Computer Vision-Based Inventory Management and Product Recommendation System

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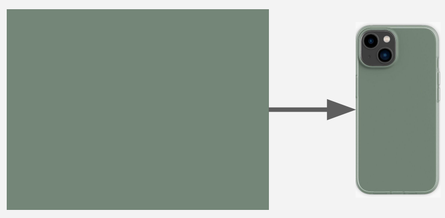
Overview

Motivation

The project's motivation lies in the critical role of customer experience in a company's success. Enhancing customer experiences can lead to business growth and loyalty. Machine learning offers the potential to transform the way businesses operate by providing personalized product recommendations. Existing search algorithms rely heavily on keyword matching, which can lead to inaccuracies due to keyword misuse in product descriptions. This project leverages computer vision for precise analysis of visual data, simplifying brand and color-based product searches.

Annotated training image



Xanadu green

Xanadu green iPhone case

Problem and Solution

- **Problem:** Inaccurate product search results hinder customer satisfaction.
- **Solution:** Develop an algorithm using computer vision to classify products based on brand and color.
  - Employ the state-of-the-art YOLOv5 model, a powerful object detection model pre-trained on Microsoft's 2017 miniCOCO dataset.
  - Phones were not part of the original dataset, requiring the creation of a custom dataset.

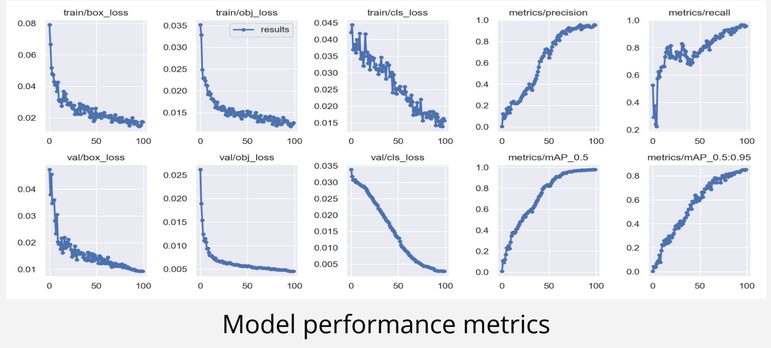
Data Collection

- To train the model, a custom dataset was meticulously crafted, comprising over 200 images of various popular phones.
- Each phone was classified into one of five classes: iPhone, Google Pixel, Samsung, Sony, and Motorola.
  - Based on the brands' popularity and their distinctive designs.
- Images were selected to show each phone's exterior.
  - The exterior often features distinct brand logos, simplifying class differentiation.

Validation set with annotated labels

Model Performance Metrics

- **Box Loss:** Measures alignment of predicted bounding boxes with actual. Training and validation losses show improvement, indicating accurate bounding box predictions.
- **Objectness Loss:** Quantifies the model's certainty in object presence. Consistent decrease suggests improved object discernment.
- **Classification Loss:** Reflects object classification accuracy within bounding boxes. Downward trend indicates improving classification accuracy.
- **mAP Metrics:** Holistic evaluation of precision across various IoU thresholds. Both metrics show steady improvement, indicating the model's robustness.

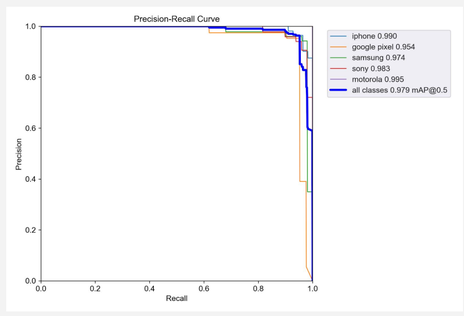


Model performance metrics

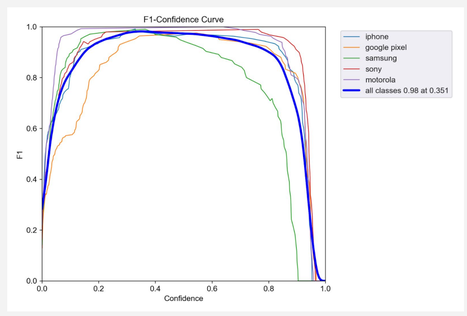
Results

Model Evaluation

- **Precision-Recall Curve:** Illustrates the balance between precision and recall at different confidence thresholds.
- **Precision:** A high precision score indicates a low false-negative rate. It measures the model's ability to accurately identify a specific category.
- **Recall:** High recall indicates a low false-positive rate, reflecting the model's capacity to correctly identify all instances of a specific class.
- **F1 Score:** The F1 score is a harmonic mean of precision and recall, providing a balanced assessment of the model's performance across different confidence levels.



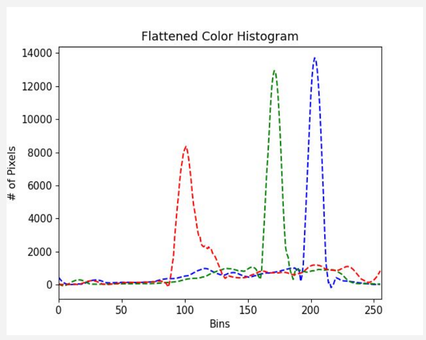
Precision-Recall Curve



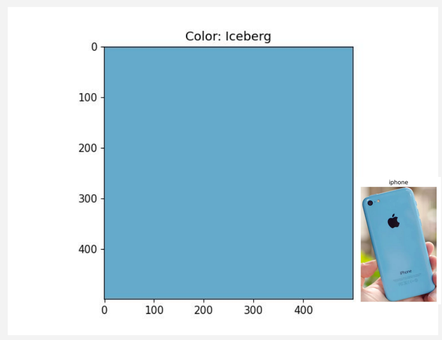
F1-Confidence Curve

Color Detection Algorithm

- Developed a color sorting algorithm to complement brand classification.
- **Process:**
  - Flatten each image to create a 3D histogram.
    - RGB channels per pixel.
  - Extract peak instances of each channel.
    - Generates RGB combination.
  - Calculate Euclidean distance to 865 existing color combinations.
    - Determines approximate color.
  - Import the trained model to display predicted brand and color.
- Achieved 96% accuracy in sorting phones by brand and color.



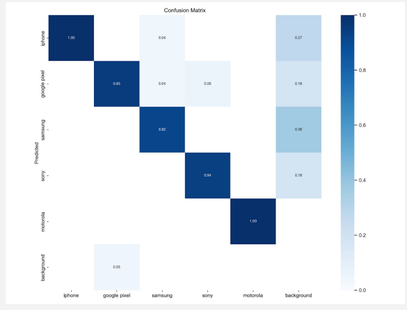
Flattened color histogram



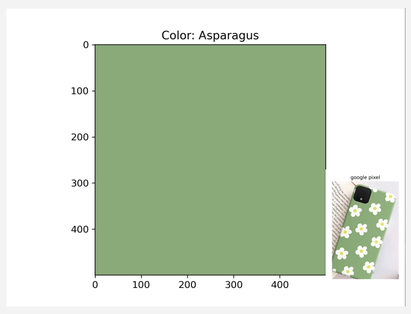
Predicted color (iceberg blue)

Results

- **Confusion Matrix:** Provides a visual representation of how the model's predictions compare to the actual labels.
  - **Precision:** The model demonstrates strong accuracy, especially for categories like iPhone (100%) and Motorola (100%).
  - **Improvement:** Some overlap is observed between Google Pixel and Sony, indicating potential areas for improvement.
    - **Background Recognition:** The model frequently misinterprets backgrounds, suggesting that the model may be identifying certain background features as belonging to a phone category.
    - **HSV (Hue, Saturation, Value):** Using HSV color space over RGB to handle images with filters. This could improve color consistency and accuracy in varied lighting conditions.



Confusion matrix



Color prediction for pixel with case

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