AI/ML Object Recognition and Analysis

ELECOMP Capstone Design Project 2024-2025

Sponsoring Company:

Zebra Technologies
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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 objects on labels. 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. This is something that could be used to improve upon our current infrared sensing technology.

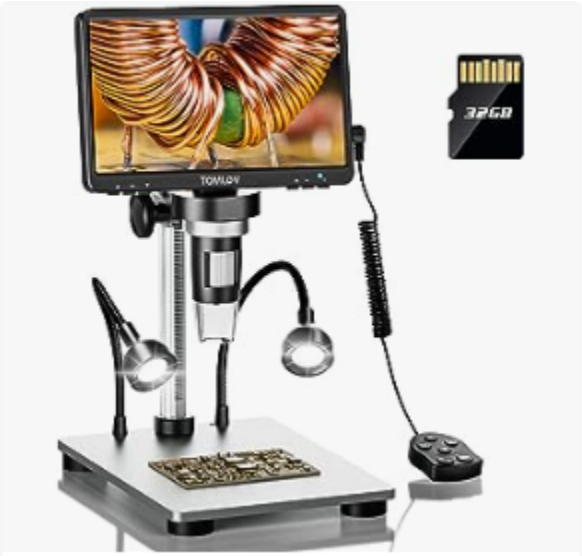
Anticipated Best Outcome:

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 the production implementation
- Document training process thoroughly
    - List of what tools are needed to duplicate training, this includes both software and hardware

Project Details:

The first thing needed is to specify an appropriate camera to be used for the task. In current proof of principle setups, we have used digital USB microscopes like the one below:

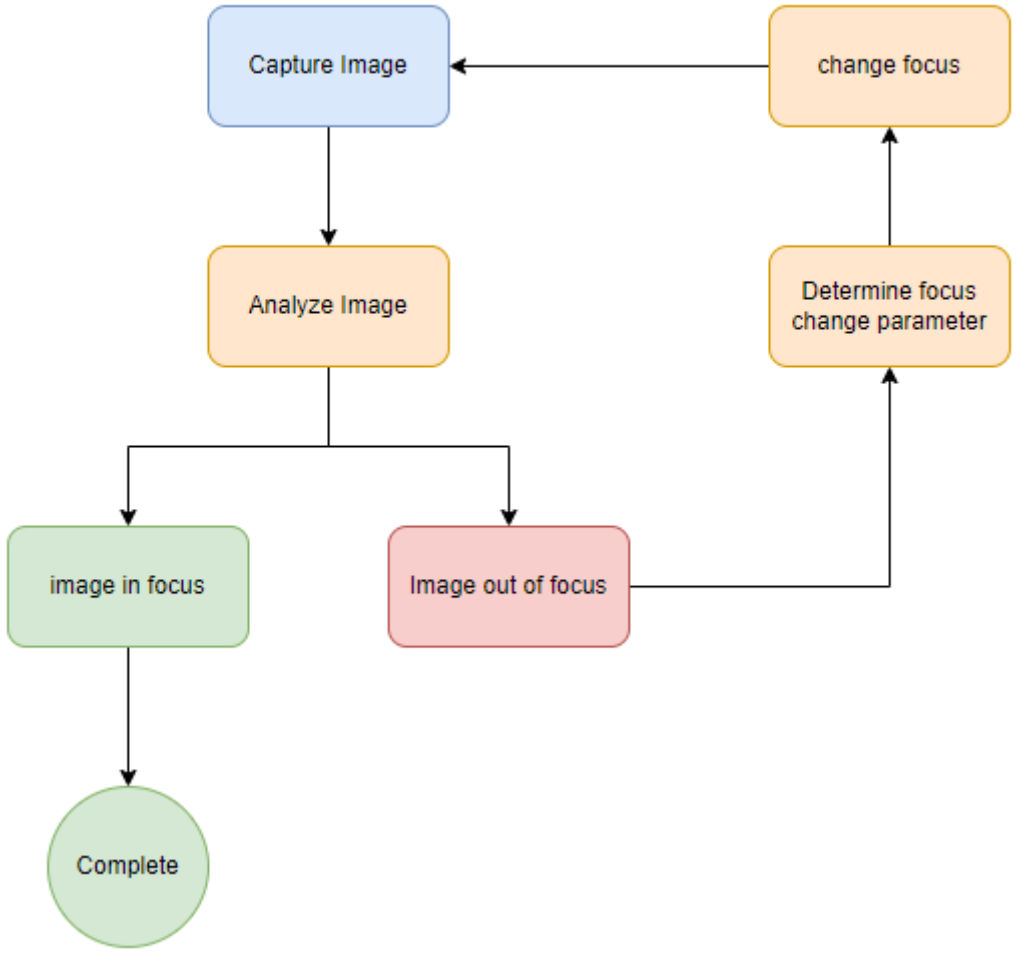


We will provide more detail of what size image we will need to analyze, and what focal distances we will need once we have a team assigned to the project. This camera will also need to integrate easily into python, so you are able to write a script to capture the image and save them locally for model training.

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. 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:

Image Focus ML Examples



Is the block diagram above, we show a workflow that captures an image, analyzes the image to determine whether the image is in focus. If it is, the routine ends, and we know the camera is set to the correct focal length. If it is not, the machine learning model will identify the image is out of focus and determine how much to change the focal length (based on the camera specifications), change the focal length, and capture a new image for analysis. This will continue until the right focus 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. This is only an example of the type of feedback loop we want to implement, this is not exactly what you will be working on. Specifics will be discussed once the team is formed.

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.