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AGROBOT: NOVEL METHOD OF IMPLEMENTING THERMAL CAMERA AND AUTOMISATION

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Abstract: *Today, technology is widely used in the economic world for improving agricultural output. However, in the developing countries the adaption of technology is very slow due to various factors such as cost and unawareness of farmers with the technology. There are reports in the literature related to all these problems in agriculture and our project will add to the knowledge the use of improved automatic pest detection in agriculture using thermal imaging. The Agrobot automatically reaches up to the crop and monitor the crop fully. If pest is detected using thermal camera then pesticide is automatically sprayed on to the pest affected portion thereby reducing the massive use of pesticide on crop. Thermal imaging is a method of improving visibility of objects in an environment by detecting the object's infrared radiation and creating an image based on that information. The final result of the project is a miniature robot with a thermal camera implanted on it. The technology here we used are evaluated on the basis of some key parameters such as type of sensor used, there cost, processing tools etc. The thermal camera constructed here is of very low cost when compared to the market prize. As far as now, the existing ones either detects or eliminate the pest affected, but here the project provide a different approach by integrating both the detection and elimination units and thereby decreasing cost, increasing efficiency, saving time and labor and much more reliable. Finally, our project and possibility of sensing technology for the future for monitoring and detection of pest in the crops are analyzed.*

***KeyWords*: Thermal Imaging, Pest detection, robotic vehicle, Thermal camera**

1. INTRODUCTION

Agriculture, with its allied sectors, is unquestionably the largest livelihood provider in India, more so in the vast rural areas. It also contributes a significant figure to the Gross Domestic Product (GDP). Sustainable agriculture, in terms of food security, rural employment, and environmentally sustainable technologies such as soil conservation, sustainable natural resource management and biodiversity protection, are essential for holistic rural development. Indian agriculture and allied activities have witnessed a green revolution, a white revolution, a yellow revolution and a blue revolution.

Growing crops is a beautiful activity which makes a farmer proud of himself, for he has created new life. Despite its beauty though, crop production requires varying farm activities and constant maintenance in order to provide a high and healthy yield. Starting with the early crop stages, a farmer must closely monitor crops because of various crop insect pests and diseases. They tend to be the biggest threat to successful crop production. Depending on the crop type and growth stage, it's estimated that early pest detection can reduce yield loss by up to 20-40%. Therefore, farmers need to put all of their effort into constant crop monitoring. Instead of walking down the field, today farmers can use various tools to monitor their crops faster and more accurately, such as sensors. Insect pests and diseases are significant issues in crop protection. For this reason, improved sensors for precision farming are constantly being improved. Such modern technology includes pest detection sensors which detect disease and insect pest occurrence on crops. Basically, the sensors provide real-time data from the field.

Automatic pest detection paves way for good quality products, reduces workload of farmers and moreover help to reduce use of pesticides thereby significant reduction of pest.

2. METHODOLOGY

The whole system is divided into 4 mechanisms.

- Navigation: This is the part which is helping in moving the miniature robot from one plant to another. This self-navigating device is moved

in any direction just like a vehicle. There are three wheels which will make the device moving. The proximity sensors sense the obstacle and change the direction of the vehicle accordingly without any physical contact.

- Surveillance: This will rotate according to the need. The rotation is done in 360 degrees. The height adjustments are also possible as we consider plants of different height.
- Sensing: This part consists of a thermal camera. The thermal camera has been designed to be versatile, capable of being mounted on the robot. The thermal camera scans the crops and detect the pest by process called thermal imaging. Here the UV radiation from a hot body is used to detect the pest presence in the plant. Mechanical stabilization of the camera improves the quality of the recorded data, resulting in higher precision.
- Triggering: This part consists of a tank which stores the appropriate pesticide which will not harm the plant. From the tank we attach a tube which will reach the top of the system so that spraying can be done easily. The tank is placed at the bottom of the robotic arm. When the pest is detected by the thermal camera and triggers the selective spraying of pesticide to the crops where the pest is present.

2.1 Thermal imaging

Thermal camera is a device produces thermal images based on the infrared radiation. Whereas the normal camera is based on the visible light .This paper shows that the application of thermal camera in agriculture for pest and pathogen detection. Noninvasive, non-contact, on destructive nature is the major advantages of the thermal camera. Thermal camera is designed to detect the pest by infrared radiation emitted by the target. Living organism produces more radiation because of the body heat other than the surrounding region. The radiation from the target is converted into electrical signal which is then processed into an image. Through this images we are able to differentiate the pest in the plants and initiate the spraying of pesticide to portion where pest is present.

Fig2: Thermal image of a pest detected leaf.

Detector of a thermal camera can detect the increased temperature or temperature change by the incoming infrared radiations. IR radiation is the part of the
Electromagnetic spectrum and which is beyond the visibility of the human eye. Camera is built to detect and make use of this radiation.The image formed by the thermal camera gives collared pictures which is called a thermo graphic picture or thermo grams. These thermal images consist of both dark and bright colours. The conclusion is that if more heat that a object had means that more heat it emits and colder organism emits less heat. Warmer organism produce much brighter colours such as red, orange ,yellow are the colours with large infrared radiation. Colder organism produce darker colours such as purple,darkblue,or even black indicates organism the heat emit less infrared radiations.

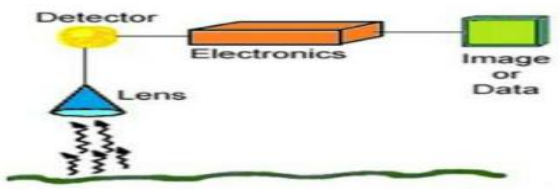

Fig 2: Components of thermal camera

2.2 Spraying mechanism

The spraying mechanism mainly consists of a controller, which is programmed to perform various functions. It also contain a tank of certain

capacity to which a pump is connected. It also contains a motor driver circuit to control the speed of spraying . The spraying mechanism is initiated when the pest is detected by the thermal camera. Thus the robotic arm carrying the camera will stop. Then using the motor that is attached at the bottom will spray the pesticide as programmed . This pesticide spraying system efficiently covers the detected part of the plant. After certain duration of spray time it'll resume the operation of vehicle

3. WORKING

The circuit consist of Adafruit 8*8 thermal camera, Teensy 3.2microcontroller,LCD display. Through this thermal camera a 64 pixel image data is obtained and it is formed as an 8*8 array in the controller.

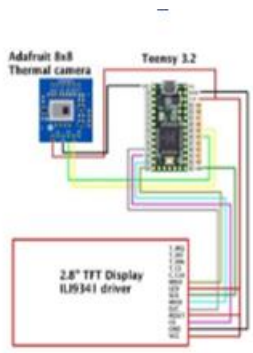

Fig 3: Thermal camera circuit diagram

8*8 array has low pixel density so we are converting it to 64*64 using interpolation. This array is obtained at the output of LCD and we obtain the thermal image in the LCD.Thermal imaging allows us to see an objects heat radiating off itself. It records the temperature of various objects in frame and the asserts each temperature a shade of a colour0, which lets you see how much heat is radiating compared to objects around it.Colder temperature are often given a shade of blue, purple or green while warmer temperature can be assigned a shade of red, orange and yellow. Thermal camera detects temperature by recognizing and capturing different levels of infrared light. This light s invisible to the naked eye, but can be felt as heat if the intensity is high enough. All objects emit some kind of infrared radiation, and it's one of the ways that heat is transferred. When the value crosses the reference value, a message is transmitted to arduino through UART communication protocol.

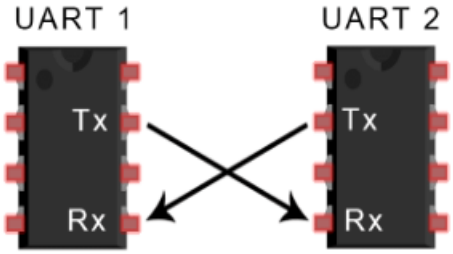

Fig 4: UART communication

In UART communication two UART communicate directly with each other. The transmitting one converts parallel data into serial the the receiving one convert serial data back to parallel. When this message is received by the arduino it stops the current action that is moving the robotic arm and base and it activate the pesticide spraying mechanism so an immediate pesticide spraying is done in that particular direction thus the pest is detected and eliminated.

4. FEATURES

We have two main features implemented

1) Robotic arm: Here our mechanical part is a robotic arm which is having 3 axis rotation with 70 degree of freedom. This arm carries our thermal camera which will detect the pest. The arm is programmed with similar functions to a farmer arm but it's more accurate than human . Controller is the main processor of our robot which will act as it's brain. The arm movement will help for easy detection of pests
2) Robotic arm base : It consists of a four wheeled vehicle that will enable the movement of our robotic arm along with thermal camera. The size of the vehicle can be varied according to the nature of are where it have to be used .

4. ADVANTAGES AND LIMITATIONS

A. Advantages

1. Assist farmers to take instant care based on the response from the sender.
2. Great tool for monitoring of large field areas with very low energy consumption
3. Efficiency has been improved, efforts decrease and boost economy
4. Protection from harm to crop health
5. Cost effective

B. Limitations

1. Only applicable for small crops , advancement is possible .
2. Return of investment for farmers with less land is low

6. CONCLUSION

Our project will successfully fulfill the physical specification so as to be able to function within the field. The system also helps in improving economic and time constraints that we face in the existing models. The design and successful construction of the system using thermal imaging and also the task of autonomously spraying pesticides can be done via a simple and cost-effective manner. Being a prototype, the system has some components(namely camera and microcontroller) that are overdesigned for the simple tasks of detecting and spraying .The use of this microcontroller enable greater cost efficiency when reproducing a commercial product as a dedicated microcontroller with less capability and a correctly desired camera for the final capture and performance requirements correspondingly cheaper. A number of additional features are considered under future work .As far as now, the existing once either detects or eliminate the pest affected, but here our project provide a different approach by integrating both the detection and elimination units and thereby decreasing cost and increasing efficiency, saving time and labor and much more reliable . Traditional methods of pest control have its own limitations. Therefore our focus is on smart, systematic technological solutions with low low labor cost. Our project could offer high effectiveness with high level of pest/disease predictions. It will enable us to take right decisions at right time. Finally our project and possibility of sensing technology for the future for monitoring and detection of pest in the crops are analyzed.

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