"DESIGN AND DEVELOPMENT OF WEED REMOVAL MACHINE AND CLASSIFICATION USING IMAGE PROCESSING"

D. VIDYA[1], NANDINI B.M[2]

[1,2]Lecturer in Electronics and Communication Engineering
[1]Government Polytechnic, Koppal, Karnataka, India
[2] Government Polytechnic, Kampli, Bellary,Karnataka, India

Abstract: A plant that is "a plant in the wrong place" is one that is deemed unattractive in a specific context. The production and productivity of the crop are impacted by the presence of these undesired plants in the field or garden. These weeds also absorb the sunlight, water, and nutrients that reach the field or garden, leaving less of these resources accessible to the crops. The traditional method of weed control is hand picking, but it is time- and labor-intensive. Herbicides can also be sprayed throughout an entire field or garden, however this practice produces a lot of pollution. Consequently, controlling weeds in agriculture is a major challenge for farmers. Additionally, the methods of farming currently in use make heavy use of pesticides and other chemicals that could have a negative impact on the ecosystem. When agricultural runoff is released into water bodies, it can negatively impact the aquatic ecology and damage the soil's fertility. It can also pollute the water. When we consume such agricultural products made with unscientific and heavy chemical use, it might also have an impact on our health.

KEYWORDS: Weed, Agriculture, Image processing.

I. INTRODUCTION

"A plant in the wrong place" is what is meant when referring to a plant that is seen unattractive in a specific context. The yield and productivity of the crop suffer as a result of these undesired plants being present in the field or garden. These weeds also devour the fertilizers, water, and sunshine that reaches the field or garden, lowering the amount of these resources that are accessible to the crops. The traditional approach of controlling weeds by hand picking is time- and labor-intensive. Herbicides can also be sprayed throughout an entire field or garden, although this method uses a lot of chemicals and may cause pollution and health risks. A study estimates that 250 million weeds are currently resistant to pesticides. The inherited capacity of a plant to endure and procreate after exposure to herbicides that would ordinarily be fatal to the wild plant is known as herbicide resistance. Herbicide resistance develops when a weed population is repeatedly exposed to the same herbicide or herbicides having similar effects or modes of action. Before a pesticide was ever applied, resistant plants were already sporadically present in the weed population. The slight genetic variance enables the weeds from those seeds to outcompete the herbicide's effects when they sprout. After employing the same herbicide, or herbicides from the same group, for a number of years, that extremely rare.

These drawbacks can be overcome by creating a system that can identify weeds automatically and remove them by handpicking or applying herbicides just where it is needed. Herbicide use can be decreased as a result of weed killer robots. Without harming any of the crops, it employs cameras and image processing tools to find and identify weeds. The Raspberry Pi module, which may be programmed to recognize the weed, receives the data collected by the camera. The robotic arm, which has a weed-cutting instrument attached to its gripper, is activated when a weed is detected. Weeds are so eradicated. Weed management is emphasized in small gardens.

Image processing is a technique for applying various operations on an image in order to produce an improved version of the image or to glean some insightful or practical data from it. It is a kind of signal processing where the input is an image and the output can either be another image or features or characteristics related to the input image. Image processing is one of the technologies that is currently expanding quickly. Within the fields of engineering and computer science, it also constitutes a core research area. Basically, image processing involves the following three steps: Importing the image using image capture instruments, such as a camera, analyzing and altering the image, and producing a report.

Image Processing Steps for Plant Detection

The detection of plants involves five key procedures. picture acquisition via a digital camera or the internet is followed by feature extraction, categorization, and picture pre-processing, which includes image enhancement and image segmentation to separate the affected from the useful areas of the image. Finally, it will be determined whether any diseases are present on the plant leaf. Leaf sample RGB photos were selected as the first phase. The detailed process is as follows:

1) RGB image acquisition
2) Convert the input image into color space
3) Segment the components
4) Obtain the useful segments
5) Computing the texture features

Image acquisition

The photographs of different leaves, taken with a digital camera with the necessary resolution for greater quality. It is obvious that the application will have an impact on how an image database is built. The image database itself is in charge of the classifier's improved performance, which determines how resilient the method.

Image pre-processing

The second phase involves pre-processing this image to remove unwanted distortions and increase some aspects that are crucial for subsequent processing and analysis. It involves picture augmentation, image segmentation, and color space conversion. Color space representation is made from the RGB images of leaves. The goal of the color space is to make it easier to specify colors in a generally understood manner. The depiction of Hue Saturation Value (HSV) color space from RGB photos. Because RGB is used to generate colors and his to describe them. A great tool for color perception is the HSV model. An observer's perception of pure color is described by the color property known as hue. the amount of white light added to anything, or what is known as saturation

Region based - In this technique pixels that are related to an object are grouped. The area that is detected for segmentation should be closed. Due to missing edge pixels in this region based segmentation there won't be any gap. The boundaries are identified for segmentation. In every step at least one pixel is related to the region and is taken into consideration. After identifying the change in the color and texture, the edge flow is converted into a vector. Then these edges are detected for further segmentation.
Edge based - Edge based Segmentation can also be done by using edge detection techniques. There are various techniques viz. gradient, log, canny, sobel, laplacian, robert. In this technique the boundary is identified to segment. Edges are detected to identify the discontinuities in the image. For classification they use both fixed and adaptive feature of support vector machine.
Threshold based - It is the easiest way of segmentation. Here segmentation is done through the threshold values obtained from the histogram of those edges of the original image. So, if the edge detections are accurate then the threshold too. Segmentation through thresholding has fewer computations compared to other techniques. The disadvantage of this segmentation technique is not suitable for complex images.

Feature extraction

Following segmentation, the section that is of interest was extracted. The meaning of a particular sample can be ascertained using the relevant features that are retrieved in the following phase. Actually, color, form, and texture aspects are typically included in picture attributes. The majority of academics are currently focusing on plant leaf texture as the key characteristic for classifying plants. As explained below, there are numerous ways for feature extraction.

Texture analysis methods

The general focus of textures, which vary in focus depending on the individual pixels that make up a picture, is on the non-uniform spatial distribution of different image intensities. The spatial relationship between the materials in an image is quantified by texture. Certain characteristics, such as uniformity, regularity, density, linearity, directionality, roughness, coarseness, phase, and frequency, are crucial in the perception of texture. The technique for classifying texture divides it into four main groups: statistical, structural, fractal, and signal processing.

Statistical

Statistical type includes grey-level histogram, grey-level co-occurrence matrix, auto-correlation features, and run length matrices for texture extraction.

Structural

The structural models of texture presume that textures are combinations of texture primitives. Conceptually, structural texture analysis carried out into two major steps i.e. extraction of the texture elements, and inference of the placement rule.

Scope of the project

1. The modern automated weed management systems on the market are more complex and out of the price range of small-scale farmers. The project's main goal is to offer small-scale farmers a low-cost automated weed management solution.
2. The project will be a good option for chemical-free farming since it intends to promote chemical-free agriculture by doing away with the usage of herbicides for weed control.

Objectives of the proposed work

1. To create an automated weed control method for small-scale farming.
2. To promote chemical-free agriculture and limit or stop the use of herbicides for weed control
3. To reduce the labour requirements and to promote cost effective agriculture.

II. LITERATURE REVIEW

Mark C. Siemens [1] : Weeds in the seed line (intra-row) between the crop plants are eliminated by robotically controlled machines, whilst weeds in the inter-row (inter-row) are controlled by traditional cultivation methods. To find plants, all systems employ a camera-based machine vision technology. The intricacies of how these machines' computer algorithms operate are unknown due to proprietary reasons, however based on observation and an examination of the product documentation, it is presumed that they do not categorize plants as either crops or weeds but rather specifically identify crops. Even under ideal circumstances, system accuracy of only 85% makes it challenging to classify plants as either crops or weeds.

Pusphavalli M et al. [2]: To identify and distinguish between weeds and crops, machine vision systems have been deployed. A real-time guidance system has been employed to accurately track the rows and drive a row cultivator and an autonomous agricultural robot. Two fundamental designs are employed in mechanical methods to automatically remove weeds from the seedline: a spinning hoe is used to remove weeds from within rows, and a mechanical knife is used to remove weeds from between rows. The suggested technique helps to reduce the use of herbicides in agricultural fields and also compensates for the workforce shortage. This research supports the notion of weed detection and removal by machines in agricultural fields.

Sachin D. Chothe et al. [3]: describes the methods for automatic plant identification that are computer-based. The leaf is chosen to gain the characteristics of the plant out of all the available plant organs. Digital image processing methods are used to calculate five geometrical parameters. Six basic morphological traits are extracted based on these geometrical factors. Leaf structure is used to extract the vein feature, which is a derived feature. Digital scanners are used to capture leaf photos at the initial stage. The retrieved morphological traits are then used as input in the classification stage, which follows.

Nidhi et al. [4]: An image can be taken using the open source computer vision library based on the hue, saturation, and color value (HSV) range. For handling and processing images, the fundamental library functions are utilized. For loading images, creating windows to contain them during runtime, storing photos, and separating images depending on their color values, simple library functions are employed.

III.PROJECT DEFINATION AND METHODOLOGY:

A plant that is "a plant in the wrong place" is one that is deemed unattractive in a specific context. The production and productivity of the crop are impacted by the presence of these undesired plants in the field or garden. These weeds also absorb the sunlight, water, and nutrients that reach the field or garden, leaving less of these resources accessible to the crops. The traditional method of weed control is hand picking, but it is time- and labor-intensive. Herbicides can also be sprayed throughout an entire field or garden, although this method uses a lot of chemicals and could have negative health effects as well as cause pollution. The inherited capacity of a plant to endure and procreate after exposure to herbicides that would ordinarily be fatal to the wild plant is known as herbicide resistance. A study estimates that 250 million weeds are currently resistant to pesticides. Herbicide resistance develops when a weed population is repeatedly exposed to the same herbicide or herbicides having similar effects or modes of action. Before a pesticide was ever applied, resistant plants were already sporadically present in the weed population. The slight genetic variance enables the weeds from those seeds to outcompete the herbicide's effects when they sprout. After employing the same herbicide, or herbicides from the same group, for a number of years, that extremely rare variety of the weed. These drawbacks can be overcome by creating a system that can identify weeds automatically and remove them by handpicking or applying herbicides just where it is needed. This strategy has the benefit of using less herbicides because they are only sprayed where they are necessary, like where weeds are present. The traditional approach involves spraying herbicides across the entire field. Herbicides should be applied in sufficient quantities at the weeds' precise locations in order to combat the issue of herbicide resistance. By creating such technologies, we can automate the weeding processes, which will lower the labor requirements. This lessens the need for labor-intensive farming practices.

The modern automated weed control devices are more advanced and expensive for small-scale farmers. They employ cutting-edge programming that uses machine learning and artificial intelligence. The majority of these systems are only intended for use in large-scale agriculture because of the complexity involved and, consequently, the high cost of installation. Therefore, it can be made available to small-scale farmers and gardeners if we lower the cost of implementation. The goal of the project is to give small farmers in particular a low-cost automated weed management option. The project makes it possible by lowering the cost of the hardware and by utilizing simply image processing and a few weed detection methods.

IV.WORKING PRINCIPLE:

The weed control robot moves through the field to detect the weed plants. The robot has a camera for image input. The image acquired by the camera is digitized by the digitizing unit and is fed into the processing module which is Raspberry pi.

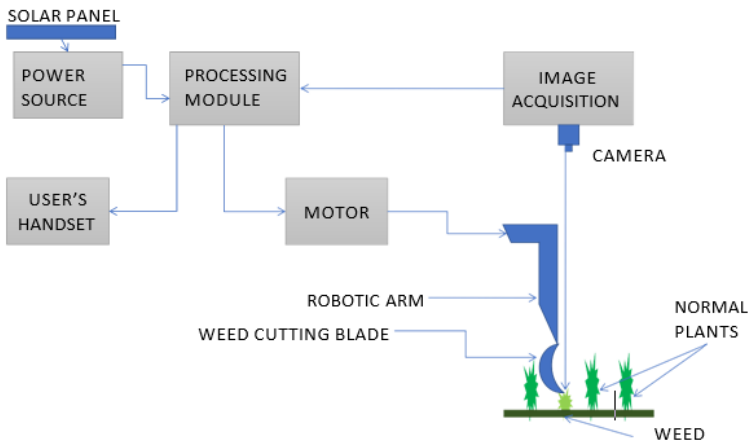
The raspberry pi is pre programmed with necessary datasets which involves the training models with which the image has to be compared. The dataset contains numerous leaf images and plant images of the desired plant with which we train the raspberry pi with suitable training algorithms. Also programs needed for image identification and image processing are also uploaded to the Raspberry pi module.

After powering up the robot, it will move forward until it detects and recognizes a weed. This detection is using the Raspberry Pi camera that is placed under the robot. Soon after detecting a weed using the color sensor, the robot stops its motion and the image of the weed is captured.

Components required

1.DC motors
2.Raspberry pi
3.Micro SD Motor
4.Driver
5.Battery
6.Color sensor
7.Gripper and weed cutting blades

Block diagram of a weed killing machine



Components used:

Raspberrypi 3b+
The Raspberry Pi is a small, inexpensive computer the size of a credit card that connects to a computer monitor or TV and operates with a regular keyboard and mouse. With the help of this competent small gadget, individuals of all ages may learn about computing and how to program in languages like Scratch and Python. With a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE functionality through a separate PoE HAT, the Raspberry Pi 3 Model B+ is the newest device in the Raspberry Pi 3 line.

Fig 1:Raspberry Pi 3b+

GPIO of Raspberrypi 3b+

The row of GPIO (general-purpose input/output) pins along the top edge of the board is a strong feature of the Raspberry Pi. All of the current Raspberry Pi boards have a 40-pin GPIO header (the Pi Zero and Pi Zero W have none). Before the Pi 1 Model B+ (2014), boards used a 26-pin header that was shorter. A broad variety of uses can be made of every GPIO pin by designating it (in software) as an input or output pin. On the board, two ground pins (0V), two 3V3 pins, two 5V pins, and other non-configurable ground pins are all present. All of the remaining pins are general-purpose 3V3 pins, which means that inputs are 3V3-tolerant and outputs are set to 3V3. An output pin on a GPIO can be adjusted to high (3V3) or low (0V). Input pins on GPIO devices can be read as high (3V3) or low (0V). The use of internal pull-up or pull-down resistors facilitates this. Pull-up resistors are fixed on pins GPIO2 and GPIO3, although they can be changed in software for other pins.

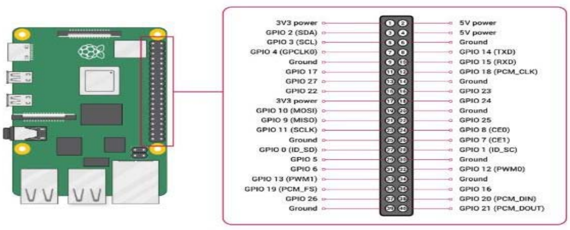


Fig 2: Raspberry Pi 3b+ pin diagram

Dc Gear Motor

A DC gear motor combines a motor and a gear box into one unit. By adding this motor, the speed is decreased while the output of torque is increased. Here, a 12 volt 100 rpm dc motor has been employed. This combines a motor with a gear reducer system, making it an easy and affordable solution for high torque, low speed applications. The metal gears are more resistant to wear and tear. Since the gear box is sealed and lubricated with lithium grease, maintenance is not necessary.

Fig 3: DC gear motor

This motor operates smoothly from 4 volts to 12 volts and provides a wide range of rpm and torque. It produces 100 rpm at 12 volts. A hole on the shaft allows for improved connection. These straightforward motors have gears on the shaft to get the best performance characteristics. Numerous robot applications, including all-terrain robots, can employ this motor (100 rpm, 12 v). These motors are easy to connect to the wheel or any other mechanical assembly since they have a 3mm threaded drill hole in the centre of the shaft. These common size DC motors are very simple to operate.Additionally, using an Arduino or equivalent board to operate a motor doesn't have to cost a lot of money. By turning on and off, a DC motor rotates.

L298 Motor Driver

The L298 is an H-bridge motor driver that can simultaneously control the speed and direction of two dc motors. The module may use a peak current to drive DC motors with voltages ranging from 5 to 35 volts.

Fig 4: L298 motor driver

Motor Pump

DC powered pumps can move fluid in a number of different ways by using the current flow from a motor, battery, or solar power. This small, inexpensive submersible pump motor may be powered by a 2.5–6 volt power source. It is a 3-6 volt little micro submersible water pump.

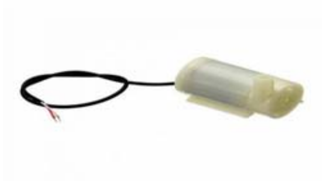


Fig 5: Motor Pump

Micro SD Card

Without having to worry about running out of room, we can save more hours of full HD videos on the card. Its lightning-fast transfer speeds make it possible to transport up to 1200 images in just 60 seconds. It delivers a quicker app launch and greater performance for an improved smartphone experience, making it perfect for Android smartphones and tablets.

Fig 6: Micro Sd Card

Raspberry Pi cam

In addition to still images, the 8MP Raspberry Pi Camera Module V2 can capture high definition video.It utilizes an add-on board with a fixed focus lens and a high-resolution 8 megapixel Sony IMX219 image sensor. It supports static images up to 3280*2464 pixels and 1080p30, 720p60, and 640*480p60/90 video resolutions.

The Raspberry Pi Camera V2 connects to the Pi via one of the tiny sockets on the top surface of the board and employs a specific CSI interface created just for connecting to cameras.

Fig 7: Pi ca

It is suitable for mobile or other applications where size and weight are important. It connects to raspberry pi by way of ribbon cable.Its easy to use for beginners. The camera works with all module of raspberry pi1,2 and 3.It can be accessed through the MMAL and V4l APIs,and there are numerous third-party libraries built for it, including the Pi camera python library.

Circuit diagram of L298 motor driver

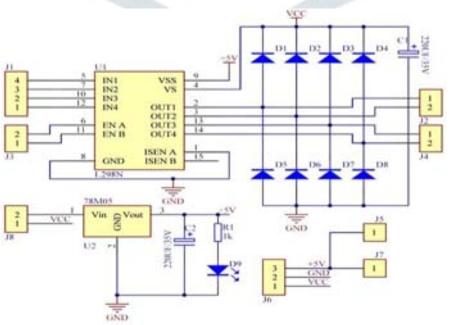


Fig 8:Circuit diagram of L298 motor driver

V. ASSEMBLY

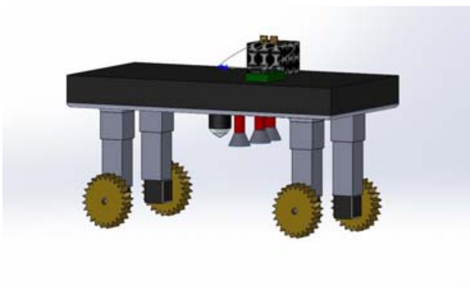


Fig 9: Assembly part of the model

VI.RESULTS AND DISCUSSION:

TESTING RESULTS

The function was ran using OpenCV and the RGB value for the color of the marijuana plant was used as an input. The color and texture of the chosen weed plant were displayed as the output as soon as the Pi camera was moved above it. By altering the plant, we have also tested the code. The RGB color value of the plant was the only aspect of the software that needed to be changed while changing. The result representing the color and texture of weed plants is shown in the figure below.

Fig 10: Screenshot of the output showing the weed plant

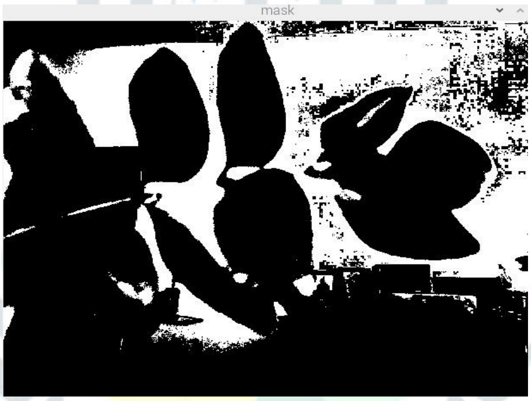


Fig 11: Screenshot of the output showing the texture of weed plant

Herbicide application can help with weed detection in crops, but in this particular instance, image processing was important because it was difficult to obtain the mask and identify the regions of interest because the light intensity in different areas isn't always the same. For the purpose of creating a chance to identify potential for weed control, it is crucial that the crops photographed are in their early stages.

VII . CONCLUSION

The drawbacks of the conventional weeding technique can be overcome by a system that can automatically identify weeds and remove them by hand pulling or selective herbicide application. Herbicide use can be decreased as a result of weed killer machines. Without harming any of the crops, it employs cameras and image processing tools to find and identify weeds. The Raspberry Pi module, which may be programmed to recognize the weed, receives the data collected by the camera. The robotic arm, which has a weed-cutting instrument attached to its gripper, is activated when a weed is detected. Weeds are so eradicated. Weed management is emphasized in small gardens.

REFERENCES:

1. Mark C. Siemens, Robotic Weed Control, International Journal of Innovative Research in Science, Volume 3, Issue 5,pp. 110-120, January 2015.
2. Dr. Pusphavalli M, Chandraleka R, Automatic Weed Removal System using Machine vision, I*nternational* Journal of Advanced Research in Electronics andCommunication Engineering (IJARECE), Volume 5, Issue 3,pp. 210-219, March 2016.
3. Sachin D. Chothe, V.R.Ratnaparkhe, Plant Identification Using Leaf Images, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Special Issue 6,pp. 71-79, May 2015.
4. Nidhi, Image Processing and Object Detection, International Journal of AppliedResearch,Volume 5, Issue 4, pp. 396-399, May 2015.