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Review on Disease Detection in Strawberry Vertical Farming using Machine Learning

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A B S T R A C T

India is a land of agriculture, which is why it is also one of the leading exporting countries regarding crops, fruits, etc. Farming on plain land is the traditional way to cultivate fruits and other food items, but in recent decades R&D in the field of agriculture has led to unique and improved methods for producing them. One of them is Vertical Farming which if used, can generate much more yield in the same area of land compared to traditional way. Advanced technology can facilitate further development of indoor farming, which has already undergone significant progress in recent times. Vertical Farming paired with the Internet of Things (IOT) using numerous sensors and embedded systems leads to improved quality of fruits grown and less human/labor interaction. Vertical Farming is cost-effective as the structure is built on can be set using recyclable material resulting in low cost yet a robust infrastructure. With the constantly developing environment in the field of agriculture, now AI-Artificial Intelligence can be paired with it to improve the production of fruits and vegetables. Having someone look over hundreds of plants and monitoring each of them is a difficult task overall. This issue can be solved by combining robotics and machine learning to track accordingly. Image processing is a very compelling tool that can be used to detect diseases and track growth of these plants.

Keywords: *Vertical Farming, Image Recognition, OpenCV, YOLOv4, Strawberry Farming, Machine Learning*

INTRODUCTION

Introduction to Vertical Farming and Image Processing using AI ML Algorithms Vertical Farming. The global population is anticipated to grow up to 9 billion by 2050, this growth in population is expected to cause immense pressure on the available natural resources [6] and demand more food which makes it imperative to intensify agricultural production [7]. Moreover, the growing purchasing power of people and changing consumer preference for example demand for organic or pollution free food is also growing due to health consciousness. Apart from this, the pollution and environmental degradation caused by traditional farming practices are leading researchers and practitioners to come up with alternate farming practices that are much more environment friendly such as greenhouse/shade net farming, terrace farming, urban farming and vertical farming. Among these, vertical farming is one such alternative, which holds the promise of addressing the issues of environmental degradation [8] and the growing demand for food as it can lead to more food production with fewer resources.

PROBLEM REPRESENTATION

As we know, for producing any fruit or vegetable, there is a constant need for proper land conditions and necessary resources to produce the same. But the amount of land required to grow these plants is a major issue, and the growing population requires us to produce more and more food. Also, insects and diseases in plants severely affect its rate of production and human intervention is difficult to monitor throughout the area.

LITERATURE SURVEY

[1] M. S. Tasrif Anubhove, N. Ashrafi, A. M. Saleque, M. Akter and S. U. Saif

In this paper M, N, A, M, S Saif have presented a recently popular deep learning-based approaches for weed classification. The network was tested on a total of 10,413 images containing 22 weed and crop species at an early growth stage. The model was able to achieve a classification accuracy of 86.2% for the 22 species. The system is built in a simple way using readily available hardware with software built from MATLAB 2016 a and the implementation of pre-selected images and testing. Most of the plants and crops will grow in the vertical farm it will be a challenging task for the farmers to observe the plants of the parallel plates in vertical farm within a small area. If the system is trained for human visible diseases like skin diseases or human internal body elements conditions like lungs visible conditions, it can detect it. Natural resources such as fossil fuel, oil, natural gas and Water are depleting in nature and will exhaust in the near future. The concept of vertical farming is much more attractive as water use is 95% less. Method The deep machine learning process has been greatly simplified using the Viola-Jones LED array algorithm. This is because many images were processed in a matter of days on the old equipment. The deep machine learning process has been greatly simplified using the Viola-Jones algorithm. Many images were processed in days on existing equipment. Detect not only spots, but also various diseases, crop quality, rot, presence of insects in crops, etc. This system can be used to detect people and other objects.

[2] Wang, W. Zhang, and X. Wei

In this paper Wang, W, X. Wei have proposed a system primarily based on IOT, the Vertical Farming Tracking Gadget aims to help detect weeds on farm fields. Vertical Farming is eco-friendly, using recycled fabrics to build mold and no pesticides. A curve fitting system was constructed and run to estimate the histogram envelope and compute the curvature cost of the fitted quadratic polynomial. As compared with some other method that used features received through GW only, the proposed method yielded better class accuracy of 94% SVM and ANN fashions become constructed using shape capabilities, and outcomes showed that SVM yielded an overall accuracy of 95.00%, slightly higher than that via ANN of 92% The model became capable of attaining a category accuracy of 86.2% for the 22 species traditional CNN uses random values to initialize the network parameters.

[3] R. Abukhader and S. Kakoore

R, S. Kakoore in this study started by stating the problem that is faced by majority of the world on everyday basis, the issue of hunger. They also mention the rapid change in climate that affect the resources that are used for food cultivation. Author’s objective was to apply a population-based search algorithm, specifically mentioned Evolutionary Algorithm so that the farmer can plan their activities based on output by the algorithm. Since farmer may have experience but a algorithm can find pattern that may not be distinct subject for an expert as in this case is farmer. The authors then move forward with explaining suitable way to implement the EA technique. Authors have mentioned a background as to what are the conditions that are needed to be taken into account. The foremost subject of this thesis is Indoor Vertical Farming, followed by stating unsupervised learning and lastly explain Evolutionary algorithms. The paper after also explains Genetic Algorithm which is a successor to EA. Method is then explained how scheduling and planning the process tasks.

[4] K. Sahoo

In this paper K. Sahoo have constructed IoT-based vertical farming monitoring system can be implemented in indoor environments, helping to reduce user burden and provide accurate statistics and analytics. The basic idea of vertical farming is to use controlled environmental agriculture (CEA) technology, which can control all environmental factors. Therefore, this project implements an automation system consisting of the Internet of Things [IoT] to provide a controlled environment for vertical farming. The main purpose of this project is to build a system to monitor and control soil moisture via web browsers on laptops, mobile phones, and other portable and small devices. This project uses a soil moisture sensor to detect moisture or water content in soil in vertical farms so that plants can be continuously monitored and controlled to ensure adequate moisture. When a low humidity level is detected, a signal is sent to the Arduino platform. The data is then finally stored in his Arduino IDE software and simultaneously sent to his web browser via Ethernet connected to an internet router. Users can monitor their plants through their web browser. This allows you to read the soil moisture status and control the water valve to water your plants when levels are low or needed. This development has made vertical farming monitoring extremely useful and allows operators to track crop growth at any time without being in the field.

[5] D. M. Woebbecke, G. E. Meyer, K. Von Bargen, and D. A. Mortensen

In this research D, G, K, D. Mortensen have implemented shape traits for identification of young weeds by image analysis 2009 Monocots have a short period of no change in shape traits and a favorable time for post-emergence weed control and soybeans are derived from color images of 10 common weeds. The properties investigated were roundness, aspect, girth/thickness, elongation, and seven invariant central moments (ICMs) for each plant type and age up to 45 days after germination. Shape features were generally independent of plant size, image rotation, and plant position in most images. The ability to distinguish between monocotyledonous and dicotyledonous plants was most pronounced between his 14th and 23rd days when these traits were used. The shape features that best differentiated these plants were aspect and first invariant central moment (ICMj), which differentiated 60–90% of dicots from monocots. Using analysis of variance and Tukey’s multiple comparison test, shape traits did not change significantly for most species during the study period. This information can be very useful for future designs of advanced spot spray applications. Keywords weed image analysis sprayer scholarship Overview Researchers used smartphone data to examine the relationship between pain and weather conditions and found a small but important relationship.

COMPARISON:

In this section we briefly discuss existing literature review on smart helmet and also discuss various methods applied along with the limitations and accuracy.

Reference Name	Technology Used	Description

[1] M. S. Tasrif Anubhove, N. Ashrafi, A. M. Saleque, M. Akter and S. U. Saif	Viola-Jones algorithm	The image recognition system required the ROI (region of interest) to be selected to identify the disease so all images of tomatoes infected with spots can be detected. Training Image Labeler app is used to select ROI and exporting the ROI's a training dot mat file is generated. The file is used to compare the positive and negative images and a training code is used to train this ROI's containing file.
[2] Wang, W. Zhang, and X. Wei	Image Processing using RGB and infrared (IR) imaging sensors	For weed detection in the field, both RGB and infrared (IR) imaging sensors have been utilized to capture field images. Then the captured images are fed as input to the processing algorithms. Typical image processing procedures include pre-processing, segmentation, feature extraction and classification
[3] R. Abukhader and S. Kakoore	Genetic Algorithm	The algorithm has been implemented on a 2.90 GHz Core i7 processor and tested on a small number of problem instances due to the limited number of tasks given in the problem. The best results are selected after multiple runs from different initial populations, parents, and generations.
[4] K. Sahoo	Vertical farming monitoring system	The IoT based Vertical Farming Monitoring System could help to reduce the burden of users, and provide accurate statistics and analysis. The system is able to offer immediate access for the users because it is an online system.
[5] D. M. Woebbecke, G. E. Meyer, K. Von Bargen, and D. A. Mortensen	35 mm slide film method	Shape feature analyses were performed on binary images originally obtained from color images of 10 common weeds, along with corn and soybeans, found in the Midwest, Features studied were roundness, aspect, perimeter/thickness, elongatedness, and seven invariant central moments (ICM), for each plant type and age up to 45 days after emergence

METHODS

Existing System

Vertical Farming

Vertical Farming is a brand-new farming method by means of forming flora together vertically in skyscrapers or using three-dimensional space. This consists of malnutrition, malnutrition, etc., which can occur with malnutrition. it will help solve many problems in the destiny, inclusive of in this type of farming, there may be extra room to get extra production as it allows more food to be grown in a smaller place than farming and other options which includes permaculture, biodynamic farming and agroecological farming, for this reason lowering agricultural land use. It also reuses and recycles different natural assets which include water and meals, and produces less waste as vegetation develop inside the surroundings of the land. Therefore, vertical farming can reduce its carbon footprint and decrease environmental pollution.

Types of Vertical Farming

- Hydroponic
- Aeroponic

- Aquaponic

Proposed System

Vertical Farming equipped with Machine Learning

Vertical Farming in itself is a development over conventional way of cultivating plants and end result. Vertical farming entails growing crops in vertically stacked layers or cabinets, often in controlled surroundings which include a constructing or greenhouse. This modern method of farming offers some of blessings over traditional agriculture, consisting of extra performance, decreased use of sources, and the ability to grow crops 12 months-round in any area. system getting to know, however, is a shape of synthetic intelligence that permits computer systems to study and enhance from revel in without being explicitly programmed. by using analyzing substantial amounts of information, machine mastering algorithms can perceive styles and make predictions with an excessive diploma of accuracy.

When applied to vertical farming, system getting to know can help optimize crop manufacturing by analyzing information on factors such as temperature, humidity, lighting, and nutrient tiers. by using tracking these variables and adjusting them in real time, gadget mastering algorithms can create best developing conditions for every crop, resulting in better yields and better-nice produce. moreover, machine getting to know can also allow vertical farming systems to analyze from beyond errors and improve over the years. by way of analyzing facts on crop overall performance and environmental conditions, machine gaining knowledge of algorithms can discover regions for development and optimize the growing method to achieve better results. In summary, combining vertical farming with gadget studying gives an effective device for enhancing crop yields, decreasing waste, and promoting sustainable agriculture.

With the aid of education computers for specific obligations, system mastering is improving their capability to carry out movements independently. For machines to replicate human-like thinking, they ought to first analyze like humans, relying on past studies or facts. this newsletter shows that the choice-making procedure of people is primarily based at the facts of the beyond to make informed selections. The application of ML algorithms in hydroponics has diverse use cases, consisting of the regulation of plant growth, electrical conductivity (EC) values, and the ingredients of nutrient solutions.

Fig. 1: Structure of a vertical farm

There are numerous routes that we can take in order to achieve the goal. But in order to find the most optimal path we formulated different machine learning techniques that took us to the end model that we finalized. Starting with SVM also known as Support Vector Machine.

SVM

The agricultural data classification is a hot topic in the field of precision agriculture. Support vector machine (SVM) is a kind of structural risk minimization-based learning algorithms. As a popular machine learning algorithm, SVM has been widely used in many fields such as information retrieval and text classification in the last decade. In this paper, SVM is introduced to classify the agricultural data. An experimental evaluation of different methods is carried out on the public agricultural dataset. Experimental results show that the SVM algorithm outperforms two popular algorithms, i.e., naive bayes and artificial neural network in terms of the F 1 measure.

CNN

Most of the traditional machine learning algorithms were based on laboratory conditions, and the robustness of the algorithms is insufficient to meet the needs of practical agricultural applications. Nowadays, deep learning (DL) methods, especially those based on convolutional neural networks (CNNs), are gaining widespread application in the agricultural field for detection and classification tasks, such as weed detection, crop pest classification, and plant disease identification. DL is a research direction of machine learning. It has solved or partially solved the problems of low performance lack of actual images and segmented operation of traditional machine learning methods. The important advantage of DL models are that they can extract features without applying segmented operation while obtaining satisfactory performance. Features of an object are automatically extracted from the original data. Kunihiko Fukushima introduced the Neocognitron in 1980, which inspired CNNs. The emergence of CNNs has made the technology of plant disease classification increasingly efficient and automatic.

The main works of this study are given as follows:

(1) we reviewed the latest CNN networks pertinent to plant leaf disease classification;

(2) we summarized DL principles involved in plant disease classification;

(3) we summarized the main problems and corresponding solutions of CNN used for plant disease classification

(4) we discussed the direction of future developments in plant disease classification.

ResNet

ResNet performs better than different models in detecting sicknesses in strawberry culmination. ResNet's deep structure lets in it to capture exceptional-grained features, making it more powerful in distinguishing among healthy and diseased culmination. furthermore, transfer learning, which entails the use of pre-educated models and adapting them to new datasets, has been shown to further decorate ResNet's overall performance in strawberry fruit ailment detection. by first-class-tuning the pre-educated ResNet model with strawberry fruit disease images, it could attain better accuracy in ailment analysis, that's vital for effective disorder control in agriculture. The architecture of ResNet includes the use of residual blocks, which permit the community to examine from residual or errors features.

The residual block can be mathematically expressed as follows:

$$y = F(x, \{W_i\}) + x \quad (1)$$

Where x is the input to the block, F is the residual function, {W_i} are the learnable weights of the block, and y is the output of the block.

System Architecture

Camera: The camera used for capturing images in real time is a Sony sensor; Sony IMX477 CMOS sensor which will be mounted

Input Image: In this stage the images from the camera will be stored and the process for Data collection will start from here. These images are raw and need to be cleaned before they can be used as sample input for the system.

Feature Extraction: This is a important stage as the raw images are then converted into useful noiseless images with all the features of image such as resolution, color, type of Disease.

Dataset: The dataset is a pre-recorded set of images which will be used to compare with the input images trained in the ML Model.

Training and compiling model: In this stage the model is defined or a pre-defined model is chosen and is then trained for a number of epochs until satisfactory results are reached.

Knowledge Graph: The graph will contain information regarding the diseases that are seen on an average in the particular test carried out.

Output: The output that is; whatever Disease that is detected will be shown as a output for the image

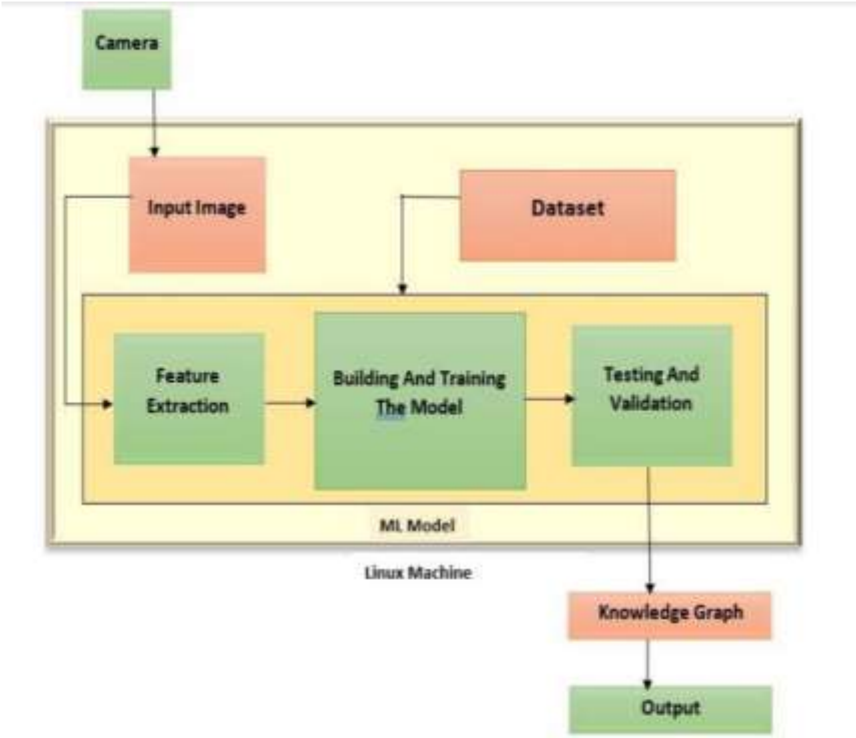

Fig. 2: System Architecture

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