Electronics Hole Qualification Project

Team Members:
Fozame Endezoumou, Seth Sady, Asma Ghamacha, Reine Clara, Ketsia Talotsing

Supervisor: Dr. Souhail Hanoune

Institution: Aivancity School for Technology, Business & Society

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

Images were collected and annotated using **Roboflow**, focusing on 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.

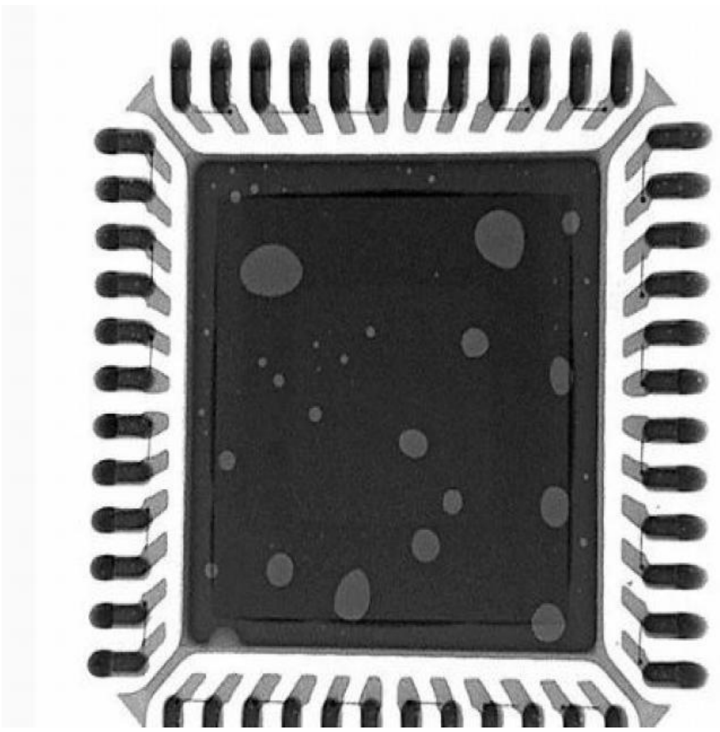

Figure 1: Sample annotated image showing voids and chips.

Model Training with YOLOv8 Segmentation

The annotated dataset was used to train a **YOLOv8** segmentation model.

Training Details

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

The training process focused on accurately segmenting voids and chips in 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.

Results are shown in Figure 2.

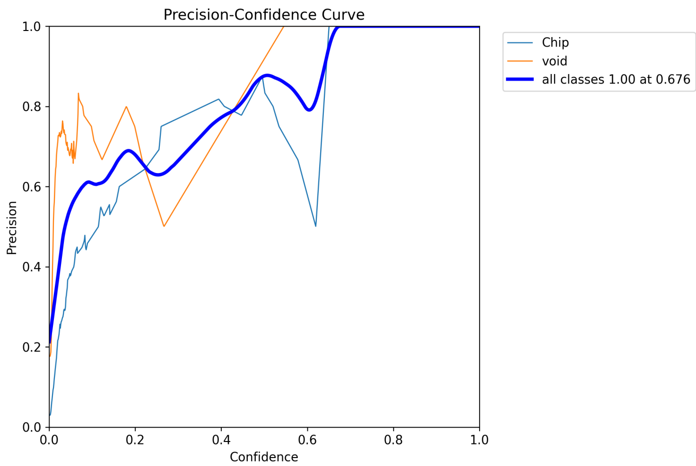

Figure 2: Evaluation metrics: Precision and Recall curve.

System Architecture

The architecture of the system is shown in Figure 3. It illustrates the workflow from data input to deployment.

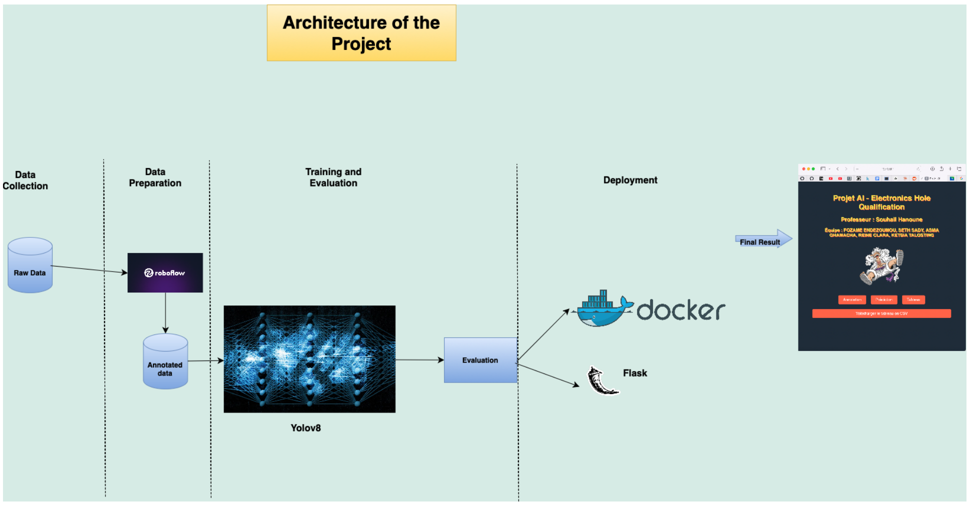

Figure 3: System architecture.

Deployment with Flask

A web application was developed using **Flask** with the following functionalities:

1. **Annotation Interface**: Uses **SAM** for image segmentation and class assignment.
2. **Prediction and Detection**: Displays predictions with annotated images.
3. **CSV Export**: Allows users to download prediction statistics.

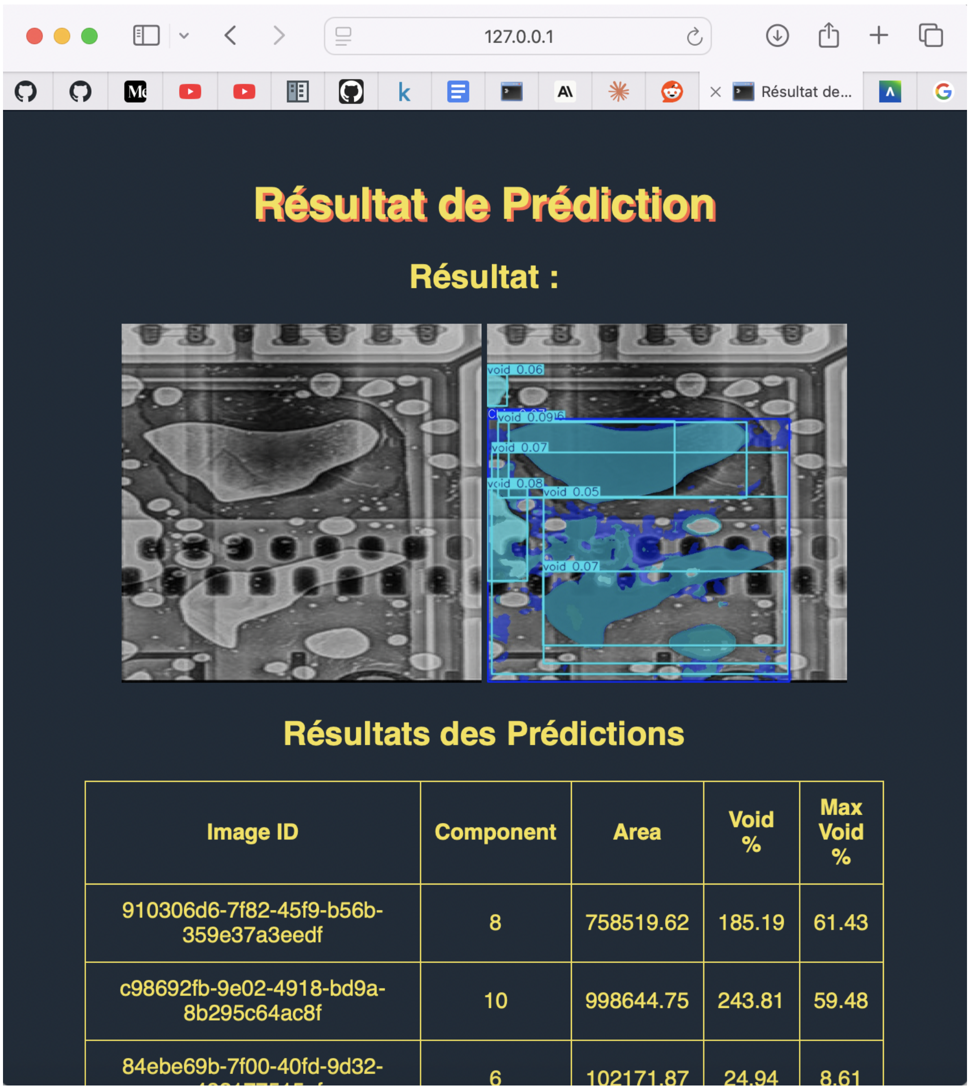

Figure 4: Web application interface showing prediction results.

Work Distribution and Synchronization

To ensure efficiency, the team divided tasks as follows:

- **Fozame Endezoumou**: Implemented the YOLOv8 model training and contributed to the Flask backend.
- **Seth Sady**: Developed the web interface and integrated the SAM model.
- **Asma Ghamacha**: Focused on dataset preparation and integration with Roboflow.
- **Reine Clara**: Conducted model evaluation and visualization.
- **Ketsia Talotsing**: Worked on deployment, including Dockerization and resource management.

Challenges and Difficulties

Several challenges arose during the project:

- **Data Limitations**: The dataset size was relatively small, which impacted the model's ability to generalize.

- **Computational Resources**: Running the SAM model alongside YOLOv8 caused performance issues, particularly during Docker deployment.
- **Dockerization**: Allocating sufficient resources to the Flask application was challenging due to hardware constraints.
- **Coordination**: Aligning schedules across team members required effective communication and planning.

GitHub Repository

The project's source code is available on GitHub:

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

Conclusion

The Electronics Hole Qualification Project demonstrates the successful development and deployment of a machine learning model for defect detection in electronic components. Despite challenges, the team achieved significant milestones, including dataset annotation, model training, evaluation, and deployment via a user-friendly web application.

Acknowledgments

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