Electronics Hole Qualification Project

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Introduction

The Electronics Hole Qualification Project aims to develop a machine learning model capable of detecting *voids* and *chips* in electronic components. This project encompasses the entire machine learning lifecycle, from data collection and annotation to model training, evaluation, deployment, and integration into a web application.

Data Collection and Annotation

Due to the specialized nature of the dataset, images were collected and annotated using **Roboflow**, a platform that facilitates dataset management and labeling. The annotations focused on identifying two primary classes:

- **Void**: Areas in the electronic component where material is missing.
- **Chip**: Defects or imperfections on the component's surface.

An example of an image is shown in Figure 1.

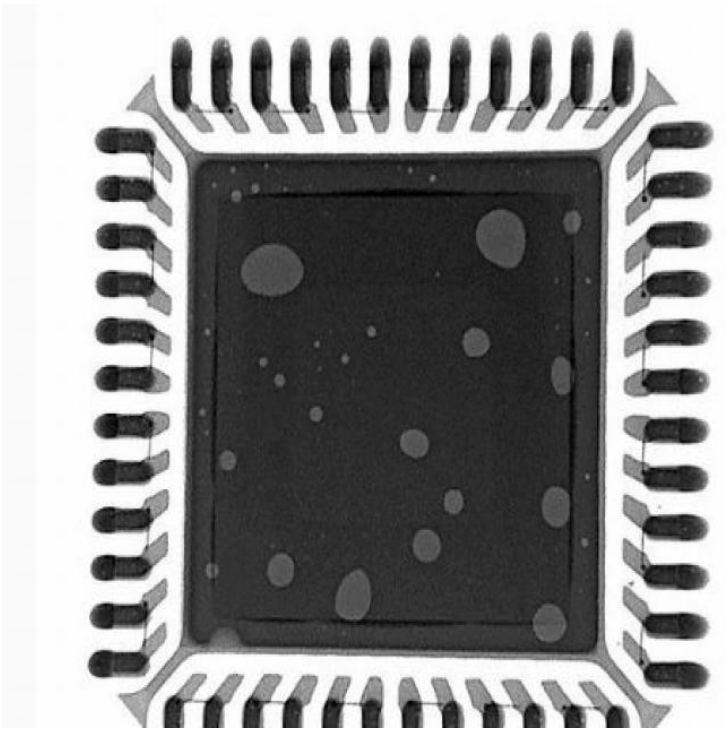

Figure 1: Sample annotated image showing voids and chips.

Model Training with YOLOv8 Segmentation

The annotated dataset was used to train a **YOLOv8** segmentation model. YOLOv8 is a great model of the *You Only Look Once* family of real-time object detection models, offering improved accuracy and speed.

Training Details

- **Architecture**: YOLOv8 Nano segmentation model.
- **Epochs**: 25.
- **Framework**: PyTorch with Ultralytics YOLO implementation.

The training process focused on optimizing the model's ability to accurately segment voids and chips in various images of electronic components.

Evaluation

The model's performance was evaluated using standard metrics:

- **Precision and Recall**: To assess detection accuracy.
- **IoU (Intersection over Union)**: For segmentation quality.

Result evalution 2.

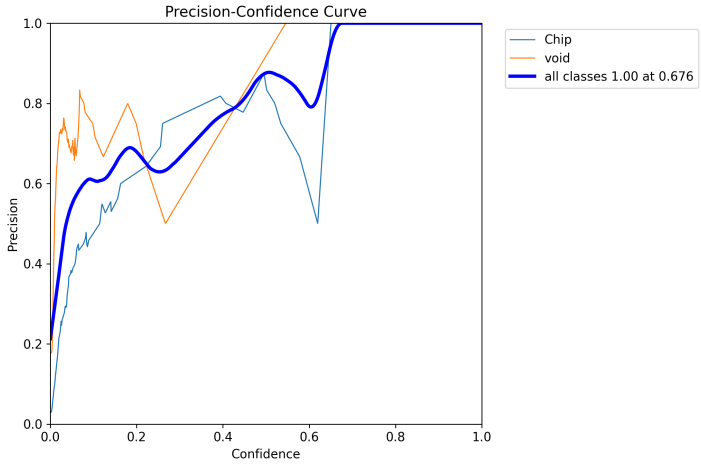

Figure 2: Evaluation

Results indicated that, despite the limited dataset size, the model achieved satisfactory performance in detecting and segmenting the target classes.

Deployment with Flask

A web application was developed using **Flask**, a lightweight web framework for Python, to provide an interactive interface for users. The application offers three main functionalities:

1. **Annotation Interface**: Integrates the **Segment Anything Model (SAM)** to allow users to upload images, perform segmentation, and assign classes. This feature facilitates the creation of custom datasets and fine-tuning of the model.

2. **Prediction and Detection**: Users can upload images to receive predictions on the presence of voids and chips. The application displays the original and annotated images side by side, along with statistical information.
3. **CSV Export**: Allows users to download a CSV file containing detailed statistics of the predictions for further analysis.

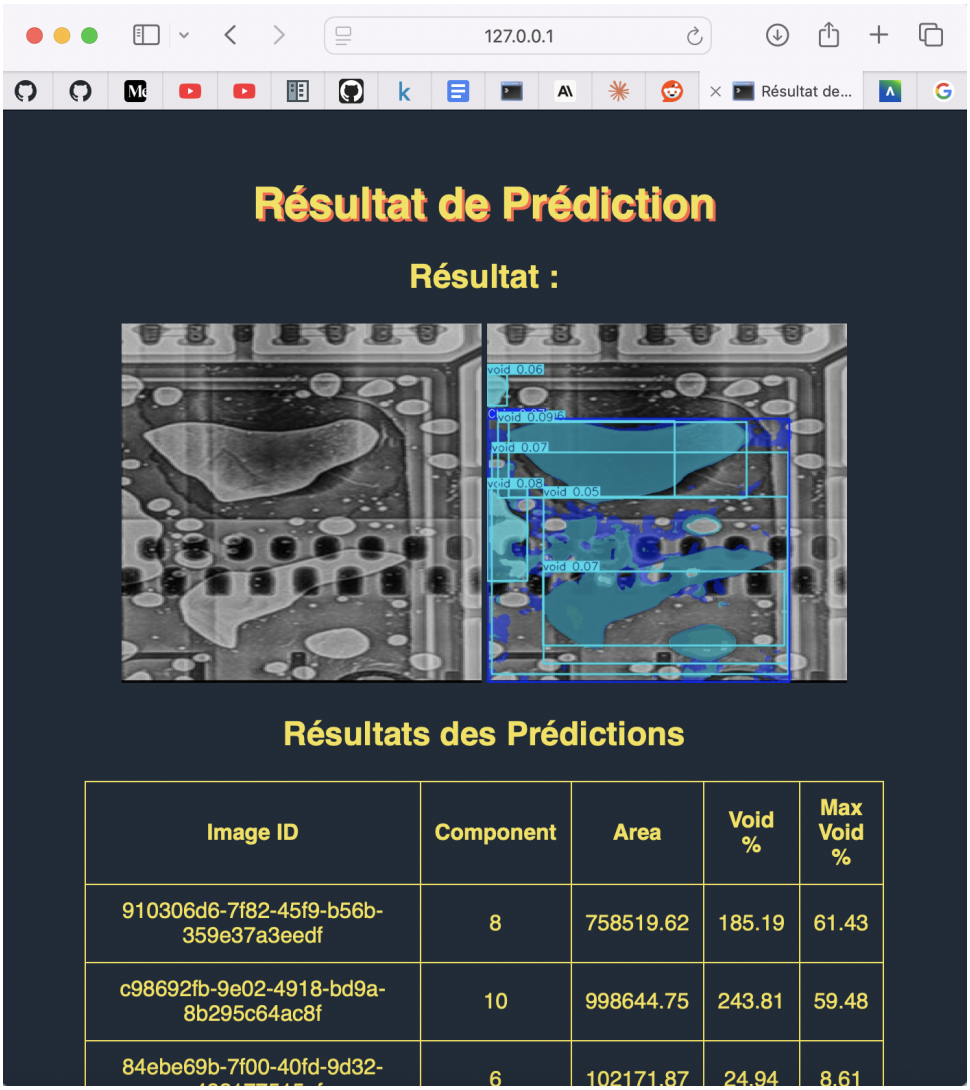

Figure 3: Web application interface showing prediction results.

Challenges and Docker Deployment

While attempting to containerize the application using **Docker**, several challenges were encountered:

- **Resource Intensive Models**: The inclusion of the SAM model, which is computationally heavy, caused the Flask server within the Docker container to become unstable and close unexpectedly.
- **Docker Limitations**: Running resource-intensive applications in Docker requires careful management of allocated resources, which was constrained in our environment.

Due to these challenges, we recommend running the Flask application locally using the following command provided in the GitHub repository:

```
python setup.py
```

GitHub Repository

The project's source code, along with instructions for setup and execution, is available on GitHub:

https://github.com/Bryan-Foxy/deployment-school

Conclusion

The Electronics Hole Qualification Project successfully demonstrates the development and deployment of a machine learning model for defect detection in electronic components. The integration of YOLOv8 for segmentation and Flask for deployment provides a practical solution with potential applications in quality control and manufacturing.

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