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Automated Robotic Car for Real Time Pest Detection on the Fields

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ABSTRACT
Recently the demand for automated technology is increasing by the passing hour. People try to find sources that not only make their work easier, but also errorless and fast. One such recent advancement in technology that aims to aid people in their day to day activities is the Autonomous robotic technology. Going by its mere definition autonomous robotics is a field in which the robots try obtain high amplitude of autonomy and accuracy. Autonomous robots, similar to the humans, have the ability to make their own decisions and later perform an action accordingly. Being precise, an autonomous robot is one that can perceive its environment, make decisions based on what it perceives or has been programmed to recognize and then actuate a movement or manipulate within that environment. In this paper, one such application of autonomous robotics has been presented. Automation in the field of agriculture is progressing by the day, with the younger generation trying to find the most convenient route for automated practices in agriculture. Similarly, the proposed paper deals with the development of an automated robotic car built extensively using the microcontroller and image sensor network that tracks the pest infestation in the crop fields. Upon detection of pests, through image processing, it alerts the farmers about the prevailing pest conditions in their field with the help of a simple message being displayed on their phones. They would then be hinted about the possible measures or pesticides that need to be used in order to counter this problem. One of the major advantages of this paper is the mobility of the car in rough terrains and real time testing conditions that give accurate results using image processing. The overall impact would be a pest free environment in the fields with a user friendly pest detection system.

Keywords: Automated robotics, microcontrollers, image sensors, image processing, pest infestation.

INTRODUCTION
"India is a country whereagriculture supports the sustenance of a majority the country's population.Agricultureis the primary source of livelihood for nearly 58% of India's population. The Gross Value Added by agriculture, forestry and fishing is estimated at ₹ 17.67 trillion (US$ 274.23 billion) in FY18 (fiscal year 2018)" [1]. This was published in a recent report by IBEF, i.e.the India Brand Equity Foundation which is a trust established by the Department of Commerce, Ministry of Commerce and Industry, Government of India.
India is blessed with suitable climatic conditions which supports the cultivation of a huge diversity of plants and crops. With proper measures taken on the fields during the time spanning from crop cultivation to harvesting it is possible to obtain a good, healthy yield. This will not only improve the quality of food produced within India, but will also provide a major boost to the percentage of GDP being contributed by the agriculture sector of India. Adopting such changes will make usthe major contributors in the world food trade. But with present system of agricultural practices being employed in the cultivation of crops this

remains a realisable, but far goal. We need reliable advancement in the field of agriculture.Previously there have been notable contributions made by various innovative groups and individuals for achieving this goal. But most of these technologies were hardly used by the farmers nor were they inculcated in their day to day activities. They found it hard in putting their trust into something that is new and barely used. Owing to this mind-set some of the farmers have to deal with umpteen issues in bringing up a successful yield. Be it with the scarcity of water resources in dry lands, irregular power supply, high cost of maintenance of the automated technology being used or pest infestation, farmers today face various problems during cultivation of a crop.

Pest infestation is definitely a prime cause of concern in agriculture today. Expensive technologies have been developed to resolve this issue but yet again it is not feasible or affordable for a majority of farmers. In fact, we found that the existence of such devices was a new topic of debate after some of our interactions with the farmers. Putting it straight, big or small, pests cause tons of loss. When famers realise the existence of a pest or insect within the plant, identification of the pest is the first issue and if that works out, later they would possibly have no idea regarding the steps they need to employ to counter this situation. It must be a well-known fact, that some of pests can be perceived or detected by the naked eye while some microscopic pests like the bacteria continue to harm the crop without leaving any clue.Tonnes of cultivated crop that is produced will be affected by pests and insects, which in turn will drastically affect the quality of food that is being produced in India.Plant pathogens can be either,fungal, bacterial, viral or nematodes they can damage the parts of the plant which are above or below the ground. Identifying all the possible symptoms shown and knowing how to effectively controlthese diseases is an on going challenge for researchers. All this ultimately contributes to a fall in productivity. Thisdeceleration in cultivation has to be arrested and agricultural productivity needs to be doubled to meet growing demands of the population. Improvement mediated with efficiency in productivity is the most viableoption in order to raise production.

At this point bringing in a cheap and affordable solution for pest or insect detection will resolve this crisis. With the current solution being adopted in agriculture, the farmer can easily identify the disease by himself without the help of any experts. There will be regular monitoring of crops being cultivated in an area and the test results will be displayed to the farmer, in case of sign of a pest/ insect with the help of an image sensor network.

1. SYSTEM DESIGN

Figure-1 gives a basic block diagram of the proposed solution to the problem of pest infestation and disease identification. The major blocks in this system include the mobile automated robotic car and finally the image capturing and sensing network.

The initial block deals with the designing of voice controlled robotic car. The user can instruct the car to start or stop whenever he/she desires. This marks the initial step of image capturing. Once the car has been instructed to start it will automatically move around the fields with the help of the ultra-sonic sensor network. These images can be then captured when the car detects a plants and these images in turn will be transmitted back to the Microcontroller. Here, it is necessary to note that the voice commands need to be issued using the Bluetooth module which has a low functioning range. Instead, the user can automate this process of starting the car by using the GSM Module which will instruct the car to start upon the reception of a text message or call from the user.

The next block deals with the design of the car itself. Here we develop a prototype model of a robotic car which is built using the wheels, chassis and 200rpm motor to achieve rotation.

With a reliable and fast motor it is possible to move the car in a fairly rough terrain. We next install the Arduino Microcontroller onto the car and provide connections between the Microcontroller and the ultra-sonic sensor network. We can also add the optional GSM module or the Bluetooth module to achieve automation using voice commands.

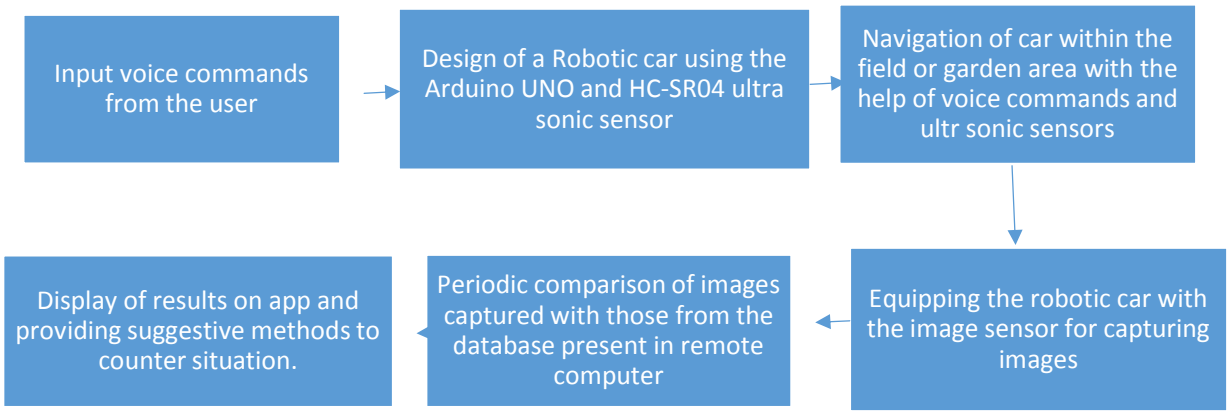

Figure-1: Functional block diagram of the proposed solution

This car hence designed can be tested by moving it within the fields and even gardens. Gardens plants also face the wrath of pest infestation wherein small microscopic organisms can destroy the entire plant. People are unaware of such symptoms the plant shows and later end up losing the plant. Hence there is a need to use this system within the gardens too.

Once the car has been tested to move around the field we can next mount the image sensor module on the car and this can be then used to periodically capture images whenever the ultra- sonic sensor network detects a plant it will pause for a predefined period of time and automatically capture images to send them back to the Micro controller which will then send the retrieved images to the remote computer system using the Bluetooth module(if the area of operation is small) or the NodeMCU Wi-Fi serial module. Using the latter it is possible to store images on the cloud and the user can later access them to perform the test.

Lastly the captured images will be compared using the compiled dataset images infected with various pests for that particular plant. It should be noted here that the database for infected plant needs to be added by the user for successful comparison. The obtained results will be shown to the user after successful detection of a disease caused by pest or a pest is detected. In case there is any pest detected then a list of preventive measures will be shown to the user.

2. METHODOLOGY

Themaingoal of this system was to develop a prototype which will be able to automatically move around the fields and capture images of the target plant and then transmit them to a remote system for processing. We initially begin with the development of a voice controlled robotic car which can be started or stopped by the user as required. This voice controlled car was designed with the help of the Arduino Microcontroller and ultrasonic sensor network. The commutation within the field will be done with help of the ultra-sonic sensors which could easily detect the presence of crops.

Upon the detection of the crop the images would be captured and sent to the microcontroller. These images will then be retrieved on cloud and then be transmitted back to the user. In case of any suspected pest/insect/disease the image of the affected plant will be displayed and then a list of possible and suitable procedures/ measures that need to be employed to counter this issue will be given to the user.

Most of us are unaware of the various types of pests infesting our crops/ garden plants, let alone knowing the name of the disease the pest/insect causes. And in such cases consulting an expert would seem a feasible and optimum solution.Here is where the technology comes in providing the access to vast compiled database of crop infected with pest causing the disease.Computer vision techniques provide effective ways for analysing the images of leaves. Support Vector Machine (SVM) is used for classification of the images with or without pests based on the image features. We can easily achieve this goal of detection of pest and disease with the help of this project.

Given below is a list of components used:

1. **Arduino UNO-**the board here used was Arduino Uno R3. It consists of a physical programmable circuit board i.e. the microcontroller and software which is the Integrated Development Environment (IDE)which is used to write and upload code to the board.This was used to integrate all the components on board.

2. **Components for the robotic car-**This includes the chassis, wheel mounting support, wheels and the motor with a motor driver module.

3. **GSM Module (SIM900) -**This was used for sending the start and stop instructions from the user with the help of a simple text message.

4. **Ultra-sonic sensors HC-SR04-** It was used for the detection of the plant/crop while hovering the robotic car within the field.

5. **OV7670 (640x480) VGA CMOS Camera Image Sensor** -This was used for the purpose of capturing images of the plant which was infected with pests.

6. **Remote computer system-** This was used for retrieving the images captured and for processing those images.

Assembling of these components was done and tests were performed on a given area of plants.

Figures 2-5 highlight some of the insects and pests causing plant diseases.

Figure-2: Tomato plants being infested by**Figure-3:**Japanese beetle

Caterpillars


Figure-4: Whitefly infestations **Figure-5:** Aphids

Capturing the diseases leaf or pest infected leaf will help us identify the underlying cause. Immediately after the capturing the image it is processed and the results and solutions will be shown to the user.

3. FUTURE SCOPE

The built model is a prototype and hence there are several changes that can be made in order to suit the user's needs. The GSM module used here can be replaced with another Wi-Fi module. We can even build an app wherein the processing time will be reduced and the results can be directly displayed on the app.

4. CONCLUSION

It is necessary that such a system be employed within the fields for the detection of the pests and insects affecting the crop or the garden plants. Most of us aren't aware of the harmful effects these pests and insects can have on the plants health. In most of the cases it will be difficult for the people to identify the underlying disease and find the preventive measures. Also it is not always feasible for the commoners or farmers to consult an expert in such cases which will again be a whole new task. Hence this system provides a feasible and employable solution to the ongoing problem of pests and insects affecting the crops. It can be easily implemented on a large scale and the results can beneficial to everyone.

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