Global Transitions Proceedings 2 (2021) 175–180

Contents lists available at ScienceDirect

Global Transitions Proceedings

journal homepage: http://www.keaipublishing.com/en/journals/global-transitions-proceedings/

Pest control management system using organic pesticides

Pramoda Kalkura*, Puneeth Raj B, Suhas Kashyap N, Surya, Ms. Ramyashree

Dept. Computer Science and Engineering, Shri Madhwa Vadiraja Institute of Technology and Management (Affiliated to VTU), Udupi, India 574115

ARTICLE INFO

Keywords:
CNN approach
Early pest detection
Feature extraction
Image analysis
Image processing
Object detection

ABSTRACT

Pest detection is the biggest challenge for the farmers in the field of agriculture. Farmer have to take proper measures to fight against pests by using organic pesticides. This project describes a software prototype system for pest control by identifying the name of the pest. Farmers have to capture the image of the pest using the Android application. Then they have to upload the pest image to the software. Identifying pests over crops is one of the major challenging tasks for the crop technicians and farmers in the field of agriculture. This also causes damage to crops leading to low yield and to the farmers. Image database of the pests is also taken for consideration. Set of training images are compared with the testing images to enable. The convolutional neural network classification approach is adopted to identify the class of Pests.

1. Introduction

India is a land of Agriculture. Many peoples are directly dependent on Farming. Agriculture also plays a very important role in a nation's economy. Farmers come from rural backgrounds. They completely depend on Agricultural activity. It contributes 17% of GDP. It will help the nation by resolving unemployment problems. Some pests like Bacteria, virus, fungus cause harm to the crops. Which results in decrease of quality and quantity of yields of crops. So without using chemical pesticides it is possible to control the Quality as well as quantity of crops. Yes, this is done by organic pesticides. It is better to use Organic Pesticides, which kills pests without causing any side effects to plants and also increases good quality and quantity. But Identifying of pests is a major challenge to farmers. a manual method for analyzing consumes more time. By the help of applications of Image processing recognition technique, there is a way to Pest identifications as well as provide particular pesticides organically. First thing is pest images are captured using cameras or through an android app. Then the captured image has to be processed to the software. The main focus of this project is on the identifications of pest image for taking biological precautions.

Identification of the pest and applying proper organic pesticides in agriculture is the main key way to stop the losses in the yields of the farmer and Quality of the food. It becomes very difficult to identify particular pests and provide proper organic pesticides manually, so Digital Image Processing used for early detection of pests [1]. This process also involves few steps like Image-acquisition, Image pre-processing, Image segmentation, Feature extraction and at the end Classification. Systems are intelligent computer programs that are capable of providing solutions and advice related to specific Problems in a given area, it compares the given images with the datasets. Advantage of system is to perform tasks more consistently than human experts. In agricultural mass production, it is needed to identify the pests at beginning stages of plant. It avoids damages in production costs and increases the yield [9].

2. Literature Survey

David Headrick.2021 [2] The Future of Organic Insecct Pest Management: this paper mainly focuses on Federal(NOP) national organic program guidelines for pest management which can be viewed to certified organic growth in their approach at economically successful management of a varieties of pests situations and knowledge required mainly entomology, for successfully implement present management techniques is overwhelming, and also there are significant gap in guidelines in which resolved could make aid in growth adoption of practices that informs good decision making and accuracy.

Mayank Mishra, Tanupriya Choudhury and Tanmay Sarkar in 2021, [3] they proposed pest control system which use IOT and Image processing technologies. CNN based efficient image classification system for smartphone device. System use infrared sensors for detecting pest. pests detected by using sensor and ultrasonic wave equipment with the help of Image processing which keeps insects away from the field.

Yaowei Wang, Haihong Pan, Zaijun Pang Yijue Wang in 2020, [4] New Image Recognition and Classification Method by Combining Transfer Learning Algorithms. In this paper they propose the importance of TL-MobileNet for welding defects detections. In this experiment of welding defects classification using 'Weld' datasets verify that the TL-MobileNet can be able to correctly identify specific defects in a

* Corresponding author.
E-mail addresses: pramoda.17cs057@sode-edu.in (P. Kalkura), puneeth.17cs060@sode-edu.in (P.R. B), suhas.17cs087@sode-edu.in (S.K. N), surya.17cs088@sode-edu.in (Surya), ramyashree.cs@sode-edu.in (Ms. Ramyashree).

https://doi.org/10.1016/j.gltp.2021.08.058
Received 28 May 2021; Accepted 2 July 2021
Available online 12 August 2021

limited number of training sets. Many experiments have been carried out to various sizes of images by using various transfer learning models. It also proves the proposed TL-MobileNet method which is better for recognizing accuracy along with smaller size of model and less time in calculation.

Brian P. Baker, Thomas A. Green, Ali J. Loker, 2020 [5] titled Biological control and integrated pest management in organic and conventional systems. This paper reveals that IPM and organic are feasible approaches for agricultural productivity that both depend on biological control as one tool for producers able to use. Both decreased in pesticide usage, risk and development impacts. Collaborating among those who work with two sets of practices can be able to make progress towards the adoption of results for production challenges that also includes biological control.

G. Singh 2020 [6] Project titled Pest management in organic farming, it becomes a challenging task without using any insecticides. It involves in careful planning in advance with minor modifications in cultural practices as primary methods of pest controlling. Using environmentally friendly techniques like by using biological control agents and other bio based products as secondary line of defense towards insect pests. These products can be used alone or combined with other techniques like integrated pest management that have potential to control insect pests and also increase the economical yield in organic farming.

Basri, Rosmavati Tamin and team in 2020 [7] this study proposes to apply image processing techniques that can identify the initial stage of pests and diseases of cacao fruits based on mobile applications. The system applied the concept of expertise in the field of cacao cultivation. It is done by pre-processing the image with the help of image processing techniques and for pattern detection and machine learning systems with deep learning algorithms. Image processing techniques are implemented into the application software to detect the pixels of the cacao fruit images.

V. Indhumathi, S.K Praveen Kumar in 2019, [8] this model suggests that the geometrical features that include the characteristics of mean and variance and morphological features of training images are compared with the testing images with their set of extracted images. Probability and likelihood of pests are taken into consideration. Naive Bayes algorithm is adopted to identify the class of pests.

Cristina A, Costa Raquel, P.F.Guine Daniela, V.T.A Costa Helena, CorreiaAnabelaNave, 2019 [11] they proposed a theory titled Pest Control in organic Farming. They inform that organic pesticides provide social, public animal health and food quality etc. Today consumer are worried about the environment and animal welfare, and regulations change to reflect to the environment. Educating people about the Mother Nature and also should know that awareness is very strong driver to organic regulation improvement.

Robert Blundell, Jennifer E Schmidt, Alexandria Igwe 2019 [12] titled Organic management promotes natural pest control through improved plant resistance to pests. It proposes organically and well grown tomatoes are dependent on Salicylic Acid highly contained in plant, they mediated by rhizosphere microbial groups. These results at end will suggests us that organically formed soils and also Microbial communities can play an unwanted role in reducing the plant attractiveness to pests by increasing in plant resistance.

S.K. Trivedi, R Nagar, D Nagar in 2019, [15] Organic Farming And Its Future, This project identifies the pests through leaf and fruit markings, and leads them in crop management specifically in pesticide applications. Here in this they also explained the importance of organic Pesticides like extracted from neem trees and its uses. Comparison between organic and inorganic farming is also explained in detail. Using organic pesticide will not harm plants they provide more strength and without any side effects.

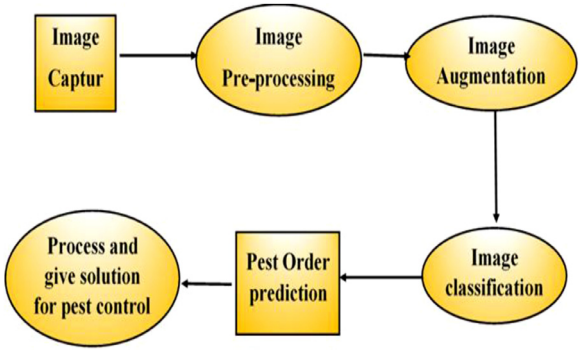

Fig. 1.. Flow diagram.

3. Methodology

3.1. Image processing and classification

*3.1.1. **Image acquisition***

The work on pest detection was carried out in the agricultural lands. The user uses a network of wireless cameras to capture the harmful pests. The captured image of the pests was processed for further analysis.

3.1.2. Image pre-processing

It is the method of generating an enhanced structure of the previous image. The enhanced image will be more powerful in processing of the image.

*3.1.3. **Detection of pests***

The detection stage is used to figure out the pests that are presented in the image. IN this they used two images to figure out the difference [14]. First captured image will work as the base image that points to the referenced values of pixels that are used for the purpose of comparison purposes, where the next image will be taken as the input image.

3.1.4. Filtering of the image

Filtering of image is the process of removing noises from the image that are caused by the different types of situations in requiring filtering to get clear and efficient end results.

*3.1.5. **Extraction of the detected pests***

One of the last step in this stage the required pest is detected and determined by the system. For this step the output of the previous image is taken as the input image. Entire flow diagram of model shown in Fig. 1.

3.1.6. Decision making

Decision making is the process of making ideas by making a decision, collecting information, and finding alternative resolutions. It involved several steps such as identification of the problem, collection and analysis of specific information, evaluation of decision alternatives and selection of best alternatives.

3.1.7. Pest identification

To effectively control a pest, it is important to accurately identify it. Proper identification of typical insects or pests in the field is important for Pest management decision making. Each pest and disease has a different management strategy.

3.1.8. Pest monitoring

Regular pest monitoring is the important stage in pest management. The main concern of Monitoring is detection of the presence and concentration of pests and natural enemies. Image enhanced by following techniques.

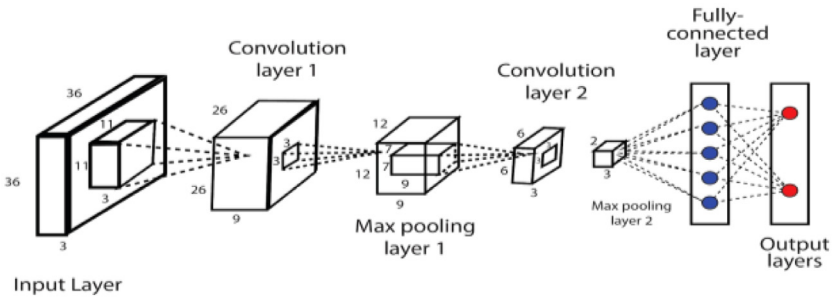

Fig. 2.. CNN Architecture.

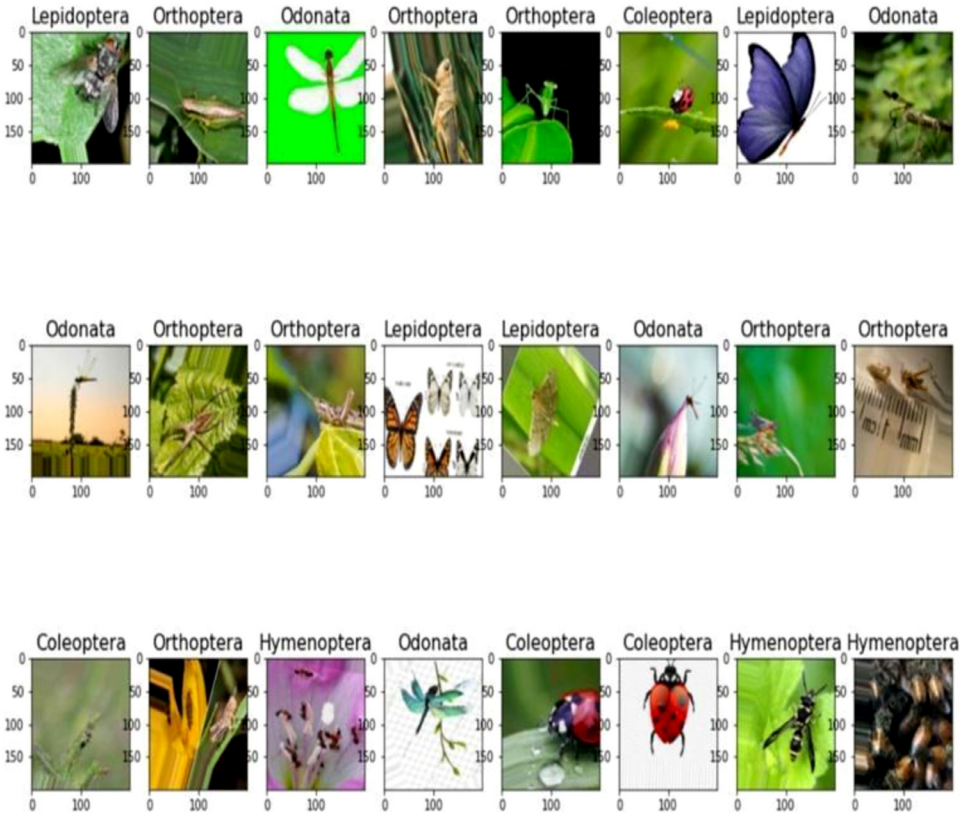

Fig. 3.. Different classes of PESTS.

3.2. *Classification technique*

In machine learning, a large number of classifiers are used for classification of respective applications. Some classification techniques include Naive Bayes classification, KNN classification, and CNN algorithm. This paper uses CNN for better image classification in the system.

Accuracy Calculation:

$$\text{Accuracy} = (TP + TN)/(TP + TN + FP + FN) \quad (1)$$

Where,

TP: Truth positive
FP: False positive
TN: Truth negative
FN: False negative

3.3. ***CNN algorithm***

Convolutional neural networks (CNN) algorithm used for Deep Learning. It takes an image as input, and assigns learnable weights and biases to the feature in the image and it is able to differentiate one image to another image. Pre-processing in a ConvNet is much lower when compared to other classifications of algorithms. Primitive method filters are hand-engineered, with enough training, ConvNets have the ability to learn these filters and characteristics. Steps as follows:

Step 1- Initialization of the model parameters, a step equivalent to Injecting noise into the model.

Step 2- .For i=1,2...N: (N is the number of epochs)

- Perform forward propagation:

∀i, Compute the predicted value of a through the neural network: $\hat{y}i\theta$

Evaluate the function:

$$J(\theta) = \frac{1}{m}\sum_{i=1}^{m}\delta(\hat{y}i\theta, yi) \quad (2)$$

where m is the size of the training set, Θ the model parameters and the cost (*) function

- Perform back propagation:

Apply a descent method to update the parameters:

$$\theta =: G(\theta) \quad (3)$$

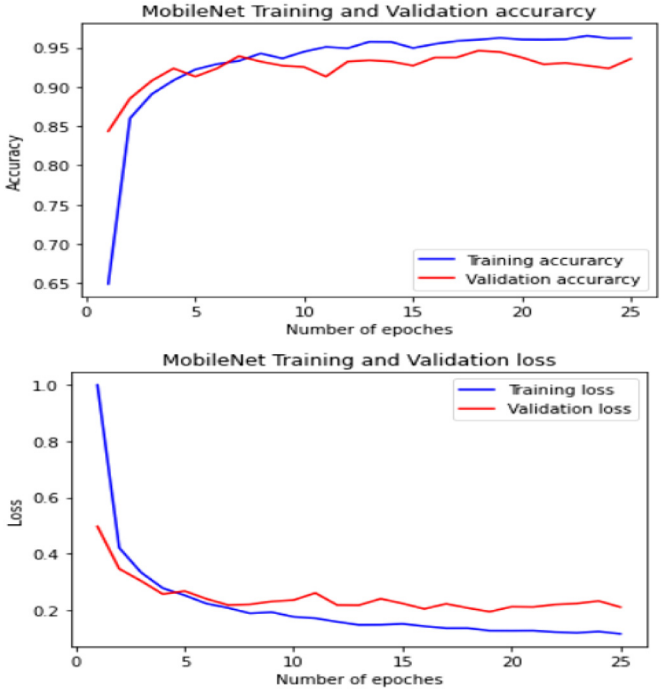

Fig. 4.. Accuracy of pest control management systems.

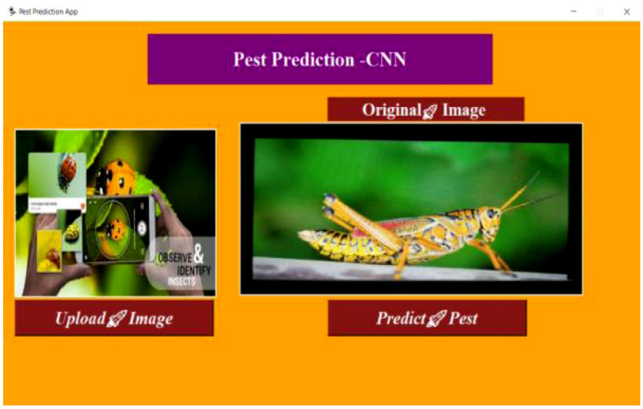

Fig. 5.. Initial page to upload the image.

Fig. 6.. Identification.

3.3.1. CNN architecture and model

A Convolutional Neural Network (CNN) is a part of Deep Learning algorithm where it will take an image as input image, assign corresponding learnable weights and biases(importance) to its various objects/aspects in the image and be able to differentiate it from the other.

A CNN Architecture is done by a group of different layers that convert the input volume into an output volume with a differentiable function. A few types of layers are commonly used. There are three types of layers that will make up the CNN models which are the convolutional layers, pooling layers, and fully-connected (FC) layers. When these layers are connected, a CNN architecture will be formed.

1 Convolution Layer: The first layer in the CNN Architecture is the convolution layer. It is used to extract the different types of features from the input images.

2 Pooling Layer: In most of the cases the convolution layer is followed by the pooling layer. The main target of this layer is to decrease the size of the convolved feature map for reducing the cost of the computation.

3 Fully connected Layer: The Fully connected layer consists of neurons. Along with respected biases and weights. This layer is used

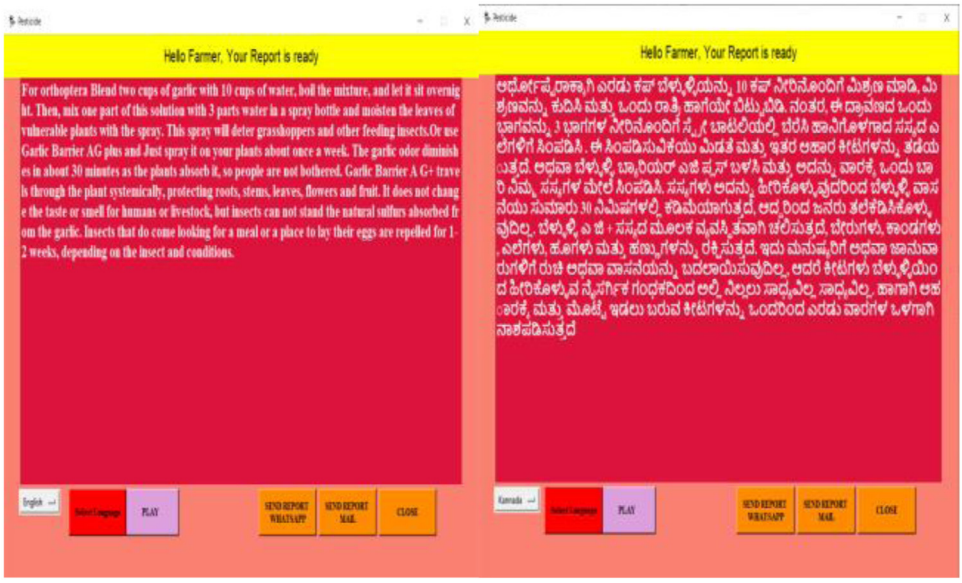

Fig. 7.. Information about identified pest.

Table 1.
Number of layers for the different CNN models.

Model	VGG-16	MobileNet	Inception-V3
No. of Layers	16	28	48

to connect the neurons between two different layers. This layer is mostly placed before the output layer of a CNN Architecture.

Advantages:

- Perception precision is more
- Positive rate is less

Disadvantages:

- Estimation is difficult and takes time
- Training time required is more
- Pest with same background colour cannot be detected properly

This project used a simple convolutional neural network, which consists of three convolutional layers, a pooling layer which connects to a fully connected layer. Here used some dropout parameter to avoid over fitting problems. Finally, a dense layer to construct a hidden layer. Image used 250*250*3 size image as input to the CNN model.

4. Proposed models

In this paper the proposed models stick on the deep learning transform CNN architectures for transferring of learning weights which result in the reduction of training time and mathematical calculations and available hardware resource consumption. The model used for this project is shown in Table 1. But when compared to a large CNN model, the mentioned CNN models consist of only a few layers. If these models are used, training time and complexity of calculations decreases.

In recent years, many advances in CNN have increased the accuracy value on image detection or classification tasks. CNN models are introduced significant developments in succeeding annual challenges of ImageNet Large Scale Visual Recognition Competition (ILSVRC) Image Large Scale Visual Recognition Competition. Many models were pre-trained like VGG-16, Inception-V3, and MobileNet [4].

4.1. Transfer learning

It is a process of utilizing a model trained from one problem to solve another similar problem. This method is a neural network used for training and then it is applied to similar problems. This model contains one or more layers which are used for new models. Transfer learning contains benefits like reducing training time and also results in decreasing of error rate. Reused layers' weights are used as initial point at training process and implemented to new problem. Then pre-trained model is used for classifying, feature extraction, and for weight initialization like VGG-16 [13].

VGG-16 is a successor for AlexNet. VGG16 refers to 16 layers along with weights. It is created with a 16-layer network which consists of convolutional networks along with fully connected layers. They have 13 convolutional layers with two fully connected layers, also 1 Softmax classifier layer. The default size for the image input model is 224x224.

InceptionV3: This model was introduced by Szegedy in 2014 with factorization ideas. It reduces the number of parameters without decreasing network efficiency.

MobileNet: In MobileNet it has depth wise separable convolutions and a single filter is fitted for each input channel. To combine depth convolutions outputs the 1*1 convolution is used. The convolutions filteriept of factorization is ng and combining processes are given as the input to the next layer. But a separate layer is used for filtering and combining processes in depth wise separable convolutions. This step of factorization helps to decrease the computational time and model size.

Table 2.
Dataset.

Class	Train	Validation
Coleoptera	1129	314
Diptera	1149	313
Hymenoptera	970	350
Lepidoptera	1000	325
Odonata	1039	314
Orthoptera	1046	305

4.2. Training and testing dataset

Six classes of pests are identified in this pest detection method. The names of the pests under classification are Coleoptera, Diptera, Hymenoptera, Lepidoptera, Odonata and Orthoptera are taken from [16]. Number of training and testing images may increase in progress. In the CNN algorithm a number of training and testing dataset are taken. Number of testing and training images of the Six Classes of pests is summarized in Table 2. The below classes of pests are shown in Fig. 3.

5. Results and analysis

Many papers concluded the usage of CNN over SVM for better performance and better accuracy. By comparing CNN with other classification algorithms, the authors suggested that CNN is best suited to obtain proper results [10]. It gives an accuracy of 90% above. So chosen CNN over SVM because Performance of the CNN is better than SVM and overall performance increases by 7.7% while using CNN.

Performed the training of dataset in three different pre-trained CNN models that are Inception v3, mobilenet. VGG16 and got accuracy in pest classification as shown in Table 4. From the analysis results that mobilenet transfer learning is more accurate and requires less training time as compared to other two models. In the mobilenet model accuracy is about 98% for dataset Table 2. This paper used 6 classes of pest in for analysis [18–20].

In this project initially need to upload the pest image in the user interface as shown in Fig. 4 which will convert into a 224*224*3 images and given to a CNN model to predict the pest class and used different Image augmentation techniques to the dataset. Table 2. Data run with different Transfer learning models and got results as shown in Table 4. MobileNet is an appropriate model for dataset that gives 90% accuracy, also Inception-V3 got almost 90% accuracy.

The graph Fig. 4 shows the accuracy vs number of epochs and loss vs number of epochs during the training process. It represents the graph during the training of the mobile Net transfer learning model [21–25].

Fig. 5 shows the interface to upload the pest image to the backend and the selected image is displayed to the user as the original image. Then need to press the predict pest button to predict the pest class. Here used the Tensorflow keras library used to predict class.

In Fig. 6 Once the pest image is uploaded, using the saved CNN model it will identify the pest and give the pest class name as result to the farmer along with it displaying a user interface.

In Fig. 7 It is user-friendly interface which gives messages which consist information about the organic pesticide. If a farmer wants audio version of the pesticide information, then he can click on the play button and to set their native language they can click on the select language button. And also there is a button to send the report to the farmer through WhatsApp and mail.

6. Conclusion and future enhancements

This paper used a pre-trained CNN model for better accuracy and pest detection. Used models are inception v3, mobilenet and VGG-16 for training. Then evaluated the performance results on the above transfer learning and deep feature extraction models and from that evaluation

Table 3.
Comparison of proposed with existing datasets related to insect pests. The 'Class' denotes the number of insect class.

Dataset	Class	Sample	Accuracy [%]
Xie et al. [17]	40	4500	89.3
Deng et al. [18]	10	563	85.5
Alfarisy et al. [23]	13	4511	87
Proposed	6	6333	98

Table 4.
Testing accuracy and performance metrics for the different CNN models.

Metric/Model	VGG-16	MobileNet	Inception-V3
Test accuracy	67	98	90

decided to use the Mobilenet transfer learning model for project which gives more accuracy 98% than other models (Fig. 2).

From study came across several ideas to detect pests and help farmers. Also to reduce use of chemical pesticides that may harm the crops. In order to maintain the food chain the presence of some pests are necessary. Biological pesticides will not cause harm to the food chain. The government has to increase research on organic farmer's requirements and implement organic farming programs in all federally funded universities, also establish farm safety and transition assistance programs that work for organic growers. Organic farming is now gaining momentum as an alternative method for modern agriculture (Table 3).

In future try to increase datasets and image classes. Which also improves accuracy of correct prediction. Also try to train dataset in modern pre trained models.

Acknowledgements

At the various stages in doing this project, a number of people have given us invaluable suggestions. We would like to take this opportunity to express our gratitude and appreciation to all those who helped us towards the successful completion of our project. And also like to express our gratitude to Ms. Ramyashree Assistant Professor of SMVITM, for providing us a congenial environment and surroundings to study in.

References

[1] L. Sun, K. Liang, Y. Song, Y. Wang, An Improved CNN-Based Apple Appearance Quality Classification Method With Small Samples, IEEE, August 2021.
[2] The Future of Organic Insect Pest Management: Be a Better Entomologist or Pay for Someone Who is David Headrick MDPI Horticulture and Crop Science Department, California Polytechnic State University, San Luis Obispo, CA, 4 February 2021 93407.
[3] Mayank Mishra, Tanupriya Choudhury, Tanmay Sarkar, CNN Based Efficient Image Classification System for Smartphone Device, Universitat Autònoma de Barcelona, Barcelona, Spain, 2021 ELCVIA ISSN:1577-5097.
[4] H. Pan, Z. Pang, Y. Wang, Y. Wang A new image recognition and classification method combining transfer learning algorithm and mobilenet model for welding defects, June 29, 2020.
[5] B.P. Baker, Thomas A. Green, A.J. Loker Biological control and integrated pest management in organic and conventional systems, 2020.
[6] G. Singh, Pest management in organic farming is a challenging task without the use of insecticides, ICICICT, 1, August 2020.
[7] B. Rosmawati Tamin, H. Karim, I. Bay, I.S. Arani, Mobile Image Processing Applications For Cacao's Fruits Pest And Disease Attack Using Deep Learning Algorithms, IEEE, 2020.
[8] S.K Praveen Kumar, Computerized System for Identification of Pests Using Machine Vision, 8, IJRTE, Indhumathi, Coimbatore, 2020.
[9] D.S. Tan, et al., Method for Detecting and Also Segmenting Infected Parts of Cacao Pods, DLSU Research Congress, 6, De La Salle University, Manila, Philippines, 2020.
[10] D. Patel, N. Bhatt, Improved accuracy of pest detection using augmentation approach with Faster R-CNN To cite this article, 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1042 012020, ICMLSC, 2020.
[11] C.A. Costa, P. Raquel, Pest Control in Organic Farming, Polytechnic Institute of Viseu, Inter University Center for Organic Farming and Sustainable Agriculture (IUCOFSA, Viseu, Portugal, 2019.
[12] R. Blundell, J.E. Schmidt, A. Igwe, Organic management promotes natural pest control through improved plant resistance to pests, Trends PlantSci 17 (5) (2019) 250–259.
[13] J. Ramesh, R. Manavalan, K.M. Prabusankar Lal, Feature extraction of ultrasound prostate image using modified Vgg-19, transfer learning, Turk. J. Comput. Math. Edu. 12 (10) (2021).
[14] D. Chang, W. Qi, Z. Zhan, X. Zhang, A Study on Different Functionalities and Performances among Different Activation Functions across Different ANNs for Image Classification, SCSET, 2020.
[15] S.K. Trivedi, R Nagar, D Nagar, Organic Farming And Its Future, Dept. of Agronomy, School of Agricultural Sciences, Career Point University, Kota, Rajasthan, 2019 324 005India.
[16] X. Wu, C. Zhan, Y. Lai, M. Cheng, J. Yang, IP102: a large-scale benchmark dataset for insect pest recognition, in: 2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), 2019, pp. 8779–8788.
[17] Chengjun Xie, Rujing Wang, Jie Zhang, Peng Chen, Wei Dong, Rui Li, Tianjiao Chen, Hongbo Chen, Multi-level learning features for automatic classification of field crop pests, Comput. Electron. Agric. 152 (2018) 233–241.
[18] P. Kiran, B.D. Parameshachari, J. Yashwanth, K.N. Bharath, Offline signature recognition using image processing techniques and back propagation neuron network system, SN Comput. Sci. 2 (3) (2021) 1–8.
[19] P. Subramani, K. Srinivas, R. Sujatha, B.D. Parameshachari, Prediction of muscular paralysis disease based on hybrid feature extraction with machine learning technique for COVID-19 and post-COVID-19 patients, Pers. Ubiquitous Comput. (2021) 1–14.
[20] Limiao Deng, Yanjiang Wang, Zhongzhi Han, Renshi Yu, Research on insect pest image detection and recognition based on bio-inspired methods, Biosyst. Eng. 169 (2018) 139–148.
[21] T. Kowsalya, R.G. Babu, B.D. Parameshachari, A. Nayyar, R.M. Mehmood, Low area PRESENT cryptography in FPGA using TRNG-PRNG key generation, CMC-Comput. Mater. Continua 68 (2) (2021) 1447–1465.
[22] N.V. Pham, T.N. Nguyen, T.D. Ngo, A.T. Truong, G.L. Nguyen, A novel approach for pivot-based sensor fusion of small satellites, Phys. Commun. 45 (2021) 101261.
[23] A.A, Alfarisy, Q. Chen, M. Guo, Deep Learning Based Classification for Paddy Pests & Diseases Recognition, ICMAI, 2018.
[24] K. Seyhan, T.N. Nguyen, S. Akleylek, K. Cengiz, S.H. Islam, Bi-GISIS KE: modified key exchange protocol with reusable keys for IoT security, J. Inf. Secur. Appl. 58 (2021) 102788.
[25] R.K. Dash, T.N. Nguyen, K. Cengiz, A. Sharma, Fine-tuned support vector regression model for stock predictions, Neural Comput. Appl. (2021) 1–15.