IP102: A Large-Scale Benchmark Dataset for Insect Pest Recognition

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Introduction

Highlights

- The largest public dataset for insect pest recognition. This dataset contains 102 insect pests, including 75,222 images with category labels and 18,976 images with bounding boxes.
- Extensive experiments on the proposed dataset.

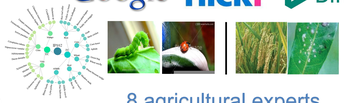
Motivation

- Insect pest is one of the main factors affecting agricultural product yield. Accurate recognition of insect pests facilitates timely preventive measures to avoid economic losses.
- Existing small-scale insect pest datasets cannot well satisfy the requirement of deep technology.

Data Collection & Annotations

- (1) Taxonomic system establishment
- (2) Image collection
- (3) Preliminary data filtering
- (4) Professional data annotation

Google flickr Bing



8 agricultural experts

Comparison to Previous Datasets

- More samples
- More classes
- In the wild
- Publicly available

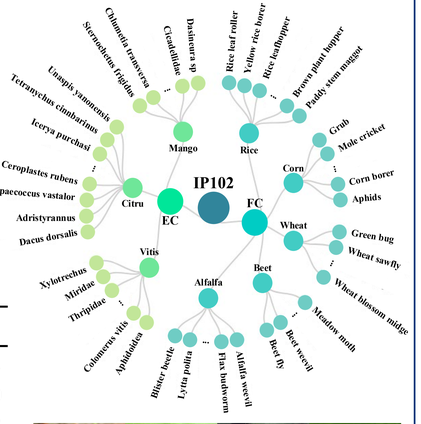
DATA

Dataset	Year	Class	Avail	Sample	Avg
Samanta et al.	2012	8	N	609	76
Wang et al.	2012	9	Y	225	25
Venugoban et al.	2014	20	N	200	10
Xie et al.	2015	24	Y	1,440	60
Liu et al.	2016	12	N	5,136	428
Xie et al.	2018	40	Y	4,500	113
Deng et al.	2018	10	Y	563	56
Alfarisy et al.	2018	13	N	4,511	347
IP102	2019	102	Y	75,222	737

IP102 Dataset

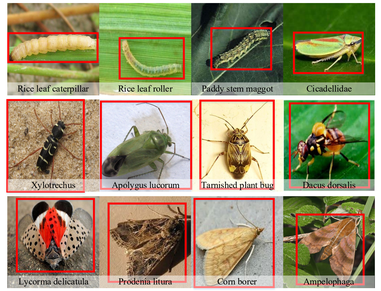
Hierarchical Taxonomy System

- Each insect pest is assigned an upper-level class based on the crop that the insect pest class mainly damages.
- FC: Field crops; EC: Economic crops



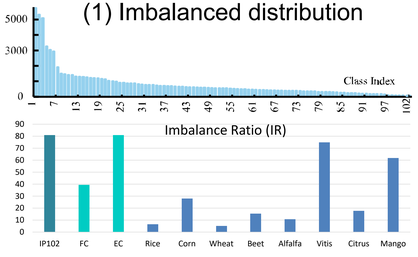
Statistical Information

Super-Class	Class	Train	Val	Test	IR
FC	Rice	14	5,043	843	2,531	6.4
	Corn	13	8,404	1,399	4,212	27.9
	Wheat	9	2,048	340	1,030	5.2
	Beet	8	2,649	441	1,330	15.4
	Alfalfa	13	6,230	1,037	3,123	10.7
EC	Vitis	16	10,525	1,752	5,274	74.8
	Citrus	19	4,356	725	2,192	17.6
	Mango	10	5,840	971	2,927	61.7
IP102	FC	57	24,602	4,098	12,341	39.4
	EC	45	20,721	3,448	10,393	80.8
IP102		102	45,095	7,508	22,619	80.8

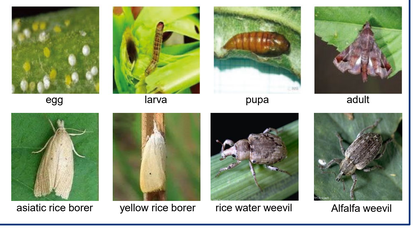


Challenges

(1) Imbalanced distribution



(2) Intra- & inter-class variance



Benchmark Experiments

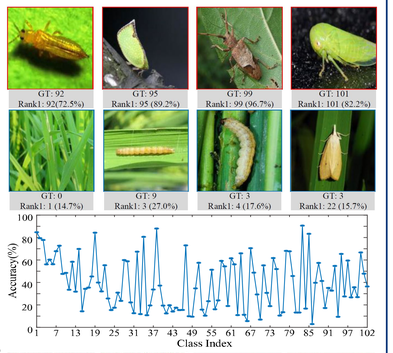
Classification Task

① Classification performance of handcrafted and deep features

#	Methods	SVM						KNN					
		Pre	Rec	F1	GM	M_{AUC}	Acc	Pre	Rec	F1	GM	M_{AUC}	Acc
Handcrafted	CH	9.7	3.2	2.5	0.3	12.0	12.9	18.2	14.2	15.0	8.3	16.8	15.8
	Gabor	8.5	3.9	3.6	0.5	12.1	14.2	22.0	14.9	16.5	9.1	20.0	19.2
	SIFT	25.1	6.3	6.8	1.0	19.9	18.1	19.4	10.3	12.1	5.6	15.9	13.1
	SURF	28.2	7.3	8.3	1.5	21.2	19.5	21.3	11.5	13.4	7.1	17.5	14.7
Deep	Alexnet	41.5	16.4	21.0	9.3	32.5	28.3	36.7	32.4	33.5	23.9	41.0	40.7
	GoogleNet	45.8	25.8	30.4	16.0	41.9	40.5	36.8	31.7	33.0	23.3	41.6	40.7
	VGGNet	43.4	37.6	39.1	28.3	48.1	48.7	41.9	37.8	39.0	29.8	47.6	47.1
	ResNet	43.6	39.1	40.6	31.0	48.7	49.5	43.7	39.1	40.5	30.7	48.2	49.4

② Classification performance with different hierarchical labels

Super-Class		Pre	Rec	F1	GM	M_{AUC}	Acc
FC	Rice	31.5	30.0	30.4	28.3	32.3	32.1
	Corn	55.1	54.4	54.6	50.3	61.9	62.2
	Wheat	37.5	34.5	35.5	29.3	52.1	53.0
	Beet	51.6	49.5	50.4	45.3	62.0	62.2
	Alfalfa	42.1	41.2	41.4	38.1	46.2	46.4
EC	Vitis	78.2	76.3	77.1	74.9	86.8	86.7
	Citrus	69.6	68.5	68.8	65.2	76.6	76.6
	Mango	75.8	74.7	75.1	72.3	89.0	89.0



Detection Task

Method	Backbone	AP	$AP^{.50}$	$AP^{.75}$
FRCNN	VGG-16	21.05	47.87	15.23
FPN	ResNet-50	28.10	54.93	23.30
SSD300	VGG-16	21.49	47.21	16.57
RefineDet	VGG-16	22.84	49.01	16.82
YOLOv3	DarkNet-53	25.67	50.64	21.79