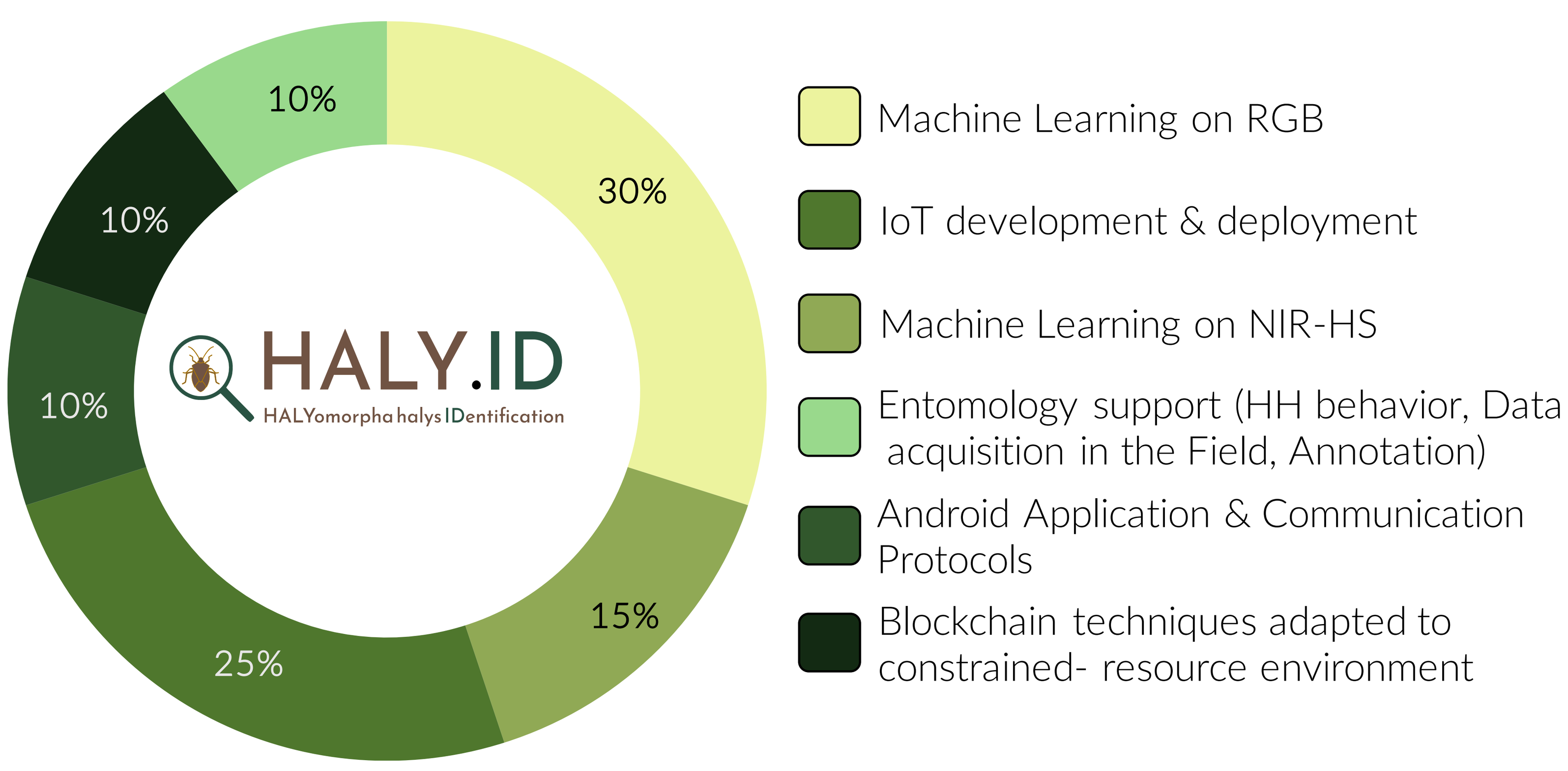
HALYomorpha halys IDentification: Innovative ICT tools for targeted monitoring and sustainable management of the Brown Marmorated Stink Bug and other pests

HALY.ID
HALYomorpha halys IDentification

Introduction

- Monitor the Halyomorpha halys (HH)—Brown Marmorated Stink Bug—an invasive alien species, that reached Europe in 2004 and so far, spread in 80% of the European countries
- Propose an autonomous field-monitoring system to detect HH based on drones, and computer vision algorithms
- Extract knowledge from an innovative sticky trap and microclimate stations to devise an epidemiological model
- Certify the collected data in a trusted logbook system to be of use in the fruit-production chain
- Investigate non-destructive techniques to increase marketable fruit quality by discarding internally damaged fruits not visible to the naked eye

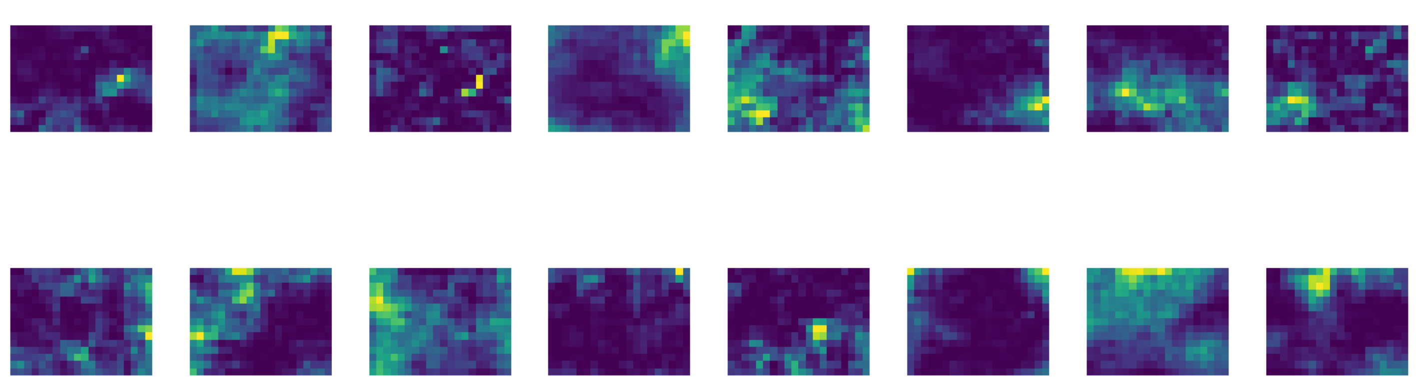
Methods

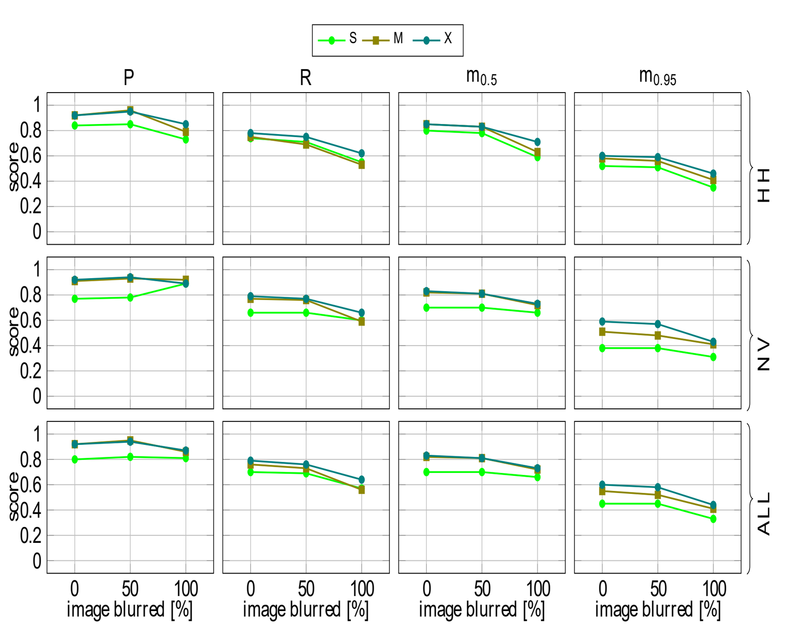


Results

Data was acquired with DJI Zenmuse H20 camera on a DJI Matrice 300

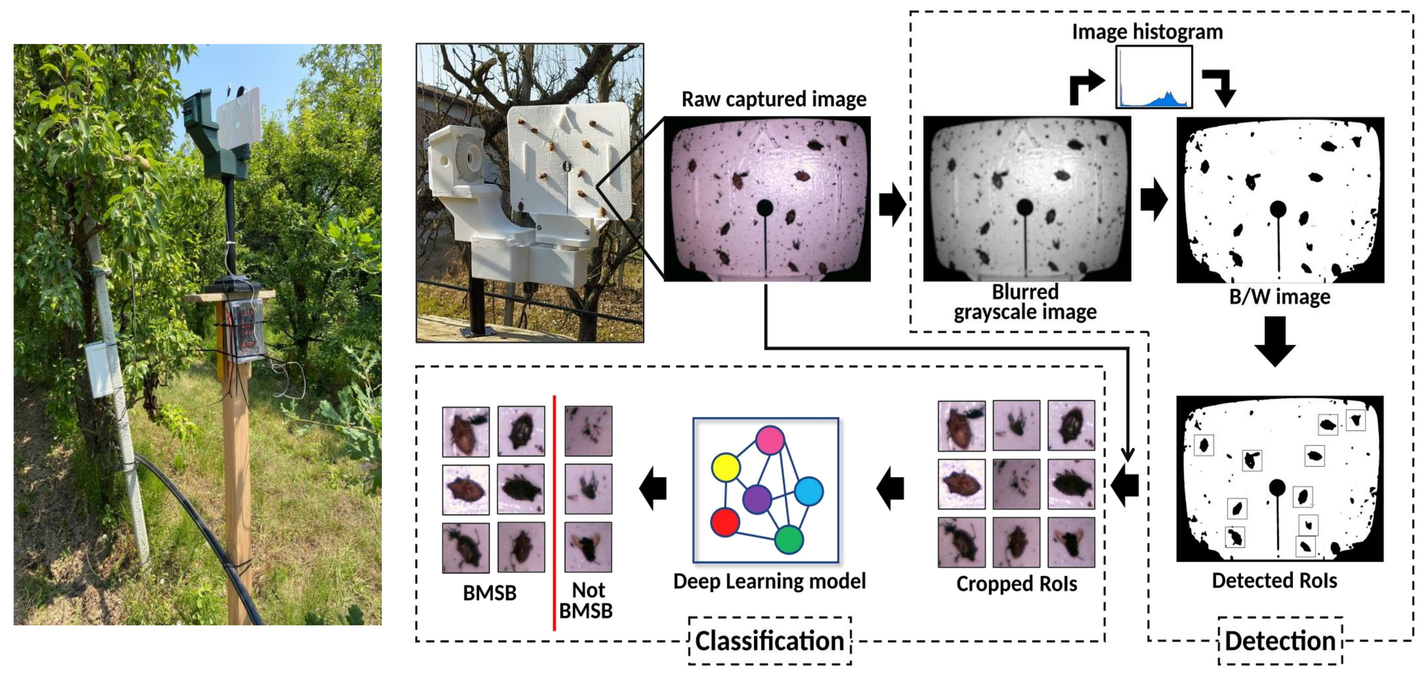
We trained HH detectors relying on RGB images autonomously collected by the drone with satisfactory results



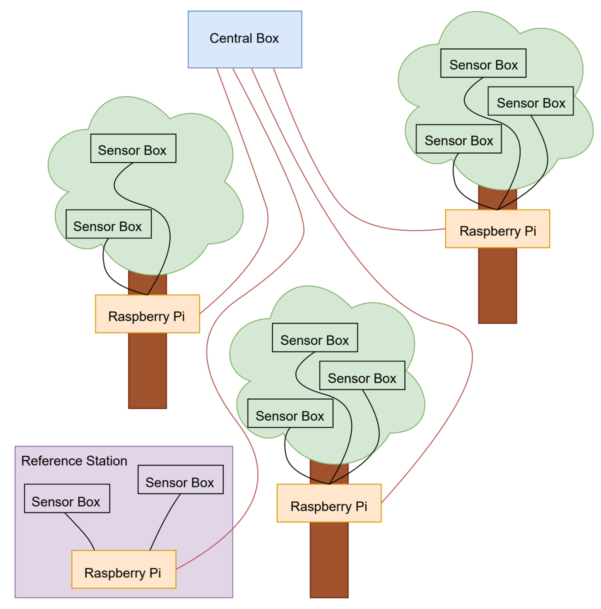


model	set	TP	FP	FN	P	R	$m_{0.5}$	error rate
M_0	all patches	52	138	19	0,28	0,73	0,58	0,072
	only postives I	52	7	19	0,88	0,73	0,71	0,077
	only positives II	55	8	36	0,87	0,6	0,59	0,088
M_{50}	all patches	28	12	43	0,7	0,39	0,36	0,006
	only postives I	28	1	43	0,97	0,39	0,39	0,011
	only positives II	31	1	60	0,97	0,34	0,34	0,011
M_{75}	all patches	40	42	31	0,49	0,56	0,5	0,022
	only postives I	40	2	31	0,95	0,56	0,55	0,022
	only positives II	42	4	49	0,91	0,46	0,45	0,044
X_0	all patches	33	30	38	0,52	0,47	0,43	0,016
	only postives I	33	5	38	0,87	0,47	0,45	0,055
	only positives II	35	5	56	0,88	0,38	0,38	0,055
X_{50}	all patches	34	30	37	0,53	0,48	0,4	0,016
	only postives I	34	2	37	0,94	0,48	0,47	0,022
	only positives II	36	2	55	0,95	0,4	0,4	0,022
X_{75}	all patches	38	33	33	0,54	0,54	0,43	0,017
	only postives I	38	2	33	0,95	0,54	0,53	0,022
	only positives II	40	2	51	0,95	0,44	0,43	0,022
f-rcnn$_{50}$ (pre-trained)	all patches	45	461	26	0,08	0,63	0,47	0,240
	only postives I	45	14	26	0,76	0,63	0,47	0,197
	only positives II	48	16	43	0,75	0,52	0,35	0,472
f-rcnn$_{50}$	all patches	46	713	25	0,06	0,64	0,25	0,371
	only postives I	46	20	25	0,69	0,64	0,46	0,282
	only positives II	48	25	43	0,65	0,52	0,35	0,274
RetinaNet$_0$ (pre-trained)	all patches	49	393	22	0,11	0,69	0,37	0,205
	only postives I	49	13	22	0,79	0,69	0,56	0,183
	only positives II	51	17	40	0,75	0,56	0,34	0,187
RetinaNet$_0$	all patches	49	410	22	0,10	0,69	0,27	0,214
	only postives I	49	10	22	0,83	0,69	0,55	0,141
	only positives II	53	13	38	0,80	0,58	0,41	0,143

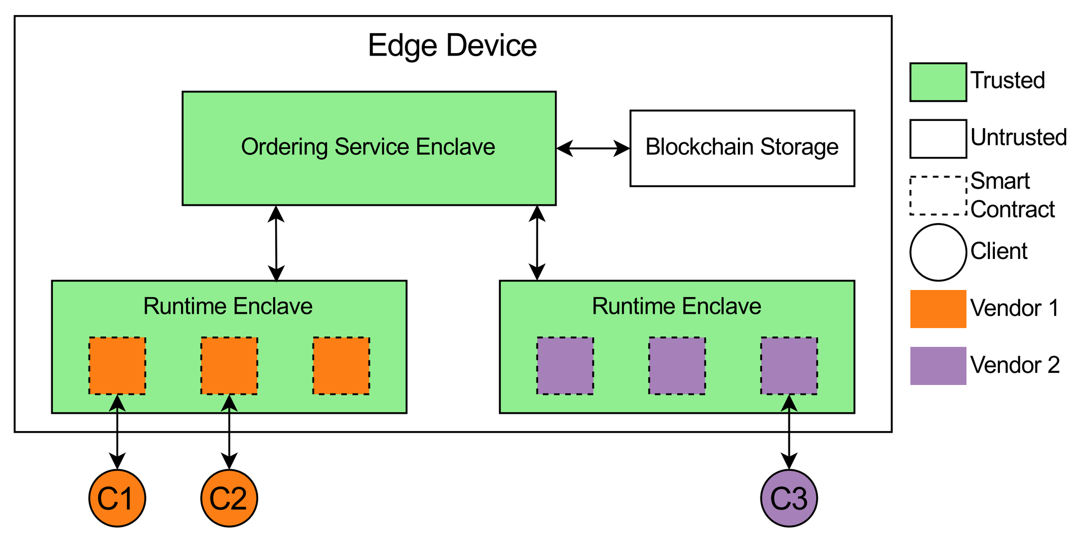
We developed an IoT HH trap with a sticky panel with pheromone lure, an Open MV board with an MCU and an embedded camera



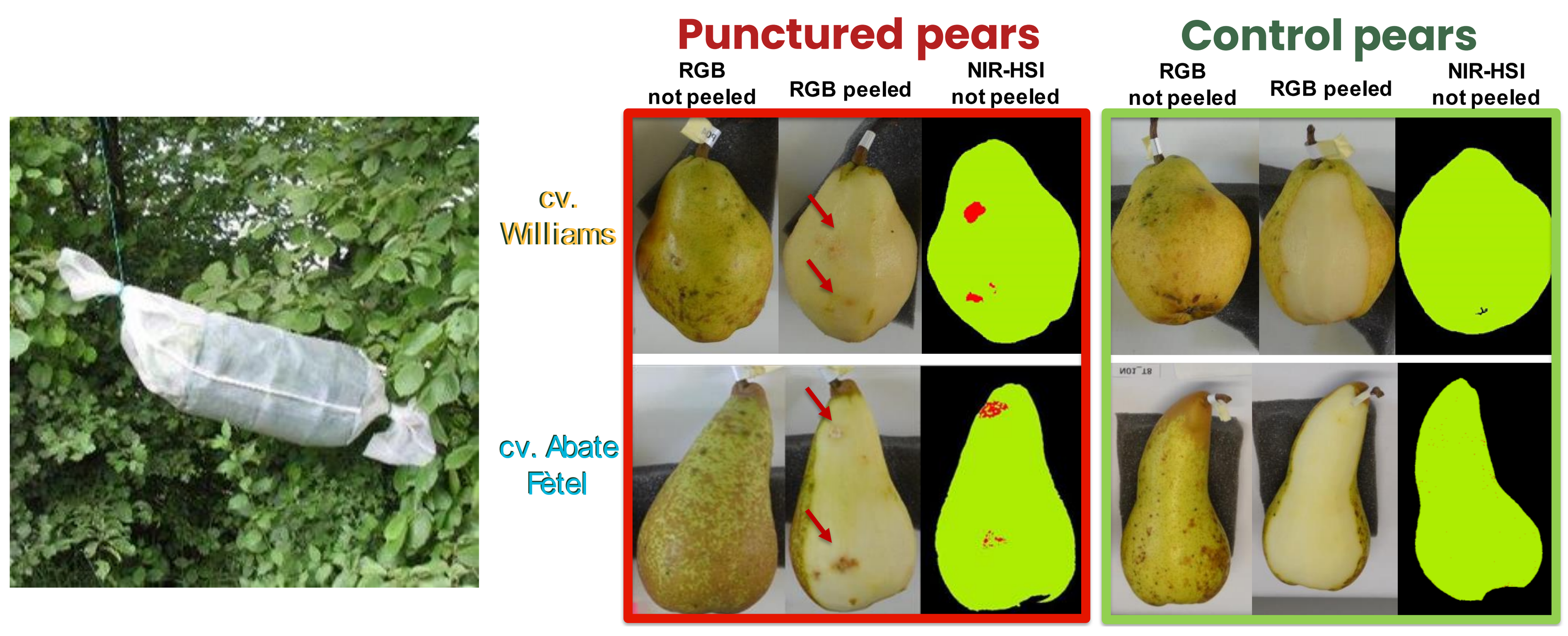
We deployed 5 microclimate stations, wired connected to a Central Box, and 7 Stationary cameras



We developed the ContractBox, a framework that offers trusted edge computing and accountable data sharing between distrusting parties



NIR-HIS images of sound and punctured pears elaboration using Machine Learning algorithms for fruit marketable assessment



Conclusions

1. The drone does not hurt the HH in terms of noise and airflow
2. The success of a computer vision algorithm depends strictly on the similarity between the trained and tested images
3. Ad hoc IoT devices can be successfully designed in a resource-constrained environment; and enclaves in a shared memory can implement trusted and accountable data sharing
4. Based on current results, it will be possible to further optimize a ML classification method to identify punctured fruits

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