64 kbps. The generated JPEG image is stored in two blocks. In our application, two partitions are reserved to store an image. The memory blocks of flash memory needs to be erased to store new data in the same block of memory. The procedure for acquiring one image and transmitting to another node is shown below:

1. Acquire an image from the camera and write on partition 1.
2. Receive image from a neighboring node and write it on partition 2.
3. Transmit the content of partition 1 and erase it.
4. Transmit the content of partition 2 and erase it.

The processor communicates to the peripheral device with the single bus. The access poling implemented is of FCFS (First Come First Serve) type and it allows coordinating reading and writing the flash memory and transmission/receiving from radios. There is serial SPI interface between microcontroller and radio devices and microcontroller is connected to the camera via USART0 interface. Cameras acquire data and buffer it in flash memory before being transferred. The host station is responsible for coordinating the client nodes that are designed to handle the camera, saving and transmitting the captured images. The base station requires all client nodes to identify themselves and communicate the state of their batteries. The developed application is designed for a node layout that corresponds to a linear network topology. The unique identification is given to all sensor nodes. The master node broadcasts a command of shooting image. Now, the sensor node captures the images of respective site and transfers the images to the master node. In the transmission of image, there is a single radio channel through which each nodes of the network sends their data to the base station through master node. At the base station, the images are processed and desired information is retrieved.

IV. IMAGE PROCESSING

An image can be defined as a two dimensional functional, f(x,y), where x and y are spatial coordinates and the amplitude of f at any point of coordinates (x,y) is called the intensity or grey level of the image at that point. When x, y and the amplitude values of f are all finite, discrete qualities, we call the image a digital image.

The idea of python originated in 1989 when its creator Guido Van Rossum was confronted by the shortcoming of ABC language (namely extensibility). Python has multiple implementations including jython, scripted in java language for java virtual machine. The application of python is in GUI based desktop applications; image processing; operating system; language development and prototyping. The advantages of python over other language are:

- Presence of third party module
- Extensive support libraries
- Open source and community development
- Learning ease and support available

- User friendly data structure

V. CONCEPTS OF PYTHON USED

A. *Reading and writing images:*

To manipulate an existing image, we must open it first for editing and we also require the ability to save images in a suitable format after making changes. The image module skimage provides method to read and write images in the specified image file formats. 'imread' is the module which is used to read the image from the appropriate path where the path is used as argument.

Img = skimage.io.imread ('path')

B. *Conversion of Image into Grey Level:*

After reading the images to numpy arrays, we can perform any mathematical operations we like on them. A simple example of this is to transform the image to grey level. In this process, we should take any function f that maps the interval image to grey level.

C. *Image De-noising:*

Image de-noising is the process of removing image noise while at the same time trying to preserve details and structures. Removing noise from images is important for many applications, from making photos better to improving the quality of satellite images. Low pass filter such as median filter is used for removing the noise. In our application, guassian filter is used for smoothening image in order to remove the noise while preserving the image details.

Img = ndimage.gaussian_filter(img, sigma)

D. *Thresholding:*

An image processing that involved the separation of image in two levels on the basis of threshold value is called thresholding. When the threshold value is constant, then it is called Global thresholding.

Global_thresh = skimage.filter.threshold_otsu(img)

Threshold = img > global_thresh

E. *Sharpening:*

High pass filtering is used for sharpening of images. High pass filter enhanced the edge of image over a dark background.

Sharpen_img = Original_img – Lowpass_img

High boost_img = A(original_img) – lowpass_im

F. *Histogram:*

Intensity transformation functions based on information extracted from image intensity histogram play a basic role in image processing, in areas such as enhancement, compression, segmentation and description. The focus of this section is an obtaining, plotting and using histogram for viewing pixel distribution to find the changes in plant morphology due to the attack of pests.

VI. SIMULATION RESULT

The captured image is in the RGB format. We need to convert it to the grey level to identify the insects and discoloring of leaves of plant due to the attack of pests, from the black background. Now, the noise inherited image is removed and global thresholding is done to detect the insects and infected part from the healthy part of the plant. The sharpening of the image gives the edge enhanced image over a black background. The histogram is the plot of frequency of pixel of certain intensity vs intensity level. It is used for the analysis of the level infection in leaves from the comparison of healthy and infected leaves of the plant.

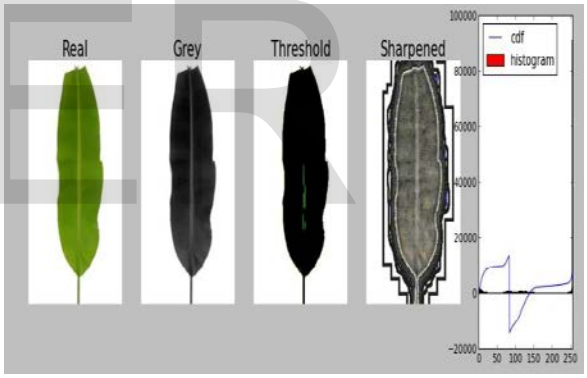


Fig: Healthy leaf

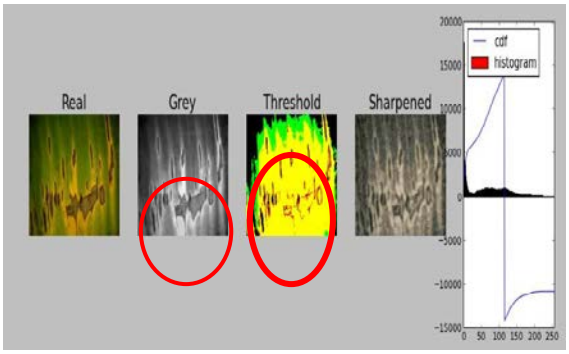
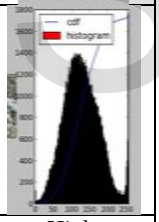


Fig: Infected leaf

Fig: insect infected leaf

VII. COMPARISION TABLE

Images / Plant	Grey Level	Threshold	Histogram
Healthy leaf			
Infected leaf			
Result	Highlighted spot shows the infection in leaf	Green-black color Infected part- other colors	High frequency of intensity level 250 in healthy leaf indicates green while frequency of several intensity level indicates the presence of infection.

VIII. CONCLUSION

The result of this study demonstrated the feasibility of pest insect automatic monitoring on the field. The level of infection can be determined from the comparative analysis of the simulation result of healthy part and infected part of the plant. The treatment procedure would follow the simulation result for the successive curing of plant from diseases and insects. Further research is still needed to improve the robustness of the measurements to more specific information and to demonstrate the cost and environment benefit of such a system.

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