AI based Electronic Component Identifier

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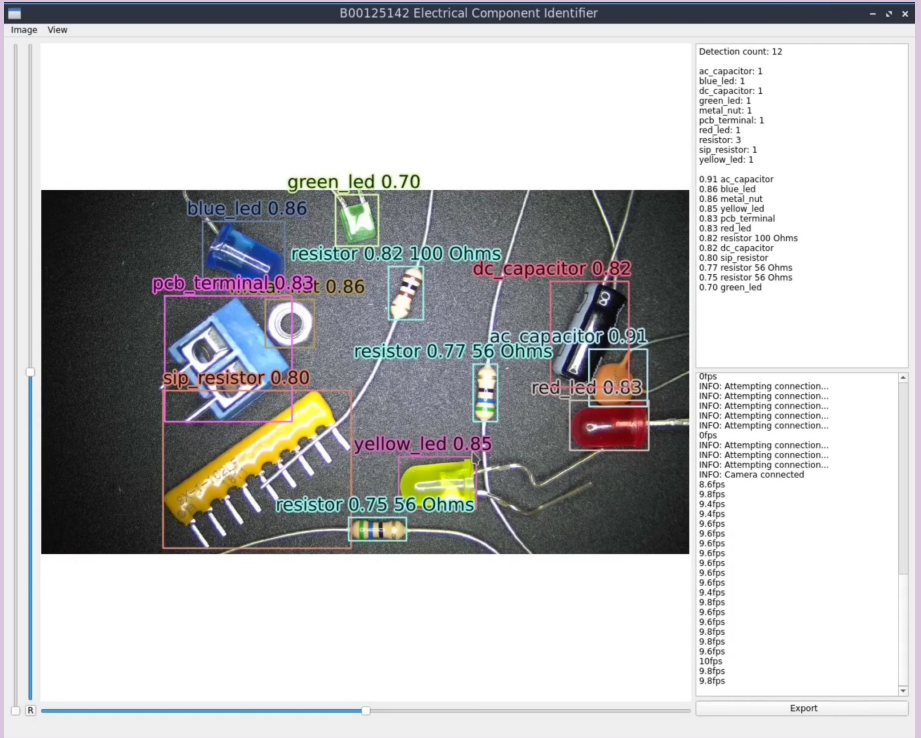
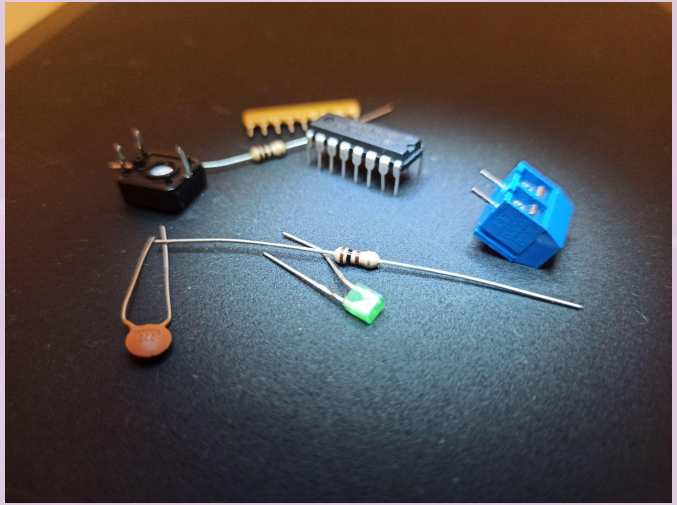
Introduction

- Uses **AI** to **detect objects** from **images**.
- Detects **electronic components**.
  - **Identifies** their properties.
    - Type
    - Color/number code
    - Marking code
- Designed as a **tool** for **engineers**.
  - Assists bulk analysis.
- **Light** to **run**.
  - Potential **mobile device** deployment.
- **Incredibly heavy** to **set-up**.
  - **Training** is done on a **powerful machine**.





Object detection

- **Important in**
  - **Security**
    - **Notifying concerns**
      - People
      - Animals
      - Flora
  - **Production**
    - **Discarding defects**
      - Damage
  - **Analysis**
    - **Quality inspection**
      - Scratches
      - Spots
    - **Classification**
      - Resistor
      - Capacitor
    - **Total and class count**

The problem

Object detection from **images**:

- Natural to **intelligent** creatures.
  - Designed for **object detection** through evolution.
    - Second nature.
- **Binary data** to **computers**.
  - **Has no concept** of **object, image, or color**.
    - Everything is perceived the same.

The solution

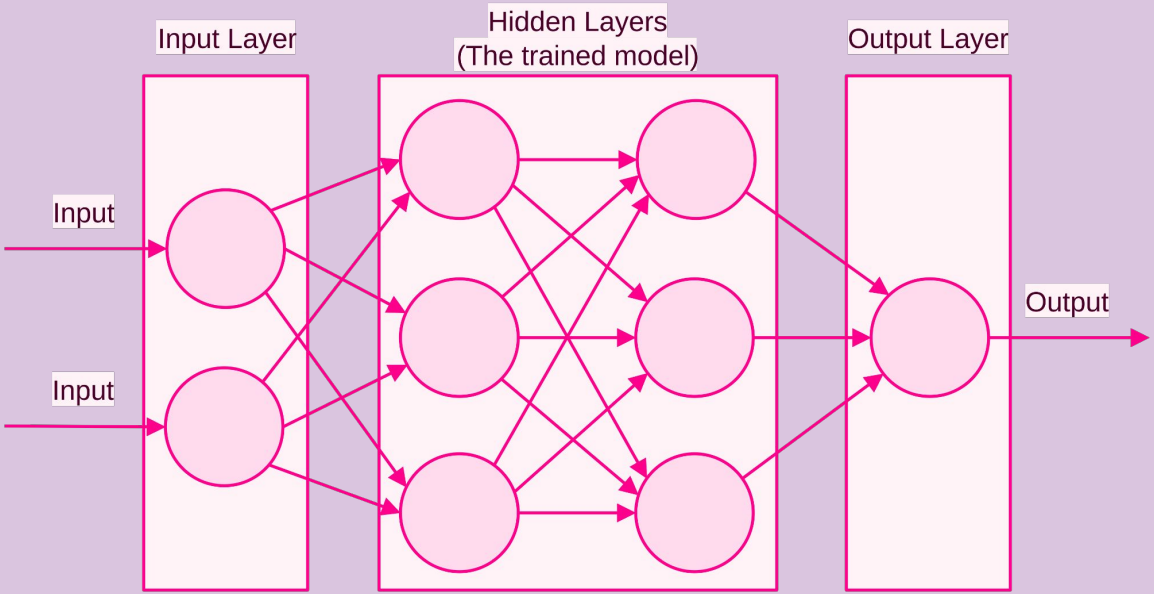
Neural Networks

- Complex networks of **neurons**.
- Each **neuron**
  - Holds **weight**.
  - **biases** the output.

Inference

- Utilises a **trained model** to **detect objects**.
  - Architecture used: **YOLO**
    - **Y**ou **O**nly **L**ook **O**nce[1]

Simple Neural Network Diagram



Chosen architecture

[1]

Model Training

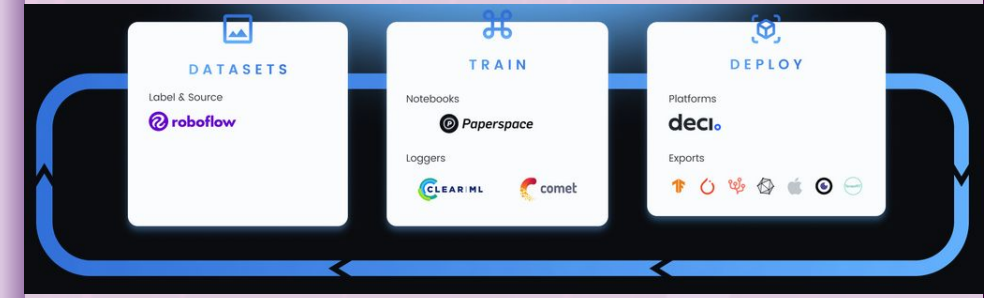
- **Images** must be **labeled manually**.
  - A **label** represents **where** and **what class** is contained.

- **Each picture** should have some **variation** in conditions.
  - **Position**
  - **Rotation**
  - **Lighting**

Model Training

- Training requires **two labeled datasets** to train on.
  - Bigger: for **training**.
  - Smaller: for **evaluation**.

- Trained on over **3000** images.
  - Manually **labeled**.
  - **Classes**:
    - Resistor (Single, SIP)
    - Capacitor (AC, DC)
    - LED (Red, Green, Blue, Yellow, Clear)
    - Metal Nut
    - Integrated Circuits
    - Light Dependant Resistor
    - Diode

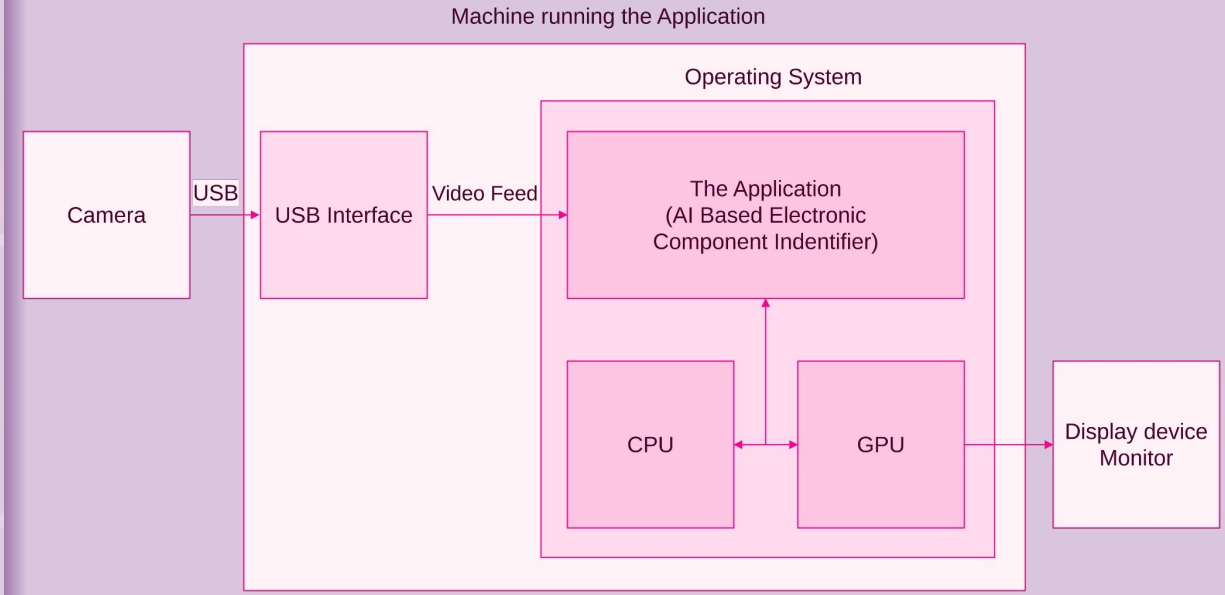


[1]

Concept Diagram

- **Camera** is External.
- Communication through **USB**.
- The application utilises both **CPU** and **GPU**.

System Block Diagram



Post-Processing

Additional processing of the **output** provided by the **inference**.

Identification of:

- resistor **color coded Ohm value**
- LED **color**

State of the project

- **Rig**
  - **Fully setup.**
  - Has an attachable **ring light.**
  - Used to **gather** all of the **training data**.
    - Taken over **300 labeled images** of **each class**.
- **Model Training**
  - Achieving confidence **up to 99%**.
    - Usually **above 80%**.
- **Inference** with **post-processing**
  - Running at **12fps**.

Timetable

Name	Begin date	End date	Duration	Duration (Weeks, rounded up)
Camera rig	9/20/22	10/4/22	15	3
Delivery times (Rig, Camera)	9/20/22	10/3/22	14	2
Physical rig setup with camera	10/4/22	10/4/22	1	1
GUI	9/1/22	10/19/22	49	7
Basic GUI (Console, smart camera connectivity, display, interface)	9/1/22	10/19/22	49	7
Camera feed to GUI interfacing (Includes resolution/framerate/frame handling, QoL methods)	10/5/22	10/19/22	15	3
Research	8/1/22	1/19/23	172	25
Optimal for inference camera research	9/1/22	9/12/22	12	2
AI object detection research and picking the most optimal architecture for the project (YoloV5 was picked)	8/1/22	9/19/22	50	8
Optimal camera rig research	9/13/22	9/19/22	7	1
Devices to potentially deploy on research	12/6/22	1/4/23	30	5
Color code identification from images research	1/6/23	1/19/23	14	2
Post processing	1/20/23	3/1/23	41	6
Optical Character Recognition (OCR)	1/20/23	2/18/23	30	5
Color code reading	1/20/23	3/1/23	41	6
Object detection implementation	9/1/22	2/14/23	167	24
First, basic dataset gathering (manual for early, asynchronous Inference testing) and model training	10/5/22	10/5/22	1	1
Bare minimum YoloV5 training and Inference implementation	9/1/22	10/30/22	60	9
Further data gathering and training of the model on various components	10/31/22	2/14/23	107	16
Deployment on a more mobile device	3/3/23	4/18/23	47	7

[2]

Discussion

- The **project** runs entirely on **C++**, and is **cross-platform.**
- **Inference** is capable of extracting an **Extremely high** level of detail from an input image.
- **Post-processing** is considerably more intensive than **Inference**.
- The **training** of the **model** for **300 epochs** took over **12 hours**.

Conclusion

- The **inference** and **post-processing** results are more than **satisfactory**.
- While the **project** is mostly **software focused**, a **high quality rig setup** was essential in gathering a **high quality dataset**.
- The **project** has achieved its goals, and is **ready to be used**.

References

- [1] YoloV5 https://github.com/ultralytics/yolov5, accessed on 6th of November, 2022
- [2] Gantt Project https://www.ganttproject.biz/, accessed on 6th of February, 2023

The end

Any questions?