AI/ML Object Recognition and Analysis

ELECOMP Capstone Design Project 2025-2026

Sponsoring Company:

Zebra Technologies
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Lincoln, RI 02865 http://www.zebra.com

Company Overview:

Zebra is a global leader in enterprise mobile computing, data capture, barcode printing and radio frequency identification devices. We provide customers in more than 170 countries with tools to help them achieve their mission-critical strategic business objectives. We have more than 8,800 employees in approximately 120 locations around the world. Use the country selector below to find contact information for our offices, warehouses and facilities.

Technical Directors:

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Project Motivation:

This project its motivated to identify certain printed patterns/objects on label. Once these objects are identified, they will be compared against an ideal version. We would like to build a library of objects that we can successfully identify and modify their outcomes to "calibrate" a printer to its optimal print quality.

Anticipated Best Outcome:

The major milestones we would like to achieve are listed below:

- Determine best machine learning algorithms to use for this application
- Successfully train a machine learning model that can identify objects in an image
- Based on identified object, machine learning model with modify input parameters and reevaluate image until desired outcome is achieved
- Identify any objects that are problematic and highlight why they are
- Determine what resolution / camera specifications are necessary to identify the objects in an image
- Specify processing needs for machine learning in production implementation
- Document training process thoroughly and create a list of what tools are needed to duplicate training, this includes both software and hardware

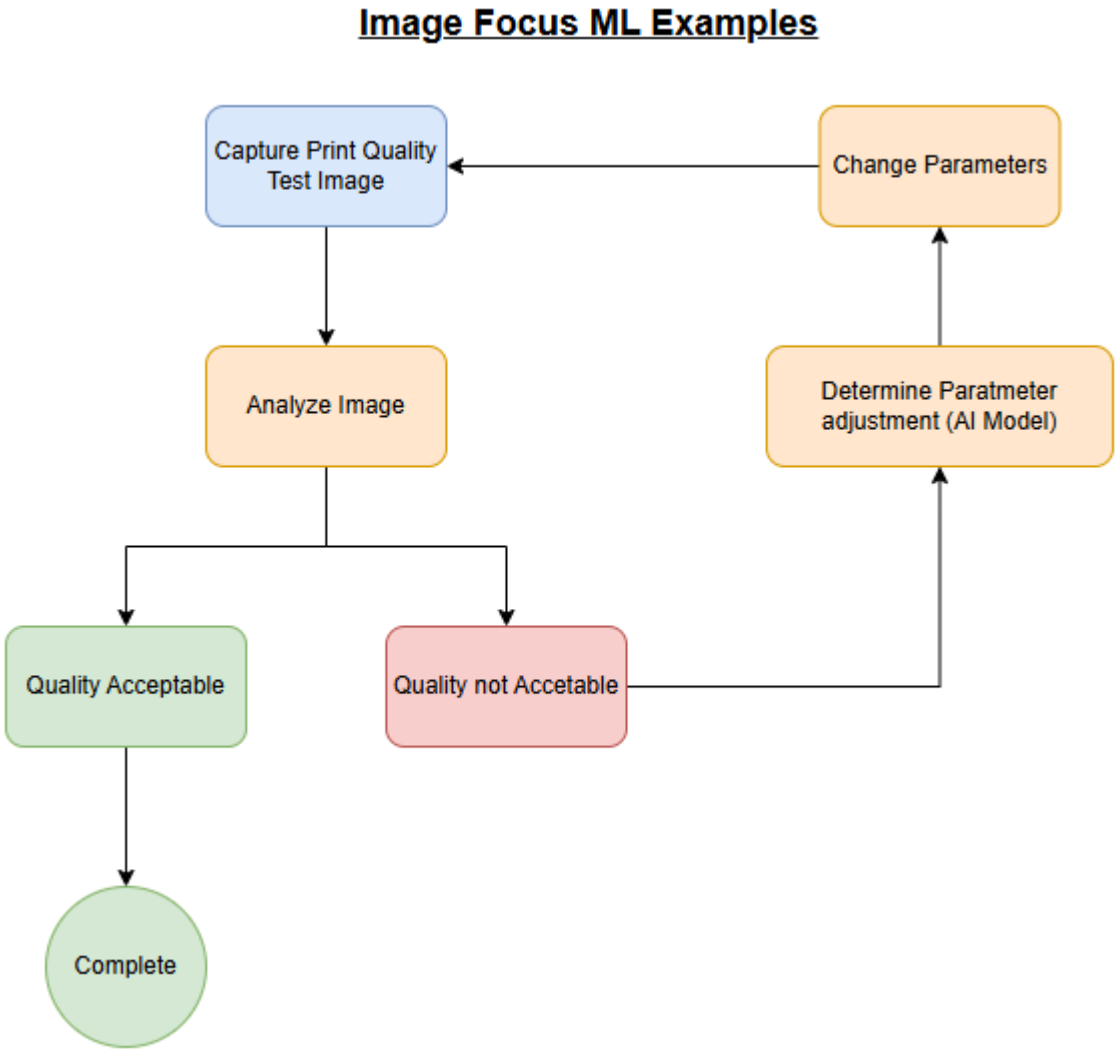
Project Details:

A camera for this project has already been chosen and proven to work from the 2023-2024 group that worked on the project. In current proof of principle setups, we have used digital USB microscopes like the one below:

This camera integrates easily into python, so you are able to write a script to capture the image and save them locally for model training. We can provide

We will also provide any hardware needed to efficiently train the machine learning model; we will purchase a PC specifically for this project, based on your recommendations if it is necessary. Once the model is trained, will we also be looking for specifications on what type of hardware will be needed to run the model in a production environment (no additional training).

An example of the type of training we intend to do can be found in the example below:



Is the block diagram above, we show a workflow that captures an image, analyzes the image to determine whether the print quality is acceptable or not. If it is, the routine ends, and we know the print quality parameters settings are optimal. If not, the machine learning model will identify the image has poor print quality, change the necessary print quality parameters, and capture a new image for analysis. This will continue until the optimal print quality is achieved. This is an example of the type of analysis we wish to perform, analyze and image, determine if it meets a

set of criteria, if it does not, make the appropriate corrections to meet the criteria, and continue this loop until the criteria is met.

Last years team has an the pattern identification working (Using YOLO) and tone adjustment trained into the model. There are other inputs that we want to add to this model as the next step, there are specific tuning parameters in firmware that are not customer facing that we would like the model to adjust. The team this year will need to evaluate the current workflow and determine if additional inputs can be added, or if adjustments to the training methods, or the tools we are using need to be adjust to accept additional inputs.

Hardware/Electrical Tasks:

None

Firmware/Software/Computer Tasks: ○ Determine specifications of camera needed (resolution, pixel dimensions, focal length, exposure time)

- Integrate with selected camera, using Python ○ Specify hardware needed to train model (GPU, CPU)
- Research AI/ Machine Learning algorithms (tensor flow, pytorch,YOLO) to determine best fit
- Create machine learning model and training methods
- Specify scalability of model once its trained (hardware need to run model after training)
- Create UI to interface with training model

Composition of Team:

3 (three) Computer Engineers (no electrical engineers) ***(preference will be given to those enrolled in the AI/ML course , which will be taught by Dr. Megan Chaivaro, Ph. D., SeaCorp.)***

Skills Required:

Electrical Engineering Skills Required:

- None

Computer Engineering Skills Required:

- Knowledge of machine learning models (pytorch), and how to implement them
- Image analysis tools (numpy, scipy, YOLO)
- Experience with Python
- Experience with camera technology

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

Introducing AI / machine learning for sensing technology will open the door to automating development tasks. This will help keep design costs down and allow for more flexibility in making changes on smaller programs to keep improving. As of now we need to support and engineers full time on a program to make improvements to sensing algorithms. This will allow us to tackle features and improvements by reducing time in development.

Broader Implications of the Best Outcome on the Company's Industry:

Continuously improving our sensor technology allows Zebra to remain the leader in the field of direct thermal printing. Introducing this will allow for an approach that is closed loop versus open loop in the past. There are sure to be more advanced ways to generate more value to our customers as this is improved upon.