Collaborative Research: CCRI:NEW: Research Infrastructure for Real-Time Computer Vision and Decision Making via Mobile Robots

(https://ri4rover.org/, Awards CNS 2120430, 2119115, 2120333, 2120322, 2112778)

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Summary

Goal: create a research infrastructure for computer vision and real-time control of autonomous mobile robots (both aerial and ground).

Components:

1. Laboratory decorated as miniature cities
2. Simulators that reflect the physical laboratory
3. Programmable aerial robots with the same interface as the simulators
4. Sample solutions for research on artificial intelligence, computer vision, and robot control for evaluation and comparison.

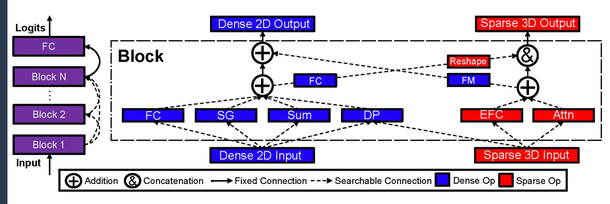
Accomplishments

1. Organize international competitions of autonomous UAV and computer vision challenges.
2. Release source code of sample solutions.
3. Design efficient computer vision: identify irrelevant pixels and remove the pixels from computation.
4. Educate dozens of undergraduate students in conducting research: design experiments, write computer programs, and collect data.

Efficient Machine Learning

Neural Architecture Search

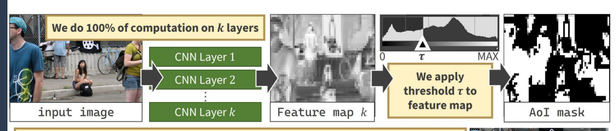
Weight Sharing Neural Architecture Search for Recommender Systems

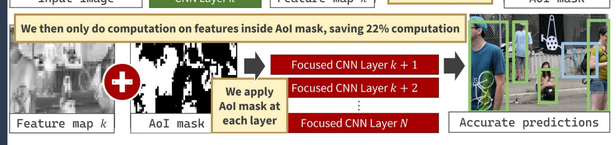


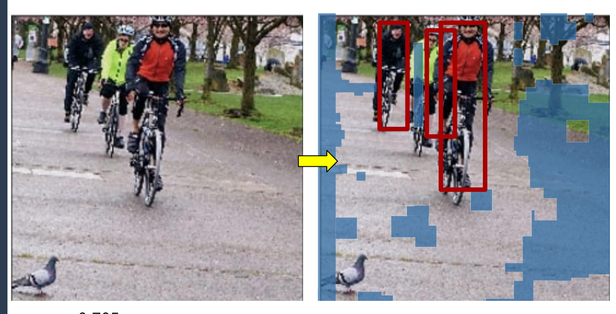
Model	Dataset	Search Space	Log Loss	AUC	FLOPS(M)
NASRecNet	Criteo	NASRec-Small	0.4399	0.8118	2.20
NASRecNet	Criteo	NASRec-Full	0.4408	0.8107	1.45
NASRecNet	Avazu	NASRec-Small	0.3747	0.7887	3.08
NASRecNet	Avazu	NASRec-Full	0.3737	0.7903	1.87
NASRecNet	KDD-Cup'12	NASRec-Small	0.1495	0.8135	3.48
NASRecNet	KDD-Cup'12	NASRec-Full	0.1491	0.8154	1.09

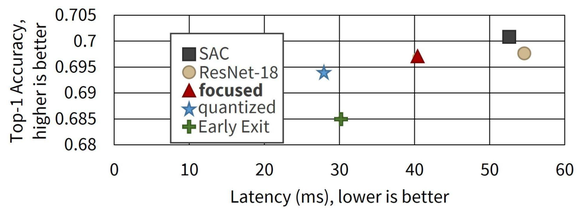
Detect and Discard Irrelevant Pixels

An automated approach for improving the inference latency and energy efficiency of pretrained CNNs by removing irrelevant pixels with focused convolutions.





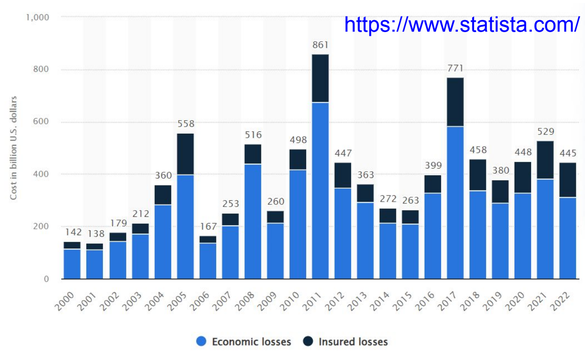




Efficient Computer Vision

Low-Power Computer Vision Challenge

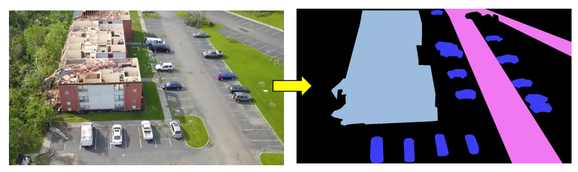
Natural disasters cost hundreds of billions of dollars each year.



Flooding

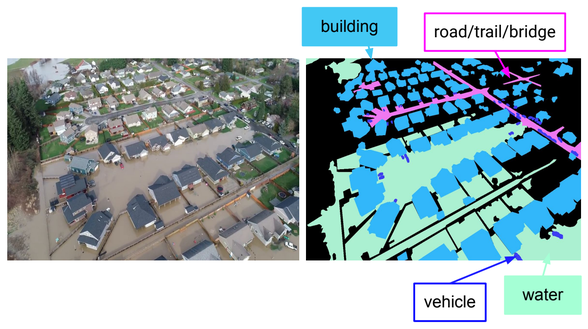
Wildfire

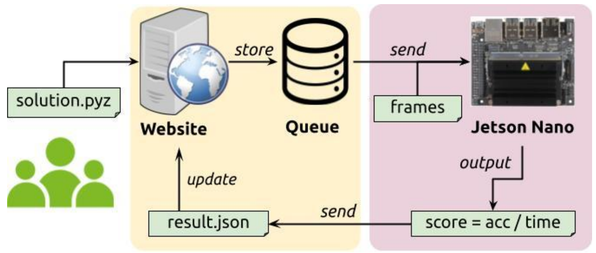
Semantic Segmentation: Label each pixel by the type of the object.



Semantic Classes:

1. Fire
2. Avalanche
3. Cracks/fissure/subsidence
4. Vehicle
5. Ice_jam_flow
6. Water
7. Building
8. Lava_flow
9. Road/trail/bridge
10. Building_damaged
11. Pyroclastic_flow
12. Debris/mud/ash/rock flow





The competition was held from 2023/07/01 - 2023/08/04; 117 teams submitted 676 solutions on https://lpcv.ai/.

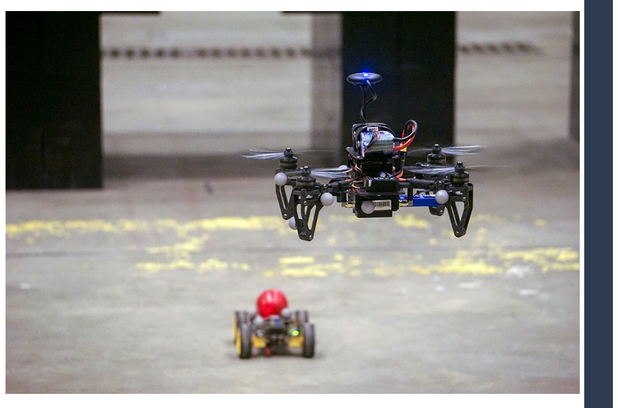
ModelTC from Tsinghua University, China was the winner of the 2023 competition. The team achieved the best balance between accuracy and execution time of 51.2% accuracy and 6.8 ms per image. The second award goes to the AidgetRock team from Midea, China. The award is received by the ENOT team from enot.ai, based in Luxembourg.

Autonomous UAV Competition

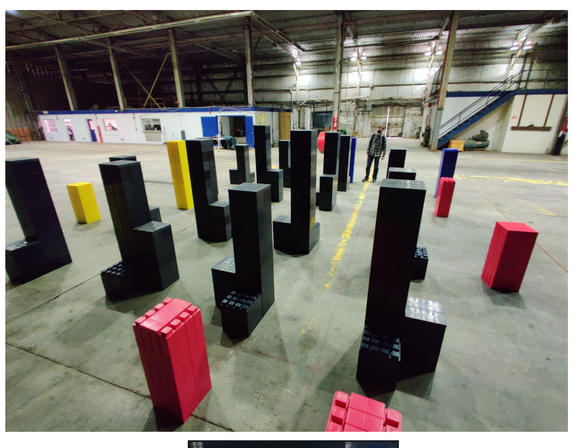
Autonomous UAV Chase Challenge

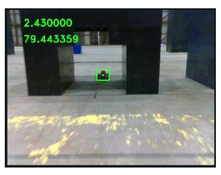
Chase a ground rover among obstacles

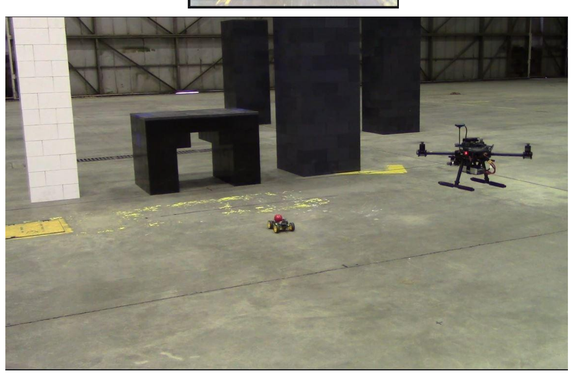
- Fully autonomous
- Only on-board computers and sensors



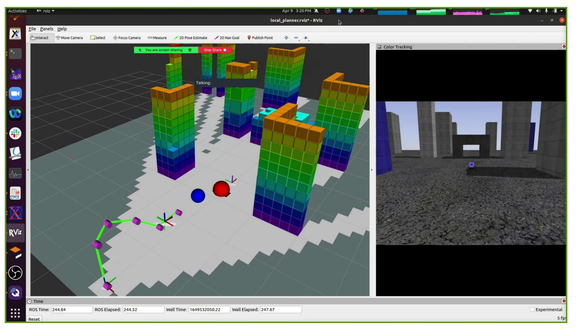
Environment with obstacle

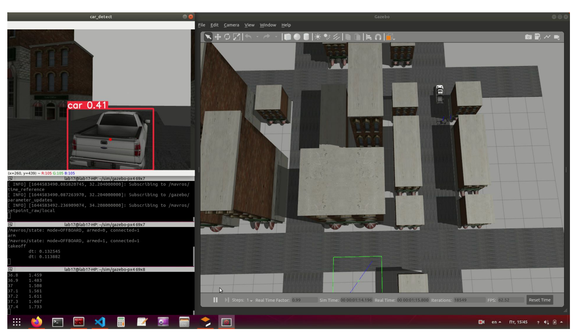






Digital Twin Simulator





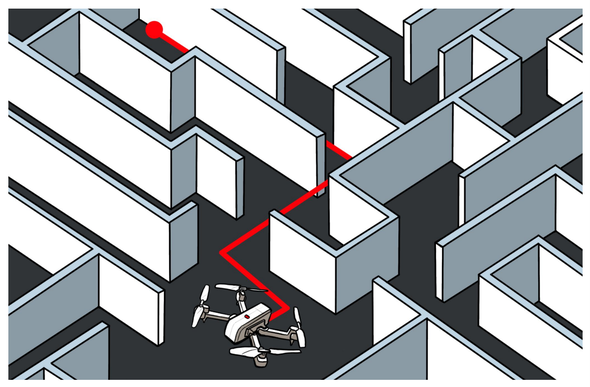
Participants, Organizers, Visitors (2023/04/23)

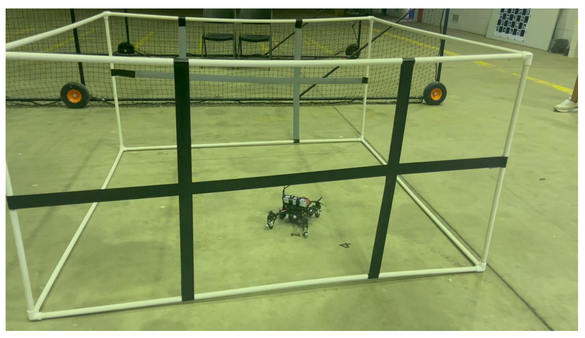
Winners:

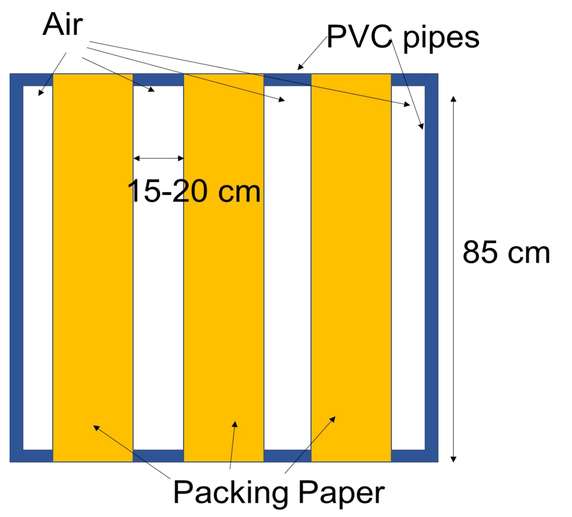
1. Scuola Superiore Sant'Anna, Italy
2. University of Science and Technology Beijing, China
3. Silesian University of Technology Gliwice, Poland

Future Work

2024 Competition: UAV in Maze







Publications

1. *Move2Hear: Active Audio-Visual Source Separation.* 2021 International Conference on Computer Vision.
2. *Research Infrastructure for Real-Time Computer Vision Applications in Unmanned Aerial Systems.* 2022 IEEE International Conference on Intelligent Transportation Engineering.
3. *Zero Experience Required: Plug & Play Modular Transfer Learning for Semantic Visual Navigation.* 2022 Computer Vision and Pattern Recognition.
4. *On the Complexity and Approximability of Optimal Sensor Selection for Mixed-Observable Markov Decision Processes.* 2023 American Control Conference.
5. *Joint Point Interaction-Dimension Search for 3D Point Cloud.* 2023 IEEE/CVF Winter Conference on Applications of Computer Vision.
6. *Weight Sharing Neural Architecture Search for Recommender Systems.* 2023 ACM Web Conference.
7. *Research Infrastructures for Vision-Based Autonomous UAVs.* 2023 Spring Undergraduate Research Expo, West Lafayette, Indiana.
8. *A Multidisciplinary approach to mentor undergraduate researchers via a vision-based auto drones project*. 2023 ConnectUR Council on Undergraduate Research Conference.
9. *An automated approach for improving the inference latency and energy efficiency of pretrained CNNs by removing irrelevant pixels with focused convolutions*. 2024 Asian-Pacific Design Automation Conference.

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