Monitoring Of Pest Insect Traps Using Image Sensors & Dspic

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***Abstract*-This paper describes the monitoring of pest insect population by using wireless sensor network in field. Monitoring pest insect population is very big issue in crop protection. At farm level it is continuously check by a human operator for adhesive traps, disseminated through the field, where insects remain stuck when attracted. This is a labor- and time-taking activity, and it would be of great advantage for farmers to have an affordable system doing this task automatically. This paper illustrates a system based on a distributed imaging device operated through a wireless sensor network that is able to automatically acquire and transmit images of the trapping area to a remote host station. The station evaluates the insect density evolution at different farm sites and produces an alarm when insect density goes over threshold. The network architecture consists of a master node hosted in a PC and a set of client nodes, spread in the fields that act as monitoring stations. The master node coordinates the network and retrieves from the client nodes the captured images. The nodes can communicate with each other by using Zigbee Transcivers. The information regarding pest can be send to the former via call/message.**

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

I. INTRODUCTION

Agriculture is heart of our civilization now a day's formers are facing many problems for getting better yield cause of rapid change in climate and unexpected level of insects, in order to get better yield need to reduce the level of pest insect. It can be possible by continuous monitoring of field manually but it is not optimized solution so that we proposed a system which continuously monitor the crop with help of camera and calculate insect count through image processing and alert the former by call/message consisting of crop health information**.**

An accurate and timely monitoring of pest insects population is a important issue in crop protection. Indeed, decisions about the timing and the number of chemical and biological control treatments are more and more taken on the base of the knowledge about current pest population levels and their dynamics. Treatments success is recognized to strongly rely on early detection of population sprouts At farm level, especially in orchards and vineyards, pest population levels during crop season are routinely monitored by means of adhesive traps disseminated through the field at appropriate spatial density, where insects remain stuck when attracted into by color appearance or odorous baits such as sex pheromone. This activity requires repeated surveys in the field with visual observation of traps and recording of the number of insects captured by a human operator. Being these surveys a highly labor- and time-consuming operation, they are unlike to be conducted at the necessary monitoring frequency, often yielding poor results, significantly affected by observer's skill or fatigue, or by surveying conditions.

The on-going developments in new miniaturized, low cost imaging devices and in wireless communication technology could give a valuable contribution in facing automatic monitoring of pest insects by establishing a wireless network of sensors able to remotely assess the adhesive traps captures in the field. Indeed, a successful development of such system would potentially allow taking decisions about insect control strategies at a farm or at district level, based on continuously updated spatial maps of pest insect population levels which are retrieved in a server from a distributed network of sensor wireless units transmitting from the field. To achieve this, a set of measuring stations have to be deployed in the field. One possibility is that each station provides directly an insect count and transmits the processed data to a host station. Even if this approach could have a great value for research purpose in insect control, the cost would be prohibitive when considering hardware and power capacity required by an operative network with a typical density of the order of ten nodes (traps) per hectare. An alternative solution, explored in this study, is based on adopting very simple stations only having the capability of acquiring and transmitting through low-power wireless networks the images. A host station will process all the images and count the trapped insects. This same station will send the message to the farmer about health status of crop through message/call.

This paper [1] presents trap cropping, it is a traditional tool of pest management. Successful deployment of trap crops within a landscape depends on the inherent characteristics of the trap crop and the higher value crop, the spatial and temporal characteristics of each, the behavior and movement patterns of insect pests, and the agronomic and economic requirements of the production system. Thus, trap cropping is more knowledge-intensive than many other forms of pest management. This paper classifies the modalities of trap cropping based on the characteristics of the trap crop plant perse and deployment of the Trap Crop.

Sensor platform idea & design has been discussed in paper [2]. This project has researched and prototyped a system for monitoring fruit flies so that authorities can be alerted when a fly enters a crop in a more efficient manner than is currently used. This paper presents the idea of a sensor platform design as well as the fruit fly detection and recognition algorithm by using machine vision techniques. The experiments showed that the designed trap and sensor platform can capture quality fly images and the invasive flies can be detected with an average precision of 80%.This paper presents the idea of a sensor platform design as well as the fruit fly detection and recognition algorithm using machine vision techniques. Manual insect monitoring is time consuming and laborious. Machine vision technology provides an alternative way to do this. Insects are firstly detected and then recognized using different features. Applications have tended to focus on pest insect recognition such as wasps and leafhoppers. Sensor platform design consists of two parts

1. Fruit fly trap design
2. Sensor system design

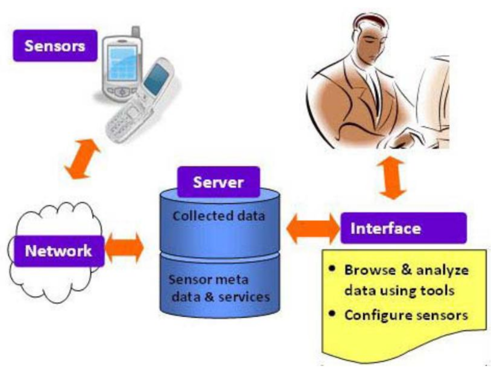

Fig. 1 Architecture of the sensor system

The proposed algorithm for recognizing the fruit flies includes the following steps

1. Image Pre-Processing
2. Image Segmentation
3. Color Space Transformation
4. Fruit Fly Recognition

In this paper, a prototype system for automatic monitoring of fruit flies is developed. This system can be used for data capture, storage, access, and analysis. A trap with Smartphone sensor has been designed and tested. A simple but effective method is developed for detecting invasive flies in the trap and the prototype is possible to be expanded for monitoring other insect pests.

Image sensor network platform [3] is developed for testing transmission of images over ZigBee networks that support multi-hopping. The ZigBee is a low rate and low power networking technology for short range communications, and it currently uses IEEE 802.15.4 MAC and PHY layers. Both ZigBee networking (NWK) and IEEE 802.15.4 MAC layer protocols are implemented on a single M16C microprocessor. Transport layer functionalities such as fragmentation and reassembly are performed at the application layer, since the ZigBee NWK does not have a fragmentation support. The multiple access schemes is CSMA/CA, therefore only the best effort multi-hop transmission of JPEG and JPEG-2000 images are tested. This paper deals with layers of zigbee architecture and image formats which can be supported for transmission over zigbee. And they concluded JPEG-2000 is images encoded into multiple quality layers are more error-resilient, and high PSNR is maintained. Therefore, it is a more suitable image compression format in low rate image sensor network applications. Multi-hop transmissions of JPEG-2000 images were unfortunately not completed due to adverse environment with interference from uncontrolled IEEE 802.15.4 and IEEE 802.11 wireless devices.

II. SYSTEM DESIGN METHODOLOGY

A. *System description*

The developed sensor network is based on the Zigbee communication protocol (based on the IEEE 802.15.4 standard). It allows implementing several networking architectures with moderate energy consumption. In particular, peer-to-peer communication is implemented in this study. Each device can work as a simple measuring node or as a communicating node that is able to receive and forward data besides measuring physical quantities. The network architecture consists of a master node, called base station, which is hosted inside a PC, and a set of client nodes. The master node has the role of coordinating the network. This node sends to the clients the request for shooting a picture and then collects all the images, sending them to the PC.

The images are processed by the PC that produces the insect count. The client nodes have the role of acquiring the images upon request and transfer them, through other client nodes, towards the master node. As the measured physical quantities are represented by images, the device complexity is an issue here: each node should contain a camera, a radio transceiver and a microcontroller with enough computing power to be able to manage image capturing and transfer.

The figures represent the transmitter and receiver

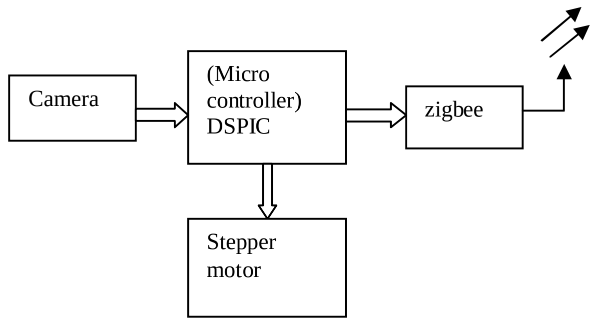

Fig. 2 Transmitter Section

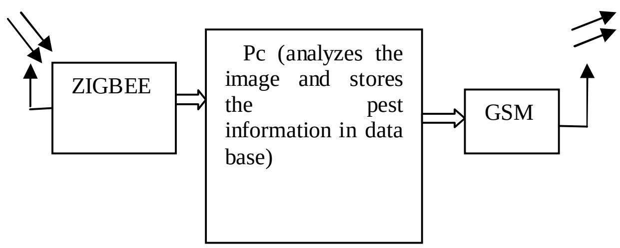

Fig. 3 Receiver Section

In this project camera in transmitter section will be interfacing with micro controller **DSPIC 30F3011**. The camera is **LS-Y201** is Link Sprite's new generation serial port camera module. It can capture high resolution pictures using the serial port. LS-Y201 is a modular design that outputs JPEG images through UART, and can be easily integrated into existing design.

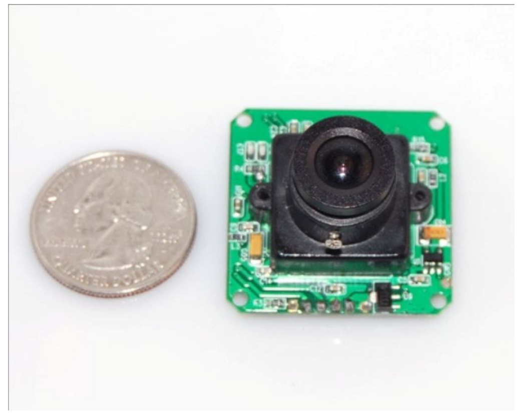

Fig. 4 Interface Model of LS-Y201

B. Specification of Camera

- VGA/QVGA/160*120 resolution
- Support capture JPEG from serial port
- Default baud rate of serial port is 38400
- DC 3.3V or 5V power supply
- Size 32mm X 32mm
- Current consumption: 80-100mA

C. Required Component Details

DSPIC 30F3011 is 16 bit high performance risc c.p.u With enhanced flash program memory having low power consumption with less cost and it is running at 7.35 Mhz. zigbee transceiver used for wireless transmission of captured image to pc and for communication between nodes, zigbee assures low power consumption with low cost and low speed. It allows maximum range of 75mts and it can capable to support up to 65,000 nodes per network. Gsm is used to convey the pest information to farmer. The communication between the micro controller and the camera consists of three phases: connection, setup, download. The first one is necessary for channel synchronization. During the configuration phase, type of image and packet size is defined. In the download phase, the camera transmits the packets composing the whole image. The acquired images have to be saved on the flash memory. To make the data transfer efficient, the flash memory of micro controller needs to organize the read/write operations in blocks of 64kbyte. The generated JPEG images never exceed 70 kbyte, therefore two blocks are sufficient to store one image. In our application, two partitions are reserved for image storage (either acquired by the camera or received from the neighboring node). In flash memories, memory blocks need to be erased (which is a high-latency operation) before new data could be written in the same block. The resulting procedure for acquiring one image and transmitting an image received to another node is the following:

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 partition 1.
4. Transmit the content of partition 2 and erase partition 2.

Since the processor communicates with the peripheral device with a single bus, all I/O operations have to be serialized and only one peripheral device at a time can be served or polled. The access policy implemented is of FCFS (First Come – First Served) type and it allows coordinating reading and writing the flash memory and transmission / receiving from radio. The microcontroller communicates with the radio device through the serial SPI interface, while it is connected to the camera via the USART0 interface. The arbiter will decide at run time which of these two components has the right to access the internal bus. The data will be acquired from the camera and buffered in the flash memory before being transferred. Considering that the nodes are battery-powered and are unevenly distributed, it is useful to monitor the network status before proceeding with the transfer of images.The host station is responsible for coordinating the client nodes that are designed to handle the camera, saving and transmitting the captured images. In this scenario, the base station requires all client nodes to identify themselves and communicate the state of their batteries: node ID, battery voltage and connection quality with their own parent node. Such information allows the base station to obtain the list of nodes and, according to this, to coordinate the image transfer from the farthest node in the network up to the base station.

The developed application is designed for a node layout that corresponds to a linear network topology. The node identifier assigned by the Base Station provides information on the topological distance from the master node: the base station has node ID=1, while all other values are assigned odd increasing numbers, starting from 3. With this numbering system, it is established, for each node, that the previous odd value corresponds to the father node and the next odd value to its son. Therefore, the implemented communication protocol can be considered multi-hop and enough time has to be left such that the information sent by the last node reaches the base station going through all the other intermediate nodes.

By exploiting the unique identifiers assigned to the nodes, the base station broadcasts to all nodes the command to shoot an image. Each node, upon reception of this command, acquires an image, saves it in the flash memory. When all the nodes have stored their own image, the multi-hop image collection phase begins: each node sends its image to its parent node, packetized in such a way to be transferred through the ZigBee channel. Only one node at a time uses the radio channel. Each node carries out the same job: saves its own image, receives images from son nodes and sends them all to their parent node. This process gives rise to a shift of the images of all nodes along the network, .up to the base station. Every single radio packet consists of 11 bytes of header, 28 bytes of payload (recommended size of TinyOS) and 7 bytes of metadata. The picture was acquired by the camera in packets of 200 bytes the first of which contains the image size to facilitate the reconstruction during receiving. The controller forwards the packets to the host PC through the zigbee that has the task of regenerating the original image. Once the first image is recovered, the BS calls the second-last node to send its image. Once an image arrives into the base station, it is decompressed, it can be visualized, and it is ready for counting the insects.

III. IMAGE PROCESSING

The captured image can be processed in pc through image processing tool box in MATLAB. A digital image is composed of pixels which can be thought of as small dots on the screen. A digital image is an instruction of how to color each pixel. We will see in detail later on how this is done in practice. A typical size of an image is 512-by-512 pixels. Later on in the course you will see that it is convenient to let the dimensions of the image to be a power of 2. For example, 2^9=512. In the general case we say that an image is of size m-by-n if it is composed of m pixels in the vertical direction and n pixels in the horizontal direction. Consider the image on the format 512-by-1024 pixels. This means that the data for the image must contain information about 524288 pixels, which requires a lot of memory! Hence, compressing images is essential for efficient image processing.

MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numerical computation. Using MATLAB, you can solve technical computing problems faster than with traditional programming languages, such as C, C++, and FORTRAN.

IV. CONCEPTS OF MATLAB USED

A. Image Conversion

The toolbox includes many functions that you can use to convert an image from one type to another, listed in the following table. For example, if you want to filter a color image that is stored as an indexed image, you must first convert it to true color format. When you apply the filter to the true color image, MATLAB filters the intensity values in the image, as is appropriate. If you attempt to filter the indexed image, MATLAB simply applies the filter to the indices in the indexed image matrix, and the results might not be meaningful. You can perform certain conversions just using MATLAB syntax. For example, you can convert a grayscale image to true color format by concatenating three copies of the original matrix along the third dimension.

RGB = cat (3,I,I,I);

The resulting true color image has identical matrices for the red, green, and blue planes, so the image displays as shades of gray. In addition to these image type conversion functions, there are other functions that return a different image type as part of the operation they perform. For example, the region of interest functions returns a binary image that you can use to mask an image for filtering or for other operations

B. Denoising

We may define noise to be any degradation in the image signal, caused by external disturbance. If an image is being sent electronically from one place to another, via satellite or wireless transmission, or through networked cable, we may expect errors to occur in the image signal. These errors will appear on the image output in different ways depending on the type of disturbance in the signal. Usually we know what type of errors to expect, and hence the type of noise on the image; hence we can choose the most appropriate method for reducing the effects. Cleaning an image corrupted by noise is thus an important area of image restoration.

C. Edge Detection

Edges contain some of the most useful information in an image. We may use edges to measure the size of objects in an image; to isolate particular objects from their background; to recognize or classify objects. There is a large number of edge finding algorithms in existence, and we shall look at some of the more straightforward of them. The general Mat lab command for finding edges is edge (image,'method', parameters. . .) Where the parameters available depend on the method used

D. Two Dimensional Convolutions

C = conv2(A,B) computes the two-dimensional convolution of matrices A and B. If one of these matrices describes a two-dimensional finite impulse response (FIR) filter, the other matrix is filtered in two dimensions. The size of C in each dimension is equal to the sum of the corresponding dimensions of the input matrices, minus one. That is, if the size of A is [ma,na] and the size of B is [mb,nb], then the size of C is [ma+mb-1,na+nb-1].The indices of the center element of B are defined as floor (([mb nb]+1)/2). C = conv2 (hcol, hrow,A) convolves A first with the vector hcol along the rows and then with the vector hrow along the columns. If hcol is a column vector and hrow is a row vector, this case is the same as C = conv2(hcol*hrow,A). C = conv2 (...,'shape') returns a subsection of the two-dimensional convolution, as specified by the shape parameter.

V. SIMULATION RESULT

The input image, which is captured by camera, is in RGB format we need to convert the input image to gray scale image to identify the insects from back ground. Next step is to remove the noise from image since noise in image will be having high frequency it is difficult to find the edge detection in presence of noise.

Fig. 5 Input image

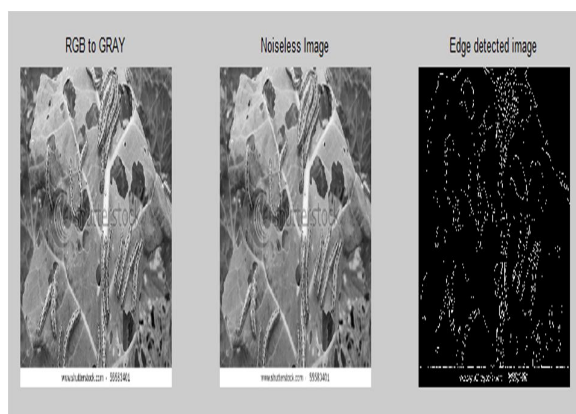

Fig. 6 Simulation result

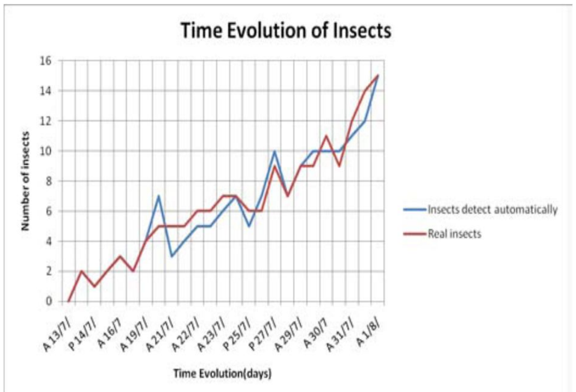

Fig. 7 Time evolution of the number of insects as automatically detected and counted

VI. CONCLUSION

The results of this study demonstrated the feasibility of pest insect automatic monitoring on the field, by wireless sensor networking. Further research is still needed to improve the robustness of the measurements, to obtain more specific information (discriminating insect species or typology) and to demonstrate the cost and environmental benefit of such a system. In this project we just found the insect count and we are not controlling so further we can develop the system for controlling the pest insects.

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