

Weed Remover Using Machine Learning

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ABSTRACT

Weed Remover using Machine Learning is an innovative solution using machine learning techniques to address the persistent challenge of weed management in agriculture. The system integrates advanced machine learning algorithms with robotics to accurately find and cut weeds in real-time. A convolutional neural network (CNN) is trained on a diverse dataset comprising images of various crops and weed species, allowing the model to develop a robust understanding of visual cues associated with both. This trained model is deployed on a robotic platform equipped with cameras and actuators for real-time decision-making and precise weed removal.

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1. Introduction

Agricultural development is the main issue in the modern world, given the need to modernize the plantation system and the rising demand for agricultural products. Food is a basic need of human life, and it is produced by the cultivation process in agricultural fields. In agriculture fields, both field crops and unwanted crops are grown, and that unwanted crop is known as weed. Unwanted plants called weeds grow around crops and take up most of the nutrients in the soil, making the crop itself unhealthy. Weed control is important in agriculture. Crops and weeds compete for resources including sunshine, water, nutrients, and space. Larger and more vigorous seedlings are less susceptible than smaller, slower-growing ones. Weed management is an important aspect of increasing vegetable crop production. According to a recent estimate, weeds cost the Indian agricultural sector Rs. 1980 crores annually—more than the whole amount of losses brought on by pests, diseases, and insects combined.

Machine learning is a method of data analysis that automates the structure of explanatory models. Using machine learning algorithms and image processing techniques, the crop, diseased plants, and weeds can all be distinguished. Grounded on the thought that systems can learn from data, identify patterns, and make decisions with the least human intervention. Based on size, shape, and color, features are extracted. The error rate is computed by comparing this pre-processed image with the threshold values of the trained dataset. In order to forecast output values that fall within an acceptable range, machine learning algorithms gather and analyze input data. Over time, these algorithms develop "intelligence" by learning from and optimizing their operations in response to fresh data, which enhances performance. Once the weeds are accurately identified, the cultivator

can be directed to specific areas where weeds are present. The cultivator operates by mechanically uprooting or cutting the weeds, eliminating them from the crop field.

In addition to machine learning techniques, advancements in agricultural robotics have also contributed to weed management. Autonomous robots equipped with cameras and sensors can navigate fields, identify weeds, and precisely apply herbicides or physically remove them. These robots can work tirelessly day and night, covering large areas efficiently and reducing the labor required for manual weeding. Moreover, integrated pest management systems combine various strategies such as crop rotation, biological control, and optimized irrigation to further enhance weed control while minimizing environmental impact. By leveraging technology and adopting sustainable practices, farmers can effectively manage weeds, increase crop yields, and contribute to global food security. Precision agriculture technologies like GPS-guided machinery and drones play a crucial role in weed management. These tools enable farmers to map the distribution of weeds across their fields with high accuracy and target specific areas for treatment. Farmers can maximize resource allocation, decrease chemical usage, and prevent environmental contamination by spraying herbicides only when necessary. Additionally, ongoing research into genetic modification techniques aims to develop crops that are resistant to weed competition, offering a long-term solution to weed control challenges. By integrating these diverse approaches, farmers can mitigate the impact of weeds on crop productivity while promoting sustainable agricultural practices for the future. While machine learning and advancements in robotics offer promising solutions for weed control, there are still challenges to address. One concern is the adaptability of weeds. Weeds can evolve resistance to herbicides, requiring researchers

to develop new control methods. Additionally, the high cost of implementing some technologies, such as robotic weed removal systems, may limit accessibility for small-scale farmers. Effective weed control has a significant socioeconomic impact. By reducing crop losses caused by weeds, farmers can increase their yields and income. This leads to greater food security, particularly in regions facing food scarcity. Additionally, weed control methods that minimize herbicide use can contribute to environmental protection by reducing soil and water contamination. Furthermore, the development of new technologies in weed control can create new job opportunities in areas such as agricultural technology research, production, and implementation. Machine learning, robotics, and other innovative technologies offer powerful tools for farmers to combat weeds effectively. By adopting a combination of these approaches and promoting sustainable practices, we can ensure a future where agriculture thrives and meets the growing demands of a global population.

2. Related Work

2.1 Approaches for Weed Detection

Distinctive approaches to Accurate and Precise weed Detection are described as follows:

The convolutional neural network (CNN) is used for weed detection. A regularized form of a multilayer perceptron, the convolutional neural network (CNN) is a deep-learning neural network. In [11], Milito et al. develop the conversation to achieve a precise and accurate weed detection outcome with the use of a CNN classifier using RGB photos and different types of soil to reduce the impact of generalization. In order to provide correct findings, a massive amount of datasets must be used. However, by employing the process of various records, we may find accuracy with the confined sum of information. Initially, the article computes distinctive vegetation records and representations used for input in CNN. In addition, the research suggests an end-to-end encoder-decoder semantic segmentation network that, in contrast to standard CNN, can anticipate pixels at a fast rate. The suggested model is extensively evaluated in the paper through experiments conducted on a variety of conditions, plant growth phases, and locations. A detailed assessment of the semantic segmentation's performance is shown, and the findings indicate that the classifier converges to a high level of accuracy (95%) in a short amount of time. In [14], Anusha et al. support its assertion of generalization across many variants by using half of the dataset for training and the other half for model testing, which yielded a significantly high accuracy rate of 90%.

2.2 Automatic dataset generation for accurate weed detection

In [15] Maurilio Di Cicco et al. present a strategy to generate a fictitious dataset for very accurate training. There are no entanglements of variability in the environment, plant stages, etc. in the model. Two-thing realism is satisfied in the dataset created through procedural generation. To produce a wacky range of conceivable data, the synthetic agriculture data must

resemble the genuine data and variety, and the dataset should include all distinct appearance variations. The process of creating data is broken down into phases, the first of which models the leaf. A kinetic tree is found using a kinetic model, and this tree can be adjusted to produce leaves with various sizes, forms, and angles. The next phase of the procedure considers the plant's leaf orientation, average number of leaves per plant, etc. The process of creating a genuine agriculture segment by modifying crucial elements like plant spawning, illumination, and soil formation is the last phase.

2.3 Accurate weed detection using the summarized training set

In [13], CiroPotena et al. employs CNN's methodology to classify marijuana in real time. They presented unsupervised data summarization, a data reduction technique that automatically chooses a more informative subset of photos from a larger dataset of N images. This algorithm selects K images similar to $K \ll N$, representing the most instructional images. This summarized dataset is used to train the CNN while achieving comparable accuracy to using the entire dataset, significantly reducing the computational cost associated with training CNNs on massive datasets.

CNN is then fed this condensed dataset in order to obtain accuracy comparable to that of the original dataset. In contrast to document summarizing, which uses a similar bag-of-words to describe sentences, data summary is done in context. With the help of the bag-of-visual words only images with more information are selected and provided as input to CNN, resulting in comparable accuracy when using the original dataset.

2.4 Weed Removal and Movement Mechanism

In [16], Rincy Johnson et al. Imagine a four-wheeled robot traversing a vast field, its onboard processing unit humming with activity. At pre-programmed intervals, the robot comes to a halt. This pause serves a critical purpose: it's decision time. A camera mounted on the robot captures a snapshot of the field in front of it. This image is then fed into the processing unit, which analyzes it with laser focus. The mission? To detect the presence of pesky weeds.

If the image processing identifies unwelcome weeds, the robot springs into action. A high-speed motor whirs to life, activating a rack and pinion mechanism. This ingenious system precisely extends a weed cutter attachment to the exact location of the weed, ensuring targeted removal. Like a silent assassin, another high-speed motor takes over, driving the weed-cutting blade with precision. The targeted weed meets its demise, swiftly cut down and eliminated. Once its mission is complete, the blade retracts, and the robot resumes its journey.

But what happens if the image processing finds no villainous weeds? No sweat! The robot seamlessly continues its forward march, leaving the pristine field undisturbed. This cycle of image capture, processing, weed identification, cutting (if necessary), and movement continues relentlessly until the entire crop row is meticulously groomed, free from any weed intrusion.

3. Proposed Work

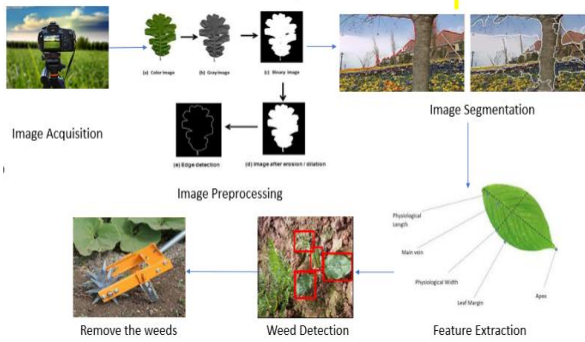


Fig 3.1: Propose System Design

3.1 Collection of weed and crop images

Training a Convolutional Neural Network requires datasets with both crop and weed data. Two categories will be created for the images. CNN is trained using crop photos and weed images, which are kept in different folders.

3.2 Training Convolutional Neural Network

A Convolutional Neural Networks (CNNs) is a type of deep learning algorithm for image recognition and processing. Unlike traditional methods that rely on hand-crafted features, CNNs learn to identify objects autonomously through a layered approach. Each layer progressively detects increasingly complex features within an image.

Imagine a CNN dissecting an image layer by layer. The initial layers might recognize basic shapes and edges, while subsequent layers build upon these foundations to detect more intricate features. This cumulative process ultimately allows the CNN to identify the desired object within the image.

To achieve this, CNNs employ filters that scan the image at various resolutions. The outputs from these filtered scans are then fed into the next layer, akin to an assembly line progressively refining the image data. This technique empowers CNNs to learn distinctive features that define objects within an image.

3.3 Prepare Training and Test Image Sets

To prepare for training a Convolutional Neural Network (CNN), we need to split the images into separate training and validation datasets. For this purpose, we will select 70 percent of images from both the crop and weed image datasets for the training data, while the remaining 30 percent will be used for the validation data. Once this is done, we can proceed to train the CNN using the training and validation sets. Divide the picture sets into datasets for training and validation. Select 70% of the photos for training and the remaining 30% for validation from each crop and weed image dataset collection. These training and validation sets are used to train CNN.

3.4 Image Segmentation

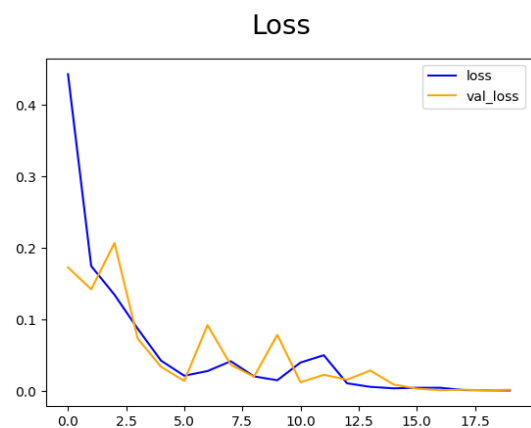
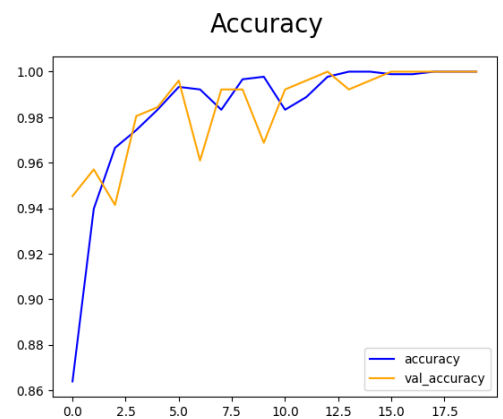
Image segmentation is among the key components of picture processing. Its goal is to create homogeneous zones inside an original image. The Watershed Image

Segmentation Algorithm is one of several techniques for segmenting images. The flooding process can be applied to a greyscale image to perform the watershed method. Important morphological activities are used in this flooding process. Pre-processing and post-processing phases that handle problems like edge ambiguity are part of the entire process. The Watershed Transform can be used on binary, textural, and grayscale images. The Watershed algorithm labels each segment uniquely and stores them in a CSV file. These marked segments are then classified by the CNN network as either crop or weed.

3.5 Deploy Trained CNN network onto Raspberry Pi

The CNN network needs to be installed on a Raspberry Pi after it has been trained. Due to RAM limitations, CNN network training on Raspberry Pi takes a long time. As a result, the CNN network is trained on a laptop before the file containing the neural network's weight is installed on a Raspberry Pi. While training a Convolutional Neural Network (CNN) directly on a Raspberry Pi is tempting due to its project-specific nature, the limitations of the device's RAM quickly become apparent. The training process involves massive datasets and complex calculations, both of which strain the Pi's resources. This bottleneck can significantly extend training times, hindering development efficiency.

4. Results and Discussion





Adopting machine learning (ML) for weed identification and control in agriculture marks a significant step forward in achieving efficient, sustainable, and environmentally friendly farming practices. By using advanced ML algorithms, agricultural systems can now distinguish between crops and weeds with high accuracy, enabling precise targeting and treatment of weeds. This precision not only leads to a substantial reduction in herbicide usage, helping both the environment and reducing farming costs but also contributes to improved crop yields by minimizing competition for resources. Furthermore, the adaptability and scalability of ML models ensure that this technology can be integrated across various farming scales and machinery, making it a versatile tool for modern agriculture. Despite facing challenges such as data diversity and the cost of technology adoption, the future of ML in agriculture looks promising, with potential for further advancements and broader implementation. Machine learning in weed management exemplifies the transformative impact of technology on agriculture, driving the industry towards more sustainable and productive practices.

5. Conclusion

As a result, our suggested solution leverages machine learning techniques to create the convolutional neural network (CNN) architecture. Weed identification is now being used. gathering of a database or data set that serves the purpose of weed identification. Clear findings regarding the grasses in the field are obtained through image collection, database creation, training, and image testing using an open CV. We looked into a lot of different weed detection devices as well. We have used machine learning to detect weeds after conducting extensive research. A large portion of research has focused on a single kind of weed in crops. But we have incorporated a variety of weeds. Our Jupyter Notebook allowed us to accurately identify weeds in the pictures. A four-wheeled robot equipped with weed management is used in a spinach field that is divided into rows. The vehicle is able to move in the actual field. The vehicle's ability to move can be enhanced by adding bigger wheels. Therefore, it will be beneficial for farmers to implement focused measures to manage weed infestations.

6. References

- [1] Abouzahir, S.; Sadik, M.; and Sabir, E., "Enhanced Approach for Weed Species Detection Using Machine Vision." In Proceedings of the 2018 International Conference on Electronics, Control, Optimization, and Computer Science (ICECOCS), Kenitra, Morocco, 5–6 December 2018.
- [2] Faisal Ahmed, A.S.M. Hussain Bari, Emam Hussain, "Performance analysis of Support Vector Machine and

Bayesian Classifier for Crop and Weed classification from digital Images", World Applied Sciences Journal, 2011.

- [3] H. Yalcin and S. Razavi, "Plant Classification using Convolutional Neural Networks", IEEE Fifth International Conference on AgroGeoinformatics, 2016.

- [4] Islam, N.; Rashid, M.M.; Wibowo, S.; Wasimi, S.; Morshed, A.; Xu, C. "Machine learning based approach for Weed Detection in Chilli field using RGB images". In Proceedings of the 16th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD), Xi'an, China, 19– 21 December 2020.

- [5] Jialin Yu, Arnold W. Schumann, Zhe Cao, Shaun M. Sharpe and Nathan S, "Weed Detection in Perennial Ryegrass with Deep learning convolutional neural network", Frontiers in plant science, volume 10, October 2019.

- [6] Monika Jhuria, "Image Processing for Smart Farming: Detection of Disease and Fruit Grading", IEEE Second International Conference on Image Information Processing (ICIIP), 2013.

- [7] R. Anirudh Reddy, G. Laasya, "Design of a weed detection system for cotton field" Mat Journal of Image Processing and Artificial Intelligence, Volume 3 Issue 3 in 2017.

- [8] R. Aravind, M. Daman, B. S. Kariyappa, "Design and development of automatic weed detection and smart herbicide sprayer robot, Intelligent Computational Systems" (RAICS), December 2015.

- [9] S. Rege, R. Memane, M. Pathak, P. Agrawal, "2D GEOMETRIC SHAPE AND COLOR RECOGNITION USING DIGITAL IMAGE PROCESSING," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 2, Jun 2013

- [10] Xiaojun Jin, Jun Che, and Yong Chen, "Weed Identification Using Deep Learning and Image Processing in Vegetable Plantation", IEEE, volume 9, 2021.

- [11] Andres Milioto, Philipp Lottes and Cyrill Stachniss "Real-time Semantic Segmentation of Crop and Weed for Precision Agriculture Robots Leveraging Background Knowledge in CNNs" in Proc. of the IEEE International Conference on Robotics and Automation 2018 (ICRA).

- [12] Philipp Lottes, Jens Behley, Andres Milioto, and Cyrill Stachniss "Fully Convolutional Networks with Sequential Information for Robust Crop and Weed Detection in Precision Farming" in Proc. of the IEEE Robotics and Automation Letters 2018.

- [13] Ciro Potena, Daniele Nardi and Alberto Pretto "Fast and Accurate Crop and Weed Identification with Summarized Train Sets for Precision Agriculture" International Conference on Intelligent Autonomous Systems IAS 2017

[14] Anusha AC, Diya N, Abdullah A Basit, Mekhala K and Prof. Bhavyashree HD “Automation Weed Removal Robot Using IOT” International Research Journal of Modernization in Engineering Technology and Science

[15] Maurilio Di Cicco, Ciro Potena, Giorgio Grisetti, and Alberto Pretto "Automatic Model-Based Dataset Generation for Fast and Accurate Crop and Weeds Detection" 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).

[16] Rincy Johnson, Thomas Mohan, Sara Paul “Weed Detection and Removal based on Image Processing” International Journal of Recent Technology and Engineering (IJRTE).