IMAGE ACQUISITION OF WEED AND SPRAYING HERBICIDE BY USING ARDUINO

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The main aim of this implementation is the automatic agricultural system by spraying the herbicide to the unnecessary weeds present in the farm field. In order to achieve this goal, plants present in the field must be differentiated into crops and weeds based on their properties which can be performed by the computer vision algorithm. Weed present in the field reduce the quantity and the quality of the crops and reduce the earnings of the farmers. Weed management is the increasing input area in the agriculture field. Increasing the weed in the field will automatically reduce the yield in the farm. To control the weed, amount of chemicals used in the agricultural crop dramatically increases which results in the contamination of water and the environmental pollution. Usage of the herbicides can be decreased only by proper analyzing of the weed. Once the position of the weed is identified the spraying of the herbicide can be takes place automatically by using the spraying module. This entire process is implementing by using the Arduino with the computer vision programming library system. This computer vision algorithm is majorly designed to attach on the movable agricultural vehicle in the particular weed block.

Keywords- Automatic planting, unwanted weeds, weed identification, spraying module, Computer vision

I. INTRODUCTION

In recent trend the processes are taken out in all the fields for the development of worldwide crops which is more friendly to the environment. Management of weed in the developing countries is done with the

help of less labor. Increased use of herbicide affects the health of the human beings and animals etc.

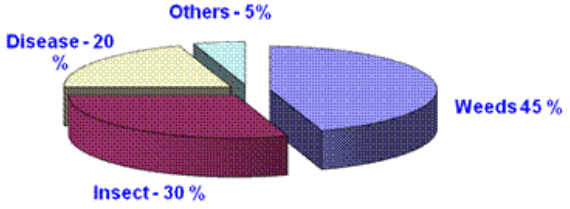

Fig 1.1 Crop yield caused by the weeds

Based on the recent research of the weed science, mostly 33% of the losses in the agricultural field can be caused by the unwanted weeds only. This can be given by the fig1.1. Apart from the pests, almost all the crops are affected by the weeds. So, it is important to minimize the losses caused by the weeds. The successful management of the weeds can be carried out by the proper training and the reorientation of the personnel of the state agricultural departments to the farmers. When compared to the global scenario, Indian scenario use lesser amount of the herbicide. The current Indian scenario of the pesticide usage is given by the fig 2. Usage of insecticide in India takes the increasing share of less

than two-third of the whole area and the herbicide usage is only less than 20% of the whole area. In future the usage of herbicide is expected to increase by 15-20% per annum.

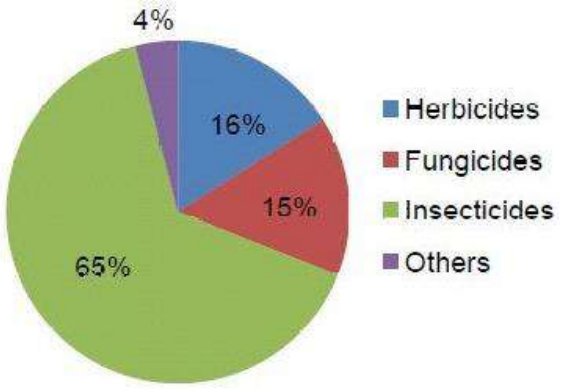

Fig 1.2 Usage of pesticide in Indian scenario

The consumption of herbicide registered in India are of low mammalian toxicity range, and it can be applied in the early stage of the growing crops, so the waiting period can be reduced and the profit can be increased in the harvesting period. All the agricultural processes can be strictly followed by the Colombia's economy; it leads to the high production costs and less accuracy. The application of agrochemicals to control the weeds will create the high environmental impacts. The steps carried out for the controlling and the eradication of unwanted weeds is done mostly by the humans which creates an appropriate time and need an alternative method to improve this process takes place in the Colombia's economy which makes the opportunity to face the world's challenging environment in all markets.

II. RELATED WORKS

In paper [1] consisted of three major parts. First, image acquisition is done by any types of digital cameras such as normal webcam. While capturing images the camera is placed on the ground side or 1.20 meters above the ground level. Images are captured with natural light conditions. The captured image is proceeding with MATLAB software. In the input image Excessive Green Color algorithm is used to remove the soil from the image and only the Green color information remains as required. Further by using Image enhancement technique, green color image is converted into gray color image. After that the noise in the gray image is removed by using median filter. After filtering intensity is adjusted by using MATLAB and labeling is done for identification. Wavelet transform is used for feature extraction of weeds and crops. Now input image is divided into smaller number of images and for each segment texture feature are extracted. This extracted texture feature of crop and weed is given to the technology of neural network areas. Output of this network is used for crop and weed classification. After detection of crop and weed, crop is masked. In order to reduce the pesticide usage, it is necessary to spray herbicides only on the weed areas. After mapping the weed co-ordinates the real plane is given to Arduino Uno controller and output of the controller is given to the motor driver. If any weed is present we give input to the controller in a way that sprayer goes to the weed and spray the herbicides. The main advantage is the Robotic system that helps to spray the herbicides automatically. But for identifying weeds, it is necessary to calculate the weed co-ordinates.

The theme of the next paper [2] is to detect weeds using image processing. Then input is given to the automatic sprayer to spray only in the weed areas. For this purpose it is necessary to take photograph of the field by attaching camera to the tractor or by taking them manually. Then image processing technique is applied to the image using MATLAB to detect the weeds. In this paper, they implemented 2 methods for detection of weeds. They are:

1. Inter row weed detection
2. Inter plant weed detection

In Inter row weed detection method, it process the images taken in real time to obtain the weed areas. Each image will take first eight frames and perform the logical AND operation to get reference image called crop row image.

Fig 2.1 Mechanical weed control

This reference image will be changed after sometime and will be replaced by a new crop image formed by the AND operation. Finally XOR operation of the processed image with the already existing reference image gives the output image containing the weed that is present in between the rows

In Inter plant weed detection algorithm, it prepares an image for further advanced processing and consists of Loading the image from source, color segmentation and edge detection. Color segmentation is one of the image segmentation method used to separate the crop from the background. Edge detection is also a method of image segmentation which uses the facts that the edge frequencies and veins of both the crop and weed have different density properties, to separate the crop from weed. Finally filtering is done for recognizing regions. As a result, image which contain weeds appear white in color. To spray herbicides, it check first row of the filtering output. If any block is found, input is given to the Arduino controller in a way that the sprayer goes to the block and sprays the herbicide. Here it is possible to reduce the usage of herbicides, thus saving the environment. But the weed block numbers from the filtering step cannot be given automatically to the mechanical system of the motor, it has to be done manual systems.

In smart sprayer paper[3], a robot spray the pesticide for a crop in agriculture fields. A vision based guidance method is presented to guide the robot platform driven along crops planted in agriculture field. Vision based guidance is obtained by image acquisition that can be done by any type of digital cameras. In this case webcam is installed on the sprayer at a particular height. The output image of webcam was in RGB format with size of 640*480 pixels. Then the acquired image is processed in MATLAB environment in order to find the location of weeds in the image. The image processing algorithm is done by two methods: Green segmentation method classify the plant into pixels which include crops, weeds and soil. The most well known vegetation method known as Excessive green used to identify green parts of the image. At this stage any plant that grows between rows is considered as weeds. Goal of the Feature extraction section is to extract proper features, so weed parts within rows could be distinguished from crops. In order to detect some activities Fourier transform is used, as it gives frequency contents of the image. It is also necessary to know the location of each frequency, hence wavelet transform is used. The processed image are then converted into voltage levels through MAX232 level converter and given to the microcontroller unit. According to the coding the robot is controlled and several motor is activated by using L293D. Here Zigbee transmitter is used to transmit the color information. LPC2148 Arm processor is interfaced with Zigbee. The Zigbee continuously read the color information and transmits the data. The Zigbee receiver receives the data and gives it to 8051 microcontroller. Now it is the job of controller to spray herbicides on the desired spot. This method does the application using wireless concept and it is cheap and very easy to implement. Lack of any feature is related to the quality of webcam.

In paper[4], there are three main parts first one is IMAQ, second one is pattern matching and finally the report generation. The objective of this paper is to introduce a new weed controller using the pattern matching algorithm. The entire process is implemented in MATLAB software and it is suitable for real time field purpose. In this process, test image is acquired by any type of digital camera and it is further processed for image acquisition. The output of the image acquisition is given for pattern matching algorithm. Then report generation tool kit is provided to view the report in word and excel sheet. IMAQ means image acquisition which can be achieved through any type of digital cameras, by placing the

camera perpendicular to the ground. In IMAQ both the test image and template image are the input images. NI vision builder provide the pattern matching algorithm. This algorithm is used to locate the template image in a test image if the test image is located. In this some parameters are necessary to achieve this matching. Report generation is one of the tool kit used to generate the report in Microsoft word and excel. This proposed system has 96% classification accuracy. It is a user friendly process and use of MATLAB software reduces wired circuits. Hardware failure is very rare compared to embedded system and monitoring the farm parameter through MATLAB is a very easy task. Here template image is compulsory for matching algorithm also various pattern matching algorithm are available, hence it is quite complex to set different parameters for each algorithm.

The objective of paper[5] is to identify the weeds from the crops with the help of field spectroscopy tools. Leaves spectral relative reflectance were obtained by Analytical Spectral Devices Field Spec Pro FR Spectrometer in the range of 400-2400nm. The Spectral camera HS with 1600 pixel per line and 849 bands in the range of 400-1000nm was selected to continue this study. The properties of the camera improve the ability to separate weeds spectrally by applying spatial factor.

Fig 2.2 Surveying the field

The output of the camera is re-sampled and thus the spatial and spectral resolution provides agricultural applications including weeds control. The plants are spectrally measured by ASD in two levels: single leaf and canopy of plants. The measurements are done with high intensity contact probe and bare fiber adaptor. The reflectance data were collected with a bare fiber adaptor at a particular distance and Field of view is estimated. Since, different samples contain different proportions, each samples were grouped differently according to the data, date and components. Now all the sets are divided into two types: qualitative and quantitative. Data were also obtained by Spectral camera HS by placing the camera 135 cm above the ground area. The images are in the process of transformation to reflectance value by ENVI software. The process is based on flat field method by applying smoothed powder of barium sulphate on the camera frame. This experiment formation provides very high spatial resolution. But only large patches of weeds might be detected.

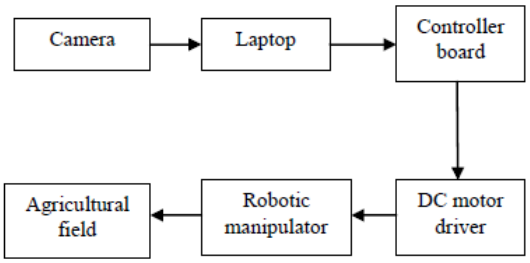

Fig 2.3 Block Diagram of Existing system

In the existing model the crop and weed detection can be takes place by capturing the image by using the digital camera. During the capturing of the image position of the camera is grounded. After taking the image it is given to the laptop for image processing. Mostly MATLAB2010 is used. After this the processing data is given to the controller. Then it transferred to the controller board through the Universal Synchronous Bus. Calculation of the actuation parameter is done for robotic manipulator moving. DC motor is connected to the robotic manipulator. After the data received by the robotic manipulator it moves in x, y, z directions and spraying the herbicides on the particular unwanted weed. After receiving the data the DC motors are connected to the robotic manipulator actuates the manipulator.

a) Technique based on biological Morphology

In biological morphology the shape and size features are extracted. Shape features like major and minor axis, areas, aspect ratio, and width are used for the plant detection. The excessive Green color algorithm for the image segmentation of vegetation and the soil, after this median filter is used for the removal of noise, the morphological features and the calculation of the statistical threshold value. By using the precision of 72.6% is obtained. Seven shape features is mostly used for the detection of crop and weed but it is limited only for corn crop and the accuracy of 98.9% is obtained.

b) Technique based on plant reflectance

Spectral reflectance parameter can be recorded by using the spectrometer but the cost is very high when Compared to the common former method used in the olden days of the weed detection. Spectrometer is necessary for the spectral reflectometer parameter recording. A different type of spectral reflectance parameter is used for the indices of vegetation, and to measure the properties of the crop typically ratios of the broadband reflectance values are used. Most important features like near infrared spectrum variance, skewness average gives the higher quantity of success in the color segmentation. In the proposed system of pironetal got the accuracy of 72% in the detection of weeds in the carrot field area.

c) Technique based on Visual Texture

In visual texture technique the features of the images such as contrast, energy, entropy, homogeneity, inertia used for the plant detection and unwanted crops. By using the algorithm of support vector and extracting the texture features to got the accuracy of 93%. Various research scientists about the weed detection results give the different accuracies with various five texture features. Wavelet transform of the Gabor combined with PCA algorithm got the precision of 90.5%. crop and weed detection can be shown by bounding box size based on the different features. Area is defined as the number of pixels present in the particular region. Perimeter is defined as number of pixels present in the boundary of the region. Major axis is defined as the number of pixels present in the longest line it moving through the middle of the region and connected to the boundary of that same region. Minor axis is defined as the number of pixels present in the shortest line which moving through the center of the region and connected to the boundary of that same region. If sugarcane can be used as a crop and 30 samples can be used for the training in that 20 samples are tested in that 18 only gives the proper result.

d) Automatic spraying of herbicide

To achieve the ultimate goal of reducing the pesticide usage, spraying the herbicide only to the weed areas. The sprayer used for the herbicide spraying may be the robotic hand or motor or the sprinkler etc. The founded block number is given to the controller the sprayer go to that particular block and sprays the small amount of herbicide. If both the weed and crop have nearly same edge frequency we should be very careful in selecting the threshold value. The weed block numbers from the filtering step cannot be given automatically to the motor.

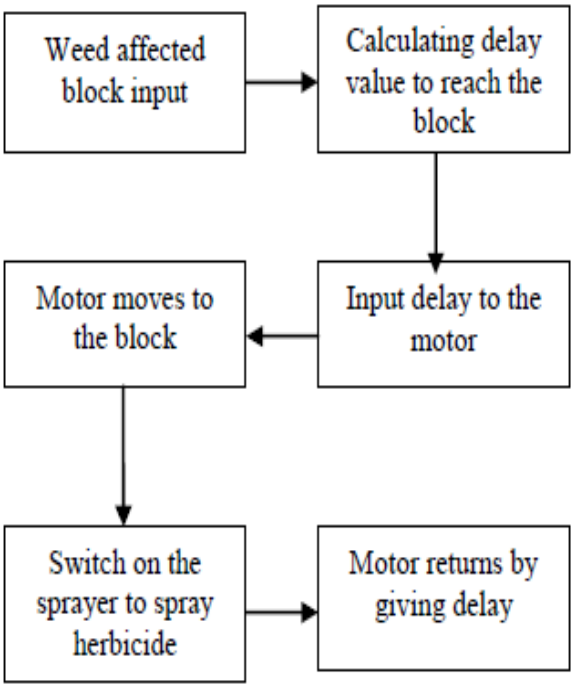

Fig 2.4 Working of the herbicide sprayer

For classifying the weeds and crops in the agricultural field many developing algorithm is used in the existing model. Mostly it is used in color property, topological property, wavelet transform, three wide band interference filter but the accuracy is very less. But most of the weed detecting techniques

is exhibited in the image processing using MATLAB. To reduce the usage of herbicide and the correct identification of the frame size computer vision of Lab VIEW system is implemented. The major difference between the existing and the proposed model is the major classification accuracy and the amount of the herbicide spraying in the field areas. As a result herbicide usage will be reduced and it creates the eco friendly nature of the agricultural field to earn more profits and product outcome in short span of time in efficient manner.

Table 1 Algorithm and its accuracy

ALGORITHM	ACCURACY
Property of spectral reflectance	86%
Property of color	49 to 97%
Property of topology	84 to 90%
Features of texture	33 to 77%
Wavelet transform	87 to 93%
Algorithm of pattern matching	92 o 96%

III. PROPOSED SYSTEM

The proposed system is consisted of three main parts. First of all is image acquisition that can be done by any types of digital cameras such as normal webcams. The camera should be installed perpendicular to ground. In this case a webcam was installed on the herbicide sprayer chassis at the height of 1.20 meters above the ground. At this height each output image covers nearly a row and two sides of that which is suitable for the purpose. It should be noted that in order to evaluate robustness of algorithm, image acquisitions were done in the presence of natural variable light conditions. The output images of the webcam were in RGB format with size of 640*480 pixels. After that the acquired images are processed in Lab VIEW environment. It is a graphical programming language which means it uses the icons as a substitute of text line for creating a applications. Lab VIEW is a development environment for a visual programming language for NI. By using the Lab VIEW we can able to generate 32-bit compiled applications it gives the faster execution speeds. The main objective is to introduce a new weed controller using the pattern matching algorithm. For much computer vision application the first step is the pattern matching algorithm. This algorithm needs to maintain its capability to locate the template pattern even though the image is changed. In practical many pattern matching algorithm is used in the vision builder but in this paper the major implementation in IMAQ Match Geometric Pattern 2 VI.

In this the test image is acquired by the any type of digital camera such as web cam etc.., first step for the weed detection is image acquisition. After that the output of the image acquisition is given as the input for the pattern matching algorithm. According to that report generation tool kit is generate the report in word and excel.

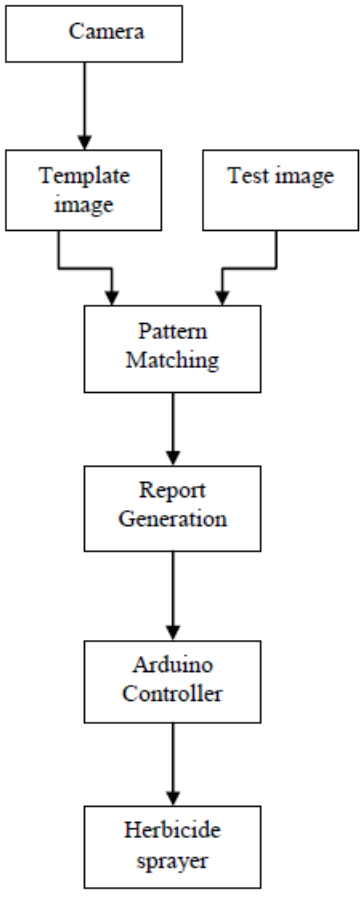

Fig 3.1 Working model of proposed system

IMAQ means image acquisition which can be through any category of digital cameras such as web camera etc., the camera shall be perpendicular to the ground and it was above the ground of 1.30 meters height. In this height all the test image was covered and that is suitable for weed detection. In this IMAQ both the test image and the template image are the input images. The test image is an image in which we want to search for a template image. The template image is nothing but an image gives the details which want to separate. NI Vision builder provide the pattern matching algorithm. Pattern matching algorithm must able to locate the template image in a test image if the test image is either scaled or rotated. In this it is necessary to set the parameter such as curve parameter, matches, minimum score match pixel etc.., after that search for a template pattern in an test image in which curve parameter and the matches are clusters. There are many pattern matching algorithm in vision builder here I use the IMAQ Match Geometric Pattern 2 VI. Report generation is one of the tool kits in the vision builder. By using the report generation tool kit we can able to generate the report in the Microsoft word as well as the excel sheet. Here the data generated is the random value. If the value is generated by the report generation tool kit then the inspection or test image have the template image. If suppose the value is not generated by the report generation tool kit then the test image does not have the template image.

To reach our ultimate goal of reducing pesticide usage, we need to spray it only in the weed areas. The sprayer we use may be a robotic hand or a set of sprinklers or motors etc. It is then connected to a driver which is then connected to a Arduino Uno microcontroller. It is a microcontroller board based on the ATmega328 chip. It contains almost everything needed to support a microcontroller, just connect it to a computer with a USB cable or power it with an AC to DC adapter or a battery to get started. First it checks the first row to find any weed blocks. . If any blocks are found it give the inputs to the controller in a way that the sprayer goes to that block and sprays the herbicide. Input always given to the sprayer is the time which is mostly important for the movement of the motor to the site of the weed location. The sprayer obtaining the time by using the only function of delay which is present in the Arduino Uno. The image taken for the processing is 2m length which indicates space between the each motor has the maximum distance of 2m length to cover the entire frame. In the frame the row length is majorly built with 0.2meters. The motor in each row has two side wheels arranged to parallel to the row of the frame. So the movement of the motor is mainly based on the movement of the wheels. If suppose the motor covers a distance of 1 meter in 4 seconds of time. By using the circumference of the wheel we can calculate the number of rpm(rotation per minute) required for the same.

In order to move the motor we need to give the time delay as input to the controller. Time delay is the time motor travels in a direction. As per the data instruction we have:

Time to travel 1 meter is = 4 sec

Time to travel for one block(0.2 m) = 0.8 sec

Time taken by the motor to travel „x" blocks from the initial positions is = 0.8*x seconds.

So the important factor about this is the consideration about the input to given to them always it will be the frame value of "x" which is the weed block number in that row, that will be varies from 0 to 9. When our motor reaches the particular block it will sprays the particular amount of herbicide by using the hands of sprinkler connected to the motor. The pins 3,4,5, of the Arduino Uno will be acts as the input pins particularly 3,4 for the movement of the motor and pin 5 for the movement of the motor to the required direction.

IV. CONCLUSION

The major part of this precision environment is automatic agricultural weed detection and spraying of herbicide. Apart from these thus restricting and preventing the unnecessary impacts of the over usage of chemical herbicides and it reduces the implementation cost. This paper aims to introduce the new model of weed detection and acquisition of image then finally the weed classification is done by the pattern matching algorithm and it was implemented in the computer vision of MATLAB software and output is obtained in the Arduino. The major advantage about the proposed system when

compared to the existing algorithm is classification accuracy of 96%.

V. FUTURE WORK

After the crop and weed are classified by the pattern matching algorithm, the data generated by the report generation is serially converted into voltage levels through MAX232 level converter and then the result is fed to the microcontroller unit. The microcontroller unit, which is already predefined by the c language coding, works on the set of codes and the robot, was controlled according to that code. Robot control is done by several motors which is activated by using the relays. Relays are electromagnetic switch which is mainly used to ON/OFF according to the control given by the microcontroller unit.

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