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# Image Processing based Robotic Car for Agricultural Ploughing using Machine Learning Approach

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**Abstract**: For a significant amount of time, agriculture was conducted in a traditional way; only more recently have mechanical technology been utilized to aid. The adoption of intelligent farming practices made possible by the development of robotic technology and sensors is the area on which the experts are concentrating their efforts. With a focus on a heterogeneous robotic system, we provide improved algorithms in this study for both the categorization of fields and the detection of viruses in leaf samples. The basic machine learning approach known as k-means clustering was used to identify the field and image processing techniques were used to the plant leaves. This was done in order to determine the proportion of affected crops. In order to provide a variety of crops utilizing the mixed cropping approach, which has an advantage over other farming techniques, the agricultural sector has been classified. Because of this, agriculture has been categorized. Early diagnosis of a disease may aid in the creation of more effective preventative measures while it is still in its early stages. We have skillfully combined 3,150 photos of crop illnesses for three different types of crops using a variety of tried-and-true techniques. This study's main goals are to do a qualitative examination of infection detection algorithms and to offer additional details about the proposed work's possible uses in intelligent farming.

***Keywords****: Machine Learning, Image Processing, Medical Robotics, Disease Detection, Mixed Cropping, Computer Vision.*

## 1. Introduction

Seventy percent of people in India rely on agriculture as their primary source of income, and the agricultural sector contributes 17.32 percent to the country's gross domestic product 1. Because of this, a significant amount of effort is now being invested into the development of technology solutions that will both boost agricultural production and ensure the industry's continued existence. The loss of agricultural productivity caused by bacterial infections, fungal infections, and other types of pest infestations is a severe problem that affects farmers all over the globe. It is crucial to notice the early disease indicators that are generated by one of these attacks in order to treat the plant in a timely manner following one of these assaults. Alterations in the physiological status of plant components such as leaves, stems, and flowers might be used to assist in the diagnosis of these symptoms. The detection of an infection might be the first stage of the investigation into these components; the outcomes of this research could then be used in the following stage, which is the diagnosis of a specific ailment. Farmers often do this task manually, which not only consumes a significant amount of their time but also makes it more susceptible to mistakes brought on by human error. The usage of autonomous cars on farms is expected to increase throughout the twenty-first century as a means of assisting farmers in more efficiently cultivating their land. Real-time robotic systems like UAVs, which are utilized by a number of independent research projects for the detection and categorization of illnesses, are not compatible with neural networks since neural networks need a significant amount of processing time and cannot be used with real-time robotic systems. The incidence rate of an illness is often used as a foundation for researchers' risk assessments. Many of the ways of cropping that are now used have the potential to be enhanced as a consequence of recent breakthroughs, which will lead to even better results. This will allow for even greater success. Mixed cropping is one such strategy, and it is rather widespread in many parts of India, especially those parts that have water problems and poor soil fertility. The strategy of farming a variety of crops on the same piece of land is one example of this strategy. emphasized the possible implications that cultivating a variety of plant species may have on organic matter.

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According to what was said in the earlier section, the likelihood of successfully cultivating a mix of grain and legume crops is higher. This is because legumes are capable of autonomously fixing nitrogen on their own. In addition, for a plant to reach its full potential in terms of production, the soil in which it is grown has to possess a certain set of qualities in order to be considered optimal. As a consequence of this, farms may be subdivided into sections, some of which, based on the most up-to-date soil data, would be more suited to cultivate a certain crop than the others [1].

A technique for identifying infection is proposed in this work in the form of an area ratio. This approach relies on the automated segmentation of the healthy zone and the leaf region. The approach was developed by analyzing the results of many algorithms and taking into consideration a number of factors, including the fact that the lighting conditions and other circumstances might change. A clustering method should also be used to split the farm into zones according to the production potential of various types of crops. After then, the method of clustering would be used to these different areas. This has been done in an attempt to take advantage of the advantages that may be gained from mixed cropping and to assist farmers in cultivating fields in a way that is both more productive and efficient. After considering the benefits of integrating unmanned robotics systems, it has been proposed that the investigation be broadened to include not only an unmanned aerial vehicle (UAV), but also an unmanned ground vehicle (UGV). Both of these types of vehicles do not need a human operator. This concept was developed after taking into account the many advantages that may be gained by making use of autonomous robotics systems [2].

Monitoring and data gathered from the field are necessities if an autonomous vehicle is to successfully accomplish its task in the agriculture industry and make decisions about what to do next. When preparing to go through an agricultural environment, a map of the smallest practicable zone that is located in the immediate neighbourhood is drawn out. It is imperative that the impediment be removed in order for you to investigate any allegations of disease or the development of weeds. All of the management duties, including harvesting, sowing, and spraying for pests, are carried out in line with the management plan that is currently being implemented in the field. In order for you to exert control over the self-operating machine when it is operating in an unstructured environment, you will need to construct a framework that is not only malleable but also has the capacity to do several tasks all at the same time [3].

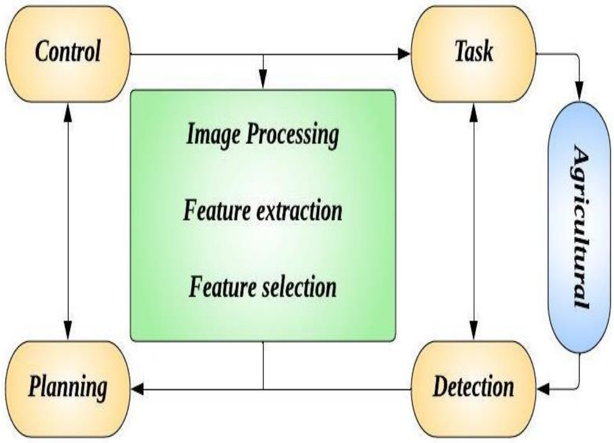


**Fig.1.** A system's framework for automation

More information on the processing flow may be found in Figure 1. Deep learning strategies might be used in agricultural robots for the purpose of performing perception-related field activities if sensor data, image processing data, and machine vision data were all combined. This would be possible if all three types of data were incorporated. Over the course of a lifetime, there is a possibility that the agricultural environment may shift. Big data is being used in the agriculture industry to analyse data gathered from unmanned aerial vehicle (UAV) and unmanned ground vehicle (UGV) flights, in addition to remote sensing images. This is being done for the benefit of artificial intelligence robots [4].

## 2. Literature Review

Agriculture automation is the key challenge facing every country and a rising subject in the field. Since the population of the globe is expanding at such a breakneck rate, there is a far greater need for food than there used to be. Because the conventional methods farmers use are not adequate to fulfil the rising demand, they are being forced to increase their use of poisonous pesticides. This is detrimental to the soil. Because of this, agricultural practises are significantly altered, and as a direct consequence, the area continues to be unproductive and uninhabited [5]. The Internet of Things (IoT), wireless communications, machine learning, artificial intelligence, and deep learning are just few of the various automation approaches that are included in this research. The agricultural industry is now facing a number of challenges, some of which include crop diseases, insufficient irrigation and water management, inadequate pesticide control, inadequate weed management, and improper storage management. All of these problems may be overcome by using one of the several strategies described in the previous paragraph. Deciphering problems such as the use of harmful pesticides, controlled irrigation, pollution management, and the environmental implications of agricultural practises are vitally required in today's society. It has been shown that automating agricultural processes results in an improvement in both the productivity of the soil and the fertility of the soil. This report offers a concise summary of the research that was conducted by a number of researchers in order to get an understanding of how automation is now being used in the agricultural industry. The study also discusses a system that may be used in a botanical farm to recognise flowers and leaves and hydrate them using IOT [6]. The system is advised to be employed in the context of the report.

Harvesting, weeding, diagnosing diseases, trimming, and fertilising are all examples of tasks that may be required on a farm. An agricultural robot that practises intelligent precision farming autonomously must cope with the planning and charting of routes across an environment that is unstructured and unpredictable. The deployment of unmanned ground and aerial vehicles, coupled with machine vision-based Aerobots and artificial intelligence, enables the reduction of personnel expenses while simultaneously increasing the amount of high-quality food that can be produced [7]. In the perception-related activity, a machine learning approach is used to analyse the agricultural tasks for the autonomous machine and determine the characteristic. This activity is connected to perception. The training data sets provide the robots the ability to learn and make judgements regarding agricultural practises on their own. With the advent of autonomous system design, we now have the potential to develop a wide range of flexible agronomic tools that are based on multi-robot, intelligent machine, and human-robot systems. These tools are able to reduce waste, promote economic viability, reduce environmental impact, and increase food sustainability. In terms of agricultural husbandry, the multitasking Aerobots surpass human farmers regardless of the conditions of the surrounding environment. [8] The purpose of this study is to investigate the control and action process of Aerobots that are effective in a range of situations, along with mapping and detection applying machine vision and machine learning approaches. All of these aspects are being investigated simultaneously.

Agriculture has been practised in the traditional manner for a good number of years, and only in more recent times have mechanical technologies been used to provide assistance. The specialists are focussing their efforts on the implementation of intelligent agricultural practises made possible by the advancement of robotic technology and sensors. Enhanced algorithms for field classification and virus detection in leaves are provided by us in this work [9], which focuses on the use of a varied range of robotic systems. Image processing methods were used to the leaves of the plants, and the fundamental machine learning algorithm known as k-means clustering was utilised to classify the field. This was done so that the percentage of crops that are infected could be calculated. Classification of the agricultural industry has been done in order to develop a range of crops using a mixed cropping technique, which has an advantage over other farming methods. This has led to the field of agriculture being classified. When a disease is still in its early stages, early detection may help in the development of more effective preventive measures. We have deftly blended a number of tried-and-true approaches together with 3,150 images depicting crop illnesses for a total of three different categories of crops. The primary objective of this study is to conduct an in-depth analysis of infection detection algorithms and to provide more information on the possible applications of the work that is being suggested in the field of intelligent agriculture [10].

## 3. Artificial Neural Network in Agriculture

A variety of artificial neural network systems have been used within the agriculture sector as a result of the many advantages offered by these systems in comparison to more traditional approaches. The ability of neural networks to do concurrent reasoning-based forecasting and prediction is the primary benefit of using these kinds of systems [11]. It could be possible to teach neural networks how to function, rather of having to painstakingly create them. used ML in order to differentiate between wild plants and domesticated species. Neural networks were used so that predictions could be made about the elements that influence water resources. analysed the crop with the assistance of expert systems and artificial neural networks in order to determine the crop's level of nutritional value. The implementation of traditional expert systems, which are more often known by their previous name, expert systems, is fraught with a number of difficulties. The implementation of ML is the solution to every problem with ES [12].

The results of a strategy that advocates utilising machine learning algorithms for crop prediction on mobile devices found that they were generally positive. the process of developing a model for use in prediction. As was mentioned before, the model that was used to make projections for this system included all three of these levels in its structure. The efficacy of the model is affected, to some degree, by the number of hidden layers it contains. In the beginning, the Delta-bar-delta, Prop, and other algorithms were used in order to develop and train the ML model in order to establish which configuration offered the greatest number of benefits. This was done in an effort to determine the most optimal configuration [13]. Finding out how many levels were concealed required some trial and error on the part of the player. Because the number of hidden layers has an impact on the accuracy of the prediction system, there has to be a method that can precisely evaluate the choices made about which hidden layers to use. The research found that in order for the ML model to generate correct predictions, it required to contain a particular number of hidden layers. Because it was designed to provide assistance to farmers in their day-to-day activities, the system was developed using the APK platform [14]. MATLAB and the ANN toolbox were used in the process of developing the methodology. The backend of the system was built using Java functions, while the source code was written in Eclipse. Both of these tools were utilised to write the code. After then, the whole contents of the file were extracted into the Android operating system, which made it possible for other devices to make use of it. In the event that the farmer decides to plant another crop, the method also provides the advantage of making recommendations on the kind of fertiliser that should be used for that crop as well as the type of crop that the farmer should grow instead [15] (Figure 2).

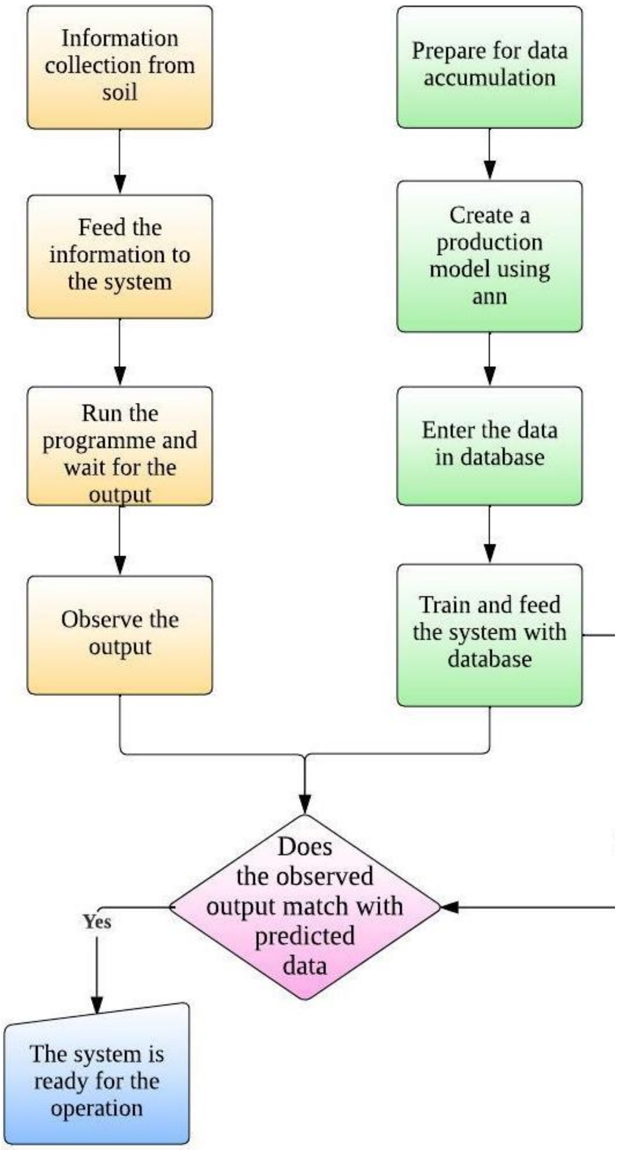


**Fig. 2.** ML-based crop predictor flowchart leveraging mobile devices

Evaporation and transpiration are both necessary activities that have to take place in order to keep the hydrologic cycle whole, to have an irrigation system that is both functional and sustainable, and to have effective water management. Some of the elements that are taken into consideration are elevation, daily mean temperature, daily maximum temperature, daily minimum temperature, daily mean wind speed, daily relative humidity, daily sunshine hours, daily daylight hours, latitude, and condition coefficient. There are around twenty distinct ways that have been tried and tested for determining ET, and each one is based on a different group of considerations. In the Dehradun valley, a comprehensive examination of the potential benefits of incorporating ML into a variety of different ET calculation approaches was carried out. Researchers were able to calculate ET by obtaining monthly climate data from the Forest Research Institute (FRI), which is located in Dehradun. In order to put the algorithms into effect, the procedures that are detailed below were carried out:

- Penman Monteith method
- Levenberg-Marquardt back propagation.

It was shown that an unstable estimation of the ET occurred as the number of hidden layers in the system grew. Therefore, the training function that makes use of the best strategy based on trial and error has to be applied in order to arrive at an estimate of ET that is as precise as is practically possible. It was discovered that out of the six different approaches to training a machine learning model, the one that utilised 75% of the data input, had the most neurons, and produced the best accurate results was function training. In addition, a comparison between the PM strategy and the ML model was carried out with the use of the single layer feed forward back propagation method. MATLAB was used as a tool to assist in the process of designing and building the ML model. The effectiveness of six different algorithms was examined and compared. This research provided evidence that the ML structure is capable of prediction under the appropriate circumstances and while taking into consideration the significant part that evapotranspiration plays in the irrigation process and the administration of water resources. In addition, the use of neural networks in conjunction with image processing led to the development of a method that is capable of differentiating between crops and weeds. In spite of the fact that the algorithm did not have any previous knowledge on the plant, it was nevertheless able to achieve an accuracy of more than 75%. constructed an expert-supported intelligent agricultural system to facilitate the construction of an intelligent agricultural system. In this particular system, the Internet of Things was utilised to transport data to a centralised server so that field actuators could make intelligent decisions. In order to accomplish this goal, the server needs the independence to choose its own path forward and make decisions independently. This system is comprised of a variety of sensors and also detects temperature, humidity, and the degree to which leaves are moist. It will just serve to offer information about the property; the operation of the irrigation system will not be altered in any way by this.

## 4. Research Methodolgy

**Comparison of algorithms:** It has been recommended that K-means clustering should be used in order to complete the segmentation of a sick soy bean leaf. The primary objective of both of these different incarnations of this project is the same. The work that was recommended did not take into consideration the necessary step of separating the leaf from the backdrop image, which is an essential component of the objective of the automated system. In addition to this, it was discovered that the method had not been tested in any experimental conditions that correctly simulated the conditions that exist in the actual world. Because it depends on the arbitrary selection of seed points to construct its groups, the K-means clustering approach yields relatively unequal results when it comes to grouping data. The problem of completely automating the segmentation of leaf segments that are infected and those that are healthy has been a key emphasis of our work. This refers to the accurate grading of leaf diseases in terms of infection percentage, and it has been a big concern of ours to fully automate this process. It was necessary to do an in-depth analysis of a wide variety of cutting-edge segmentation algorithms in order to accomplish the goal of selecting the most efficient technique for segmentation. It was found that the quality of "percentage infection" was the most effective in properly classifying leaves into the categories of "infected" or "healthy" in order to conduct a more in-depth investigation into the data.

**Implementation of the algorithms and disease detection:** Corn, tomatoes, and bell peppers are the three different kinds of crops that will be evaluated in this study. In order to carry out the experiment, four distinct sets of photographs were used. Regarding the maize crop, one healthy image and three diseased photos were employed; regarding the bell pepper crop, one healthy image and three diseased images were utilised; and regarding the tomato crop, one healthy image and three diseased images were utilised. The findings of the recommended approach were calculated using three different kinds of leaves: tomato leaves injured by early blight disease, bell pepper leaves affected by bacterial spot, and maize leaves affected by cercosporin. Each of these three types of leaves was afflicted by a different pathogen. The percentages of infection that were found to be present in each of these three types of leaf were, respectively, 20.83%, 15.85%, and 45.562%. In addition to the standard deviation of each set, an average infection % is calculated for each photo set and crop. The results of the harvests of bell peppers (a total of 200 photographs), maize (a total of 400 photographs), and tomatoes (a total of 400 photographs) are shown in Table 1.

**Table 1.** Classification of crop infections in tomato, bell pepper, and maize leaves

| ***Leaf infection calculation*** | | | | |
|---|---|---|---|---|
| **Sr.No.** | **Type of leaf** | **No. of images** | **Average infection % (2020)** | **Average infection % (2022)** |
| 1 | A bacterial speck on a tomato | 100 | 13.67 | 13.78 |
| 2 | Early tomato blight | 100 | 30.5 | 16.98 |
| 3 | Healthy: tomatoes | 100 | 8.17 | 5.05 |
| 4 | Late blight of the tomato | 100 | 45.9 | 23.55 |
| 5 | neither them leaf blight nor maize | 150 | 23.8 | 16.98 |
| 6 | Corn: common rust | 150 | 35.87 | 17.89 |
| 7 | corn and cercosporin | 100 | 28.8 | 14.87 |
| 8 | Healthy: maize | 150 | 16.8 | 15.76 |
| 9 | bell pepper: good for you | 100 | 9.56 | 8.45 |
| 10 | Bacterial stain on a bell pepper | 100 | 38.9 | 17.87 |

**Performance of Diverse Individual Learning Classifiers:** The primary emphasis of this study has been placed on the application of four unique learning classifiers, namely j48, random tree, naive bayes, and ken, to a wide range of academic datasets. After then, a series of methods, such as oversampling and under sampling, were used to the academic dataset in order to determine whether or not there had been any improvement in the success rates of predicting student outcomes. An approach that is analogous to ensemble approaches like as bagging and boosting is applied in order to ascertain whether or not the learning classifier among base or meta has generated findings that are persuasive.

## 5. Result and Discussions

Logistic regression analysis was performed to examine the influence of Average infection % (2020) and Average infection % (2022) on variable Type of leaf to predict the value "A bacterial speck on a tomato". "Logistic regression analysis" shows that the model as a whole is significant ($Chi^2(2) = 6.5$, p .039, n = 10).

The "coefficient of the variable **Average infection % (2020)"** is b = -33.51, which is negative. This means that an increase in Average infection % (2020) is associated with a decrease in the probability that the dependent variable is "A bacterial speck on a tomato". However, the p-value of .998 indicates that this influence is not statistically significant. The odds Ratio of 0 indicates that one unit increase of the variable Average infection % (2020) will increase the odds that the dependent variable is "A bacterial speck on a tomato" by 0 times.

The "coefficient of the variable **Average infection % (2022)"** is b = 33.31, which is positive. This means that an increase in Average infection % (2022) is associated with an increase in the probability that the dependent variable is "A bacterial speck on a tomato". However, the p-value of .998 indicates that this influence is not statistically significant. The odds Ratio of 292281682107689.1 indicates that one unit increase of the variable Average infection % (2022) will increase the odds that the dependent variable is "A bacterial speck on a tomato" by 292281682107689.1 times.

**Table 2.** Hypothesis

| Null hypothesis | Alternative hypothesis |
|---|---|
| There is "no significant difference" between the groups of the first factor Average infection % (2020) and Average infection % (2022) (measurement repetition) in relation to the dependent variable. | There is a "significant difference" between the groups of the first factor Average infection % (2020) and Average infection % (2022) (measurement repetition) in relation to the dependent variable. |
| There is "no significant difference" between the groups of the second factor Type of leaf in relation to the dependent variable. | There is a "significant difference" between the groups of the second factor Type of leaf in relation to the dependent variable. |
| There is "no interaction" effect between the factor Average infection % (2020) and Average infection % (2022) and Type of leaf | There is a "interaction" effect between the factor Average infection % (2020) and Average infection % (2022) and Type of leaf |

## 6. Conclusion

The use of intelligent technology by farmers is a direct response to the changes brought about in agriculture as a direct result of the employment of robotic devices. The purpose of the algorithmic strategies that are going to be covered in this article is to raise the overall agricultural output. These strategies are geared at achieving success among composite robotic systems as their end goal. Since the height of a crop varies during the length of its growing season in the real world, the most practical method for collecting data about the soil is to use robots that are placed on the ground. When gathering images of crops at different phases of their life cycle, the drone performs better than when certain characteristics, such as the camera angle, the quantity of field space that is accessible, and the variance in plant height, are taken into consideration. There are a great deal of different approaches of diagnosing conditions, many of which have been the focus of inquiry and investigation at some point. In the process of leaf segmentation, the iterative selection threshold technique beat other algorithms that were examined and had distinct benefits. In addition, a dataset consisting of 2,000 leaf photographs of three distinct types of crops that were affected by a variety of diseases was investigated, and it was found that the overall accuracy of the recommended approaches for disease diagnosis was assessed to be 69.89% right. This information was gleaned through the examination of the dataset. Even though a single macronutrient was used in the classification of land for mixed cropping, more research may be carried out making utilisation of a suitable algorithm to include other nutrients.

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