Data-Efficient Strategies for Object Detection

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Tutorial Goals

01

Train an Object Detection model on custom data

02

Use **Active Learning** to reduce annotation workload

03

Understand how **annotation quality** affects model performance

04

Apply **Transfer Learning** to boost performance and reduce training time

Agenda

- Case Study
- Hands On
  - Background in Object Detection
  - Application of Active Learning
  - Impact of Data Quality
  - Transfer Learning

Case Study

Motivation

- Pests destroy up to 40% of crops globally
- Traditional pest control is costly, chemical-heavy, and often reactive

- Feeding the world sustainably requires smarter farming : more precise and proactive
- Early detection can save billions and reduce pesticide use, which means healthier crops, safer food, and a greener plane

Data-driven farming is the future

Case Study

The whitefly pest

Whiteflies are small, sap-sucking insects that pose a significant threat to agriculture worldwide

- Feed on plant sap, weakening crops and reducing yields
- Reproduce rapidly
- Vectors of many plant viruses
- Spread worldwide and affect a multiple range of crops — including cotton, tomato, soybean and cassava

- One the **most significant agricultural pests** globally
- Lead to **billions of dollars in economic losses annually**

Case Study

Conventional methods

Conventional methods include:

- **Yellow sticky traps** to monitor populations, manually checked
- **Manual removal** of heavily infested leaves in small-scale farming.

  - Time consuming as it is totally **human-based**
  - Heavy reliance on insecticides that leads to **resistance development**
  - **Costly**

Case Study

Smart farming methods

Scoutboxes combine sticky traps with **IoT sensors, cameras, and connectivity**.

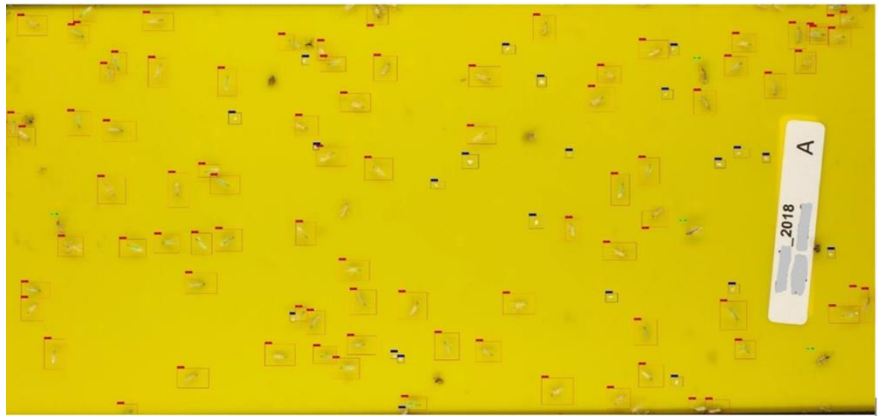
- Capture images of trapped insects automatically
- Can use onboard or cloud-based to **identify, count, and report pest populations** in real-time

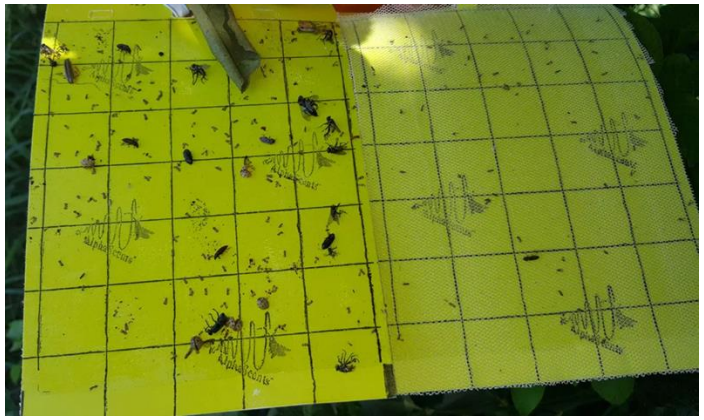
Benefits include:

- ✓ **Early detection:** enabling rapid intervention before outbreaks spread.
- ✓ **Reduced labor:** eliminating manual scouting rounds.
- ✓ **Data-driven decisions:** providing precise pest population trends over time.
- ✓ **Sustainability:** allowing targeted treatment and reducing unnecessary pesticide use.

Case Study

Challenges





- **Species identification:**
  - differentiating similar insect species remains difficult
  - insects captured in traps are usually degraded
    - ➢ **Object Detection with few high-quality annotated data**
- **Image quality & environmental conditions:** dust, rain, humidity, or sunlight glare
    - ➢ **Noisy environment**
- **Cost & scalability:** Initial investment and maintenance costs can be high, especially for small-scale farmers.
    - ➢ **Low-cost equipment**

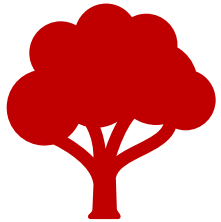
Object Detection with few high-quality annotated data in noisy environment with low-cost equipment

Case Study

Goal

Pest detection

Whitefly Pest



Detections in Natural Environments

Goal is to detect and count whiteflies in an image

Hands on

URL: bit.ly/ibpria25tutorial