Internet of Things (IOT) Based Electronic Pest Control Using Image Processing System

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ABSTRACT

This paper explores the possibilities of integrating the science of image processing of a plant leaf and integrate the results to fulfilling an outcome for pest control using Ultrasonic sound and Radio Frequency through the use of Internet of Things. The temperature and humidity sensors also play a vital role in gathering the supporting data needed to reach the outcome using beta regression model to predict a protection plan evaluated using the python programming language and combining it with the main hardware such as Raspberry Pi. The whole system is dedicated to using alternate systems instead of pesticides or bring down the use of pesticides to a minimum level. As the pesticides companies keep increasing the cost of their product while farmers do not get enough value of their home grown local produce, it is essential for us and science to find cheaper ways to protect and manage farming. The whole system is supported by use of cloud storage and computing giving the real time data to the farmers in a very simple language of their understanding on their phone.

Keyword: - *Pest Control, Internet of Things (IOT), Image Processing, Smart Farming.*

1. INTRODUCTION

Total land on this earth is limited but the population is always increasing and to feed the increasing population we need to increase the crop production. To do so the farmers use fertilizers and pesticides to get the maximum yield from the crops. With the rising cost of pesticides all over the world and the companies producing it with no intention of lowering the prices, today's farmers look towards alternate solutions of farming and managing the pests attacks. Since 2006 the growth rate of pesticides in USA has been on the rise and in 2015, it was 48% of crop revenue alongside cost of seeds and fertilizers. In India, pesticides have 18% of goods and service tax which makes it harder for the farmers to cultivate the crops as the land for farming is also decreasing but agricultural productivity should not be hampered. According to a survey in 2014, fig. 1 will show us the use of pesticides during that year which emphasizes the need and importance of pesticides in farming. Thus not being able to get the right value for their produce and not being able to cope up with the rising prices of pesticides and fertilizers, farmers are in debt to various banks and thus loose on the only skill and asset they have to feed their families.

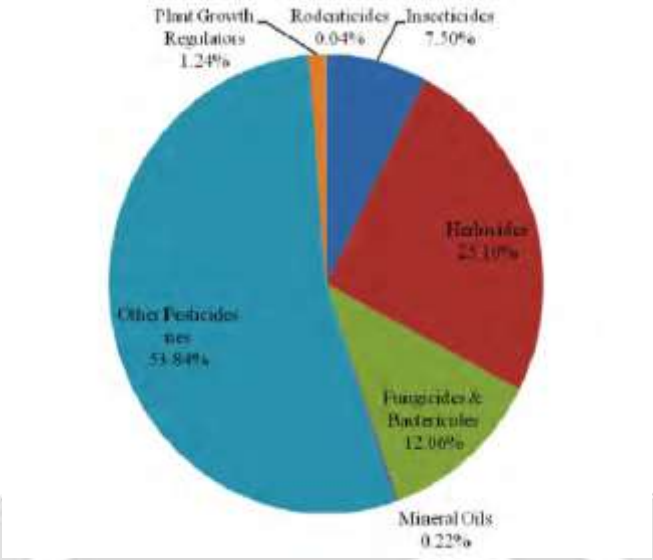

Fig -1: Percentage of Global Pesticide use in 2014

2. LITERATURE REVIEW

Image processing uses mathematical operations on image or images by using any form of signal processing where the input extends to a video or video frame too. It uses edge detection system and grid formations on the images and the output can be for pattern recognition, feature extraction and projection. The initial steps of image detection system are k means clustering followed by three different edge detection techniques named sobel, prewitt and canny algorithm. The paper suggests that canny algorithm is reliable and is easy to implement during the whole process and for that quality it is the most sought after algorithm in edge detection method [3]. Plants go through subtle to drastic changes under the effect of temperature, soil and humidity changes and it affects the health of a plant. The changes are captured by the sensors and analyzed in the MATLAB software. For future predictions the results can be stored in the SD card. Thus predefined data results can be run against the newly found data to cross verify the results and thus predict the condition of the plants [1]. The data from the soil, humidity, temperature and leaf wetness sensors can also be fed into the beta regression model through database connectivity and send data to the computer, the python programming can calculate the infection index [5].

The detail trapping and monitoring of pests is not an easy task and there are more than thousands of pests and insects to study, thus it is only a futile effort nut again they remain a distress for the crops. The use of nets, barbed wires, poison etc. by the farmers around the field putting a lot of effort during every crop rotation is a huge task and the results are not consistent. An electronic trap for insects and pests is proposed in the paper using Ultra violet and LED light is supported. The trapped pests can be studied for better pesticides and thus less pesticides can be used [4]. Ultrasonic devices generate high frequency sound waves that are too high pitch for the human ear. Humans can't hear higher than 20 kHz but for grasshoppers the range is 50,000 Hz to 100,000 Hz and moths can hear up to 240,000 Hz. The sound will not hurt the birds since they cannot hear ultrasonic sounds. Radio Frequency (RF) Waves can also be used to change the behavior of the pests since the energy generated through RF waves can heat the water molecule in the body thus eliminating the pests without hurting the crops or environment [2].

3. OBJECTIVE

The hardware sensor data gathered from the hardware unit of Raspberry Pi will be sent to the python program alongside the digital image of leaves from the plants and the collective data will be run in two different software named MATLAB for digital image processing to tell us if the plant needs water or is infected by pests and the Python programming will use beta regression model to predict if the plants are in danger of pesticides. The data

from both the software will be compared and then the electronic pest control devices will be activated depending on the type of pests present or could harm the crops.

4. PROPOSED SYSTEM

The main system in our hardware is the Raspberry Pi 3. It is used to control and monitor other sensors, camera and send the data to the cloud. It is the first of its model that has Wi-Fi enabled hardware and software. The cloud services are free to use till a minimum of certain GB. Paid services are also available.

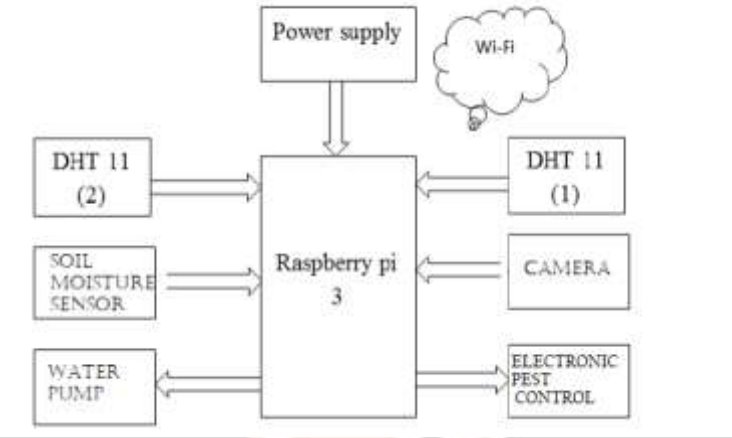

Fig -2: Block Diagram

Raspberry Pi 3 is used since it has evolved through several versions in hardware performance, memory and peripheral device support. Built around a CPU of Quad Core 64-bit ARM cortex A53 clocked at 1.2 GHz with a GPU of 400 MHz Video Core IV multimedia and 1 GB memory, it is the first of its kind to have a Wi-Fi enabled hardware. Both DHT 11 sensors will send the real time temperature and humidity values to raspberry pi so that it can be used for beta regression model to predict diseases. Power supply for the Raspberry Pi will be 12V. Soil sensor data will tell us if the land is wet or dry and the water pump should be on or off. Other data that can be gather is the amount of nitrogen, ammonia and percentage of other vital nutrients in the soil. The camera used is serial JPEG module to capture images in regular intervals. Some test images are stored to compare the specific environment factor and mineral factor that might affect the plant's condition, a database is prepared.

The general equation for beta regression model used will be $y = \alpha t^{\beta} (1-t)^{\gamma} H^{\delta}$ (1) where y is the disease severity index and δ, γ, β, α and t are unknown parameters from the data while H is the relative humidity. The severity index ranges from 0 to 1.

Range of y	Severity Index
< 0.5	Low Risk
0.5<y<1	Moderate Risk
>1	High Risk

Table I: Severity Index Ranges

The above equation is linearized by using log on both sides: $\log(y) = \log(\alpha) + \beta \log(t) + \gamma \log(1-t) + \delta \log(H)$ (2)

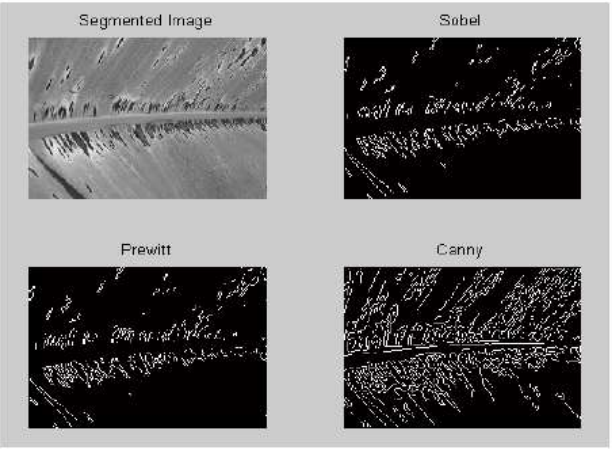

Fig -3: Digital Image Processing of Plant Leaf

The image processing is done using MATLAB and the changes that a plant undergoes are captured by the camera and analyzed. As mentioned earlier, the digital image is processed using k means clustering to segment the image followed by canny edge detection system for more reliable and better detection. The captured images from the serial JPEG camera module are fed into the system with the data from the other factors while some of the predefined factors are stored in the database such as water deficiency, light and temperature variations. The images are turned to monotone to obtain accurate results provided in the form of histograms.

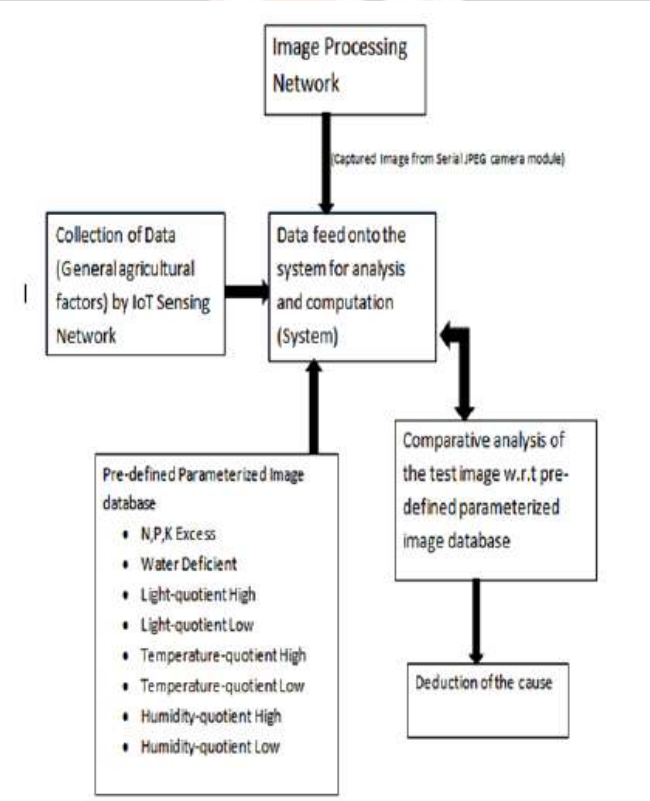

Fig -4: Flowchart of the Digital Image Processing

Electronic pest repellants are safe to use as they emit Ultrasonic and Radio Frequency to kill or repel pests while not harming the crops or poisoning them. Thus the produce is fresh and more hygienic for consumption. The results

from the beta regression model and python image processing set the pest control to the desired frequency and switch it on/off accordingly to remove pests. With the use of these repellants, the use of pesticides will decrease and farmers will have more funds to grow more crops. These repellants are cheap and attached to the robot vehicle controlled by the Raspberry Pi 3.

Fig -5: Multi-purpose Pest Repellant

5. RESULTS AND ANALYSIS

The aim of the experiment was to show how the beta regression model and image processing techniques can be used to predict and apply the pest repellant controller and later the leaves of the plants can be analyzed to check if the prediction and the pest control mechanism was successful enough to prevent diseases. The concept of IoT makes the whole thing automated and more real time data is collected in the process. The values of temperature and humidity sensor help in the regression model while the soil sensor helps water the plants. The images obtained by the serial JPEG camera help reflect on the changes found in the other sensor data. A healthy sample specimen of plant will have the following histogram graph:

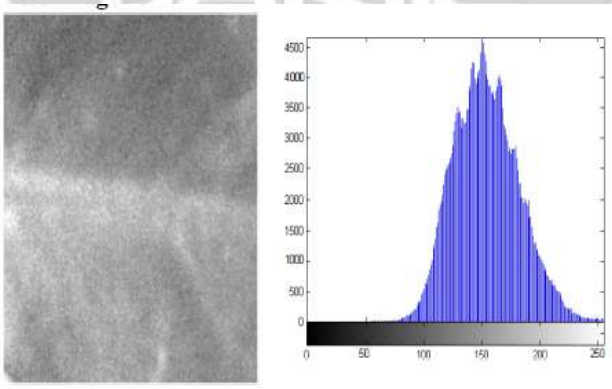

Fig -6: Healthy Specimen

As we can see there is no pixels from 0 to 80 thus showing no dark regions in the area, hence the test image is healthy.

6. CONCLUSIONS

The automated electronic pest control mechanism that takes help from the regression model and the image processing results to set up the correct Radio Frequency to remove pests from the crops and save them from diseases. This reduces the use of pests and thus the crop s are healthier and more hygienic since less poison is being introduced into the soil and surface of the crops. This also helps the farmers as they don't need to buy much pesticide thus reducing the expenses and help in the savings. The electronic pest repellants are one time cheap investment which don't require much maintenance and is easy to use. It doesn't harm humans, birds or other animals. During rain, the pesticides wash off into the lakes and ponds killing aquatic life, electronic pest repellant will control that too.

7. FUTURE WORK

The system proposed in the paper can be mounted on a rover or drone which can monitor the land 24 hours. The rover can have specific amount of pesticides and fertilizer on board while it keeps emitting the Radio Frequency Wave around the crops. Another proposed addition is the installation of solar panels to the rover thus using clean renewable energy. Another future application can be the use of Support Vector Machine (SVM) for classification of crops and plants according to yield.

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