V SEMESTER MINOR PROJECT REPORT

ON

"Millet Disease Detection Using Deep Learning Techniques"

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included. We have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be caused for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Dated: 11th Dec'19

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Plagarism Report

millet

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Figure 1: Plagarism Report

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This project report entitled "Millet Disease Detection UsingDeep Learning Techniques" by Nilanjana Jaysi, Pratik Gupta, Saanika Gupta and Vinayak Bhartia is approved for Vth Semester Minor Project.

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Dr. N. Srinivas Naik

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Dr. Venkanna U.

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Certificate

This is to certify that the project titled "Millet Disease Detection Using Deep Learning Techniques" by Nilanjana Jaysi, Pratik Gupta, Saanika Gupta, and Vinayak Bhartia has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

Dated: 11th Dec'19

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Pratik Gupta
Saanika Gupta
Vinayak Bhartia

ABSTRACT

In recent times, millets have become important owing for their good nutritional values, documented health benefits, versatile environmental adaptation, sustainability in low input agriculture and organic cultivation amenability. Deep learning in precision agriculture enables a practically quick and exciting data analysis. In this document, we have developed a platform independent application using Flutter which takes real-time millet image as an input to identify different millet diseases and suggest remedy for those diseases. The model is built using the GoogLeNet architecture and deployed into a platform independent application using Django. The predicted benefit of the project is the accessibility of knowledge and awareness to farmers and researchers. In particular this would help the farmers to prevent and cure millet diseases which would lead to increased production of millets. The experimental outcome provides an encouraging result which is 81.4% accuracy for five-class classification (classes : healthy, smut, rust, bacterial, ergot).

Keywords: Millets, Diseases, Farmers, GoogLeNet, Django

1 Introduction

Millets are group of small grained cereal food crops which are highly nutritious and are grown under marginal/low fertile soils with very low inputs such as fertilizers and pesticides. These crops largely contribute to food and nutritional security of the country. Most of millet crops are native of India and are popularly known as Nutri-cereals as they provide most of the nutrients required for normal functioning of human body. Millets are rain fed crops and are grown in regions with low rainfall and thus resume greater importance for sustained agriculture and food security.

It is therefore very essential to detect and diagnose these illnesses. Traditional identifying disease methods involve understanding of agricultural fields from specialists. It is hard and less efficient to use these methods to enhance identification of disease. The computer vision and the Internet of Things, however,bring a different method of automatic pattern recognition centered on disease crop identification. They actually lead to the growth of agriculture together. To obtain important outcomes, we need to introduce techniques and approaches for analyzing,interpreting and visualizing the details

Deep Learning is a collection of automatic techniques of learning based on multi-layered “artificial neural networks”. These networks can classify data from the simplest to the most complicated, as it is important for supervised learning, unsupervised learning and reinforced learning. The primary motive of this work is to build a deeply convolutionary neural network model in order to develop a disease recognition system in crop millet.

The remainder of this paper is structured as follows: In Section 2 we present an overview of the related work. Section 3 presents our proposed solution. The contribution of our work is demonstrated in Section 4. The results are shown in Section 5. Conclusion is drawn along with future work mentioned in Section 6.

2 Related Work

Detecting dieseases in crops has currently become an important research area in agricultural field and millets as we know are major energy source and staple foods for people living in the dry and arid regions of the world. In India, a total of about 12.5 m tonnes of millets food grains are produced from nearly 14.6 m ha area, which constitutes 7% of national food grain basket [2].

Pooja et al. [3] made a model which identifies plant leaf diseases using image processing techniques. The image is segmented using K-means clustering to get infected area. The clusters are obtained for each of the 3 channels of RGB. Then the disease is predicted using SVM model but it was not fully automated as region of interest (ROI) was explicitly selected by the user and The model wasn't be able to deal with the leaves in natural scenario.

Kumari et al. [4] also used K-means clustering but ANN for classification. Their approach was specific for limited plants such as tomato and cotton with an accuracy of 80 percent.

Sladojevic, Srdjan et al. [5] used deep neural network for recognition of plant diseases by leaf image classification but this model also didn't use real world images.

Mohanty, Sharada P. et al. [6] used deep learning techniques for plant disease detection but the input dataset wasn't consisting of images of real environment scenarios. Hence it is not an efficient approach and the accuracy would substantially be reduced by 31% when deployed in real environment conditions. Another approach was by Coulibaly, C. Kamsu-Foguem et al. [7] who had developed a deep neural network with transfer learning model for detecting diseases in millets. They used image augmentation for increasing their small dataset and then feature extraction is done using transfer learning. This had some limitations such as a small dataset was used, image segmentation wasn't done and the model could detect only one type of disease (mildew disease).

A summary of the above discussed methods is shown in Table 1.

We have overcome certain limitations by using a self-collected millet dataset which captures the real-environment scenarios of the field. Also our application would not only detect the millet diseases in real-time, but it would also provide the solutions to farmers for curing some of the diseases namely, smut, rust, bacterial, and ergot.

Table 1: Literature Survey

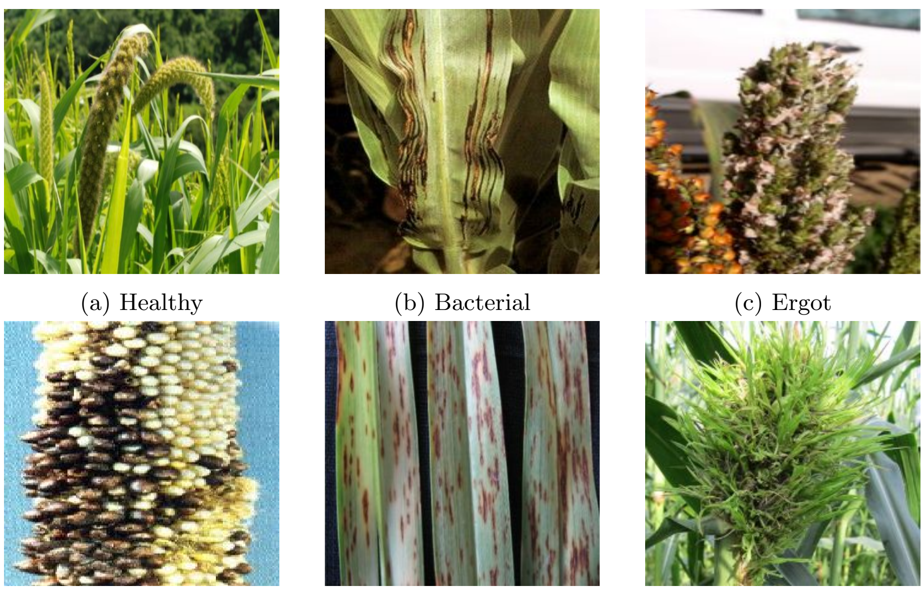
First Author, Year	Approach	Limitations
• Coulibaly, 2019	• Image Augmentation • VGG pre-trained model	• Only one type of disease • No image segmentation is there
• Kumari, 2019	• K - Means clustering segmentation • Artificial neural network	• Limited dataset • Limited number of disease classes
• Pooja, 2017	• K - Means clustering • Support vector machine	• Not fully automated • Segmentation can be imporved using YCbCr channel
• Sladojevic, 2016	• Leaf Image Classification • Convolutional Neural Network based plant disease detection	• Giving poor results on real time dataset • Heavily dependent on segmentation
• Mohanty, 2016	• Segmentation of leaf image • AlexNet for detection of plant disease	• No good result on real time dataset • Only limited diseases that can be found at the top of the leaves

3 Proposed Work

We are proposing a deep neural network which is deployed on Django REST API. The farmers can use our application to directly capture millet crops from the field and check whether the crop is healthy or not and in case of latter, the model provides methods to cure those diseases. This whole system is carried out in four phases:

3.1 Image Acquisition

Due to absence of publicly available millet dataset, we collected images of healthy as well as different kinds of diseased millets (as shown in figure 2) from various sources such as Google Images, Twitter, Facebook and certain random sites. The image after acquisition is resized into a shape of 224x224 to feed it to the model.



(a) Healthy (b) Bacterial (c) Ergot

(d) Smut (e) Rust (f) Downy Mildew

Figure 2: Acquired Images

3.2 Augmentation

Since the dataset is collected manually from various sites, the size of dataset is very small (185 images). In order to get reliable results we need to obtain a bigger set of images. In order to accomplish this task we took the help of augmentation technique. Different augmentation techniques such as horizontal and vertical shift, horizontal and vertical flips, random rotation, brightness, and zoom are carried out to increase the number of images. Details of some of these augmentation techniques are provided below.

Figure 3: Original Image

1. Horizontal and Vertical Shift: The shift moves all the pixels of the original image (as shown in figure 3) either horizontally or vertically (as shown in figure 4), keeping the dimension of the image same. The augmentation clips off some of the pixels from the image and there will be a region of the image where new pixel values will have to be specified.

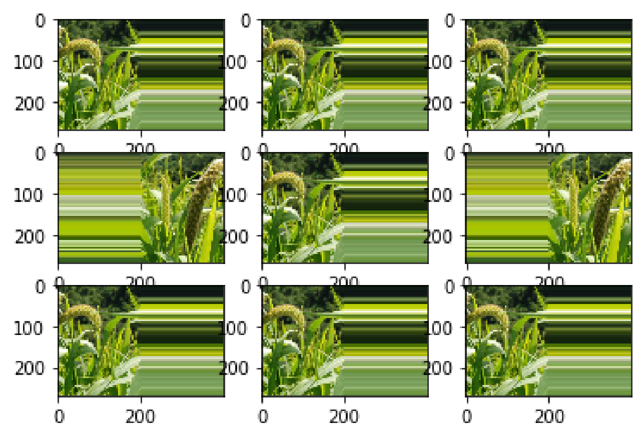


Figure 4: Horizontal and Vertical Shift Augmentation

2. Horizontal and Vertical Flip: The flip augmentation technique reverses the rows of pixels in case of vertical flip and reverses the columns of pixels in case of horizontal flip as shown in figure 5.

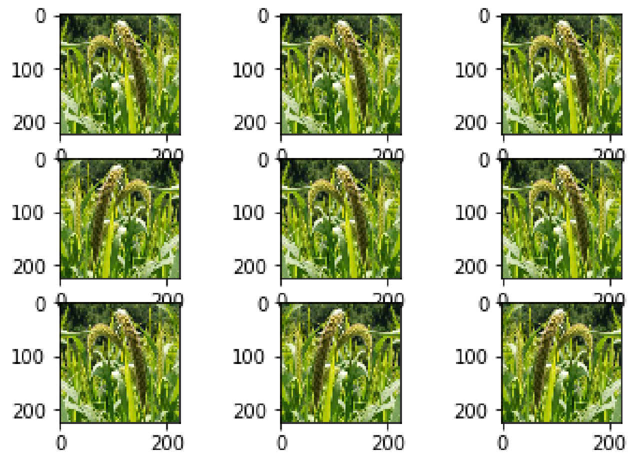


Figure 5: Horizontal and Vertical Flip Augmentation

3. Random Rotation: The random rotation augmentation randomly rotates the image in the clockwise direction by the provided number of degree from 0 to 360 as shown in figure 6.

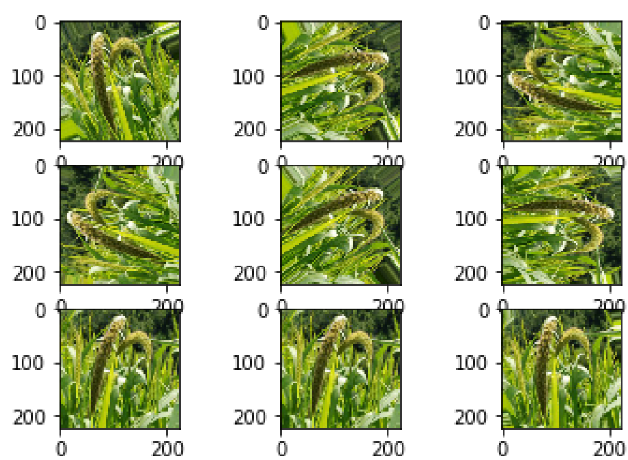


Figure 6: Random Rotation Augmentation

4. Random Brightness: The brightness augmentation randomly darkens the image, brightens the image or both as shown in figure 7. The purpose is to let the model generalize across various images trained on different lighting levels.

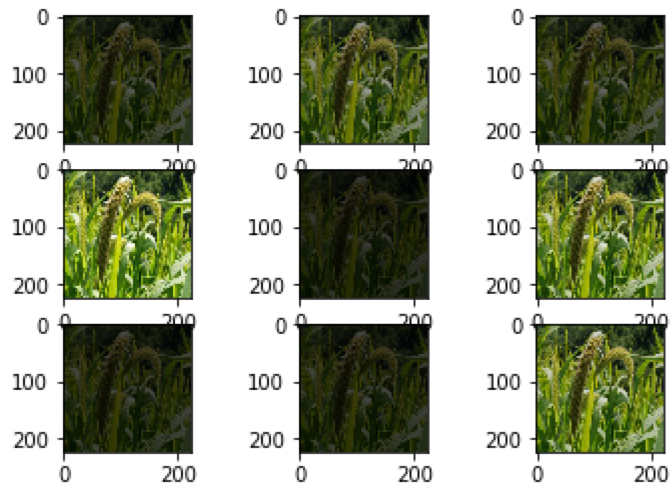


Figure 7: Brightness Augmentation

3.3 Model Construction

Once dataset is ready, a model to classify the dataset accurately is to be built. Different deep learning architectures are used to implement the model and the results of each are being properly analysed.

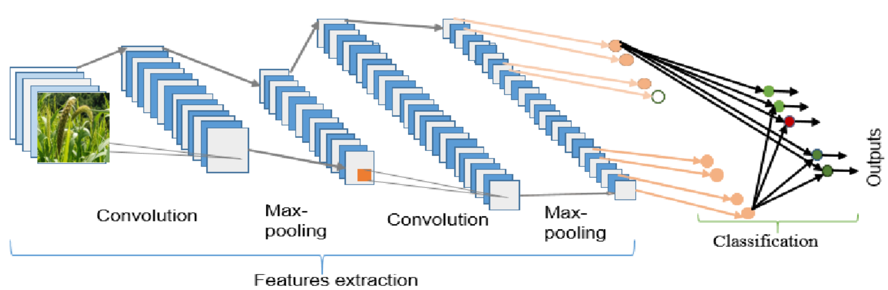


Figure 8: Convolutional Neural Network Architecture

At first the dataset is trained on a simple CNN (as shown in figure 8) which gave good results in case of healthy crop but suffered to classify different varieties of diseases. The problem primarily occured due to very less number of images for each class of disease.

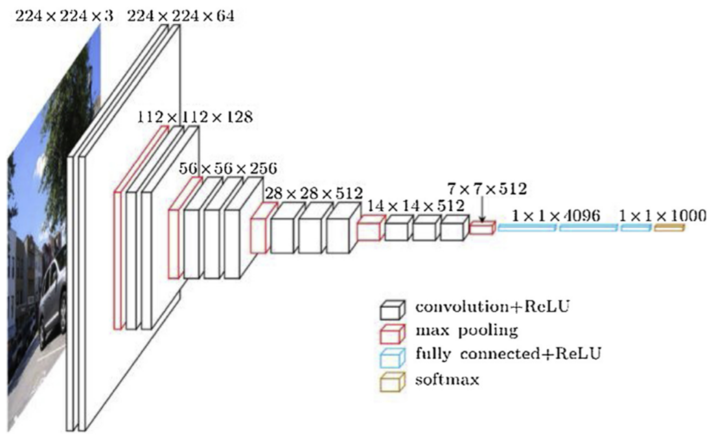


Figure 9: VGG16 Architecture

Then we trained and tested the dataset using VGG16 architecture (as shown in figure 9) in which we freezed the original weights of the custom layers of the model which was pretrained on ImageNet dataset. This process is known as transfer learning and is useful in case of limited size of dataset. The model gave an accuracy of 62% in binary classification task (healthy or diseased).

Different other architectures were implemented (AlexNet, ResNet, GoogLeNet) but the best results were recorded on GoogLeNet architecture (as shown in figure 10) which gave an accuracy of 81.7% for five-way classification.

The model once constructed is compiled using categorical cross entropy. The training process undergoes through 100 epochs which constitutes 20 epochs using Adam optimiser and 30 epochs using SGD optimiser alternatively twice. The technique helps to improve the accuracy. The model is later deployed into a platform independent application.

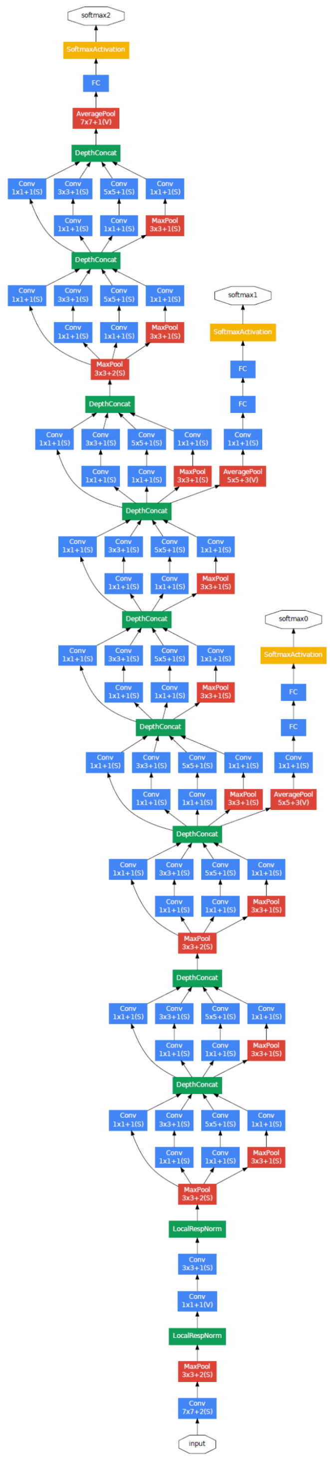


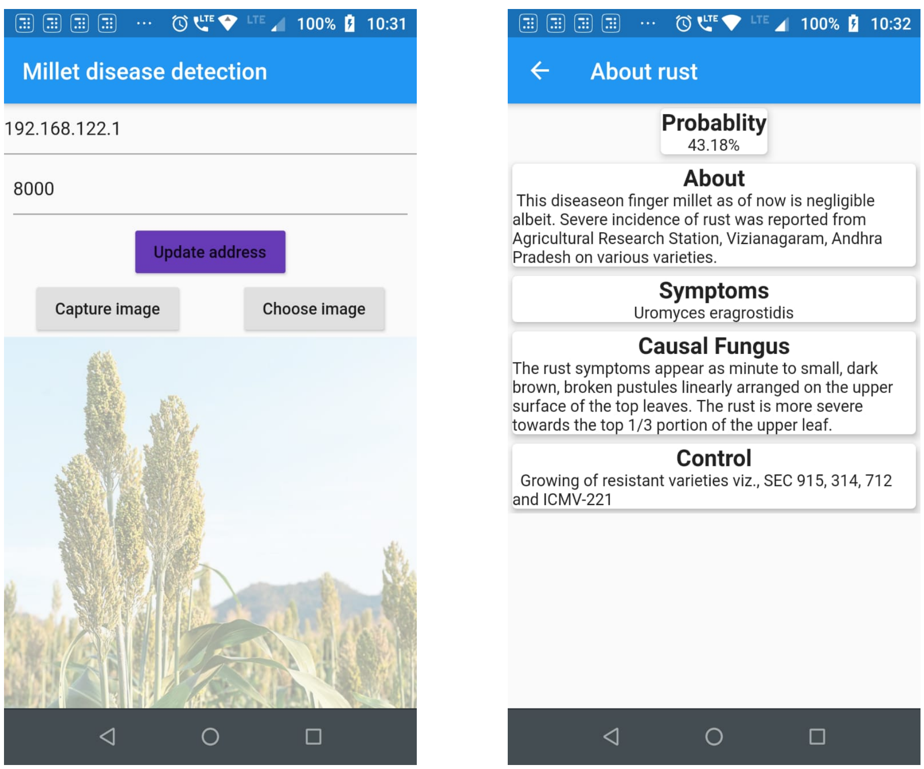
Figure 10: GoogLeNet Architecture [1]

3.4 Deployment

The complete system broadly consist of two components-

1. A mobile application to capture and send image of millet
2. A server, where model is hosted, to identify disease.

The application is made using flutter and provides two options (capture or select from gallery) to select the millet image for disease detection. The captured image is sent to server (using http) for processing. After receiving, it displays the information about the disease, symptoms and cure, if the disease is present as shown in figure 11. Otherwise, it shows a dialog with appropriate message.



(a) Main Page (b) Result Page

Figure 11: Front-end of our Application

The server contains a REST API which receives the image by a post request. It first detects whether millet is present in the image using ResNet model. If millet is present it detects the disease along with probability of decision using our trained model and sends this data to the application as a response.

4 Contribution

Following are the major contributions of our work.

1. A platform independent application is made which takes in image as the input either by instant capturing or from the gallery (already clicked pictures).
2. A deep learning model which detects several types of diseases in millet crop (mainly fungal, bacterial and viral) is intergrated with the application as a server.
3. The dataset is manually obtained, then the model is trained by dividing them into five different classes of diseases.
4. The application then after detecting the disease pops up a dialog box with an output which consists of the name of the disease and the suggestions to cure the crop from that particular disease.

5 Result Analysis

We trained our model on the self-collected dataset. In order to further optimize the model's performance, we optimized the hyperparameters as shown in Table 2. This helped in improving the results. The results that we obtained in five-way classication are mentioned below.

1. An accuracy of 81.4% was observed. The application is able to classify between healthy, ergot, rust, smut and bacterial millet images quite accurately and efficiently.
2. As we can see in figure 12 and figure 13, with each epoch there is a improvement in the accuracy and reduction in loss. The epochs carried alternatively with Adam (20 epochs) and SGD optimizers (30 epochs) twice in order to improve the accuracy.

Table 2: Parameters of GoogLeNet Architectrre

Model Parameters	
Optimiser	SGD and Adam
Loss	Categorical Cross Entropy
Training Parameters	
Batch Size	16
Learning Rate	0.001
Epochs	100

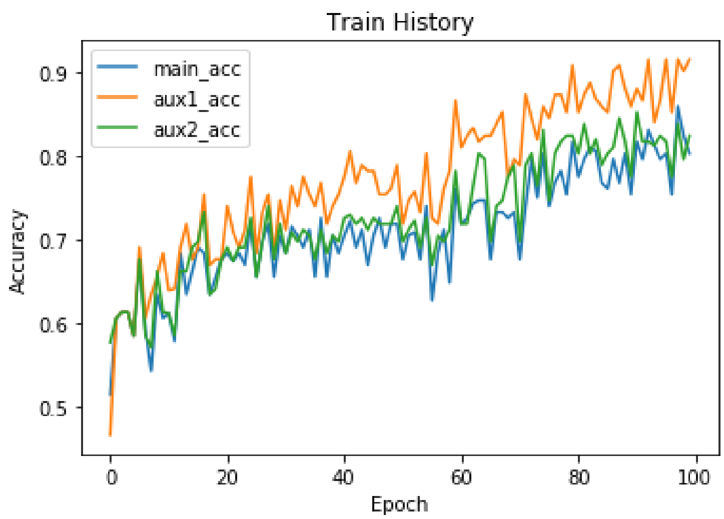


Figure 12: Train History of Accuracy

3. Since most of the downy mildew disease pictures resemble a healthy millet crop, hence it is being predicted as healthy.

4. The accuracy is also not very high when predicting viral disease as the dataset is limited.

5. At first identifying whether the input image contains millet crop or not further results in a little drop in accuracy

6. Since the model is integrated inside a server, it takes around 4-5 seconds to load the model and predict the result for the image.

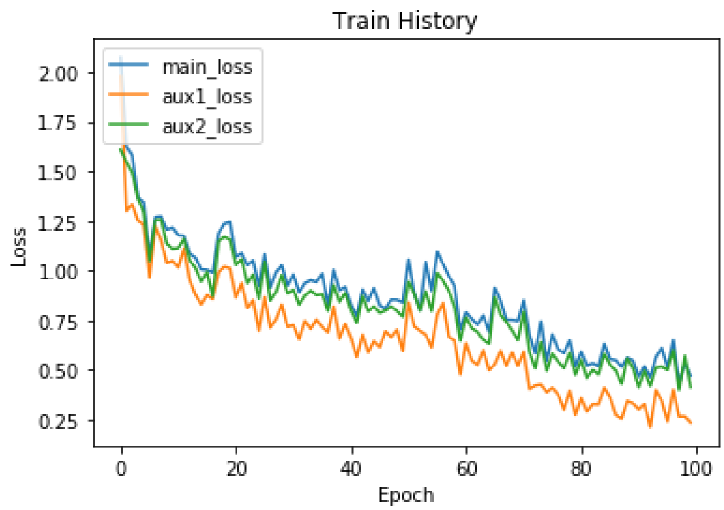


Figure 13: Train History of Loss

6 Conclusion and Future Work

Millets are the lifelines of dry regions of Asia and Africa for food and fodder. Some varities of millets are majorly grown in India. These are able to survive the hottest and most arid climates. Also, there are many health benefits of millets. Hence, this research plays an important role in contributing to the argicultural sector. p Conclusions of our work are mentioned below.

- We proposed a solution using GoogLeNet architecture to detect diseases in millets which may help farmers to analyse their millet crop's health.
- The model is deployed on Django REST API and it predicts whether the millet crop is suffering from some of the specific diseases or not.
- This was a five-way classification problem with the labels namely, healthy, smut, rust, ergot, and bacterial.
- The application also provides the remedy for the particular disease through a dialog box.

Future work includes:

- Collecting a large dataset by field work

- Increasing the dataset for bacterial and viral diseases.
- Integrating the model inside the application so that it can be used anytime and anywhere
- Replying the user with regional voice message.
- Further optimising the application by feeding more information about the diseases and methods of curing them.

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