Agriculture Robotic Vehicles based Pesticides Sprayer

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Abstract— This project deals with the exposition of how robotics can be applied to various fields of agriculture. One of the most important occupations in a developing country like India is agriculture. It is very important to improve the efficiency and productivity of agriculture by replacing laborer with intelligent machines like robots using latest technologies. The project proposes a new strategy to replace humans in various agricultural operations like detection of presence of pests, spraying of pesticides, spraying of fertilizers, etc. there by providing safety to the farmers and precision agriculture. The developed system involves designing a prototype which uses simple cost effective equipment's like microprocessors, wireless camera, various motors and terminal equipment's which is an aid to the farmers in various crop field activities.

Key words: Pesticide Sprayer, Agriculture Vehicle, Robot, Automated Pests Management, Image Analysis, Object Detection, Object Extraction

I. Introduction

Agriculture is one of the most important occupations in a developing country like India. The problems related to the traditional farming such as lack of knowledge of using fertilizer/pesticides, lack of man power, etc. due to which farmers are leaving the farming profession. Advancement in the field of robotics has widened and its applications extend from home automations, military operations along with agriculture related activities. Automation may prove as attraction to young farmers to continue their traditional profession with improved efficiency, precision along with the safe cultivation practices.

To provide safety to the farmers and the main objective of this work is to provide precision farming. Here, Robots will be replacing laborers for the farm activities like detection of pests, spraying of pesticides/fertilizers etc. whose operations will be automated or can be controlled by the farmer.

This system involves designing a prototype using equipment's like microprocessors, wireless camera, motors and terminal equipment's which will offer an aid to the farmers for automation.

The rationale behind the proposed project is to bring in the improvements in safety of farmers during the crop activities like spraying chemicals, fertilizers and pesticides. The research projects finds its relevance in the field of Agricultural Engineering, Electrical Engineering, Electronics Engineering, Telecommunication Engineering, Mechatronics Engineering, Environmental Engineering, Biomedical Engineering, Mechanical Engineering etc.

II. Review of Literature

Robotics plays a major role not only in industrial, medical, military but also in agricultural applications [2]. The Agricultural robotic systems are used as a tool that can enable a transformation of practices and the adoption of new technologies in field and crop management. The smart machine called as "green seeker sensor" that was developed at Oklahoma state university which reads a plant's needs and then applies precisely the amount of fertilizer or herbicides needed [3]. Some authors have worked on Autonomous Pesticide Spraying Robot for spraying pesticides in greenhouse [4-6].

A robotic vehicle using PIC Microcontroller to control the movement of robot with the help of transmitter, a receiver and a wireless camera mounted on the top of the vehicle that tracks the path taken by the robot for spraying harmful pesticides has been developed [1]. This robot mainly emphasizes on pesticide spraying by farmers from a remote location without directly coming in contact with it. Robotics Technology has been implemented for weeding, sowing and reaping of fruits from the field [7]. Another project that developed a multipurpose machine, which is used for digging the soil, seed sowing, and leveler to close the mud and water sprayer to spray water [8]. Further, companies like WIPRO are actively working on making advanced systems and robots for agriculture [9]. Such techniques can be implemented for improving the productivity and efficiency of Indian agriculture in future.

III. Description of the Proposed System Components

Agriculture robot vehicle consist of basic equipment's such as microcontroller, transmitter & receiver, driver circuit, stepper motor and wireless camera. This robot vehicle which navigates in between the crops based on the instructions given by the farmer using joystick. The transmitted instructions will be received at the receiver end and corresponding movement of the robot will be obtained. The instruction transmitted from the transmitter, reception at the receiver and corresponding movement of the robot is depicted as shown in the block diagram in Fig. 2.1

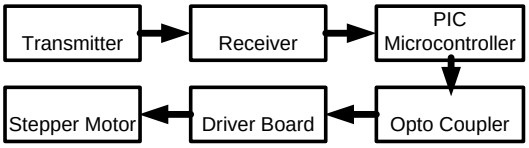

Fig. 2.1: Block Diagram of Robotic Motion

These robotic vehicles mainly consist of the following parts:

A. Motherboard

The motherboard consists of the PIC18 micro controller, crystal oscillator, and filters. The PIC microcontroller is the main controller which drives the entire robot. It gives

command signals to the driver circuit which drives the stepper motor to run the robot. Optocouplers are present in the motherboard, these are optically coupled and electrically isolated with the driver circuit. This protects the microcontroller and ensures that data leaves the microcontroller and no external data enters the microcontroller. It protects the controller from large back electro motive force else it may destroy the components

B. Transmitter & Receiver

The block diagram of the transmitter is shown in Fig.2.2.

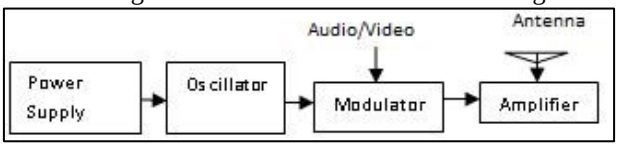

Fig. 2.2: Block Diagram of Transmitter

The transmitter consists of a carrier signal generator (oscillator) which produces the carrier wave frequency, modulating signal generator which produces the signal to be modulated according to the command given by the user, mixer which mixes the signals and amplifier which increases the power of this signal then the modulated signal is sent to the transmitter. The transmitter transmits this signal.

The receiver board consists of IC (12D), a wireless receiver of 434 MHZ and LEDs. The receiver IC consists of antenna which captures the RF signal, RF amplifier which amplifies the weak signal, a tuner and decoder which demodulates the information signal of particular frequency from the carrier signal and performs the needed control action. The block diagram of receiver is as in the Fig-2.3.

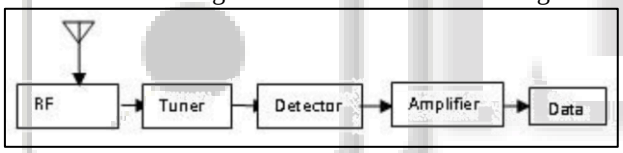

Fig. 2.3: Block Diagram of Receiver

C. Wireless Camera & A Television

A wireless camera is used for live transmission of the images of crops and the path to the remote user (farmer). The wireless camera is mounted on the top of the robot. The viewing angle of the camera can also be adjusted. The RF based live video acquisition module consists of a wireless camera and in built transmitter. This transmitted data is received by an RF receiver and it is viewed using an appropriate terminal device (television). The live streaming allows the farmer to specifically guide and navigate the robot. The remote manipulation of robot is possible using this facility.

Instead of using a separate microcontroller, RF transmitter, RF communication controller wireless camera with inbuilt transmitter, joystick and a single microcontroller to control the entire working of robot is used for simplicity and cost efficiency.

D. Stepper Motor

A stepper motor is a brushless DC electric motor which rotates through a number of steps. According to the input current pulse from the controller it rotates through a fixed angular step. Stepper motors can be directly controlled using microprocessors, computers and programmable controllers. It is ideally suited for situations where precise positioning and precise speed control is required in various autonomous systems. It is well suited for open loop control system as a precise output can be obtained as the output depends on the count of pulses sent to the motor thereby eliminating the need of sensors or feedback system and hence it reduces the overall cost.

E. Driver Boards

The signal is sent to power driver circuit which further drives the current and provides the necessary current to drive the motor. It works based on Automatic gain control method. The signal is sent from the driver circuit to the stepper motor. The stepper motor works according to the pulses it receives from the driver circuit.

This project serves to lessen the laborious work of the farmers and also proves to be very economical and efficient

IV. PROPOSED METHOD FOR PEST DETECTION ON PLANTS/ CROPS

Detection of pest can be done more accurately using image processing method. Image processing is the analysis and manipulation of graphical images from sources such as photographs and videos. There are three main steps in image processing; first is the conversion of captured images into binary values that a computer can process; second, is the image enhancement and data compression; and the third is the output step that consists of the display or printing of the processed image. Image processing is used in such applications as satellite weather mapping, machine vision, and computer-based pattern recognition. Here is the block diagram of pest detection and spraying of pesticides as shown in fig. 2.4.

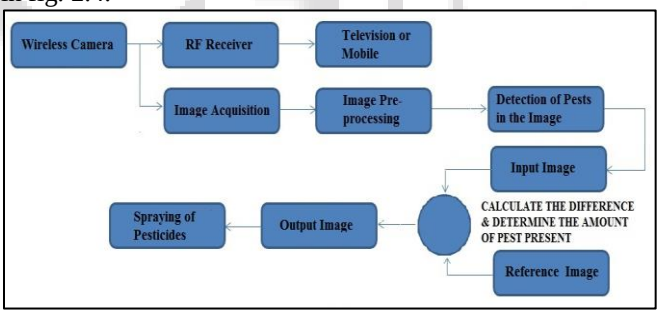

Fig. 2.4: Block Diagram of Pest Detection & Spraying of Pesticides

As the images/ video captured by camera is used for detection of the pesticides. There are some types for techniques used in image processing.

There are various types of image processing method:

1) Image Pre-Processing
2) Image Enhancement
3) Image Segmentation
4) Feature Extraction
5) Image Classification

A. Image Pre-Processing

In image preprocessing, image data recorded by sensors on a satellite restrain errors related to geometry and brightness values of the pixels. These errors are corrected using appropriate mathematical models which are either definite or statistical models.

B. Image Enhancement

Image enhancement is the modification of image by changing the pixel brightness values to improve its visual impact. Image enhancement involves a collection of techniques that are used to improve the visual appearance of an image, or to convert the image to a form which is better suited for human or machine interpretation.

Sometimes images obtained from satellites and conventional and digital cameras lack in contrast and brightness because of the limitations of imaging sub systems and illumination conditions while capturing image. Images may have different types of noise. In image enhancement, the goal is to accentuate certain image features for subsequent analysis or for image display. Examples include contrast and edge enhancement, pseudo-coloring, noise filtering, sharpening, and magnifying. Image enhancement is useful in feature extraction, image analysis and an image display. The enhancement process itself does not increase the inherent information content in the data. It simply emphasizes certain specified image characteristics. Enhancement algorithms are generally interactive and application dependent. Some of the enhancement techniques are:

a) Contrast Stretching
b) Noise Filtering
c) Histogram Modification

1) Contrast Stretching

Some images (e.g. over water bodies, deserts, dense forests, snow, clouds and under hazy conditions over heterogeneous regions) are homogeneous i.e., they do not have much change in their levels. In terms of histogram representation, they are characterized as the occurrence of very narrow peaks. The homogeneity can also be due to the incorrect illumination of the scene. Ultimately the images hence obtained are not easily interpretable due to poor human perceptibility. This is because there exist only a narrow range of gray-levels in the image having provision for wider range of gray-levels. The contrast stretching methods are designed exclusively for frequently encountered situations. Different stretching techniques have been developed to stretch the narrow range to the whole of the available dynamic range.

2) Noise Filtering

Noise Filtering is used to filter the unnecessary information from an image. It is also used to remove various types of noises from the images. Mostly this feature is interactive. Various filters like low pass, high pass, mean, median etc., are available.

3) Histogram Modification

Histogram has a lot of importance in image enhancement. It reflects the characteristics of image. By modifying the histogram, image characteristics can be modified. One such example is Histogram Equalization. Histogram equalization is a nonlinear stretch that redistributes pixel values so that there is approximately the same number of pixels with each value within a range. The result approximates a flat histogram. Therefore, contrast is increased at the peaks and lessened at the tails

C. Image Segmentation

Segmentation is one of the key problems in image processing. Image segmentation is the process that subdivides an image into its constituent parts or objects. The level to which this subdivision is carried out depends on the problem being solved, i.e., the segmentation should stop when the objects of interest in an application have been isolated e.g., in autonomous air-to-ground target acquisition, suppose our interest lies in identifying vehicles on a road, the first step is to segment the road from the image and then to segment the contents of the road down to potential vehicles. Image thresholding techniques are used for image segmentation.

After thresholding a binary image is formed where all object pixels have one gray level and all background pixels have another - generally the object pixels are 'black' and the background is 'white'. The best threshold is the one that selects all the object pixels and maps them to 'black'. Various approaches for the automatic selection of the threshold have been proposed. Thresholding can be defined as mapping of the gray scale into the binary set {0, 1}: equation Where S(x, y) is the value of the segmented image, g(x, y) is the gray level of the pixel (x, y) and T(x, y) is the threshold value at the coordinates (x, y). In the simplest case T(x,y) is coordinate independent and a constant for the whole image. It can be selected, for instance, on the basis of the gray level histogram. When the histogram has two pronounced maxima, which reflect gray levels of object(s) and background, it is possible to select a single threshold for the entire image. A method which is based on this idea and uses a correlation criterion to select the best threshold is described below. Sometimes gray level histograms have only one maximum. This can be caused, e.g., by inhomogeneous illumination of various regions of the image. In such case it is impossible to select a single thresholding value for the entire image and a local binarization technique must be applied. General methods to solve the problem of binarization of in homogeneously illuminated images, however, are not available.

Segmentation of images involves sometimes not only the discrimination between objects and the background, but also separation between different regions. One method for such separation is known as watershed segmentation.

D. Feature Extraction

The feature extraction techniques are developed to extract features in synthetic aperture radar images. This technique extracts high-level features needed in order to perform classification of targets. Features are those items which uniquely describe a target, such as size, shape, composition, location etc. Segmentation techniques are used to isolate the desired object from the scene so that measurements can be made on it subsequently. Quantitative measurements of object features allow classification and description of the image.

When the pre-processing and the desired level of segmentation has been achieved, some feature extraction technique is applied to the segments to obtain features, which is followed by application of classification and post processing techniques. It is essential to focus on the feature extraction phase as it has an observable impact on the efficiency of the recognition system. Feature selection of a feature extraction method is the single most important factor in achieving high recognition performance. Feature extraction has been given as “extracting from the raw data information that is most suitable for classification purposes,

while minimizing the within class pattern variability and enhancing the between class pattern variability". Thus, selection of a suitable feature extraction technique according to the input to be applied needs to be done with utmost care. Taking into consideration all these factors, it becomes essential to look at the various available techniques for feature extraction in a given domain, covering vast possibilities of cases.

E. Image Classification

Image classification is the labeling of a pixel or a group of pixels based on its grey value. Classification is one of the most often used methods of information extraction. In Classification, usually multiple features are used for a set of pixels i.e., many images of a particular object are needed.

By using this process the output images is obtained from the captured image/video. Once this output images is found area of this image is calculated and compared with it mean area. This calculation is done so as to minimize the use of amount of pesticides to be sprayed on the crops. This will help the farmer in optimizing the cost and will eventually increase the productivity.

Once the area is calculated the amount of pesticides to be sprayed is determined and appropriate amount of pesticides/ fertilizers are sprayed on the crops. This project will minimize the risk associates with the health and safety of the farmer.

V. EXPERIMENT RESULTS

The accurately detection and classification of the plant disease is very important for the successful cultivation of crop and this can be done using image processing. This program uses various techniques to segment the disease part of the plant. This program also discussed some Feature extraction and classification techniques to extract the features of infected leaf and the classification of plant diseases.

The use of ANN methods for classification of disease in plants such as self-organizing feature map, back propagation algorithm, SVMs etc. can be efficiently used. From these methods, we can accurately identify and classify various plant diseases using image processing techniques. The fig. 3.1 shows the output of the program used for detection of the pest using image processing techniques.

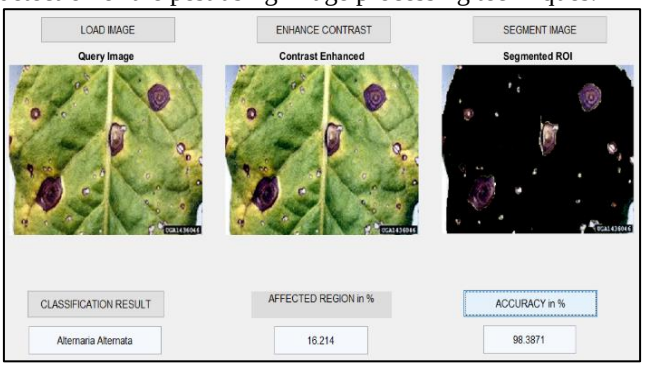

Fig. 3.1: Output of Program Used for Detection of Pest Using Image Processing Method

VI. CONCLUSION

This considered work is aimed to extend the application of advanced technology in the field of agriculture. This work promises to overcome precision and safety challenges in field of agriculture and farmers respectively. It reduces tedious work like detection of pests, spraying of pesticides/ fertilizers which will results in the improvement of productivity. Hence, encourages many people to take up agriculture as an occupation. The user friendly agriculture robot used for spraying pesticides is an association of all basic feasible technologies, to bring out a new and needed robot to assist farmers in risk involving tasks.

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