Neuromorphic Surprise in a Surveillance Framework

Building Luke Skywalker's Binoculars

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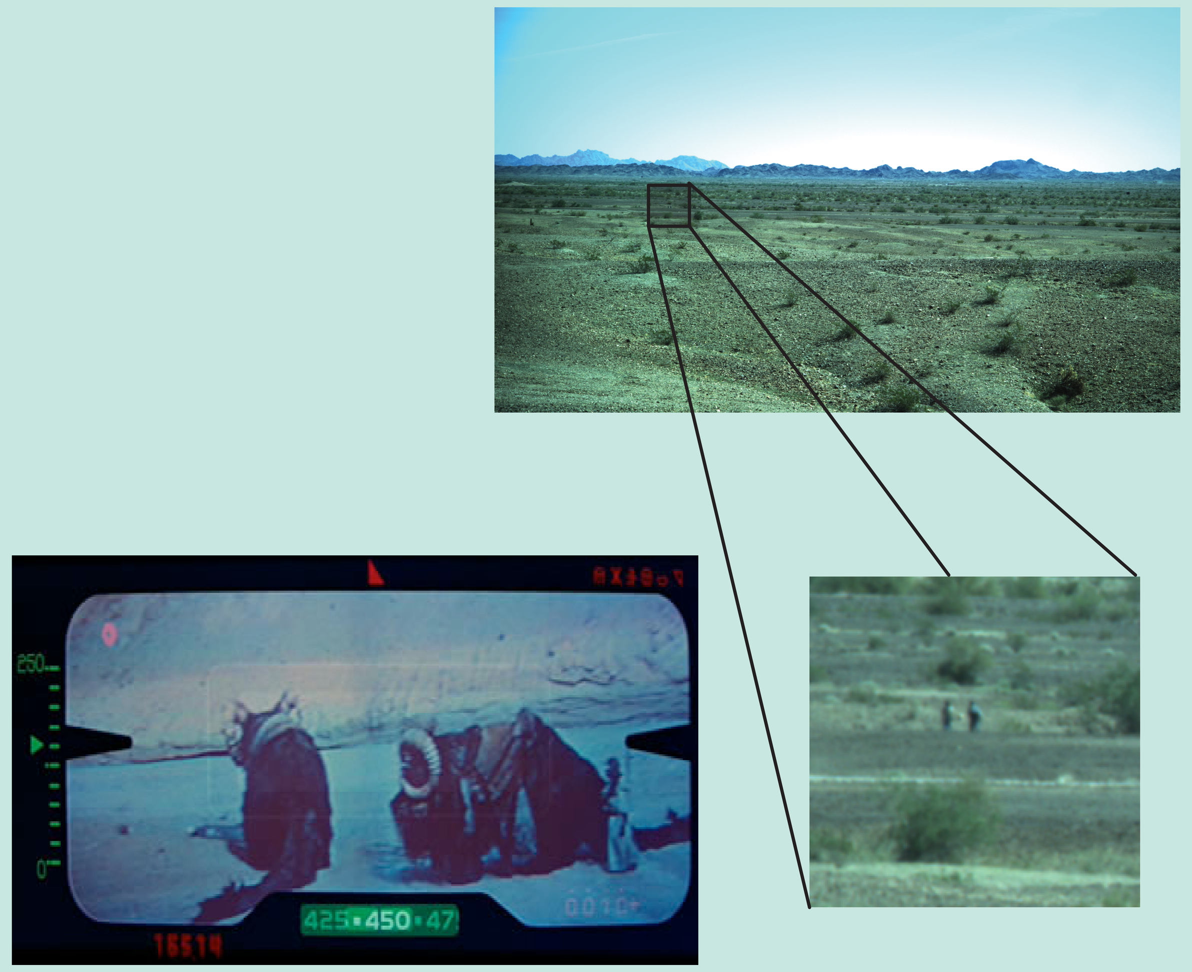
Initial DARPA Goal

• Develop a front- end system to detect very small distant targets in very large images.

• Targets averaged 20x37 pixels, though many were as small as ~10x10

• 4864x3248 pixels/frame, 3 frames/second

• Target hardware was a 100 megapixel camera array



Background

• Segmenting and tracking humans (Zhao, Nevatia 2004)

• Detecting 'unusual events' (Zhou, Kimber 2009)

• Segmenting foreground and background pixels (Li, et. al 2004).

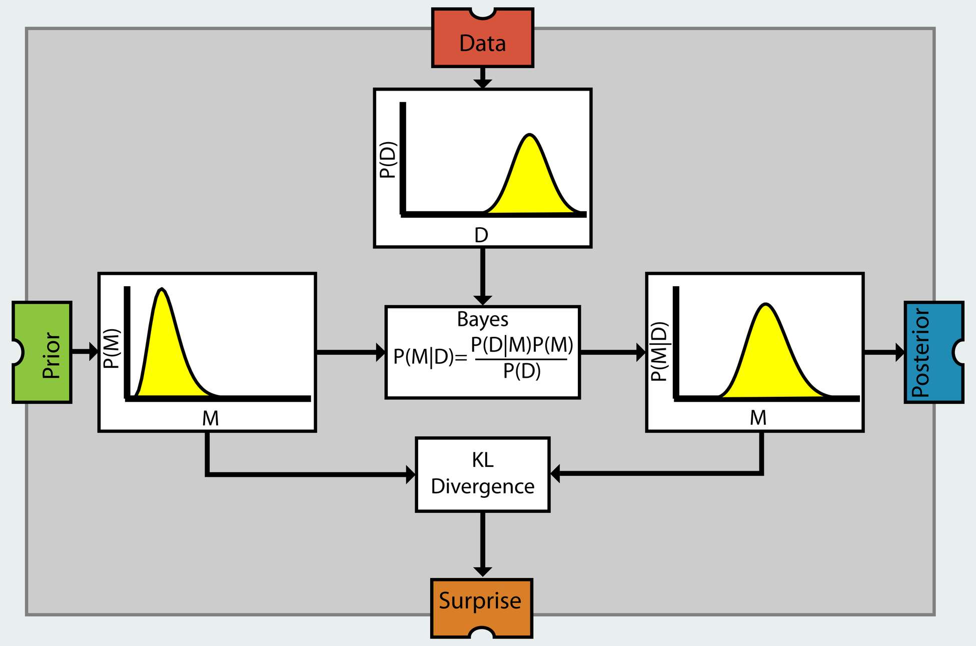
• Little work has been done on the detection of such small targets in such large images.

Surprise

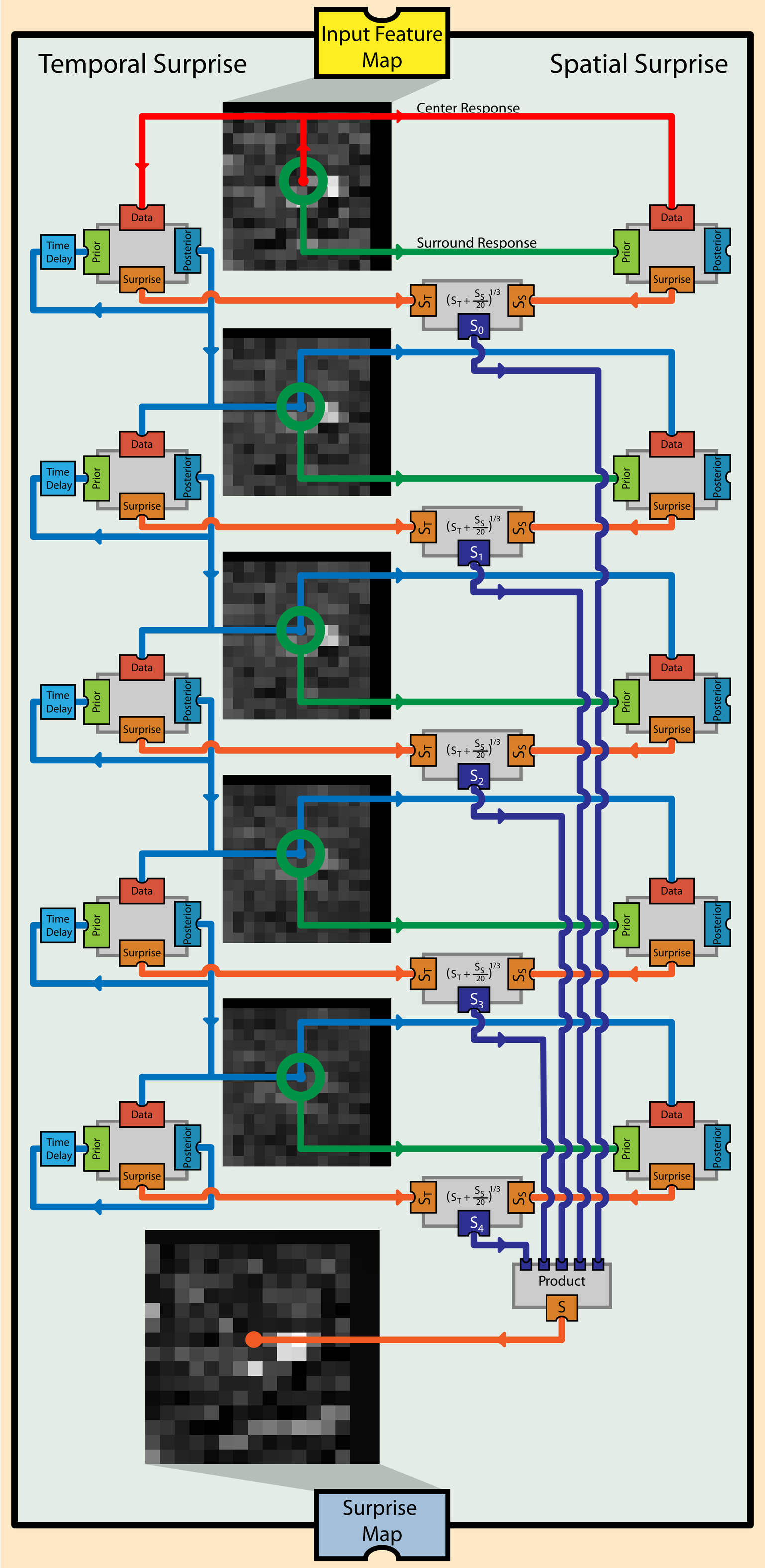
• We adapt Itti & Baldi's neuromorphic visual "Surprise" model to processing and aggregating data from very large images.

• The amount that one's belief is changed by observing new data.

• More formally, the distance between the prior and the posterior in a Bayesian learner.

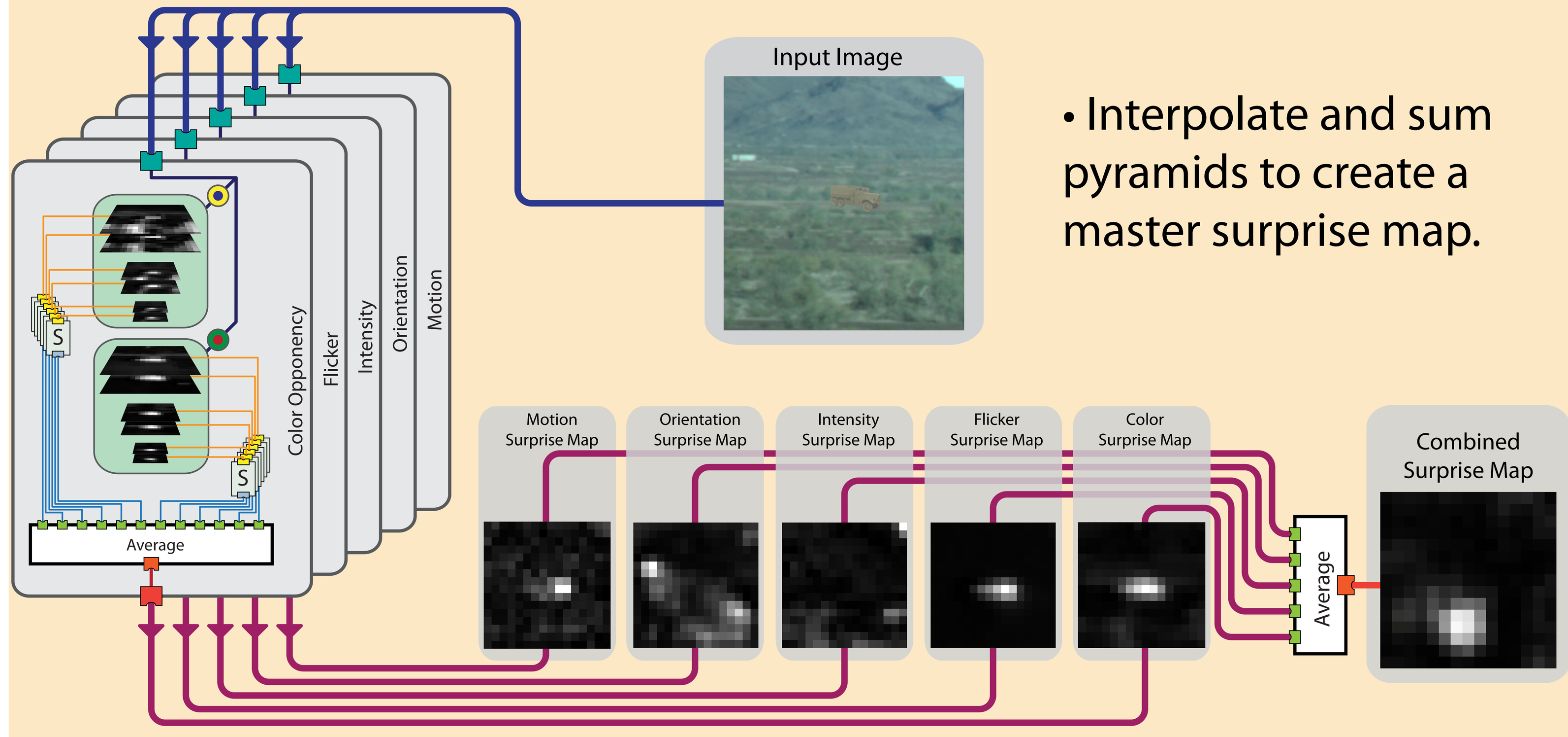


Detecting Surprise in Video



• Decompose images into various feature pyramids

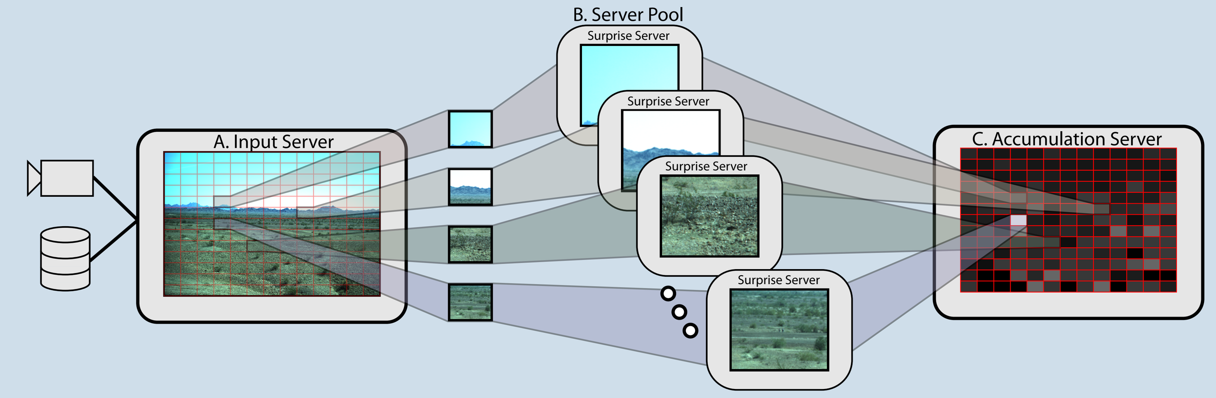
• Compute spatial and temporal surprise on each level of each feature pyramid by routing priors, posteriors, and surprise values as shown here.



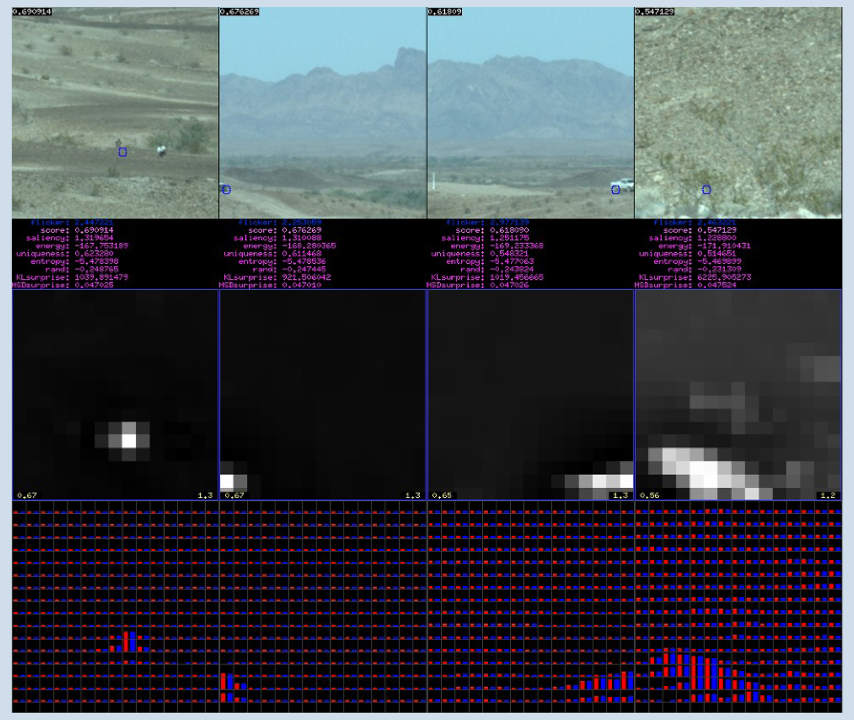
• Interpolate and sum pyramids to create a master surprise map.

Distributed Architecture

• Surprise computation is expensive!



• A distributed architecture was created to spread the computation over an arbitrary number of computation nodes



Algorithm	FPS
Li, et al. 2003	9.53
Surprise (All Channels)	4.16
Surprise (Flicker)	49.18
Fast Saliency	105.69

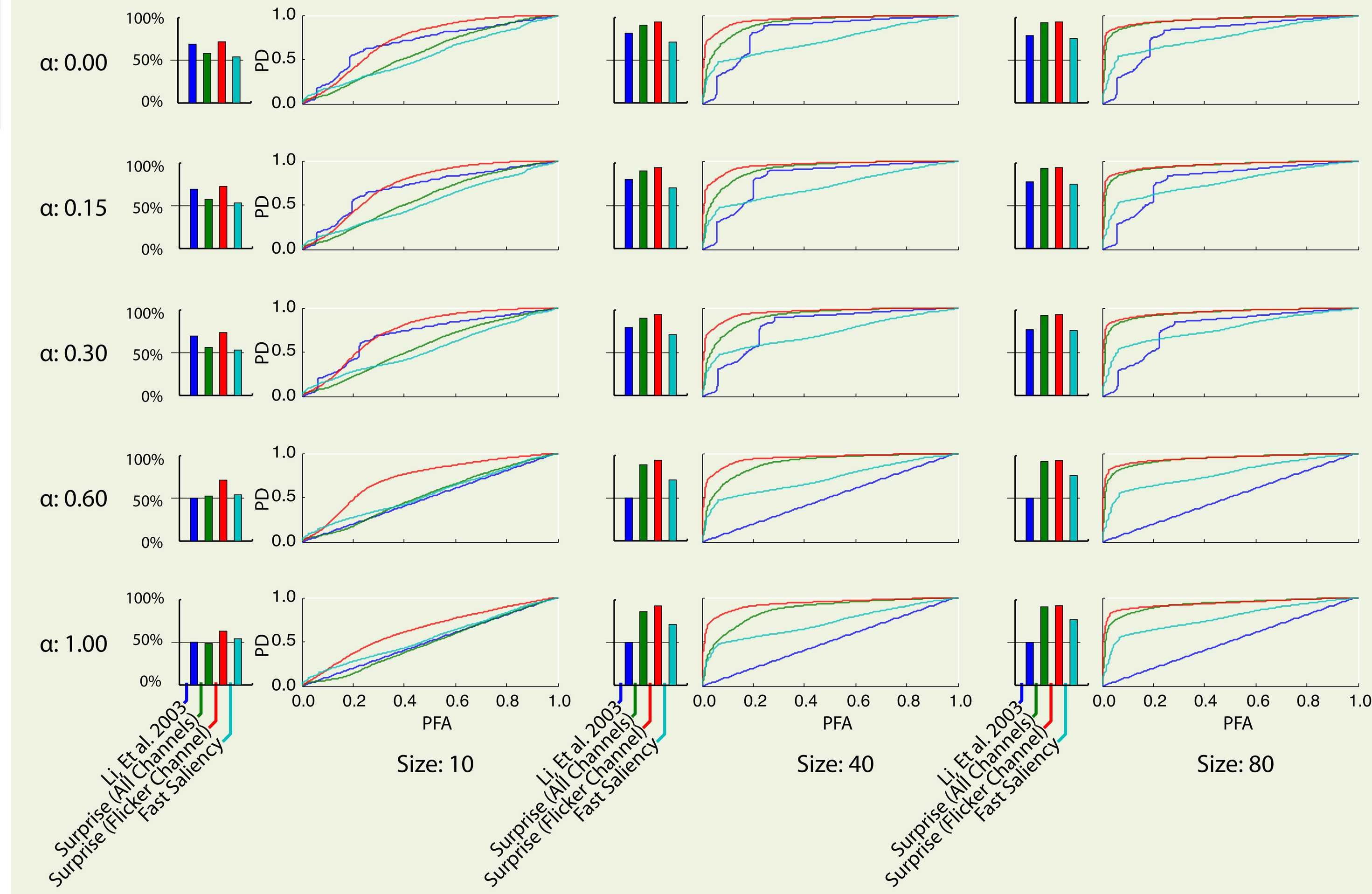
Runtime on a 256x270px region

Results

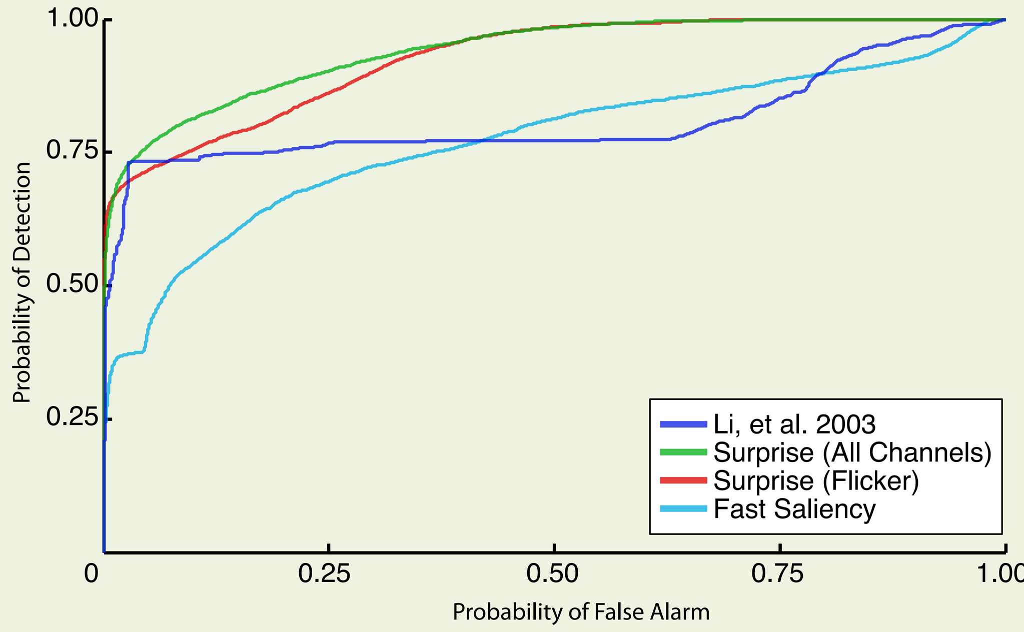
• We quantify the performance of the system by generating video sequences with artificial 'targets'.

• 'Targets' were presented at various sizes.

• Various amounts of Gaussian and Poisson noise were added to the generated sequences.



• Additionally, the system was tested in the desert using real people and vehicles as targets of interest.



Algorithm	ROC AUC
Li, et al. 2003	0.81
Surprise (All Channels)	0.94
Surprise (Flicker)	0.93
Fast Saliency	0.77

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