Abstract

The detection of surface anomalies such as dents, cracks, and rust on aircraft surfaces is crucial for ensuring safe and reliable flight operations. In this research article, we propose a novel approach for identifying these surface anomalies using a combination of convolutional neural network (CNN), decision tree, and ensemble learning techniques.

We first collect and preprocess a dataset of labeled aircraft images, which are used to train a ResNet-based CNN to extract features.(if reqd we can use any transfer learning technique like VGG to reduce model training time instead of ResNet). We then apply dropout regularization to the features to prevent overfitting and improve generalization performance. A decision tree is trained using the most important features selected from the CNN, which are used to identify dents, cracks, and rust on aircraft surfaces.

Multiple decision trees or CNNs with different hyperparameters are combined using ensemble learning techniques such as bagging or boosting to improve the robustness and accuracy of the model. The resulting model is evaluated on a test dataset of labeled aircraft images, and hyperparameters are fine-tuned to optimize performance.

Experimental results should show that our approach achieves state-of-the-art performance in identifying dents, cracks, and rust on aircraft surfaces, with an accuracy of more than 98%.

Research Methodology:

Data cleaning: A webscraped dataset of labeled aircraft images is collected from various sources, with images of dent, crack, and rust are provided.The dataset is should be cleaned and preprocessed to standardize the size and format of the images.

CNN Training: A ResNet-based CNN is trained on the preprocessed dataset using a cross-entropy loss function and stochastic gradient descent optimizer. The CNN is trained to extract features from the images that are relevant to identifying surface anomalies.

Dropout Regularization: To prevent overfitting, dropout regularization is applied to the extracted features of the CNN. Dropout rates are experimentally determined to optimize performance.

Decision Tree Training: A decision tree is trained using the most important features selected from the CNN. The decision tree is used to identify dents, cracks, and rust on aircraft surfaces.

Ensemble Learning: Multiple decision trees or CNNs with different hyperparameters are combined using ensemble learning techniques such as bagging or boosting to improve the robustness and accuracy of the model. The optimal ensemble configuration is determined experimentally.

Model Evaluation: The resulting model is evaluated on a test dataset of labeled aircraft images using metrics such as accuracy, precision, recall, and F1-score. The model is compared to existing state-of-the-art methods for identifying surface anomalies on aircraft surfaces.

Hyper parameter Tuning: Hyperparameters such as the number of trees in the ensemble or the dropout rate are fine-tuned using grid search or Bayesian optimization to optimize performance.

Experimental Analysis: An analysis of the experimental results is conducted to determine the effectiveness of the proposed approach in identifying dents, cracks, and rust on aircraft surfaces. The robustness of the model to variations in lighting, scale, and orientation is also evaluated.

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**Note from the client:**

File(Zip) after data cleaning and preprocessing should be provided to client.

Around 5000 labeled images of Dents,Rust,Cracks are provided since they are web scraped might contain irrelevant so data cleaning reqd and if reqd we need to use some data augmentation also to improve accuracy.

Following visualization documents to be shared:

1.Visualization charts of training and validation loss and accuracy showing model accuracy.

2.Confusion matrix.

3.Evaluation metrics like F1 score,Precision and Recall in tabular form

4.CNN layer wise model architecture.