Hybrid Optimization of Coccidiosis Chicken Disease Prediction, Detection and Prevention Using Deep Learning Frameworks

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Introduction

Coccidiosis poultry disease is one of the most important diseases caused by protozoans of the genus Eimeria which is mainly transmitted via the fecal-oral route. Due to its fast spread, poultry production is affected in a great way leading to losses and a threat to food security. In the event of an outbreak, severe losses are incurred attributed to the high cost of treatment, isolation of affected birds, and low-quality produce from the birds. As is the case with all other diseases, early diagnosis of coccidiosis disease would greatly help to offset the cost burden to farmers and also minimize the occurrence of zoonotic diseases to the consumers. However, the available conventional techniques of diagnosis which are mainly sound distinctions and visual observations, are time-consuming, labor-intensive, and inaccurate diagnosis by the farmers.

Figure 1. Chicken infected with Coccidiosis. *Source: Farmers review Africa*

This study presents a deep learning machine vision-based early detection, prediction and auto vaccination technique to aid poultry farmers tackle the disease. Deep learning is a subset of machine learning inspired by the anatomy of the human brain and has recently gained application in agriculture. The detection was aided by Convolutional Neural Networks (CNNs) which are the most effective and versatile deep learning architectures. They work by the principle of mimicking the human brain thus being able to interpret things the same as humans would, and even better. They have gained much attention and popularity because of their multi-later processing ability, less computation power is needed, and permit extracted features to be optimized. Therefore, they allow the computer system to capture only the required data, classify and recognize automatically, and hence trigger an action to be done as per the data captured.

The objective of this study, therefore, is to develop a novel system to predict, detect and automatically give vaccinations to the birds to protect them from contracting the disease with minimal or no human intervention. This will be enabled by fecal images of birds suffering from coccidiosis.

Materials and Methods

Dataset

For purposes of this study, fecal images of coccidiosis were obtained from Kaggle Datasets and processed for purposes of training the model. Kaggle is a public online community that offers open-source datasets for deep learning. The dataset contained 2476 colored images of coccidiosis each of size 224 by 224 pixels and 2404 images of healthy fecal matter with similar properties as those of coccidiosis, which were all labeled and annotated for training.

Figure 2. Fecal image of Coccidiosis: *Source: Dataset*

Figure 3. Fecal image of Coccidiosis: *Source: Dataset*

Model's Architecture

The transfer learning approach was used in the training of the models. Images of size 224 by 224 pixels were fed into the convolution layers as inputs for ResNet50, MobilenetV2, and VGG19. An image size of 299 by 299 pixels was used for the Xception model architecture. The batch size of the input images was set to 32. After the convolutional layer, which operates over a 2 by 2-pixel window, is the max-pooling layer, which has filters with narrow receptive fields of 3 by 3. A combination of these layers takes place leading to the formation of a single block which is applied iteratively while raising the network's filler depth to integer values such as 32, 64, 64, 128, 128, 256, 256, and 512 which makes it a full block convolution. Adam optimizer was used for VGG19, MobilenetV2, and Resnet50 with a learning rate of 0.001 to minimize the error. The Sparse Categorical Crossentropy probabilistic class was used to compute the loss between the predictions and the labels and SoftMax activation function in the output layer.

Autovaccination

Embedded systems offer a novel way of deploying deep learning models in real life and using them to make inferences. In this setup, Raspberry Pi 4 model B, 4Gb RAM was used to deploy the TensorFlow Lite quantized model. The micro-submersible pump was connected to a 5V relay module to offer protection to the Raspberry Pi board. The VCC port for the relay module was connected to General Input and Output (GPIO) pin 17 which was configured to give a signal whenever coccidiosis was detected. To get the image data, a USB webcam was connected to the Pi USB 3.0 port.

Results and Discussion

The dataset obtained from Kaggle with four classes was used to develop the Convolutional Neural Network to detect and classify coccidiosis disease from infected fecal images. From the different architectures that were used, ResNet50 produced the top performance of 96.32% after finetuning the model. Before finetuning was done, the model produced an overall test accuracy of 94% using the transfer learning approach. To increase this accuracy, finetuning was done for additional 10 epochs and a learning rate of 0.0001 to minimize the overfitting of the model. Accuracy scores for the other models were MobilenetV2 model 93.95%, VGG19 model 89.15%, and Xception model 96.14%. However, it is worth noting that the Xception model performed closely to ResNet50.

Model	Test Accuracy (%)	Validation Accuracy (%)
VGG19	89.15	90.63
Resnet50	96.32	95.96
MobileNetV2	93.95	93.75
Xception	96.14	96.75

Table 1. Model's Performance

The training and loss curves for the best performing model was as shown in fig 4 and fig 5 respectively.

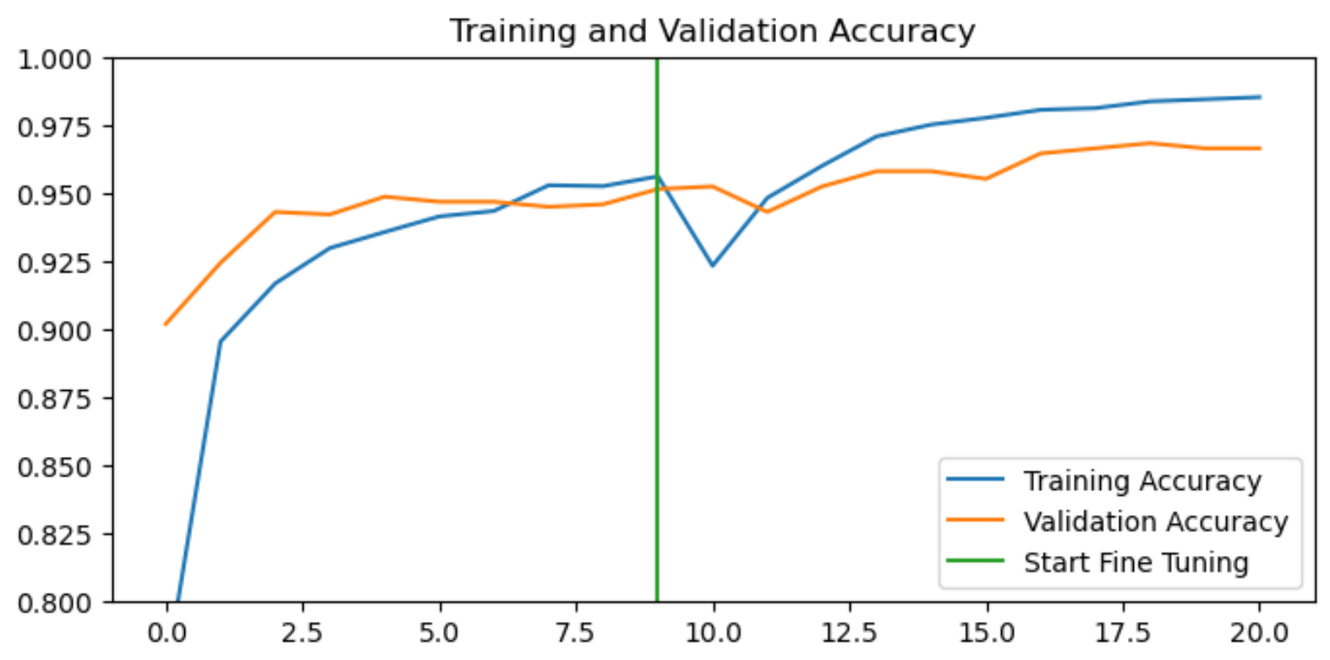

Figure 4. Training curve

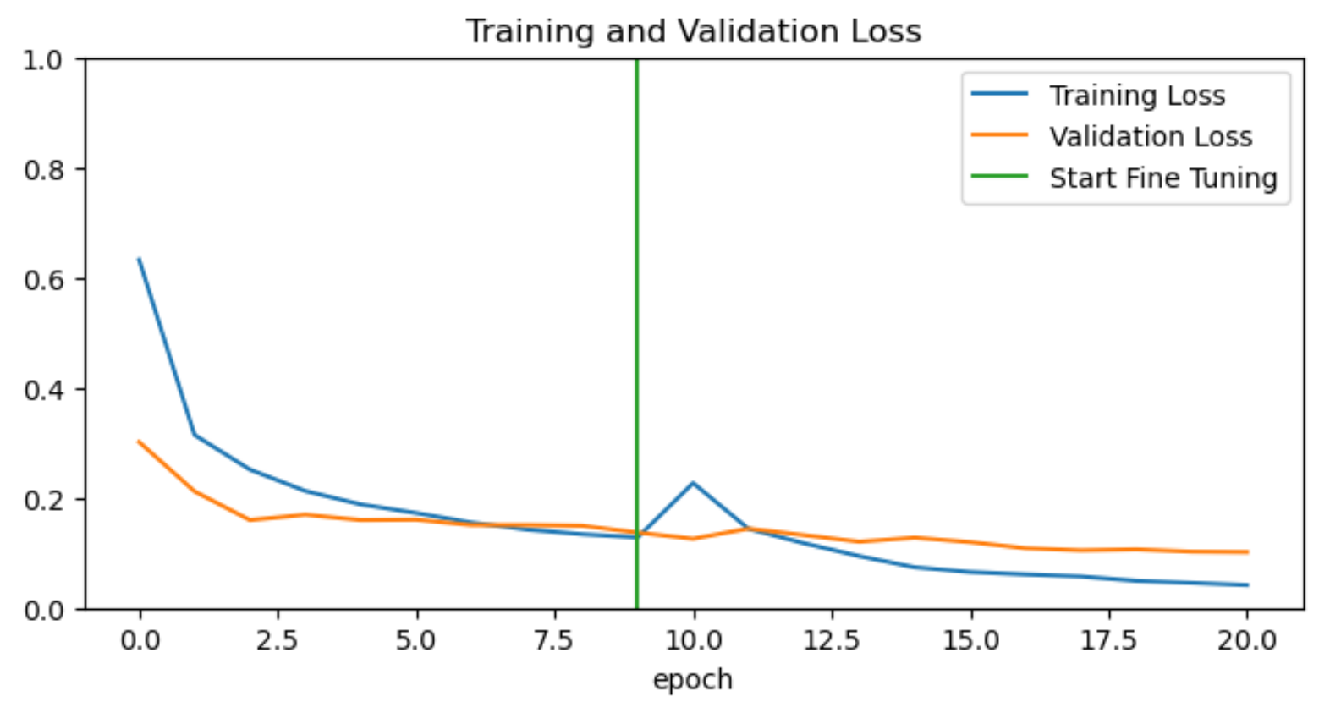

Figure 5. Loss curve

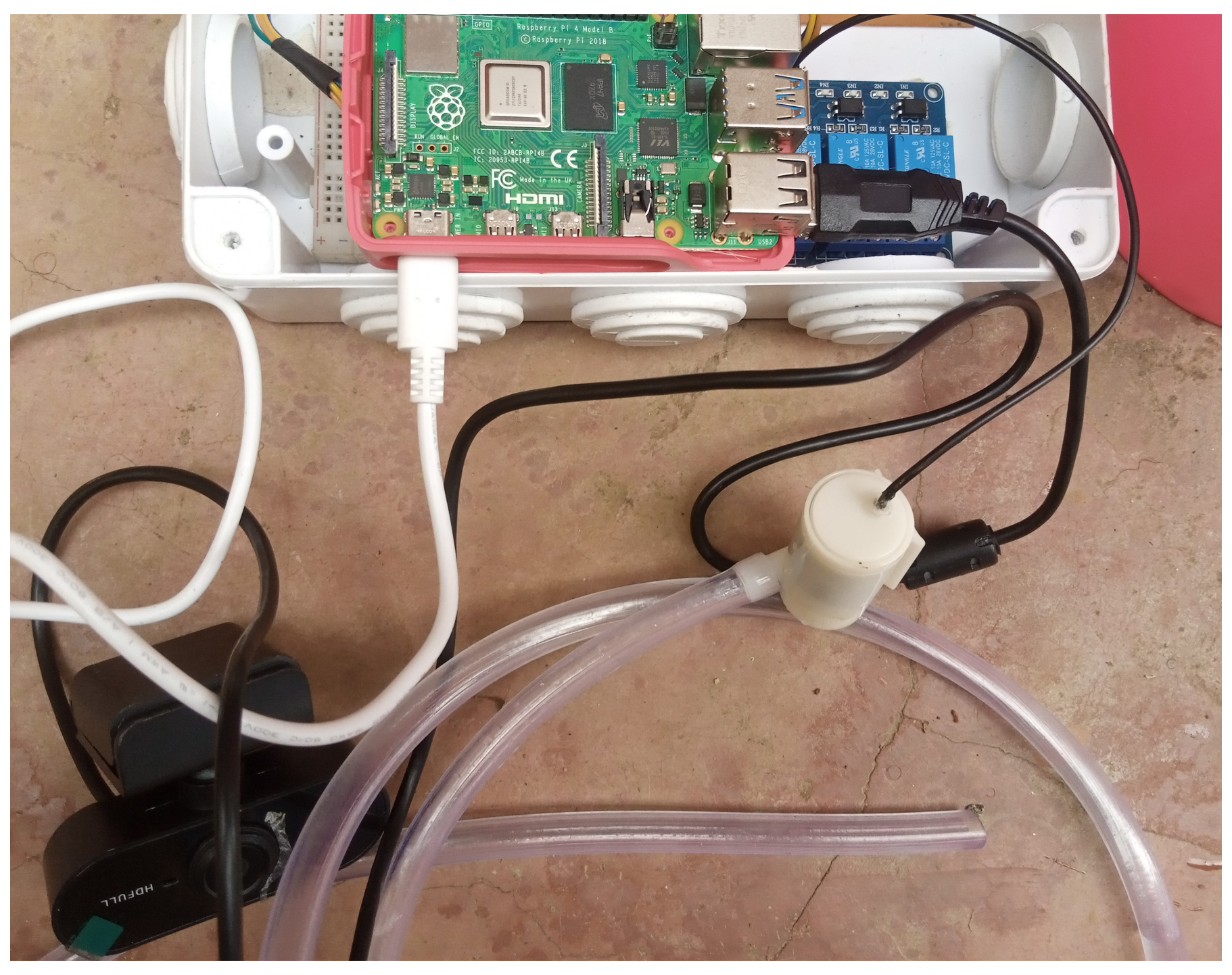

Figure 6. Autovaccination components

Conclusion

As a result of using deep learning technology to identify coccidiosis disease in chicken houses, vaccination systems can be used to counter the onset of the disease and hence minimizing on losses incurred by the mass death of chickens. Instances of the disease occurrence can also be recorded and reported to the farmer to enable them to make informed measures and decisions on their rearing practice.

Benefits

Leveraging artificial intelligence comes in handy in that farmers can boost and expand their production with minimal reduction in losses anticipated as a result of a disease outbreak. In combination with other systems, this paper proposes a framework where the integration of other systems can be combined to build intelligent chicken farming systems while leveraging deep learning and computer vision. These include; live streaming of the detections made, integration with feeding systems, and recommendations to farmers based on data collected.

References

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