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CLASSIFICATION OF SOYBEAN LEAVES USING THE EDGE IMPULSE PLATFORM

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Summary- Modern agriculture increasingly relies on technology, including artificial intelligence (AI) image classification, to improve crop management. This study focuses on applying image classification to diagnose diseases in soybean leaves using a convolutional neural network. The results show 95% accuracy in identifying healthy and diseased leaves, indicating the potential of AI as an effective tool for monitoring crop health.

Key words: image classification, artificial intelligence, agriculture, soybeans, leaf diseases

INTRODUCTION

Uncertainty about the health of soybean plants is a persistente challenge for farmers, given the economic relevance and growing demand for this crop in global agricultural scenarios. Soy plays a key role in both food and feed production, making its health essential for food security and the economy [1].

A Soybean agriculture faces significant challenges, including the spread of specific diseases that can reduce production and increase management costs. Diseases such as Asian rust and powdery mildew can spread quickly, causing substantial losses to farmers. Therefore, early and effective detection of these diseases is of utmost importance for modern soybean agriculture [1].

Before the advent of artificial intelligence and computer vision, farmers relied primarily on visual observation to detect diseases in soybean plants. This approach was prone to human error and often resulted in inaccurate diagnoses. Furthermore, it was difficult to monitor large areas of cultivation efficiently. This made disease detection and management a constant challenge for farmers [2].

The characteristics of diseased soybean leaves can vary depending on the type of pathogen affecting them, but they usually have visible signs that indicate health problems [3]. Diseased soybean leaves often exhibit changes in color, such as yellow or brown spots or necrosis in certain areas. Furthermore, they may have irregular textures, with roughness, wrinkles or deformations.

Visible lesions such as pustules, mold spots or insect marks are also common on diseased leaves. These diseases not only reduce plant productivity but also increase production costs due to excessive use of pesticides [3]. In Fig. 1 it is possible to identify some of these characteristics

Figure 1 – Sick Soybean Leaf [7].

Accurate identification of these characteristics plays a key role in early detection and differentiation of healthy soybean leaves from those affected by disease, enabling effective intervention to ensure plant health and crop productivityand positive implications for the environment and agricultural sustainability. Reduced pesticide use resulting from early detection contributes to reduced environmental contamination and promotes more sustainable agricultural practices [3].

In this context, the project aims to classify images of soybean leaves, with the aim of distinguishing those that are healthy from those affected by diseases. To perform this task, the "SoyNet" dataset was used. This dataset includes images of healthy and diseased soybean leaves, which were captured in Jabalpur under natural light conditions using a Nikon L810 camera and a Motorola g40 cell phone. The images went through a pre-processing process, being converted to grayscale and resized to a resolution of 256x256 pixels [4].

In Fig. 2, the images captured without any type of prior treatment are shown, that is, the original images. In Fig. 3, the same images are found after having gone through the pre-processing process. This prior treatment is essential to prepare the images before they are used in the classification process.

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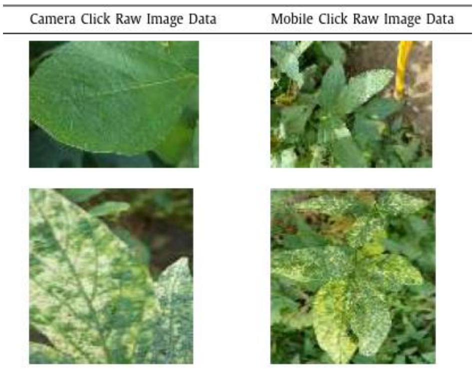

Figure 2- Images without Processing [7]

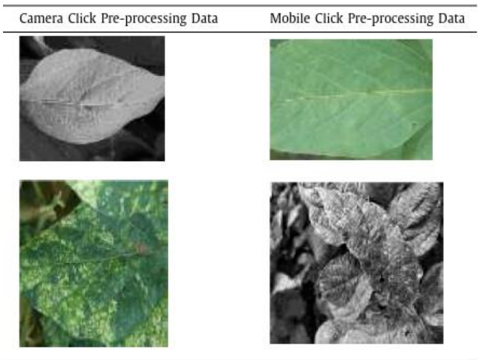

Figure 3 – Pre-Processed Images [7]

This "SoyNet" set of over 9,000 images was created to support research in machine learning and deep learning for disease classification in soybean leaves. It is divided into two subfolders: one for raw data and one for preprocessed data. These high-quality features are essential for developing robust machine learning models in the area of soybean agriculture [4].

Using computer vision algorithms, the application analyzes characteristics such as color, texture and lesions. This allows for the early identification of diseases, saving resources and reducing environmental impacts. Furthermore, image analysis can be integrated into real-time monitoring systems, ensuring effective plantation management [4].

DEVELOPMENT

The study in question adopted an image classification approach that is based on the application of advanced algorithms and techniques. This approach enables a computational system to automatically identify objects present in an image, assigning them specific categories [5].

Categorization occurs based on a comprehensive analysis of various visual attributes, including shapes, colors, textures and other relevant factors. To achieve high-accuracy results, pre-labeled datasets were used, in which the system learned to establish solid correlations between visual patterns and specific categories [6]. This methodology allows efficient and precise image analysis, with wide applications in several areas.

The application of image classification proves to be particularly valuable in the context of modern agriculture, as evidenced by a concrete example related to the health assessment of soybean leaves. This approach allows for agile and accurate detection of healthy leaves and those affected by diseases, providing crucial information that enables farmers to make informed and strategic decisions for the management of their plantations [7].

When creating the model on Edge Impulse, a platform specialized in developing and implementing machine learning models for embedded devices, 368 images of healthy and diseased leaves were used, with equal distribution in both categories. To evaluate the effectiveness of the model, these images were divided into two sets: 80% for training and 20% for testing, as detailed in Fig. 4.

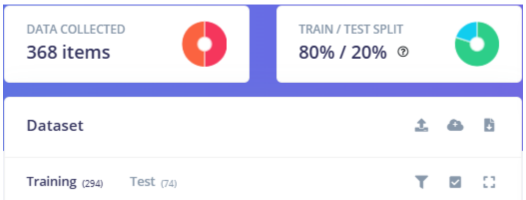

Figure 4 – Photo Separation on Edge Impulse

After selecting the data, the next step on the platform is defining the standardization of images and labels. In Fig. 5, the configuration of the image size to 96x96 pixels can be seen, along with the definition of two output labels: "Sick_Soy" and "Healthy_Soy".

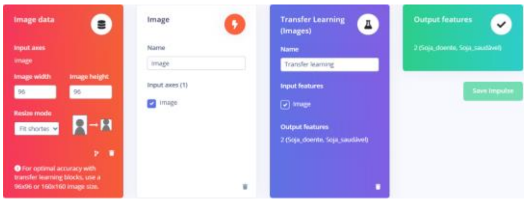

Figure 5 – Standardization and Output Label

RESULTS AND DISCUSSIONS

In order to achieve more accurate results, the team conducted a series of tests, adopting different approaches. One of these approaches consisted of increasing the number of neurons and experimenting with different models, as explained below.

Initially, sets of 147 images of sick soybeans and 147 images of healthy soybeans were used. For the tests, 37 images were selected from each category. In the first phase, the team opted for a configuration that involved 40 training epochs, using the MobileNetV2 architecture with dimensions of 96x96 and a scale factor of 0.1. This setup was configured with 8 neurons and a dropout rate of 0.1, as described in Fig. 6 .

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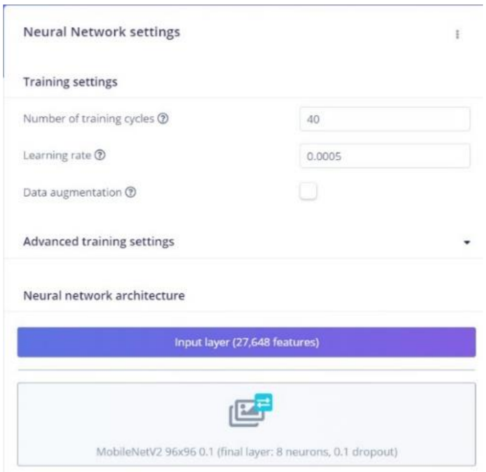

Figure 6 – First training settings

As illustrated in Fig. 7, the initial model showed an accuracy of 86.4%. However, further analysis of the confusion matrix, a key tool in evaluating classification models, revealed that the initial model was experiencing particular difficulties in classifying images of healthy soybeans. This distinction is crucial to avoid mistakes in detecting diseases in soybean plants, such as false positives or false negatives. As a result of this analysis, the team decided to explore an alternative approach with the MobileNetV2 model by tuning its parameters.

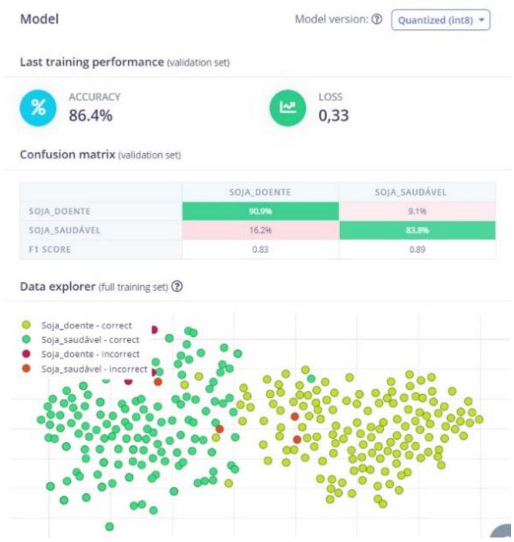

Figure 7 – Trained Model and Confusion Matrix

In order to improve accuracy, the team carried out a second test, replacing the previous model with MobileNetV2 with dimensions of 96x96 and a scale factor of 0.35. The 8 neurons and the dropout rate of 0.1 were maintained. As evidenced in Fig. 8, the result obtained showed an increase in accuracy to 91.5%.

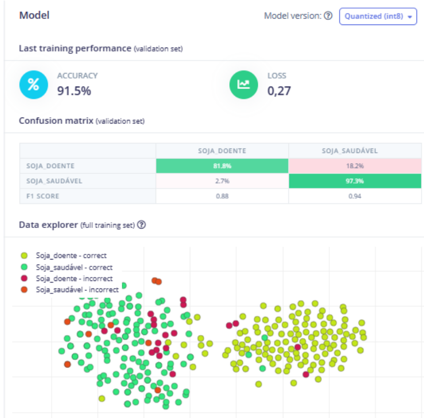

Figure 8 – Second Trained Model and Confusion Matrix

These results demonstrate the sensitivity of applying AI in detecting foliar diseases in soybean plants and its ability to significantly contribute to modern agriculture. The accuracy achieved, around 91.5%, is promising and suggests that this approach could be an effective tool for farmers in early identification of health problems in their crops.

In addition to disease detection, AI in soybean agriculture can also be applied in other areas, such as monitoring pests, optimizing the use of water resources and forecasting yields. The integration of drones equipped with high-resolution cameras can provide a detailed aerial view of crops, allowing early detection of problems and optimization of agricultural management [7].

In summary, the results of this study indicate that the application of AI to classify soybean leaf diseases has great potential to revolutionize agriculture, providing farmers with valuable tools to improve crop management and ensure healthy, high-quality production. .

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