Analysis of dynamic multispectral video using systems factorial technology (SFT)

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Scan to connect with the WSU's Cognitive Modeling Group

Introduction

The additional information available from infrared sensors can aid in decision making when combined in visual information.

Despite the potential benefits of having multispectral information, recent research indicated limited capacity whether images were combined in a single image or presented side-by-side.[4]

Dynamic environments provide real-world stimuli with highly correlated movement of objects across time that may provide speed-ups in cognitive processes.

- We are interested in whether the results of processing strategies for static stimuli generalize to dynamic environments.

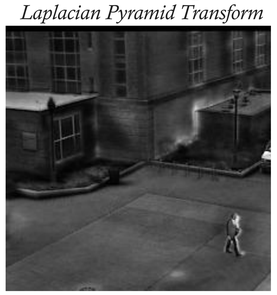
Experimental Design

Visible

Thermal

Fused Image

Laplacian Pyramid Transform



Task: Is the person(s) walking toward the left or right side of the camera? Respond quickly and accurately (> 80%).

Multispectral Presentation Conditions (300ms) :

1) **Side-by-Side (SxS):** Display the two videos directly next to one another with no overlap.

2) **Algorithm (Alg):** Display a single, composite video that combines relevant information from each individual sensor video using the Laplacian pyramid transform.

Model Comparisons

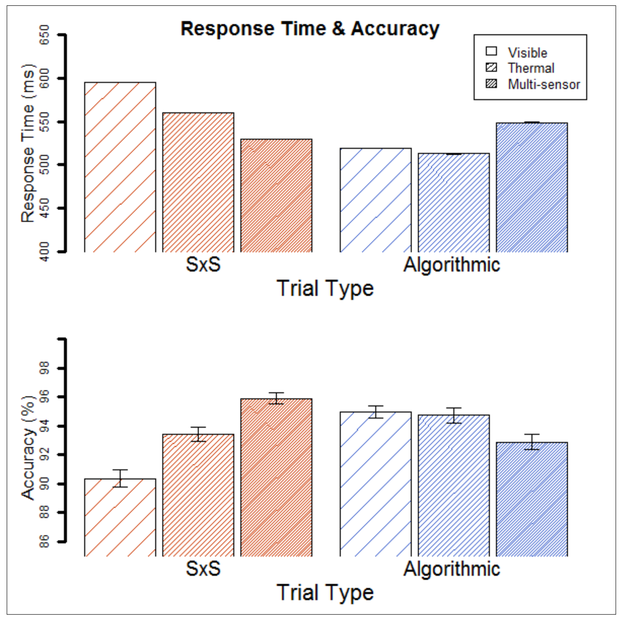
Capacity Coefficient[6,7]:

$$C_{OR} = \frac{\hat{H}_{1..n}(t)}{\sum_{i=1}^{n} \hat{H}_i(t)}$$

- **C = 1: Unlimited**
- **C < 1: Limited**
- **C > 1: Super**

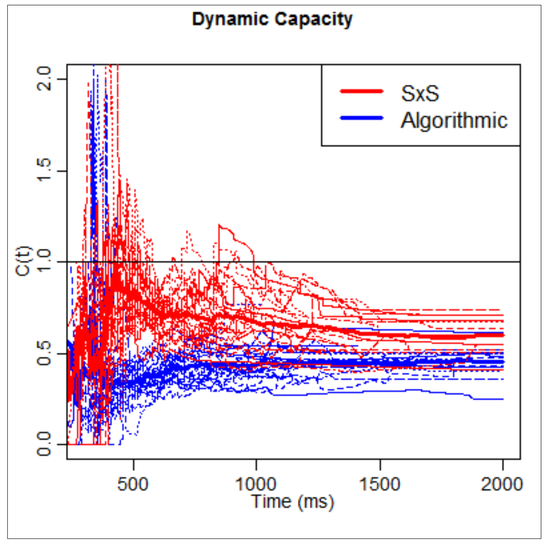
Results

Response Time and Accuracy



		Response Times		Accuracy	
	df	*F*	η	*F*	η
# of Sensors x Condition	1,21	178.25***	0.071	34.20***	0.101
# of Sensors (single, multiple)	1,21	7.96*	0.003	10.51***	0.014
Condition (Alg, SxS)	1,21	6.52*	0.020	0.00	0.000
Single-sensor presentation	1,21	39.38***	0.164	8.65***	0.121

Capacity Coefficient



Capacity z-score values significantly differ by presentation condition, $t(20) = 14.66$, $p < .05$.

z-score (range, *M*):

Side-by-Side:
-4.59 to -1.17 (*M* = -2.93)

Algorithmic:
-10.36 to -6.26 (*M* = -7.95)

Discussion

1) Display of dynamic multispectral information shows less efficient processes than we would expect given the processing of each sensor alone.

2) The redundancy of movement across various types of multispectral imagery displayed simultaneously may provide additional speed-ups that are not provided by a single, composite image.

Conclusions

- Response time and accuracy performance significantly varies based on the sensor and the multispectral presentation method.
- For these stimuli, all multispectral fusion methods result in limited workload capacity and capacity varies by condition.

Future Research

- Dynamic visual search[5]
- Response classification[1,2,3]

References

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[7]Houpt, J. W. & Townsend, J.T. (2012). Statistical measures for workload capacity analysis. *Journal of Mathematical Psychology, 56,* 341-355.

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