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Autonomous Weed Detection Rover using Image Processing

Dr. M. Kandan, Professor, Dept of Information Technology , Aditya Engineering College(A)
Ms. N.L.Sudharani, Department of Information Technology, Aditya Engineering College(A)
Ms. K.L.Tarunya, Department of Information Technology, Aditya Engineering College(A)
Ms. B.Lahari, Department of Information Technology, Aditya Engineering College,
Mr. CH.Sai Varaprasad, Department of Information Technology, Aditya Engineering College(A)

Abstract
This paper "Autonomous Weed Detection Rover using Image Processing" is to identify and detect the weeds in agriculture. Agriculture is one of the origins of human sustenance in this world. Nowadays due to growing population we need the greater productive capability of the agriculture to meet the demands. One of the serious issues in agriculture is the control of weeds growing among the plantation crops. Weed is a major threat to crops as it absorbs vitals and curb the crop of its nutrients. They compete with the desired plants for the resources that a plant typically needs, namely, direct sunlight, soilnutrients, water, and (to a lesser extent) space for growth. The final result of this project is to detect the weeds using Image processing in fields and eliminates them with the use of a laser beam. In this project, we are proposing a rover so that can be implemented by controlling it both manually and autonomously.
In existing system weed detection was done by employing some men, especially for that purpose. They will detect the weed by checking each and every place of the field. Then they will pluck them out manually using their hands. Later with the advancement in the technology they started using the herbicides to remove the weeds. The usage of deadly poisons as herbicides has increased to a drastic level. By doing so we got success in increasing the productivity but we have forgotten the damage done to the environment, which will raise a doubt in our sustenance on this beautiful earth. So, the existing process is costly, because lot of manpower is used. If less manpower is used it takes more time for removal of unwanted weed.
In proposed system, we are creating this rover in order to solve the problem of weed cutting and elimination. The main context of the project is to identify the weeds in agriculture. This project detects weeds using Image processing in fields. This can be implemented by controlling the rover both manually and autonomously. The autonomous control can be implemented by using GPS integrated with Real Time Kinematics. This is achieved by detecting and tracking the weed plant by controlling X-axis and Y-axis. The weed can be killed by blasting laser beam directly on to the weed itself. The main purpose of developing this model is to assist farmers in eliminating weeds from their fields and to overcome the issues that are faced with the traditional process.

Introduction

In this paper "**Autonomous Weed Detection Rover using Image Processing**" is to identify and detect the weeds in agriculture. Agriculture is one of the origins of human sustenance in this world. Nowadays due to growing population we need the greater productive capability of the agriculture to meet the demands. One of the serious issues in agriculture is the control of weeds growing among the plantation crops. Weed is a major threat to crops as it absorbs vitals and curb the crop of its

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nutrients. They compete with the desired plants for the resources that a plant typically needs, namely, direct sunlight, soil nutrients, water, and (to a lesser extent) space for growth. The final result of this project is to detect the weeds using **Image processing** in fields and eliminates them with the use of a laser beam. In this project, we are proposing a rover so that can be implemented by controlling it both manually and autonomously.

Our main focus is on Autonomous Weed Detection Rover to identify and detect the weeds autonomously using rover. Due to the use of our system, we can detect and separate out weed affected area from the crop plants. The reason for developing such system is to identify and reuse weed affected area for more seeding. This specific area can be considered for further weed control operations, resulting in more production. The autonomous control can be implemented by using GPS integrated with RTK (real time kinematics). This is achieved by detecting and tracking the weed plant by controlling X- axis and Y-axis. The weed can be killed by blasting laser beam directly on to the weed itself. This process is applied when the rover moves on to the field it identifies the weed and matches the data which the information weed images already existing in the dataset by converting it to RGB color space to grey scale color base by obtaining the crop grows and dividing the cells then the image pre- processing is done by which It takes decision making automatically and shoots laser beam directly on to the weed.

Literature Survey

Research Problem Identified

Weed plant detection is a new research problem in agricultural field which want to take help from computational science to detect unwanted growth of weed along with other crops/plants. Usually in farming when farmers grow something, due to soil property and pre available micro seeds, additional growth, weeds, will grow which will spoil the actual outcome of farming as they affect the growth of planted crop. So weed detection is problem of accurately identifying the area of weeds so that the weeds can be removed by either manually or spraying specific areas with minimum spraying on the other plants of interest. These methods are manually removing or spraying are considered as traditional methods. These methods do produce good practice but with a few drawbacks. The cost and time taken for these traditional methods is very high for the task alone. Dangers and accidents might occur where the labor's life is at risk. So, to produce more efficient results we can use the modern technology to solve the issues. In recent years, as the world population growth, existing land and natural resources decreased, the precision agriculture is increasingly capturing more attention of the researchers. Image processing approaches could be applied to solve this problem.

Crop detection by machine vision for weed management

Ashintosh K Shinde proposed this project to detect the weeds by using machine vision technique. He demonstrated weed detection by its Size features. Excessive green algorithm was developed to remove soil and further avoidable things from the image. Image enhancement techniques are used to eliminate Noise from the images, by using Labelling algorithm. Each component in the image were extracted, then size-based features like Area, Perimeter, longest chord and longest perpendicular chord have calculated for each label and by selecting suitable threshold value Weed and Crop segmentation is done.

Crop and weed detection based on texture and size features and automatic spraying of herbicides

Amruta A Aware proposed this project and developed the image processing algorithm for yield finding and

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management of weed. Five texture features are used for detection of crop. Compared the all results and taken majority decision for detection of crop and weed. Image segmentation combines image processing techniques in categorizes to take out cell from the image. The decision making determines the cells to be sprayed. Further the Cartesian robot manipulator is developed to locate the weed position on real field by calculating the coordinates to selectively spray the herbicides.

A Novel approach for weed classification using curvelet transform and Tamura Texture feature (CTTTF) with RVM classification.

Prema P proposed an efficient curvelet make over and patch level Tamura texture feature extraction method for weed classification. The relevance vector machine classification technique was developed for crop and weeds classification and weed partition. The results were compared support vector machine and with random forest classifier technique. The planned method outperforms all the other transform in conditions of correctness, specificity and sensitivity.
Weed detection using image processing

Ajinkya Paikekari, Vrushali Ghule proposed this project to detect and separate out weed affected area from the crop plants using image processing. They give the inputs of the weed areas to an automatic spray pesticide only in those areas. He takes a photograph of the field with good clarity to detect the weeds with more accuracy. Taking a photograph can be done by attaching a camera to a tractor or taking them manually. Then they apply image processing to that image using MATLAB to detect the weed.

Autonomous Herbicide Spraying System using AI and IoT

Prajwal B, Rakesh Shridhar proposed this project to provide a solution that addresses the common health hazards that are generally seen in the traditional method of spraying herbicides to detect the weeds. This emphasizes the method of filtering Global Positioning System (GPS) data using a moving average filter to improvise on the autonomous navigation system of the robot. Furthermore, the robot is capable of evaluating the count of weeds while spraying the herbicides when the threshold is crossed. Additionally, the robot incorporates a liquid-level sensor for measuring the amount of herbicide in real-time and transmitting the same using IoT.

Weed Detection Using Convolutional Neural Network

Arvinth S, Balakrishnan A proposed this project which provide a device which is integrated with camera and there will be a live video streaming in that it will detect the weed in the crop by using image processing. This system will use a Convolution neural network algorithm to extract the features from image and train them by using neural network. Their module has been trained in such a way that when the algorithm is embedded with robotics and the robot would move along the field and remove the unwanted weeds in the fields preventing them from damaging the crops.

Modules

Module Description
Autonomous Weed Detection Rover is including the following basic modules. They are:

ArduPilot
It is used to maintain stability and controls acceleration in different axis and maintains altitudes and indicates the directions of the rover.

GPS (Global Positioning System)
It is used to track the location of the rover. It actually communicates through radio signals and increases accuracy and stability. It is used to execute locations taken from the user.

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Linear voltage regulators
Linear voltage regulators are used to step down the voltage that comes from the battery.

Raspberry Pi 4
It is a powerful palm size microprocessor integrated with RASPIAN OS it supports python Andi with open CV multitasking feature open-source low power consumption.

R P CAM
It is easy to interface with raspberry Pi.

Radio transmitter and receiver
An electronic device which transmits radio waves with an antenna radio operates in 24 GHz band.

Power module
Power module sense the value of power consumed or power left in the rover to ground station.

PDB (Power Distribution Board)
It distributes the power to the different sectors of the rover.

Laser diode
This is used to kill the weed plant which is existing in the form, it shoots high potential laser to kill the weed by burning it.

Stepper motor driver
Stepper motor driver IC are used to control step rotation of stepper motor.

Algorithms Used
DNN (Deep Neural Network)
At its simplest, a neural network with some level of complexity, usually at least two layers, qualifies as a deep neural network (DNN), or deep net for short. Deep nets process data in complex ways by employing sophisticated math modeling. Deep nets allow a model's performance to increase in accuracy. They allow a model to take a set of inputs and give an output. The use of a deep net is as simple as copying and pasting a line of code for each layer.

Architecture of DNN
Practically speaking, a DNN is made of several successive layers of neurons building up to an output layer. These layers can be seen as successive representations of the input data [23], a multidimensional vector X, each of them corresponding to one of the parametric functions mentioned above. Neurons constituting layers are modeled as elementary computing units applying an activation function to their input. Layers are connected using links weighted by a set of vectors

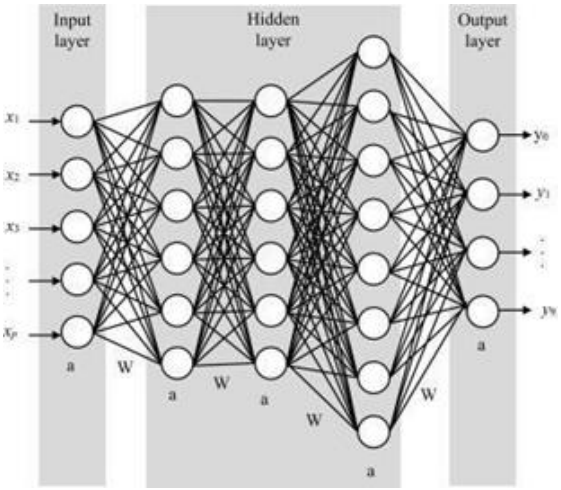

Fig : Architecture of DNN

DNN Algorithm

Step 1: Choose a dataset of your interest or you can also create your own image dataset for solving your own image classification problem.

- This dataset contains 12,500 augmented images of blood cells (JPEG) with accompanying cell type labels (CSV).
- There are approximately 3,000 images for each of 4 different cell types grouped into 4 different folders (according to cell type).
- The cell types are Eosinophil, Lymphocyte, Monocyte, and Neutrophil. Here are all the libraries that we would require and the code for importing them.

Step 2: Prepare Dataset for Training.

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- Preparing our dataset for training will involve assigning paths and creating categories(labels), resizing our images.
- Resizing images into 200 X 200

Step 3: Create Training Data.

Training is an array that will contain image pixel values and the index at which the image in the CATEGORIES list.
Step 4: Shuffle the Dataset.

Working of DNN
Deep Neural Network (DNN) is a class of machine learning algorithms similar to the artificial neural network and aims to mimic the information processing of the brain. DNN shave more than one hidden layer (l) situated between the input and output layers (Good fellow et al., 2016). Each layer contains a given number of units (neurons) that apply a certain functional transformation to the input. These types of models can approximate the behavior of any function (universal approximation theorem). The output (y) of a unit (i) in layer (l) is related to the output (x) of the earlier layer (k) with J outputs through a set of weights (wi k), a bias (b) and a non- linear activation function f.

(3) yil= f∑j = 1Jwi, kxk + bi

To fairly compare the various models in this work, only feed-forward layers were used. Despite the considerable interest, DNNs have gained in regression applications, few have dealt with the uncertainty in the prediction. This could be due to the complexity required to perform such an analysis. In this work, we use a probabilistic machine learning technique by introducing a probabilistic layer after the dense layers that can learn the distribution over the weights in the network. This layer learns the probability distribution of the outputs (y) related to the inputs (x) through weights (w). This makes it possible to model the loss function as the negative log- likelihood. The DNN was implemented using the TensorFlow frame work along with the TensorFlow distributions to model the probabilistic layer (Dillon et al.,2017). Grid-search was used to optimize the DNN hyperparameter systematically by varying the number of neurons, and dropout rate between [8,16,32,64], and [0.2-0.6] respectively. This resulted in a DNN comprised of: three dense layers (64) separated by three dropout layers (0.5) with a learning rate of 1e- 4and using the "Adam" optimizer and the "ReLu" activation function. The architecture was determined using an 80:10:10 training, validation, and testing split.

Results:

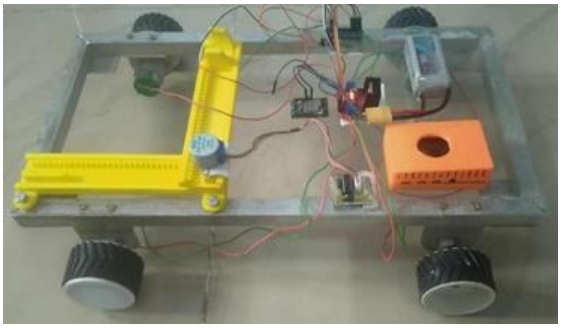

Fig: Rover Image

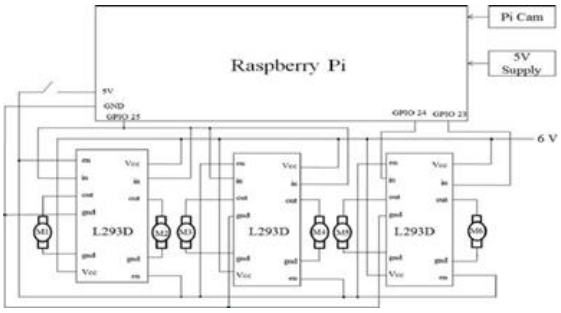

Fig: Circuit Diagram

Conclusion
In this paper, we propose "Autonomous Weed Detection Rover" to detect and destroy weeds using Image Processing. With the use of our proposed model, weed detection and elimination can be done without much effort and cost. Detecting weeds with image processing gives accuracy to the task. Time and cost spent on this particular weed elimination task in agriculture will be saved along with several other advantages. The space occupied by the weeds can be reused after eliminating the weeds, which increases the actual crop production.

The rover functionalizes itself using the coordinates autonomously and travel through rough and rigid areas. The transmitter is used to transmit the data to the autopilot controller for the user to operate the rover non-autonomously. Thus, the handling of rover is easier than traditional methods. So, we believe the proposed model for weed detection and reduction is more effective and efficient than the other models or methods used.

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