Analysis of Fused and Unfused Imagery

Elizabeth Fox[1], Joseph Houpt[1], Jennifer Bittner[2], Fairul Mohd-Zaid[3]

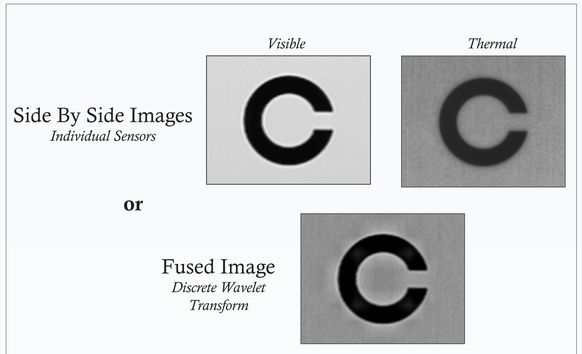
[1]Wright State University, [2]Ball Aerospace, [3]Air Force Institute of Technology

Dayton, Ohio Dayton, Ohio Wright-Patterson Air Force Base

Introduction

- Image fusion combines multiple sensor types into one image as compared to traditional decision fusion, or side by side image presentation.
- Current literature evaluates images quality but is sparse in examining human performance with fused images.
- Systems factorial technology[1] is a general framework for assessing how human observers process multiple sources of information.

Experimental Design



Double Factorial Paradigm[1]

Capacity Coefficient:

	Thermal	$Ø_{Thermal}$
Visible	**VT**	**VØ**
$Ø_{Visible}$	**ØT**	

Survivor Interaction Contrast:

	$Thermal_{High}$	$Thermal_{Low}$	$Thermal_{Ø}$
$Visible_{High}$	V_HT_H	V_HT_L	$V_HT_Ø$
$Visible_{Low}$	V_LT_H	V_LT_L	$V_LT_Ø$
$Visible_{Ø}$	$V_ØT_H$	$V_ØT_L$	

$H_{visible}/H_{thermal}$ indicate high salience (fast) stimuli.
$L_{visible}/L_{thermal}$ indicate low salience (slow) stimuli.
$Ø_{visible}/Ø_{thermal}$ indicate the absence of a signal.

Capacity Coefficient[1,2]

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

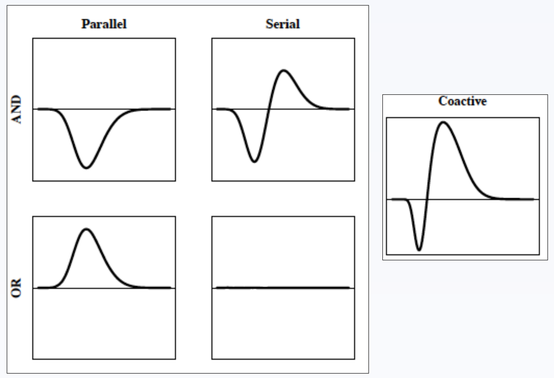
Limited Workload Capacity (C < 1): Decrease of performance in each individual sensor type as number of sensors increase.

Unlimited Workload Capacity (C = 1): Performance of each individual sensor type stays consistent with baseline performance as number of sensors increase.

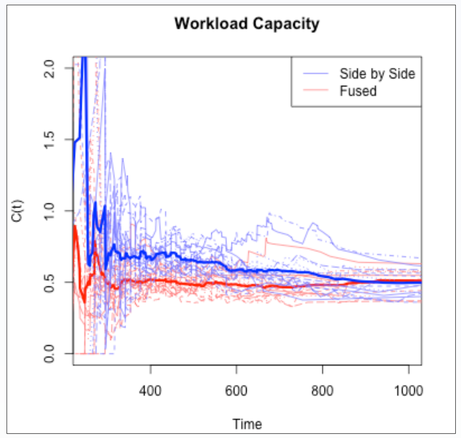
Super Workload Capacity (C > 1): Increase in performance in each individual sensor type as the number of sensors increase.

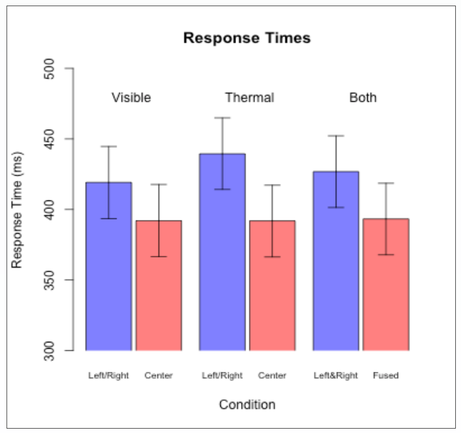
Survivor Interaction Contrast[1,3]

$$SIC(t) = [S_{LL}(t) - S_{LH}(t)] - [S_{HL}(t) - S_{HH}(t)]$$



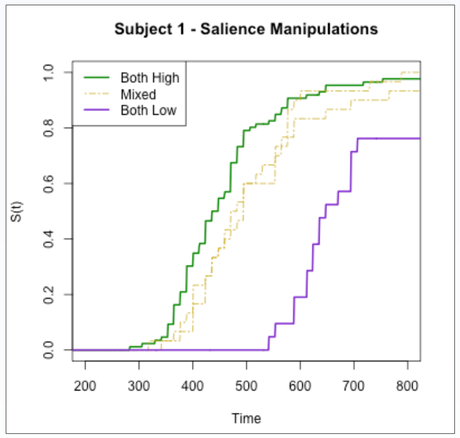
Capacity Results

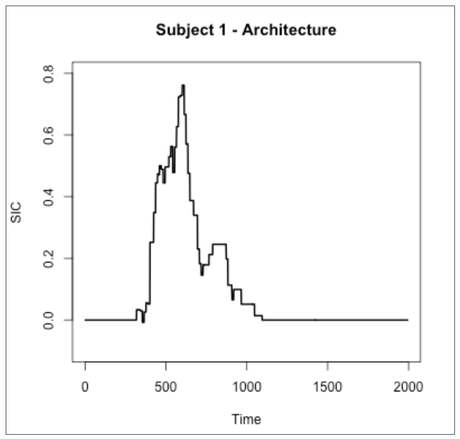




Variance intervals are based on 95% highest probability density region.

SIC Results





Statistics

Capacity:

- Decisive evidence for limited capacity with side by side presentation, BF = 2.4 x 10^8.
- Decisive evidence for limited capacity with fused presentation, BF = 1.8 x 10^{12}.
- Decisive evidence that fused presentation is more limited than side by side presentation, BF = 5.4 x 10^3.
- Decisive evidence for a model including an interaction effect above a model with only both main effects, BF = 5.4 x 10^3.

SIC:

- Of 21 subjects, 9 determined correct survivor orderings, all visually illustrating a positive SIC.
- 4 subjects were significantly positive, no subjects were significantly negative.

Conclusions

- A redundancy gain in side by side condition but decrement due to attending to multiple sources of information.
- Consistent reaction times across individual sensor types and fused image resulting in limited capacity.
- Do not expect to this pattern when moving to complimentary information image fusion.
- Parallel-OR processing of side by side information.

References

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