Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

Monitoring of Green House Gases using Wireless Sensor Network and Pests Detection using SVM Classifier

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Abstract – **This paper describes about the "Greenhouse gases monitoring using sensors and pest detection using image processing". Nowadays, due to the man-made activities such as deforestation, burning of fossil fuels, coals are major causes of Greenhouse effect which results in Global warming. So all across the world researchers are trying to monitor the various greenhouse gas parameters such as CO_2 , CO, Methane etc. in the atmosphere. In this paper, we trying to look into the problem of pest detection in the greenhouse are widely applied to agriculture field and it has great perspective to prevent plant which leads to crop management. The technique used for pest detection is SVM classifier which is used to identify the pests and classify the pest according to their components.**

Key words: Sensors, Greenhouse gases, Image processing, SVM (Support Vector Machine).

I. INTRODUCTION

A greenhouse gas is any vaporous composite in the atmosphere that is equipped for absorbing infrared radiation, accordingly trapping and holding heat in the atmosphere. By increasing the heat in the atmosphere, greenhouse gases are liable for the greenhouse effect, which eventually leads to global warming. Many of the world's major cities today have horrific air quality. To keep away from such impact observing of greenhouse gases is important Wireless sensor networks (WSN) have been organized for efficient greenhouse gases monitoring. Agriculture is the backbone of our Country. However, the cultivation of crops for ideal yield and quality produce is very essential. A considerable measure of exploration has been done on greenhouse agro systems to control pests and diseases by naturally rather than pesticides. Research in agriculture is directed towards proliferation of productivity and food quality at reduced expenditure and with increased yield, which has received significance in recent time. A solid request now exists in many nations for non-chemicals control techniques for pests or diseases. In fact, underway conditions, greenhouse staff intermittently notice plants and hunt down pest. This manual strategy is very tedious. The recent improvement in image processing techniques, it is potential to develop an independent system for disease classification of crops. There are diverse yields which are developed under greenhouse e.g. Rose, Cucumber, Tomato, gerbera, Capsicum etc. The most common pests which attach on greenhouse crops are the Thrips, aphids and white flies and these pests are normally smaller in size. Generally the measure of adult whiteflies is 1/12 inch long. The lifetime of whiteflies is 21-36 days. The Thrips are minute, slight pest about 1/25-inch. Thripes produces on flower plants and fruit plants. Aphids are tiny. Aphids are delicate-bodied, inactive pests. They shape bunch in states on the leaves of the host plant and their life span is 20 to 30 days. But over usage of the pesticides is very harmful to the crops, soil, air, water resources and the animals which interacted with the pesticides. Pesticides deposits have likewise have been found in rain and groundwater. The use of pesticides drops the general biodiversity in the topsoil. The reduction of nitrogen fixation and reduced crop fields are due to over usage of pesticides. Animals might be harmed by pesticides. Early discovery of pests or the beginning vicinity of bugs is a key-point for crop management. Enhanced yield insurance systems to anticipate such harm and misfortune can build generation and make a considerable promise to food security.

II. RELATED WORK

Mallakalva Aneelkumar Reddy, et al [1] the paper titled as "On-line Monitoring of Green House gases Storage and Leakage Using Wireless Sensor Network" In this paper an effective observing of greenhouse gases is implemented by means of X-bee Digi modules and open source hardware platform Arduino, where each sensor nodes are equipped with Arduino microcontroller and X-bee Zig-bee series module and a battery source. The sensors detect the information and the gathered data is sent to the central monitoring unit which acts as a sink node. Data are constantly transmitted from zig-bee sensor nodes to zig-bee coordinator node. This method can be used anywhere in the atmosphere and particularly useful in industries, hospitals etc. Web-server is formed using Ethernet shield which is used to make the complete system on-line. The detected information can be available to client anyplace on the planet using World Wide Web.

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Rupesh G. Mundada et al [2] the paper titled as "Detection and Classification of Pests in Greenhouse Using Image Processing" This paper proposes a software prototype scheme for early pest recognition on the infected crops in greenhouse. Images of the infected leaf are caught by a camera with pan tilt and zoom and processed using image processing techniques to spot presence of pests. SVM classifier identifies the pests and in the classification of pest based on their structures. Results indicate more accuracy in recognizing the presence of pest at early stage.

M.Gao et al [3] the paper titled as "Environmental monitoring system with wireless mesh network based on Embedded System" This paper presents the environmental monitoring system with ARM9 S3C2410 microprocessor. The adaptable and self-sorting out wireless mesh network is utilized to accomplish the constant procurement and multi-hop wireless communication of parameters of the observing atmospheric environment, for example, SO_2, NO_2, NO, temperature, moisture etc. The whole monitoring system can be immediately arranged and quickly pulled back without backing of base station and has a solid self-healing capability and network robustness and can be utilized for an assortment of infrequent atmospheric environmental monitoring.

Vincent Martin et al [4] the paper titled as "Early Pest Detection in Greenhouses". The objective of this paper is the location of bio-aggressors on plant structures such as leaves. The objective of this work is to characterize a creative choice emotionally supportive network, which handles multi camera information and takes after a nonexclusive way to deal with adjust to various classes of bio-aggressors. This methodology is non-damaging and non-intrusive. It will permit makers to take rapid remedial decisions. The major issue is to achieve an adequate level of power for consistent observation. To this end, vision algorithms (segmentation, classification and tracking) must be adjusted to adapt to brightening changes, plant developments, insect attributes. The primary model of our system is under test in a rose greenhouse outfitted with five wireless video cameras and this shows preliminary results for insect detection on sticky traps.

Anuj Kumar et al [5] the paper titled as "Indoor Environment Gas Monitoring System Based on the Digital Signal Processor". The objective of this paper is to monitor indoor environment the sensor arrays have been developed, however, these systems are costly and have not gained wide acceptance. Precise monitoring of building environment has a vast potential in terms of energy savings. This system is utilized to overcome the problem of real time processing of carbon monoxide and carbon dioxide gases measurement using a DSP board (TMS320C6455) and then applying to the proposed gas monitoring system.

III. HARDWARE IMPLEMENTATION

A) Greenhouse Gas Monitoring

Greenhouse gas monitoring is the direct measurement of greenhouse gas emissions and levels. The monitoring and reporting of greenhouse gas emissions forms the basis for the evaluation, planning and monitoring of climate policy. Monitoring and reporting can be used to make sure that nations adhere to agree upon emission limits. The primary aim for the project is to assess monitoring techniques for geological storage of carbon dioxide (CO_2) Monitoring the effectiveness of geological storage of CO_2 is a challenging task because CO_2 is present naturally in the atmosphere.

The Greenhouse gases such as CO_2, CO, Methane etc. are present in a Greenhouse. The Gas sensor (MQ-6) senses CO_2, Methane and the CO sensor (MQ-7) sense the CO content from the greenhouse. The gathered information is sent to the Microcontroller. The collected data will be in analog form and it is converted into digital form using the Microcontroller. The data from microcontroller added with the pest detection output is sent to computer system using Zig-bee and the information is provided to the user with the help of GSM.

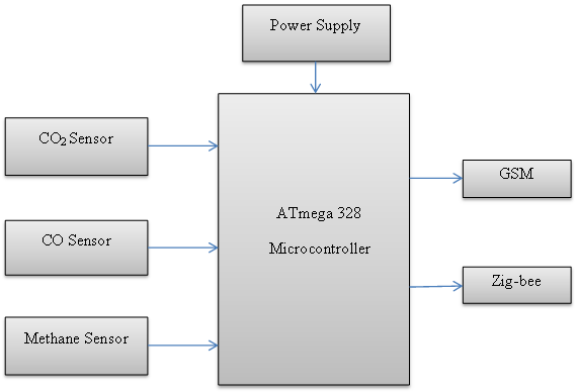

Fig-1: Block diagram of greenhouse gases monitoring

The monitoring of Greenhouse gases are implemented using the following components.

1) Arduino UNO R3 Microcontroller

Arduino can be used to improve stand-alone interactive objects or can be connected to software on your computer (ex., Flash, Processing, MaxMSP). Arduino is an open-source physical computing platform based on a simple I/O board and a development environment that implements the Processing/Wiring language. The Arduino Uno Rev3 is a micro-controller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the micro-controller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

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2) ZIG-BEE Transceiver

ZigBee is an IEEE 802.15.4 based description for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios. The technology defined by the ZigBee description is proposed to be simpler and inexpensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that require short-range low-rate wireless data transfer. Its low power consumption limits transmission distances to 10–100 meters line-of-sight, depends on power output and environmental features. ZigBee devices can communicate data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking. ZigBee has a defined rate of 250 Kbit/s, best suited for intermittent data communications from a sensor or input device.

3) GSM

A GSM modem is one of the wireless modem that is conceived to work with a GSM wireless network. It works with the same frequency of GSM wireless network. GSM/GPRS RS232 Modem is made with SIMCOM SIM900 a Quad-band GSM/GPRS engine, works on frequencies 850 MHz, 900 MHz, 1800 MHz and 1900 MHZ. It is very compact in size and simple to use as plug in GSM Modem. The Modem is designed with RS232 Level converter circuitry, which allows us to directly interface PC Serial port. The baud rate can be configurable from 9600-115200 through AT commands. Initially Modem is in Autobaud mode. This GSM/GPRS RS232 Modem is having internal TCP/IP stack to allow you to connect with internet via GPRS. It is appropriate for SMS as well as DATA transfer application in M2M interface. The modem needs only 3 wires (Tx,Rx,Gnd) except power supply to interface with microcontroller/Host PC. The built in voltage regulator allows you to connect wide range of unregulated power supply (4.2V-13V). This modem is able to send & read SMS connect to Internet via GPRS through simple AT commands.

IV. SOFTWARE IMPLEMENTATION

A) Pest Detection

Image Acquisition

The image acquisition is always the first step in image processing application. The images are captured by means of a pan tilt camera with 20X zoom sustaining equal illumination to the object. All the images should be secured in the same format such as JPEG, TIF, BMP, PNG etc. The camera is interfaced with the system which will take the image captured by the camera as an input.

Image Pre-processing

Image pre-processing creates an superior image that is more useful in processing the still image. The image preprocessing steps used in the system are: 1) Conversion of RGB image to gray image 2) Resizing of the image 3) Filtering of the image.

1) Conversion of RGB to gray image

In RGB color model, each color seems in its primary spectral components of red, green, and blue. The color of a pixel is made up of three components; red, green, and blue (RGB), defined by their resultant intensities. RGB color image need large space to store and takes more time to process. In image processing it needs to process the three different channels so it takes large time. The formula used for converting the RGB image into gray scale image.

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

2) Resizing of the image.

The acquired image is resized according to the condition of the system. The various methods available for image resizing are Nearest-neighbor interpolation, bilinear, and bicubic.

In Nearest-neighbor interpolation the output pixel is allotted the value of the pixel that the point falls within. No other pixels are considered. In bilinear interpolation the output pixel value is a weighted average of pixels in the nearest 2-by-2 neighborhood. In bicubic interpolation the output pixel value is a weighted average of pixels in the nearest 4-by-4 neighborhood.

In this system bicubic interpolation is used to generate more accurate results than any other method.

3) Filtering of the image

Filtering is a process of cleaning up the appearance of the image from noise caused by different lighting conditions. A number of methods are available and the best options can depend on the image and how it will be used. Both analog and digital image processing may require filtering to yield a practical and attractive result.

There are different types of filters such as low pass filters, high pass filters, median filters etc. The low pass filters are smoothening filters whereas the high pass filters are sharpening filters. Smoothening filters are used for smoothening of the edges. Sharpening filters are used for enhancing the edges in the image. The smoothening filter is used in this system. The purpose of smoothing is to reduce noise and improve the visual quality of the image. The simplest smoothening filter is average filter. It consists of a 3X3 matrix of 1 and it is divided by 9.

Feature Extraction

Some properties of the image are essential for feature extraction. There are different properties like region properties, gray covariance matrix properties. From that the properties like entropy, mean, standard deviation, contrast, energy, Correlation and eccentricity are extracted from the image. They are equated and based on that the support vector machine is trained and used to classify the images. Support Vector Machines (SVM's) are a comparatively new learning method used for binary classification.

The basic idea is to find a hyper plane which splits the d-dimensional data exactly into its two classes. However, since example data is often not linearly separable, SVM's introduce the notion of a kernel induced

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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feature space" which casts the data into a higher dimensional space where the data is separable. Typically, casting into such a space would cause problems computationally, and with over fitting. The VC-dimension of SVM's can be obviously calculated, unlike other learning methods like neural networks, for which there is no measure. Overall, SVM's are intuitive, theoretically well- founded, and have shown to be practically successful. SVM's have also been extended to solve regression tasks.

Disease classification

The disease classification is done by the Support Vector machine classifier. The two categories are formed such as affected leaf and unaffected leaf. Based on this the data provided to train the support vector machine. Using the properties such as entropy, mean, standard deviation, contrast, energy, Correlation and eccentricity the image is classified into categories. The standard deviation and contrast are considered for training the support vector machine.

Detection and identification of Pests

The input image is given to the support vector machine. As the support vector machine is trained with the data collected from our data base which was collected earlier. The properties of the input image are extracted and given as an input to the support vector machine. Based on the comparison with the features of database support vector machine generates the output.

If the leaf is found to be infected then the next step is to find out the type of pest. The identified pest is classified into two categories which are whiteflies and aphids. For identification, after the averaging filtering, a special type of mask is used. Then the filtered image is convolved with the mask. Then extracting the region properties and gray co-occurrence matrix properties the classification is done in two types, whiteflies and aphids. For identification the properties like standard deviation and contrast are used. For determining the group SVM classifier is used.

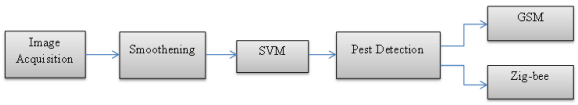

Fig-2: Flowchart for pest detection

V. RESULTS AND DISCUSSION

The below image specifies the results acquired after interfacing all the sensors to the terminal device. The readings are taken at the coordinator node which is always connected to personal computer. Below results are taken from coordinator node's COM port from the hercules_3-2-8 software.

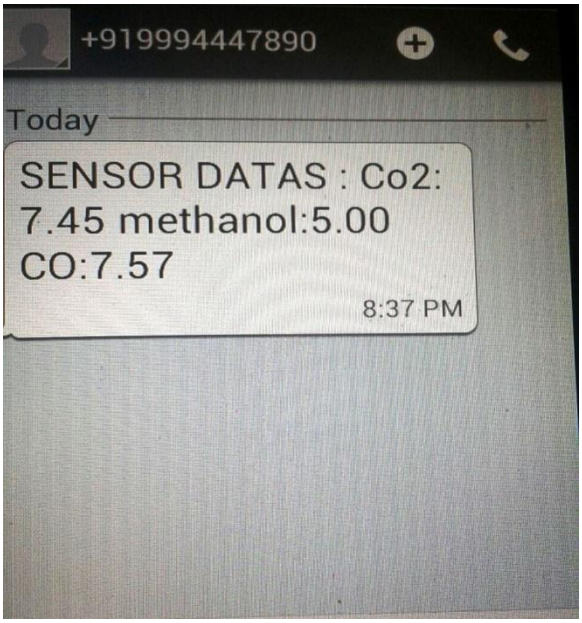

Fig-3 Message from GSM

The various parameters such as entropy, standard deviation, eccentricity etc. are considered for the identification of pest such as aphids and whiteflies in the plant. The sensor values are measured in parts per million (ppm).

The database which is provided for the training of second SVM is shown in figure.

Fig-4: Database for classification

CONCLUSION

In this paper, a cost effective and highly reliable system is implemented using open source hardware platforms using wireless sensor network and the image processing technique plays a significant role in the detection of pests. This system detects the various greenhouse gases in the greenhouse and it also identifies the type of pest in the plant which also sends the solution for the pest that is the pesticides. The data are sent to the client through GSM. Hence user can access these data anywhere over the GSM. This system can be used effectively anywhere in industries and our objective is to detect aphids and thrips on greenhouse crops. So without disturbing the plants the images are detected using pan tilt camera with zoom. In the upcoming years with further advancement of technology in wireless sensor network will helps in advance the system with better features and by using best quality sensors the accuracy of the readings can be enhanced to meet the real-time needs. It is rather simple to use and displays the same performance level as a classical manual approach. Our goal is to detect the pests as early as possible and shrink the use of pesticides.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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