



THE ELECTRONICS RESURGENCE INITIATIVE

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WHITNEY MASON

PROGRAM MANAGER
DARPA MTO



RECONFIGURABLE IMAGING (REIMAGINE)



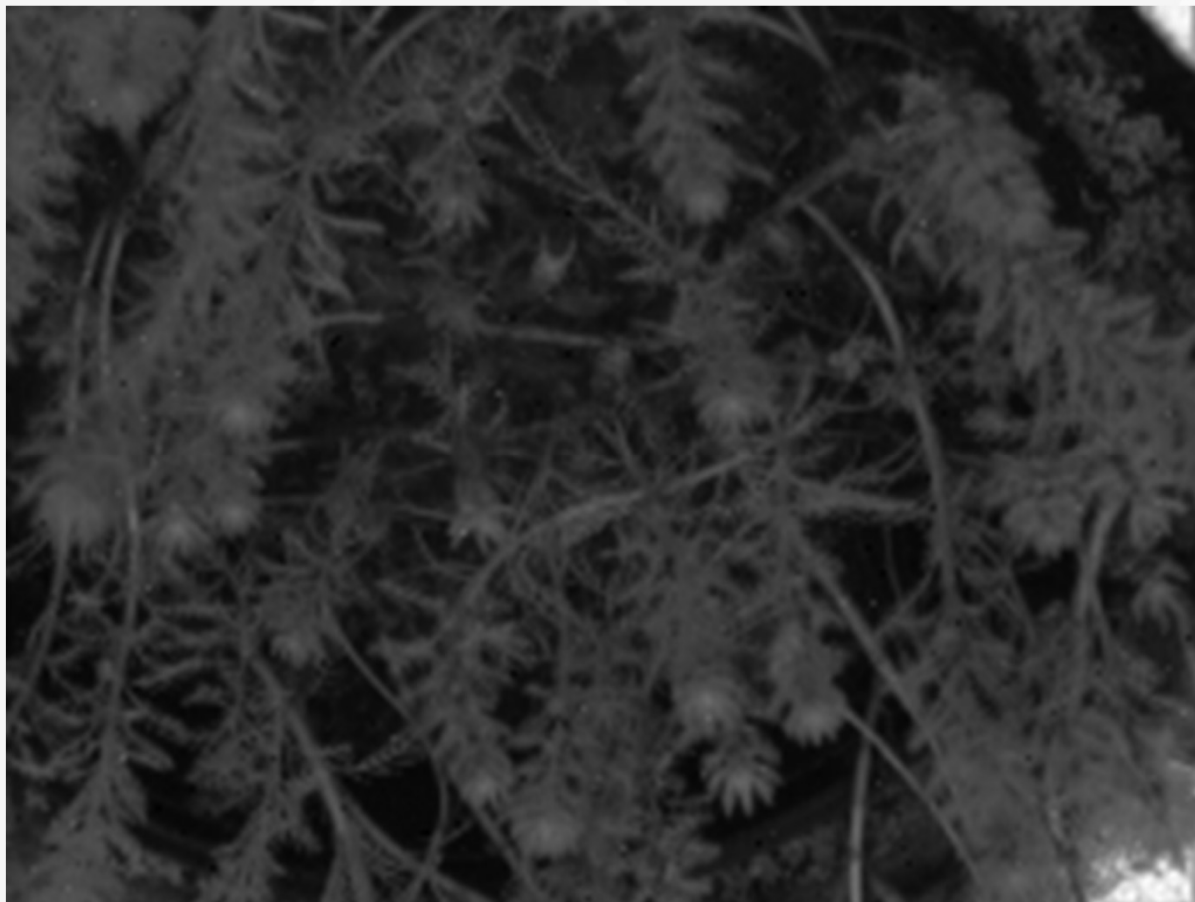
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WHAT IS RECONFIGURABLE IMAGING?

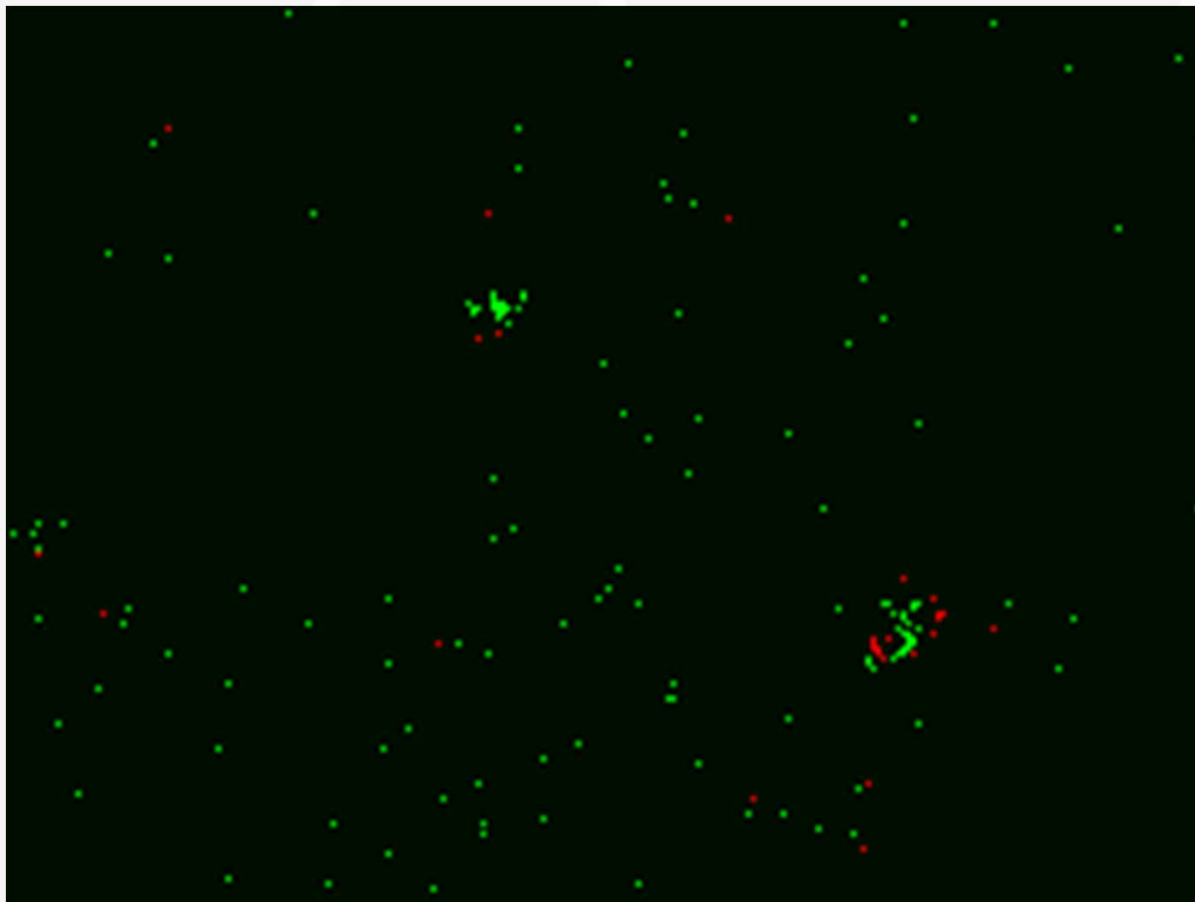
LET'S TAKE A LOOK AT A TYPICAL VIDEO, THEN DISSECT IT FOR RELEVANT INFORMATION



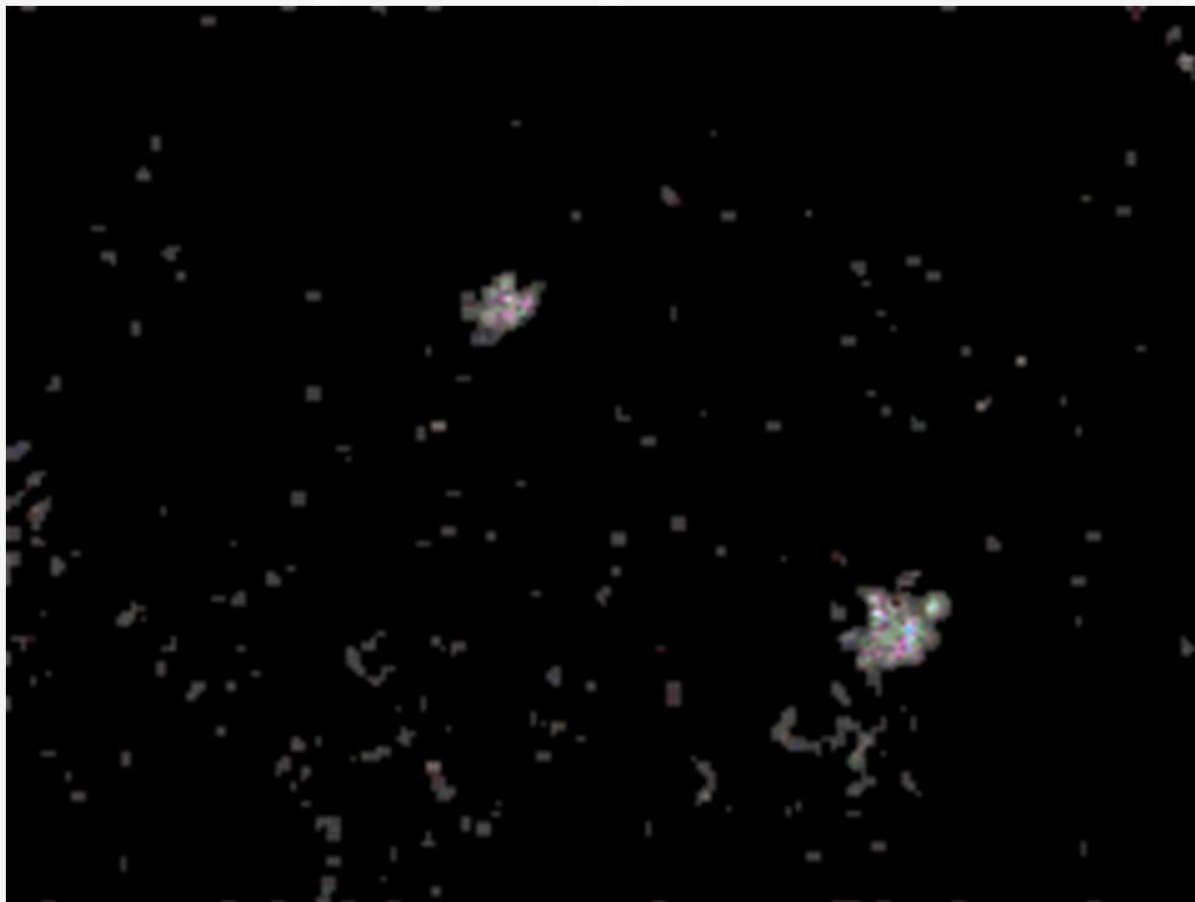
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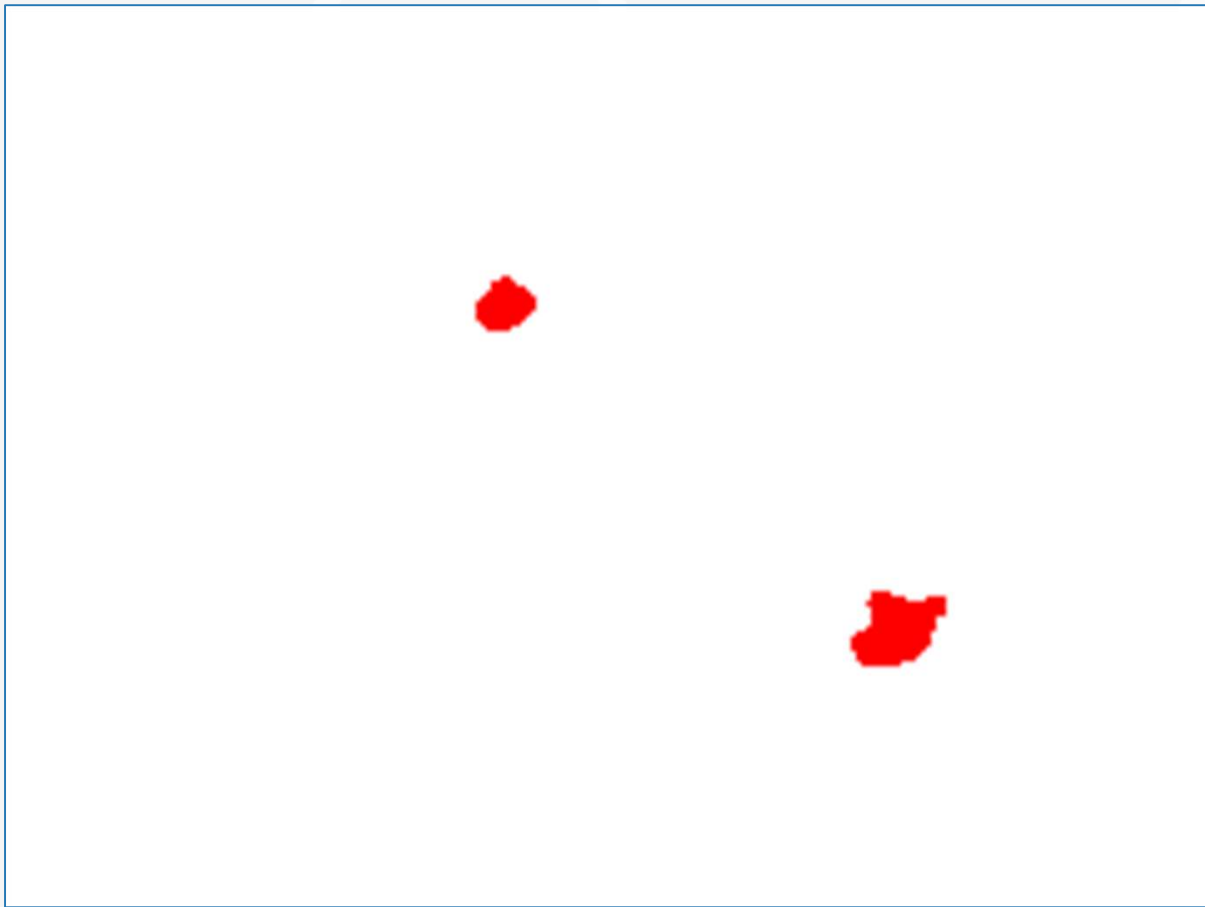
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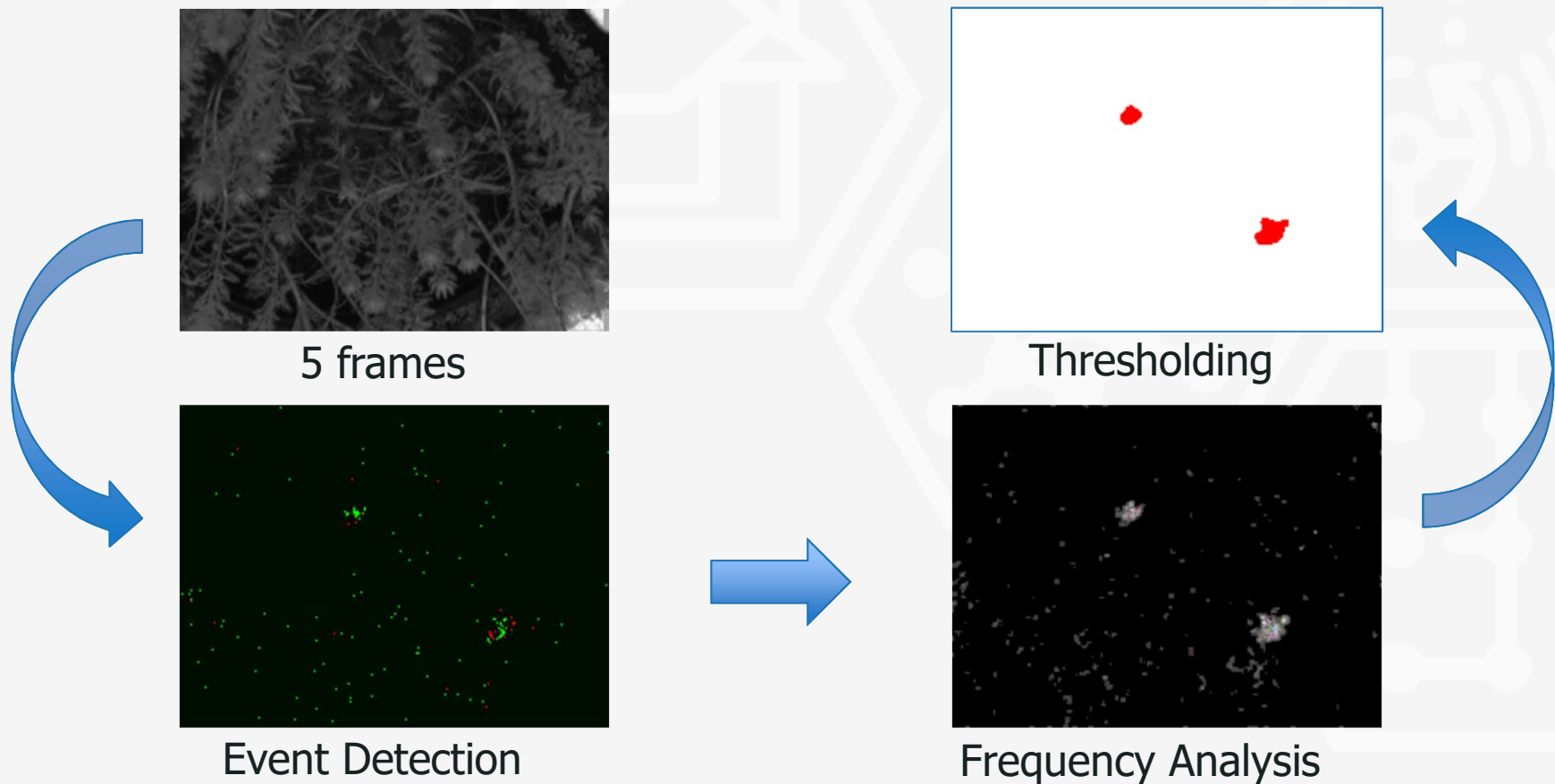


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ANALYZING THE VIDEO

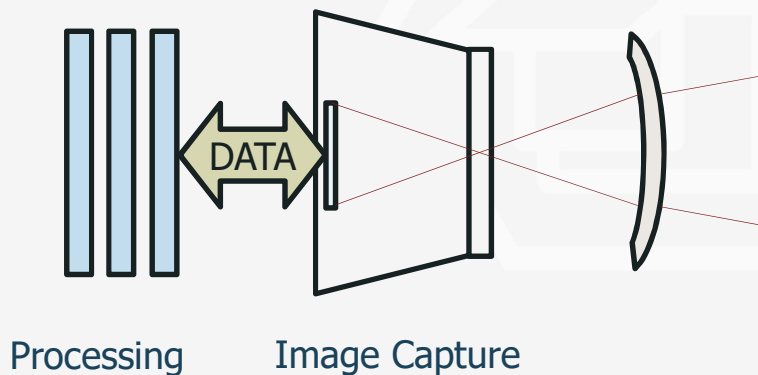




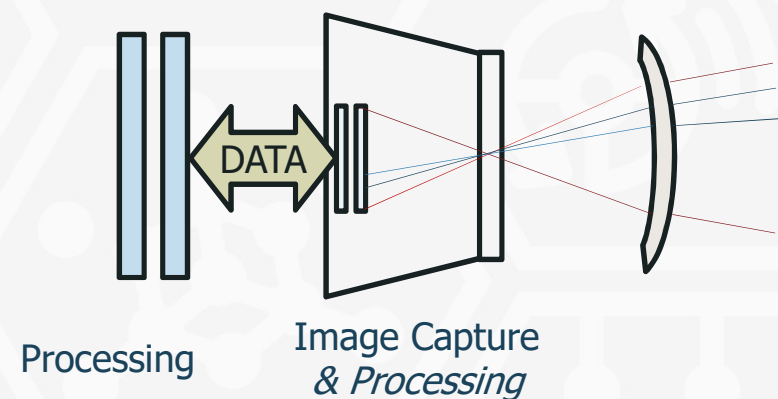
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HOW DOES THE HARDWARE DIFFER?

OPTICAL SENSOR HARDWARE



- Focal planes provide predetermined outputs
- Electronics perform all image processing



- Move some of the processing into the focal plane
 - Focal plane can adapt its outputs based on the scenario
 - Can save power and bandwidth

Adding field programmability to the focal plane allows adaptive and flexible imaging modes to meet a variety of sensor needs

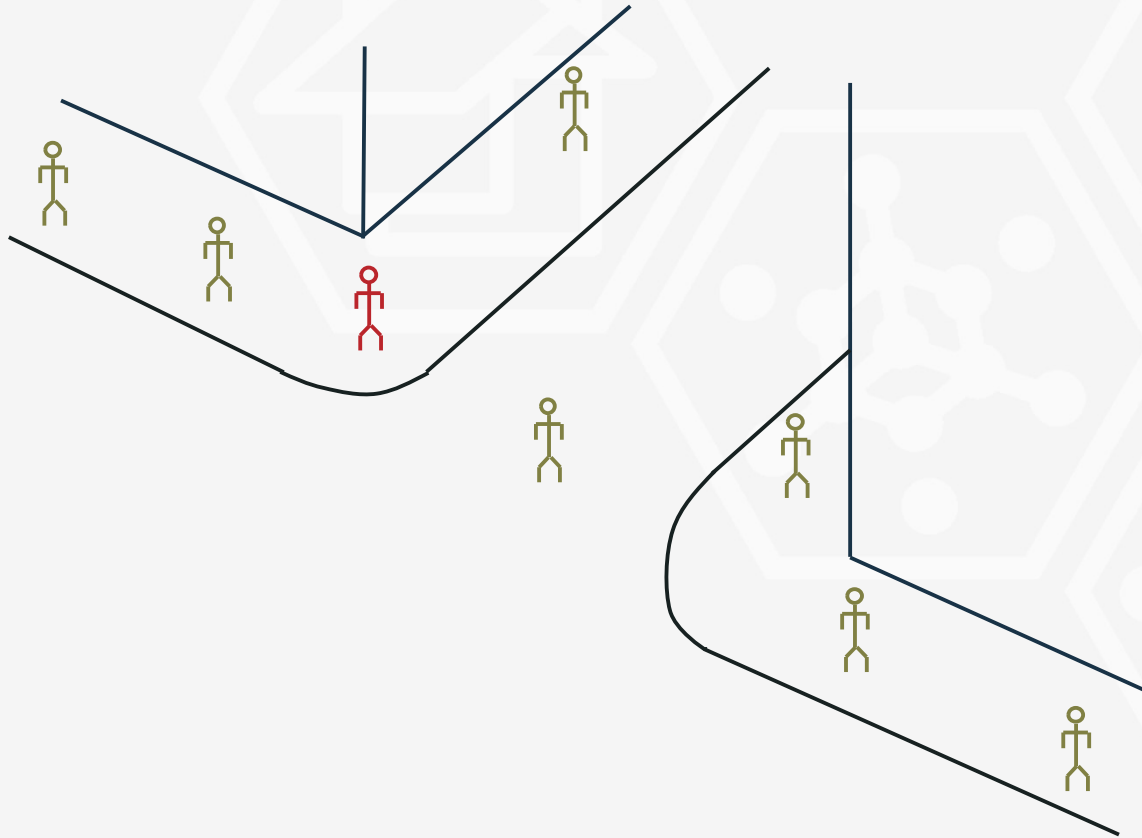


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SENSOR SOFTWARE POSSIBILITIES

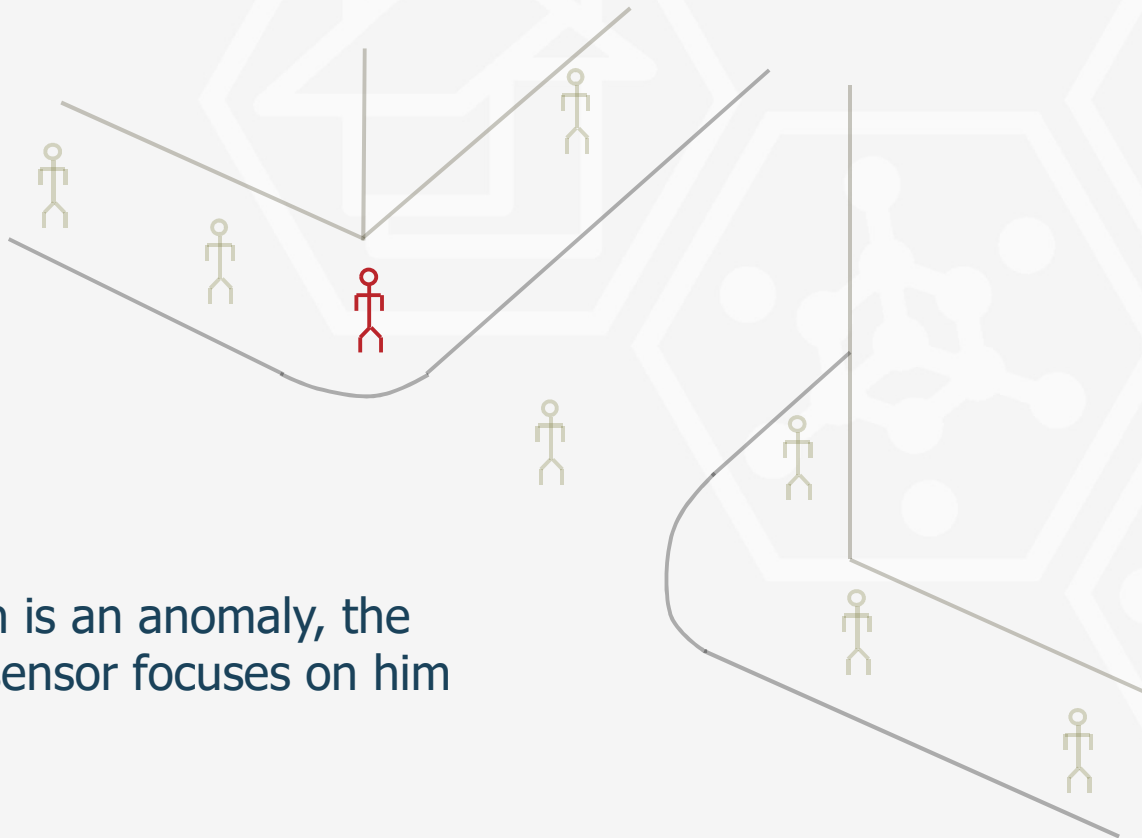
MIMIC NEUROLOGICAL ANALYSIS OF AN IMAGE

A TYPICAL SCENE ...



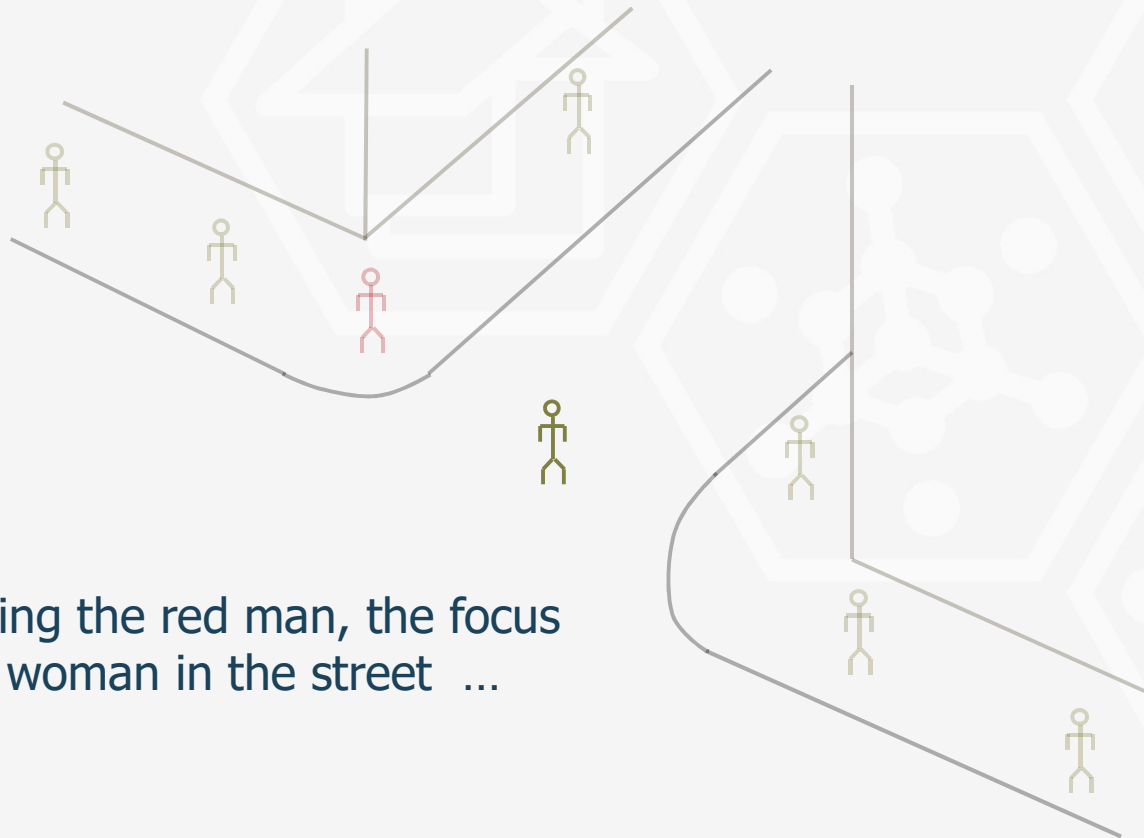
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REIMAGINE SENSOR SOFTWARE



The red man is an anomaly, the ReImagine sensor focuses on him

REIMAGINE SENSOR SOFTWARE



After observing the red man, the focus shifts to the woman in the street ...

REIMAGINE SENSOR SOFTWARE



And then moves onto the people on the sidewalk ...

REIMAGINE

- Adds processing to the focal plane
 - Allows a single sensor to provide a variety of outputs
 - Field programmability based on the application and software
- Processing in the external electronics
 - Supports software to dynamically evaluate the scene
 - Determine where the information lies in the image
 - Reconfigures the focal plane to provide that information
- By focusing on information, the sensor can
 - Reduce output bandwidth
 - Accelerate decision making



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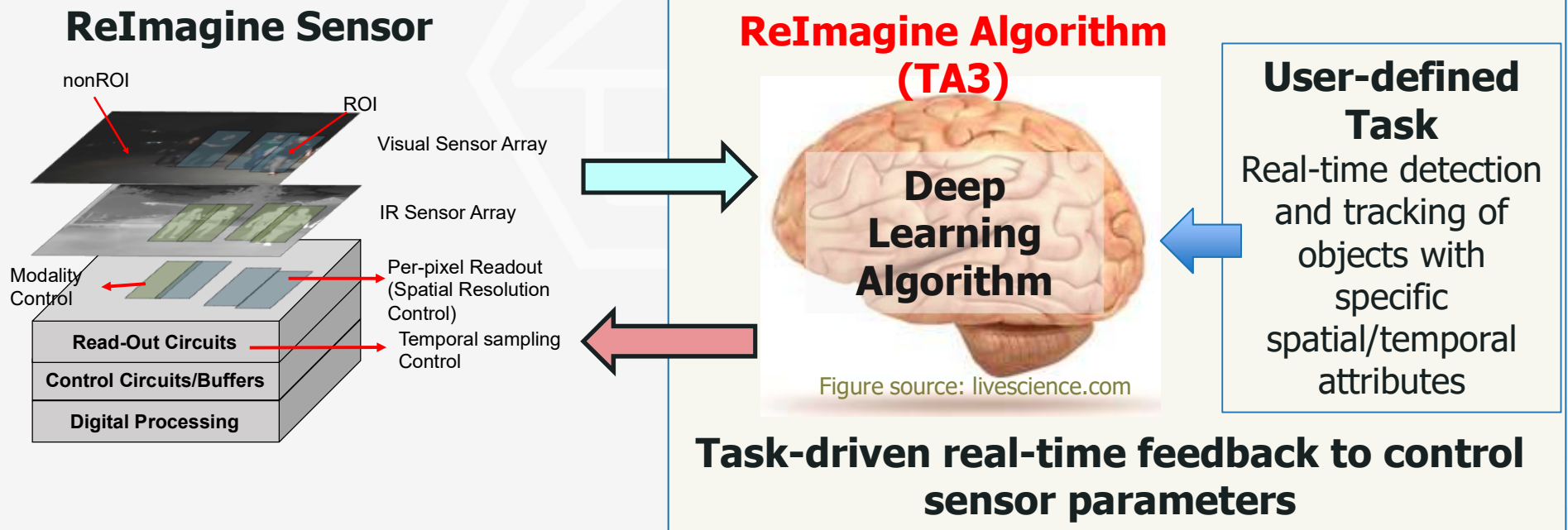
SAIBAL MUKHOPADHYAY

GEORGIA INSTITUTE OF TECHNOLOGY



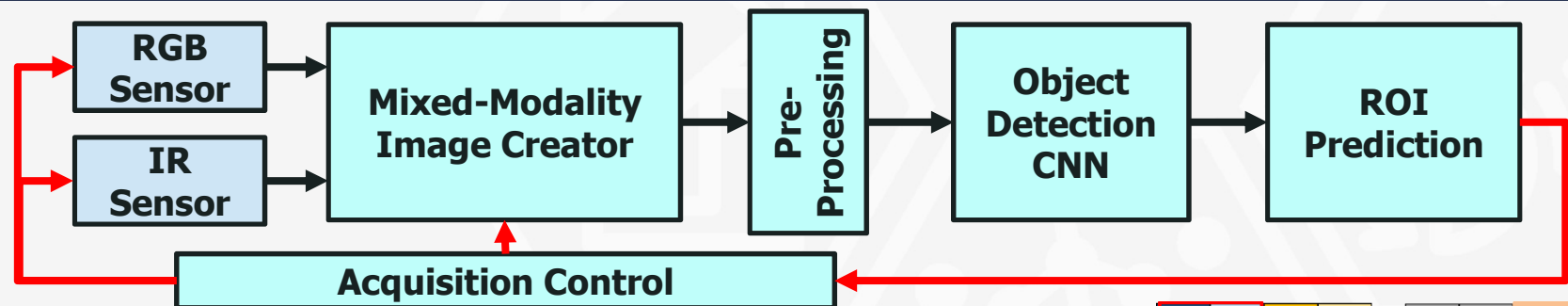
CAMEL: CAMERA ADAPTATION WITH EMBEDDED MACHINE LEARNING BASED FEEDBACK CONTROL

CAMEL: A CAMERA WITH BRAIN

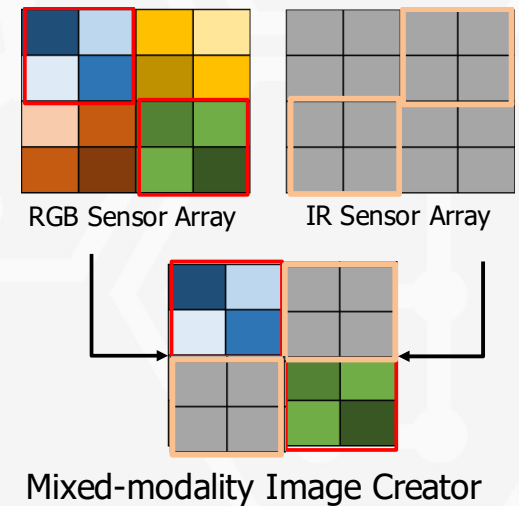
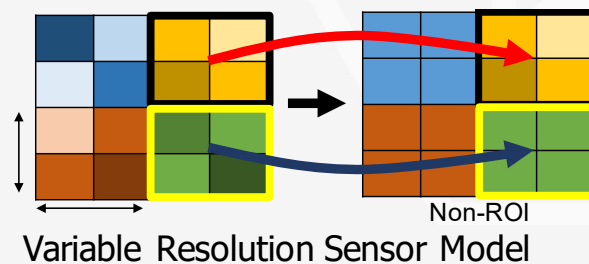


A camera that autonomously controls sensor parameters to increase information content in the picture or video by embedding deep learning algorithms in the processing layer.

EMBEDDED MACHINE LEARNING IN THE FEEDBACK LOOP



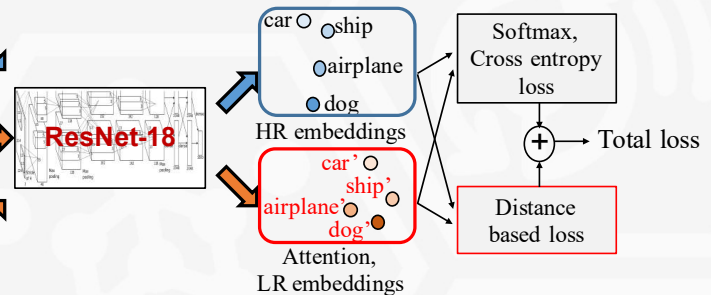
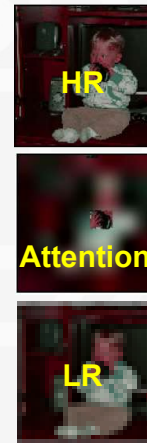
Embedded deep learning algorithms dynamically control the sensor parameters to improve quality of delivered information at reduced bandwidth from the sensor.



TRAINING DEEP LEARNING FOR FEEDBACK SYSTEM

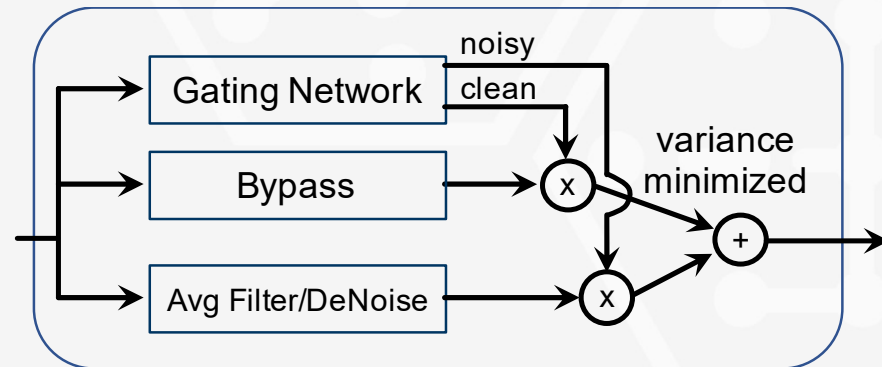


[Attention]
+
[Low
resolution]



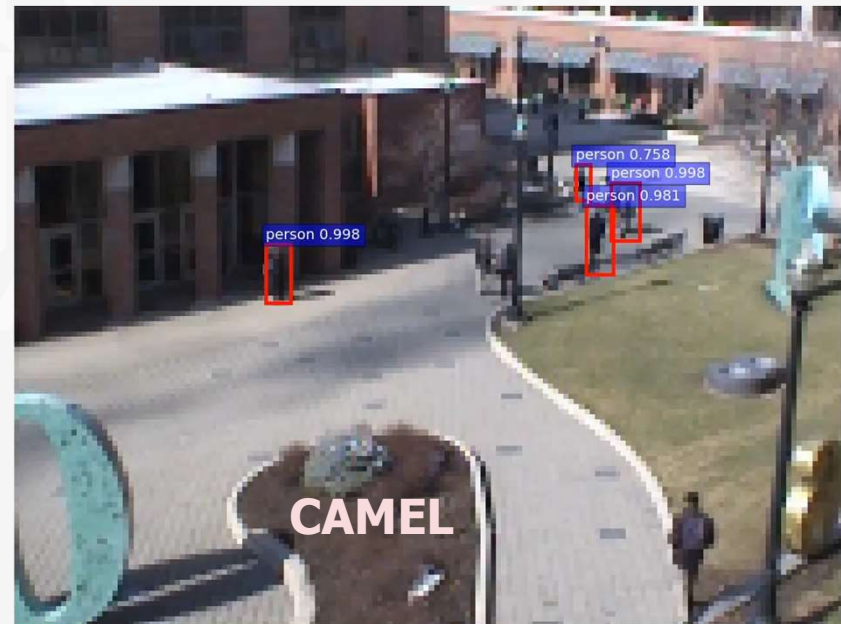
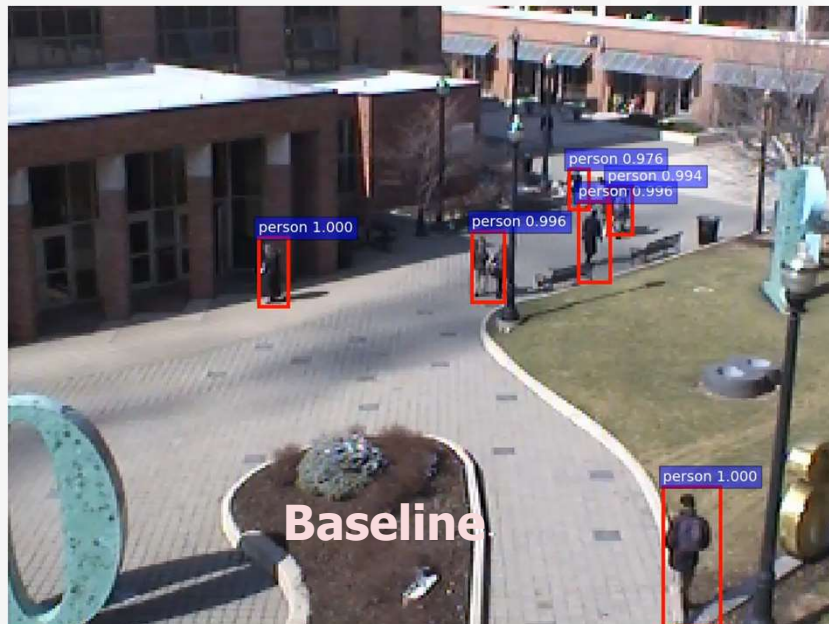
Innovations in DNN training helps improve accuracy of adaptive camera considering:

- Mixed- resolution/modality images
- Random noise in input images



Noise-robust design with mixture of pre-processing engines

RESULTS: MORE INFORMATION AT LESS BANDWIDTH

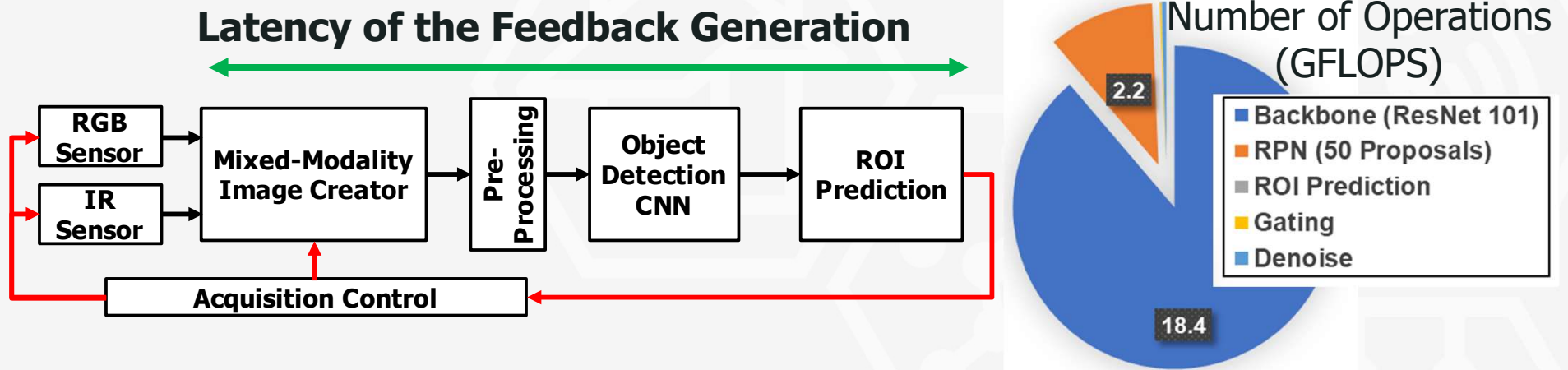


Detection maintained despite illumination variance

	Tracking Accuracy	Bandwidth (Normalized)
Baseline	0.528	1
CAMEL	0.650	4X Lower

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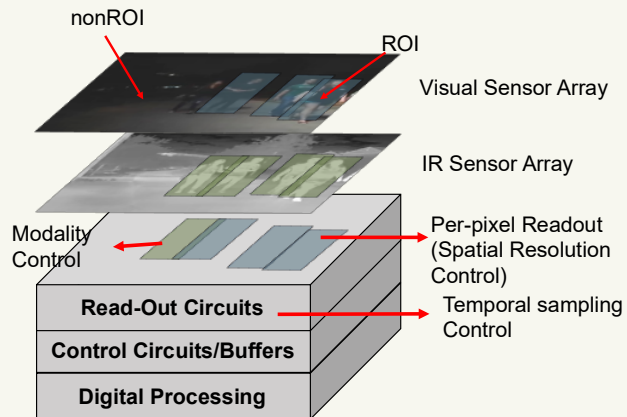
CHALLENGE: FEEDBACK LATENCY



Platform	Conv Backbone	Latency (s)	Frame Rate (fps)	Object Detection (AP, Person)	Tracking (MOTA)
GTX1080 [300W]	ResNet-101	0.128	7.8	0.43	54%
mGPU [5W]	ResNet-101	21	0.04	0.43	5%
	SSD MobileNet v1, Class-based Training+Pruning	0.099	10.1	0.27	35%

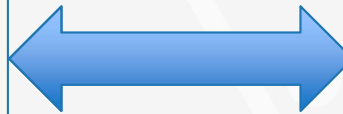
CONCLUSIONS

ReImagine Sensor

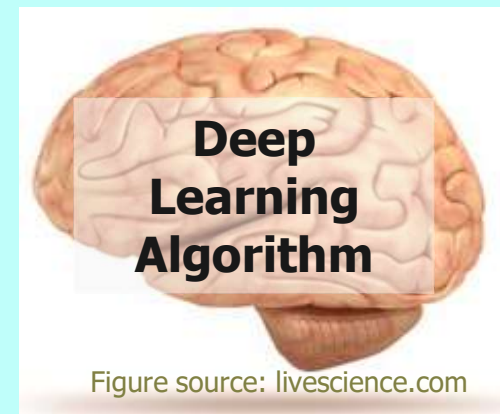


Unprecedented flexibility in reconfiguring sensor parameters

Camera with brain that senses *usable information* not only images



ReImagine Algorithm



Real-time feedback to control sensor parameters

Collaboration with ERI will help in software-hardware co-design to enable complex algorithms within the resource-constrained camera platform



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