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Automated Weed Detection and Removal in Cultivation via Image Processing

Mr.B.Santhosh Kumar[1]., Dongara Gourishreeka[2]
1 Assistant Professor, Department of ECE, Malla Reddy College of Engineering for Women., Maisammaguda., Medchal., TS, India
2, B.Tech ECE (20RG1A0474),
Malla Reddy College of Engineering for Women., Maisammaguda., Medchal., TS, India

Abstract
Weed control in agricultural areas will benefit from this effort. To identify weeds in agricultural areas, it employs an algorithm based on image processing. Binary categorization will be the first use of this method. The first thing to do is to dig up the dirt and green plants. It is necessary to eliminate irrelevant data prior to segmentation using medium and morphological filters. Finally, a threshold depending on the detecting area might be used for weed detection. The last step is to use the suggested algorithms to eradicate the identified weeds. When compared to state-of-the-art approaches, these algorithms provide superior outcomes.

Keywords: Weeds, Binary classification, Segmentation, Morphological filters.

I. INTRODUCTION

To be able to swiftly adapt to new conditions; for example, a weed is any plant that requires intervention to avoid negatively impacting human health, the environment, cultural practices, or public spaces. Weeds are another name for invasive species. The last two centuries have seen the introduction of several invasive species to Australia. The vast majority of weeds have an abundance of seeds that they use to disperse. In addition to being the first species to infect and thrive in damaged ecosystems, they are outstanding at adapting to and reproducing in these conditions.
It is possible for a plant to be an emergent crop or an endangered species that successfully establishes itself in a new environment. No ecosystem is safe from weed invasion; this includes coastal areas, deserts, and mountainous regions. The rules have prioritised the control of some weeds because of their importance [1]. Regulating weeds in Australia requires a lot of work because they grow too quickly. The capacity to manage weeds is being threatened by environmental changes.

There are a number of political efforts in Australia aimed at improving the integration of weed management across different levels of government.
As a result of climate change, weeds will have an advantage over plants that aren't as hardy. Complex repercussions on humans, animals, and ecosystems are anticipated as a result of climate change. Some non-native species that were previously able to withstand high temperatures may become endangered due to climate change, which can also make sleeping weeds more aggressively weedy and alter the relationships between various mechanisms, such as land use change and climate extremes.

Weed invasions from nearby areas are predicted to become more common as a result of climate change. Weeds that are already well-established in Australia but have a limited range may see their situation improved as a result of climate change. The ability of weeds to spread and establish themselves quickly gives them a leg up in expanding their range when climatic zones change. In addition to replacing native species that are less able to withstand the effects of climate change, weeds with the genetic potential to do so may alter the very nature and structure of ecosystems, thereby amplifying their influence. Indeed, certain natural plants may become weeds as a result of climate change's favourable effects.

A research conducted by faculty members of the University of Buenos Aires's Faculty of Agronomy (FAUBA) has projected that weed control receives at least approximately 1,300 million dollars annually. The majority of farmers that engage in export agriculture adhere to traditional practices when it comes to land preparation, irrigation, and crop management, all of which contribute to an exceptionally high standard of product quality [2]. Even while the country's output is of good quality, it has not yet reached the level of excellence seen in industrialised nations. Where there is a difference is in the use of modern technology to enhance and optimise soil research and crop management. Thanks to Precision Agriculture (PA), new avenues have opened up for the integration of technology into agricultural practices, which in turn has increased crop yield efficiency. Thanks to this novel idea, industrialised nations have achieved unprecedented levels of agricultural output, thanks to their use of cutting-edge methods for technologically enhancing agricultural business management. This is how farming is evolving; instead of using inputs based on average values as in conventional farming, farmers are aiming for more precision via localised management that tracks changes in output throughout an entire region. The optimisation of input utilisation, assessment of land availability of nutrients, organic matter, water, etc., reduction of production costs, and improvement of crop quality are some of the major advantages that result. Weed management is crucial in agriculture since weeds are a major pain for farmers and may ruin crops. Contamination of produce, refuge for insects and illnesses, growth facilitation of other pests, and increased irrigation expenditures are some of its negative impacts. Therefore, we decided to write this work to offer a new method for weed identification and eradication in agricultural areas. When compared to all of the state-of-the-art procedures, this one yields superior outcomes.

II RELATED WORK

The block diagram of existing method is given below:

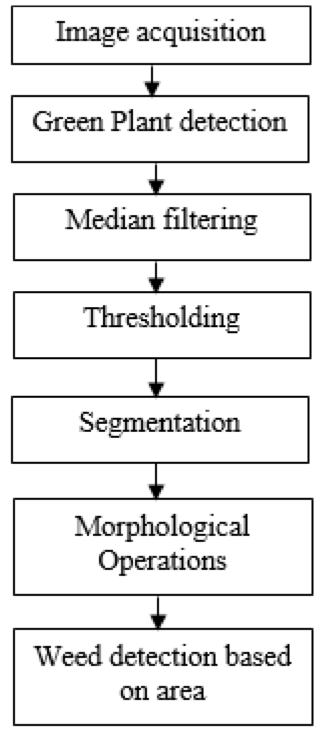


Fig 1: Block diagram of Existing method

A. Acquisition of the Image

One benefit of being able to take one's own pictures and use them to test the algorithm is that the algorithm will learn to fit the pictures' specific features. A 24.2 megapixel semi-professional camera capable of shooting at 1080 pixels resolution—more than adequate to get respectable shots—has been suggested for usage. Weirs and crops on the ground could be clearly seen in the high-resolution photographs taken from a height of 1.20 metres above ground. With a pixel density of 4512 x 3000, each captured picture covers an area 180 × 120 cm above the crop. The camera was angled vertically to eliminate shadows and provide even lighting. All photos with uniform lighting are processed using the suggested method; better-lit images are treated with more accuracy.

B. Detection of green plants

Indexes that highlight the green component of the source picture, such as the Normalised Difference Vegetation Index (NDVI) and the Soil Adjusted Vegetation Index (SAVI), have been used as selection criteria in previous research. The rgb2gray function may be used to convert the original picture to grayscale intensity, which means that the saturation and hue information is removed but the luminance is kept. To isolate the green parts of the image from the rest of the picture, we use the image's RGB components to remove all the XY components that match to the green value from the grayscale version.

C. Median Filter and Threshold Segmentation

Image noise reduction using component removal techniques, such as the median filter, is common practice [3]-[5]. This filter creates a mask over the picture by swapping out the centre pixel of a neighbourhood area, in this example a 3x3 neighbourhood. Instead of using the mask's centre value, the median of the nearby pixels' values is computed. The medfilt2 function allows for the execution of this procedure. Image segmentation follows the use of the medium filter. The Otsu approach, which is well-known and often used for segmentation tasks, is the one that is suggested. To achieve segmentation, the following phrase is used (2)

$$I(x,y) = \{0, \qquad I_{median}(x,y) < t \;\; 1, \;\; I_{median}(x,y) \geq t \qquad .... (2)$$

The selection of an appropriate threshold is carried out with image histogram, taking the valium t calculated by the operation gray thresh the value of t is based on the average intensity value of the light and dark areas of the image [6].

D. Morphological filters

The classification of the labels is based on the area of each object, it is convenient to fill the holes in the objects of the image. Therefore, a filter based on morphological reconstruction should be applied in order to fill the holes and obtain a more effective area.

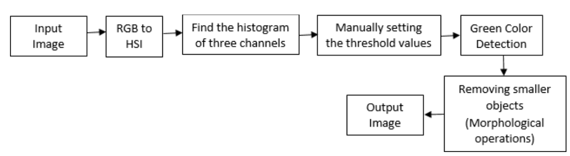
in the image are filled. This operation can be done using the Morphological operator's infill and bwmorph.

E. Labeling and classification labels

Importantly, in order to extract attributes from the labelled regions, it is required to name the items in the picture as plants. The rectangles that surround the areas of all the recognised objects serve as labels. Using a heuristic based on pixel values according to predecessor labels at north and west positions, the area labelling stage assesses each pixel using a 4-neighbor-connectivity. Here, the computational technique known as the blabel comes into play. The next stage, once scene objects have been labelled, is to extract area characteristics from each element in order to distinguish between crop and weed. After the algorithm determines the region by counting the pixels in the object's territory, it stores the value for all objects. Using the region props function, we can extract picture area properties. The first of the algorithm's two discard steps for weed identification involves removing regions that are too little to be deemed significant weeds. Following the first round of discarding, a weed-based threshold is established by subtracting the average values of the biggest regions corresponding to crop plants. As a starting point for weed and crop categorization, we compute the average crop value. All of the items in the picture are compared in size to the threshold value. Weeds are discovered when the analysed object's area is less than the threshold value.

III METHODOLOGY

The proposed method consists of the weed detection and weed removal using a novel architecture which is described below:



The methodology iterates until all holes of the objects

Fig 2: Block diagram of proposed method

A. Image acquisition and preprocessing

Obtaining images Using manual processing, 1300 images were captured at the experimental site on the Northwest A&F University campus between May and July 2013. The photographs were shot in a variety of lighting conditions (sunny, overcast), at different times of day, and in different plots. Same here. The camera was placed on the console. The document
in JPEG format, with dimensions of 4208 x 3120. Colour space selection: The plant's colour is a key differentiator. The photographs presented in this research were taken in different lighting situations and are thus susceptible to a wide range of environmental factors; hence, improved crop classification and assurance are necessary.

A good colour space is required, the identification method must be consistent, and it is critical to pick vector colour characteristics appropriately. Colour space, often called colour pattern, is a way to describe colours by referring to a certain subspace or coordinate system. The three most used colour spaces right now are RGB, HSI, and YCrCb. The three colour channels R, G, and B in an RGB colour space may be transformed and superimposed in a reciprocal fashion to produce an infinite variety of colours. The colour space model, closely linked to the three colour sources that are more light-sensitive, may represent both of the colours that people see.

The picture histogram, like all histograms, repeats. Histograms of images, however, show the frequency of content based on pixel size. In a photo histogram, the x-axis shows the intensities of the grey levels, while the y-axis shows the amplitude of those levels.

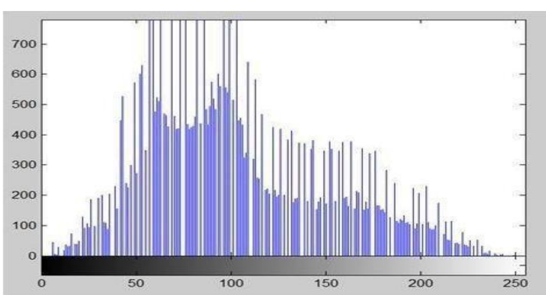


Fig 3: Histogram of an image

The histogram x axis displays the range of pixel values. Since it is an 8 bpp image it has 256 gray levels or shades of gray within it. That's why the x axis range starts with 0 and ends with a gap of 50, at 255. Whereas those intensities are counted on the y axis.

As you can see from the graph, most of the high-frequency bars are in the darker portion of the first half. This is, the picture we have is brighter. And from the illustration this can be proven too.

Knowledge of the objects, application and environment should be used for manually selecting the threshold:

* Properties the strength of the artifacts

* Element proportions

* Fractions of the image the objects occupy

* Number of objects of various types appearing in the image

* Binary images could have a number of problems. Noise and texture, in particular, introduce distortion into the binary zones that are generated by simple thresholding. By considering the picture's form and composition, morphological image processing attempts to lessen these flaws. Greyscale images may also be processed using these techniques.
A set of non-linear operations performed on picture areas according to their shape or morphology is known as morphological image processing. For the processing of binary pictures, methods are often applicable since they only consider the relative ordering of pixel values, not their numerical values. The field of morphological image processing deals with a variety of non-linear problems related to the shape and structure of an image's characteristics.
Processes for thresholding are well-suited to dealing with binary pictures as they rely entirely on the convincing precedence of pixel values rather than counting them. The structuring element contrasts with the surrounding area of each pixel and may be found anywhere in the picture. A few actions check whether the element is contained inside the neighbourhood, while others check its entry or alignment points.

IV RESULTS AND DISCUSSION

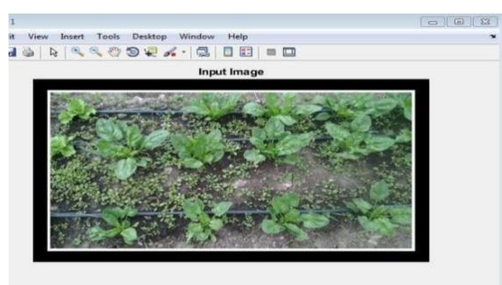


Fig 4: Input image

The image taking in the agricultural field with weeds in it is taken as the Input image.

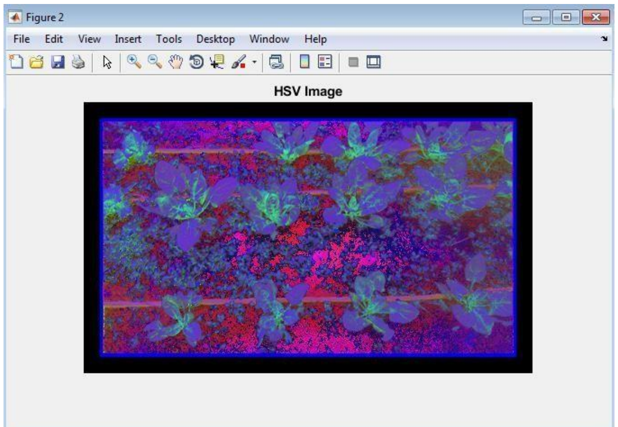


Fig 5: HSV image

Then the image is converted into the HSV color space for better identification of the pixels in the image.

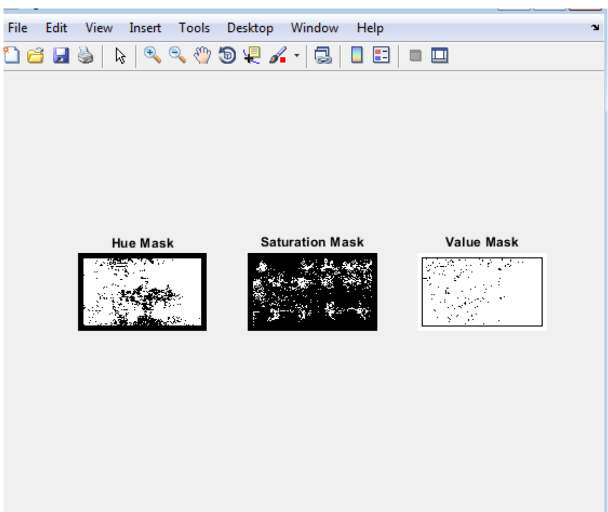


Fig 6: Individual components of the HSV image

Then the individual components of the HSV image like Hue, Saturation and intensity are separated from the image.

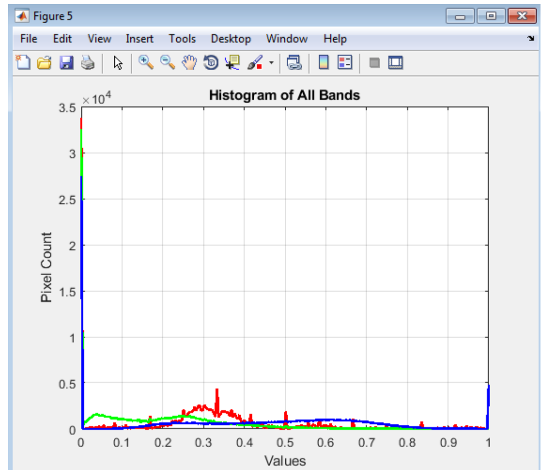


Fig 7: Histogram of all bands

The histograms of the components are calculated and plotted.

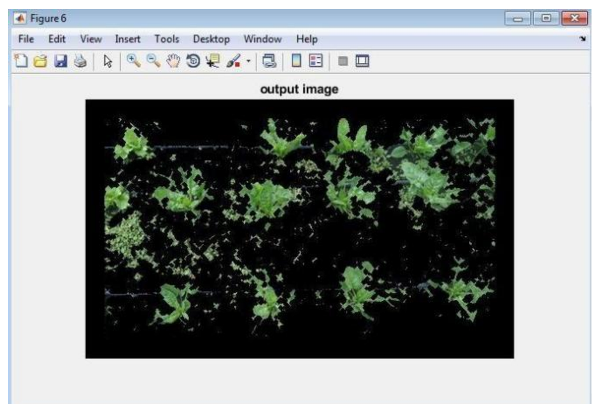


Fig 8: Output image

Then finally by performing the morphological operations the weeds are removed in the input image.

V CONCLUSION

Results are good enough to utilise the algorithm in real applications of precision agriculture. The suggested method, which uses low-level features and an area-based threshold, has an improvement field in the specificity indices and NPV. Then, for better results, the weeds in the picture are recognised and eradicated.

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