

# Robustness of Convolutional Neural Network in Classifying Apple Images

Dzalfa Tsalsabila Rhamadiyanti

*Department Informatics*

*Telkom University*

Bandung, Indonesia

dzalfatr@student.telkomuniversity.ac.id

Suyanto Suyanto

*Department Informatics*

*Telkom University*

Bandung, Indonesia

suyanto@telkomuniversity.ac.id

***Abstract***—Apple is one of the popular fruits for public consumption. People can distinguish many apples based on their colors and shapes, such as the Braeburn Apple with skin color varies from orange to red, the Pink Lady Apple that is red with pseudo pink, the Crismon Snow Apple that has dark red skin. Recently, computers can automatically recognize them using digital image processing techniques such as Convolutional Neural Networks (CNN). In this paper, a CNN-based classification model of apple types is developed using 1856 apple images from three classes derived from the fruit-360 dataset on the Kaggle website, and its robustness is then examined. Two types of testing have been carried out in this study: testing five scenarios for sharing training data and testing five scenarios for robustness to noise. An examination based on 5-fold cross-validation shows that CNN is robust to decreasing the portion of training set size up to 50% to get high accuracy of 99.97% in classifying 50% testing set, which is better than previous models that use VGG16, faster R-CNN, and Tanh. Decreasing the portion training set to 40% and 30% reduces the accuracy to 95.97% and 95.29%, respectively. Adding low-level noises of 10% into the testing images decreases the accuracy slightly to 99.17%. However, high-level noises of 50% drastically make the accuracy drastically drops to 63.93%.

***Keywords***—apple classification, convolutional neural network, image processing, robustness, skin color