Streamlined Hybrid Annotation Framework using Scalable Codestream for Bandwith-Restriced UAV Object Detection

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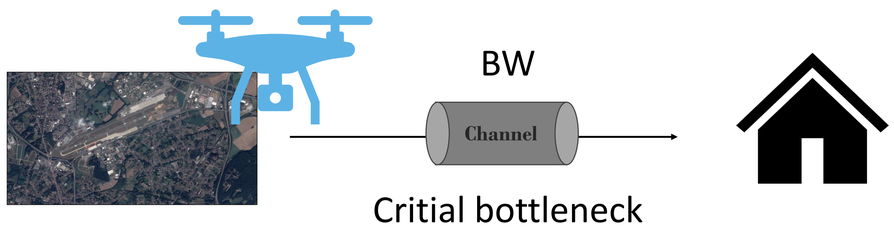
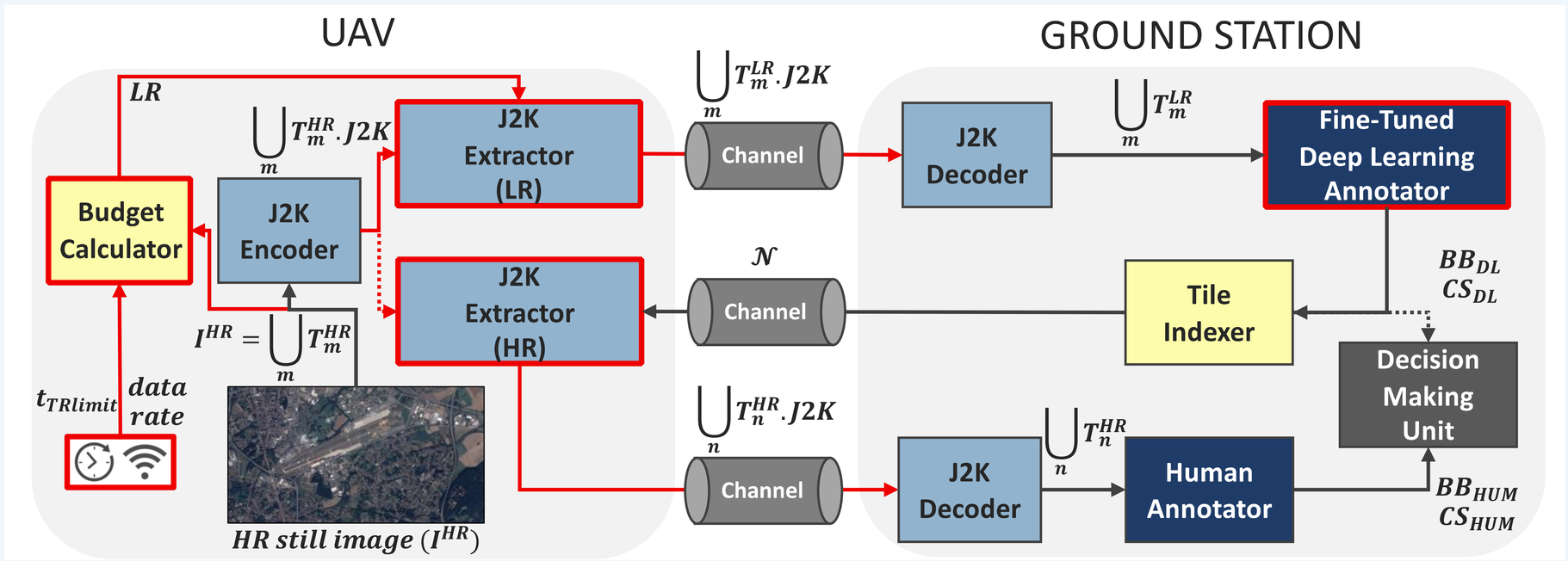
1. CONTEXT: UAVs are essential in emergency scenarios



2 challenges for decision-making:
Fast transmission and **annotation**
→ Use of **multiresolution** and **hydrid annotation** to allow **fast** and **accurate** decisions while **saving expert time**

2. METHOD: Proposed approach



3 improvements:
- **Scenario constraints are integrated** to determine the highest available resolution **LR** instead of HR (baseline)
- Only tiles selected for human annotator are sent in **HR**
- DL models are fine-tuned at different resolution levels

3. EXPERIMENTAL SETUP: Application on satellite images of airports with aircrafts

- 165 HR images (60 MP)
- Fine-tuned Yolov8 on 5 resolutions levels
- BW fixed : 176, 88 and 22 kbps
- Level of emergency fixed, determined by $t_{RSlimit}$: 3, 10 and 30 min
- 2 metrics to compare the proposed approach to the baseline : t_{RS}_*ratio* and *recall_diff*

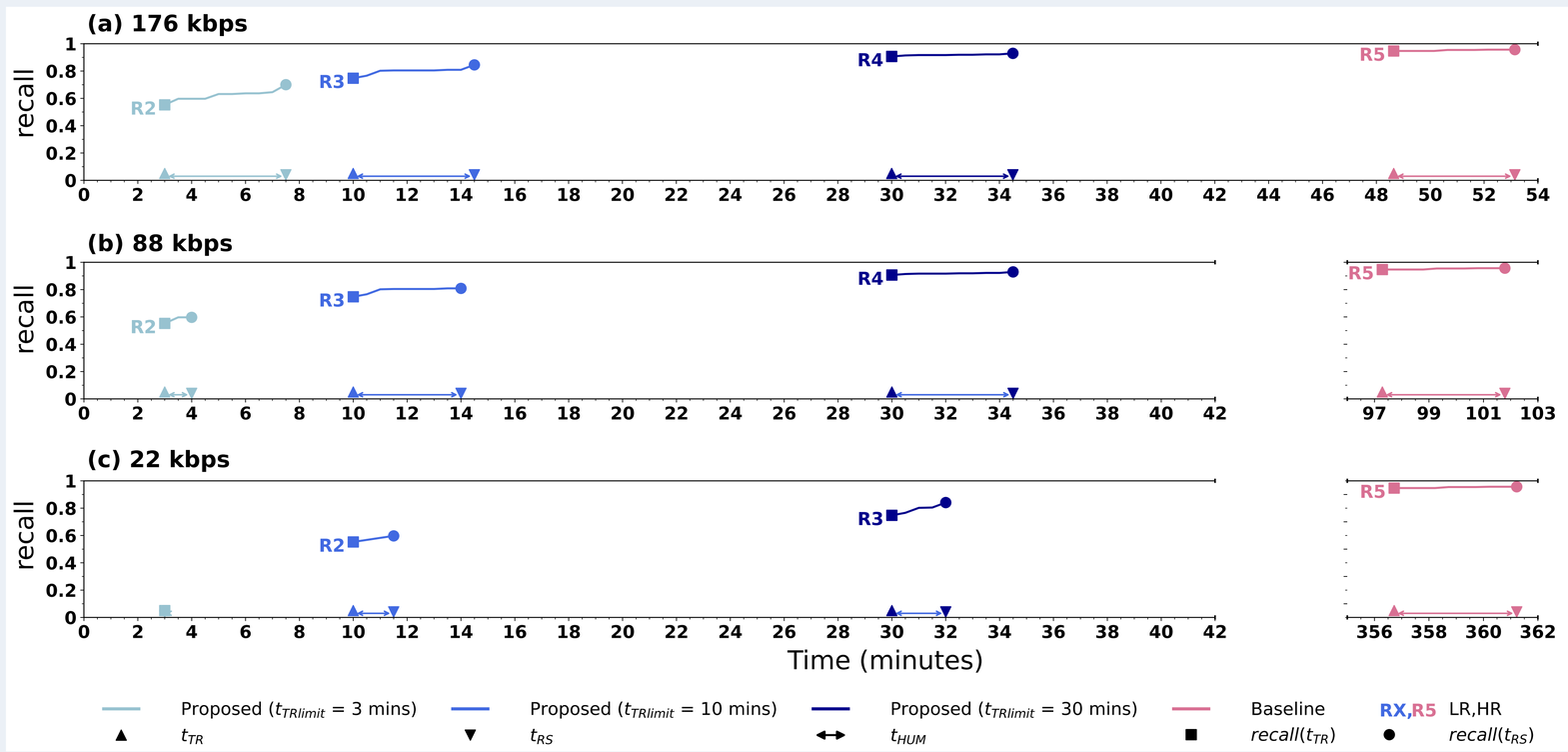
	3	10	30
176	0.257	0.112	0.028
	7.08	3.67	1.54
88	0.35	0.148	0.028
	25.44	7.27	2.95
22	/	0.359	0.115
	/	34.4	11.28

4. RESULTS: Response time is reduced by a factor of 34

176 kpbs:
Proposed transmits LR tiles LR
→ Improvement of t_{RS}_*ratio*
Baseline always transmits HR tiles → Penalty in *recall_diff* because performance of fine-tuned model at HR is better

88 kpbs:
Higher improvement of t_{RS}_*ratio* and lower decrease of *recall_diff* because budget for human annotation is lower

22 kbps:
Highest gain in t_{RS} . However, at 3min, even the lowest LR cannot be sent because the BW is too restrictive



Key References

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[4] Yamani, *et al.*, "Active learning for single-stage object detection in uav images," in Proceedings of the IEEE/CVFWinter Conference on Applications of Computer Vision (WACV), January 2024, pp. 1860–1869.

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5. CONCLUSION

The combination of fine-tuned DL model and human annotation with multiresolution allows to speed up the decision-making process in BW limited scenarios, up to 34 times in the most restrictive case
FUTURE WORKS will focus on optimizing each component of the framework (fine-tuning of the model and tile selection strategy for human annotation)

The Pléiades images were obtained via the Pléiades 4 Belgium platform under an agreement with BELSPO and labeled by ISSeP.
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*Denotes equal contribution