Automatic Insect Detection and Classification on Sticky Traps

Mary Aghili, Computer Science Ph.D candidate in Florida International University, graduate in summer 2019 Predictive Analytics Data Scientist in Breeding (Imaging and Pathology) Team, Team lead: Anju Panicker & Bing Liu
My interests are Computer Vision, Machine Learning and Data Mining

Introduction

Timely pest control decision is critical for the success of the nursery program to meet seed target. This process is time consuming and could result in a delayed decision of control. Automating the process of pests estimation enables faster and better data driven decision making, and ensure the success of nursery pest management.

Solutions Evaluation

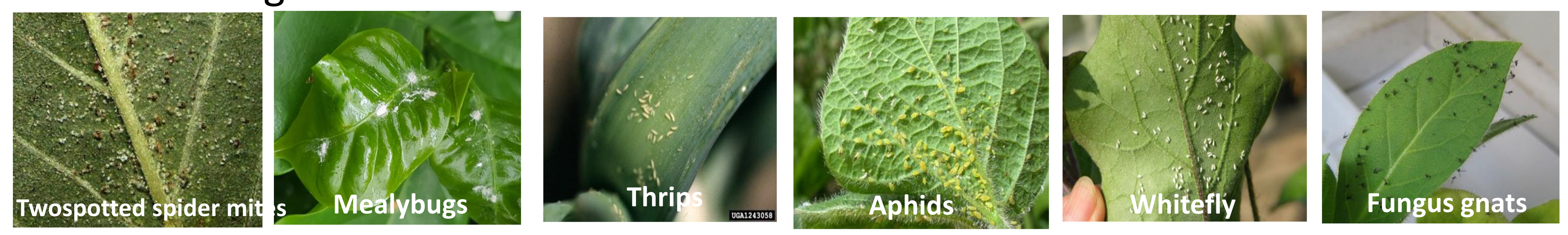
Several approaches for automatic decision making process by analyzing the sticky traps have been proposed and tested. A summary of those solutions and their weakness is provided here:

- Estimate the covered area of the sticky traps and decide based on it's condition. If sticky is too dirty then there are many insects on the traps and should be sprayed.
  - × The plant residual, dirt and dust mislead the decision process.
  - × Types of pests and frequency of each types are important for decision making process.
- Segment insects and define types of insects based on their predefined size and then count them and decide.
  - × Same insect species can have different size.
  - × Different insect species can have same size.
- Segment insects with image processing methods and classify them with feature extraction and machine learning techniques.
  - × Traditional feature extraction can not extract rich features to detect the subtle differences between insect species.
- Segment insects with image processing methods and use a Convolutional Neural Network with Transfer Learning to classify them.
  - × Due to inefficient region proposal process this solution is very slow.

After an exhaustive search around various solutions we adopted a Faster Region-based Convolutional Neural Networks for the problem.

Research Objective

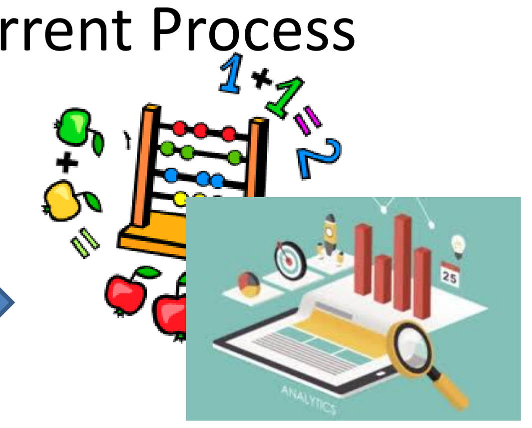
Design and build a model that automatically detects the pests on yellow sticky card, and report the number of each species. Associate the counting with an unique identifier assigned to it.



Process Engineering

Current Process

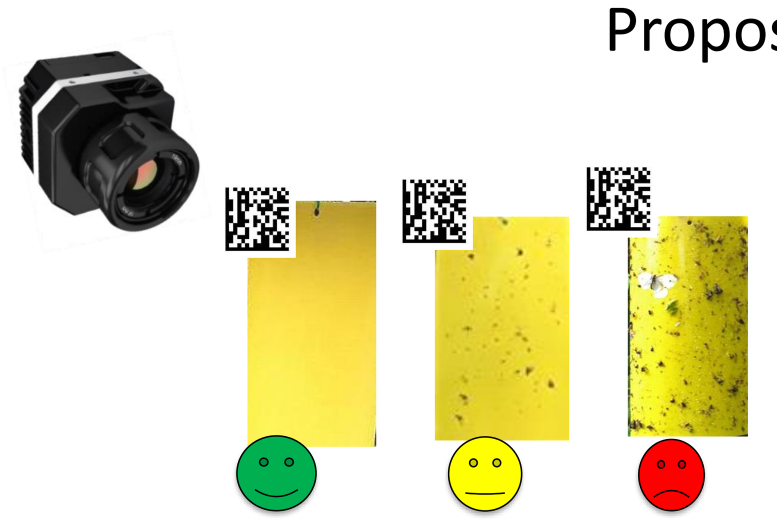
Specialists check the sticky traps periodically



Manually count & analysis the insects

Make a decision based on action threshold and domain knowledge

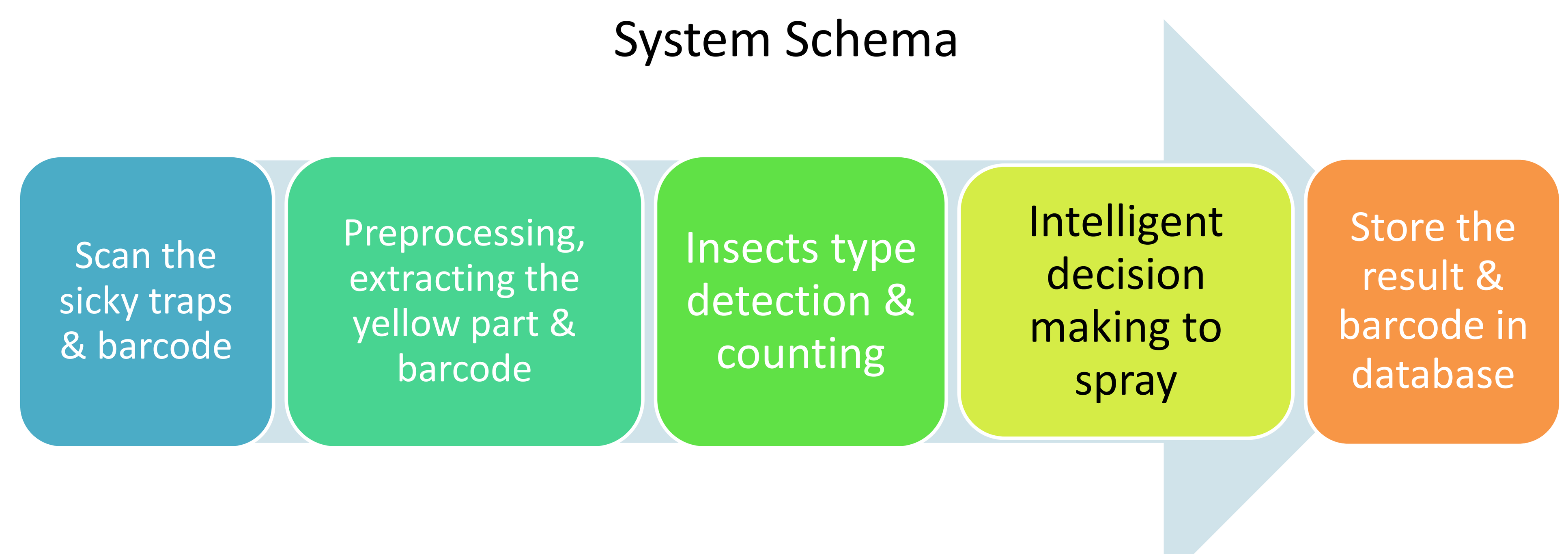
Proposed System Design



An automated camera scans the sticky traps periodically

An intelligent model detects and counts the insects in the sticky traps
Make a decision based on action threshold and domain knowledge

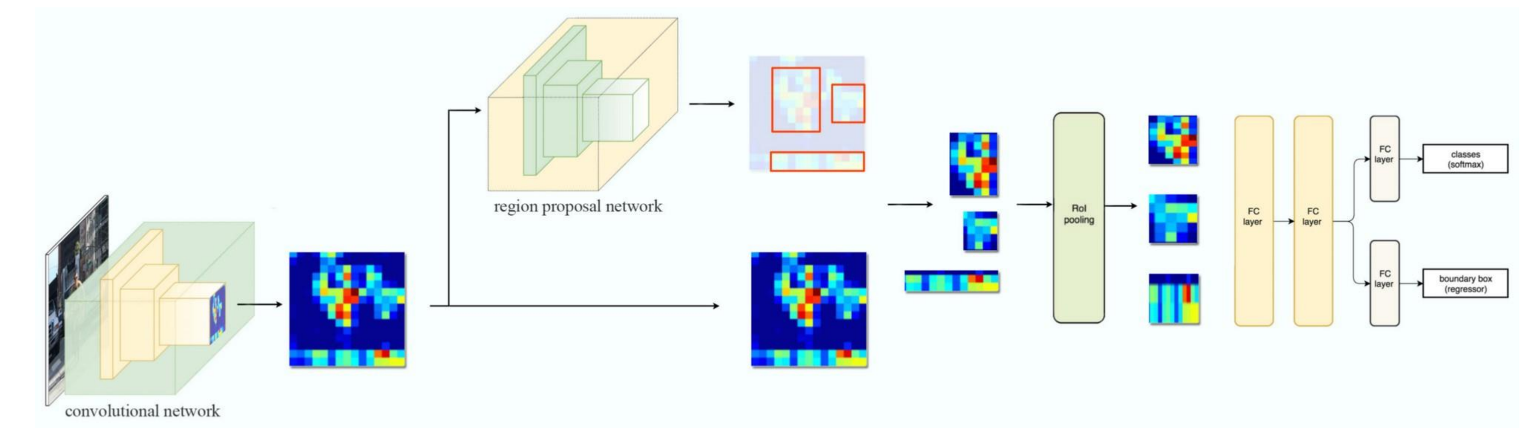
System Schema



Research Contribution

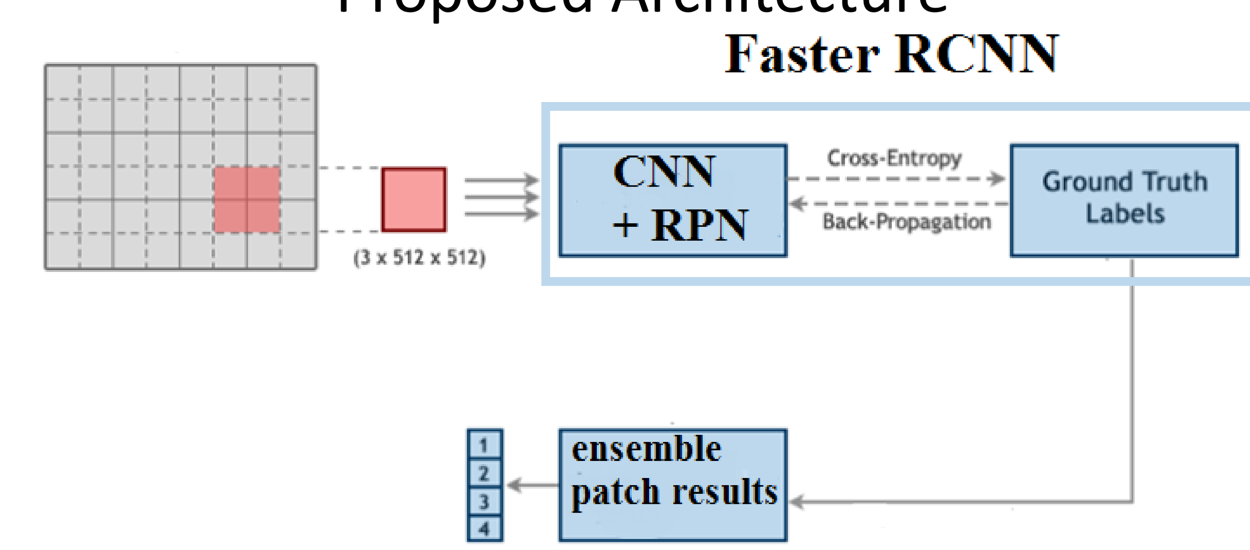
The proposed model for pests detection is based on Faster RCNN model on the backbone of inception V2 which is pretrained on COCO dataset. It is implemented with TensorFlow's Object Detection API .

Faster RCNN Architecture



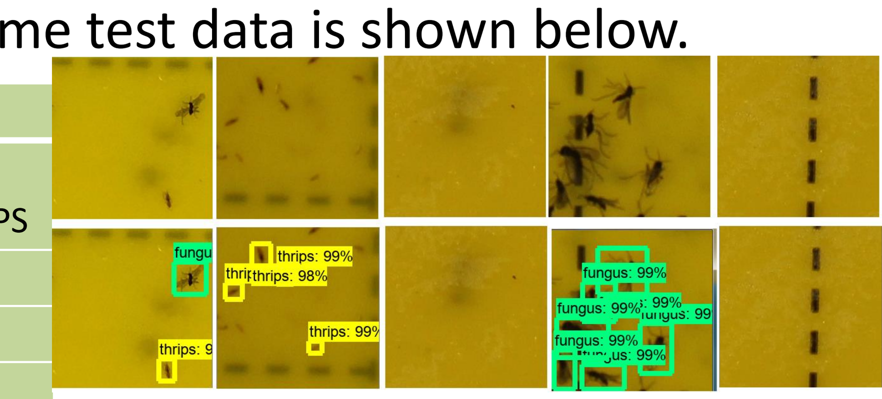
The model breaks down the whole sticky image to multiple overlapping patches and applies Faster RCNN on each patch separately to address the difficulty of the small object detection. Then the outcome of all patches combines together to predict the type and population of insects in the sticky trap.

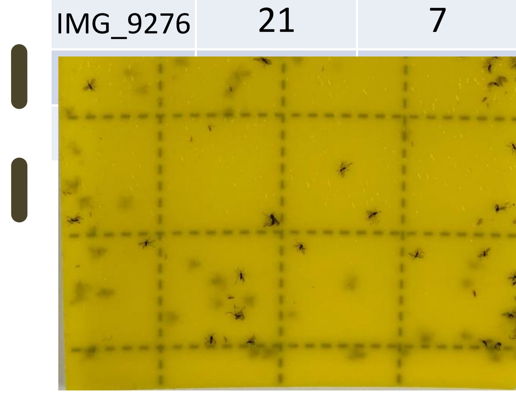
Proposed Architecture



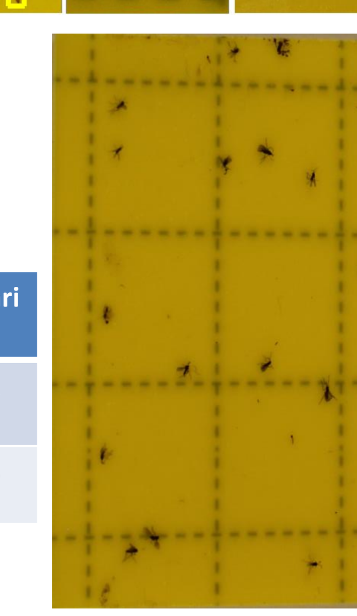
The system prediction on some test data is shown below.

	Ground Truth		Prediction	
IMAGE	FUNGUS GNATS	THRIPS	FUNGUS GNATS	THRIPS
IMG_9237	30	12	31	13
IMG_9269	2	61	5	27
IMG_9268	18	2	20	6
IMG_9272	244	14	238	8
IMG_9274	3	29	6	27
IMG_9275	21	6	24	13
IMG_9276	21	7	15	2





	fungus gnats	Thrips
Ground truth	30	12
predicted	31	13



	fungus gnats	Thrips
Ground truth	18	2
predicted	20	6