Single display versus dual displays: A cognitive modeling perspective

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Rationale

Radiologists often work with multiple display workstations. However, few studies have assessed radiologists' performance with different configurations for multiple displays. We briefly summarize studies we ran comparing performance with multi-sensor imagery in a single fused image display to side-by-side displays. Our assessment is based on a mathematical cognitive modeling framework, which we propose as a method assessing radiologists' performance in future studies.

Methods

In the side-by-side display conditions, observers could strategically choose to process the images either sequentially or simultaneously. We examined their strategies using Systems Factorial Technology (hereafter, SFT). SFT is a framework that analyzes information processing from several perspective: architecture (serial/parallel),workload capacity (limited/unlimited/super), stopping rule (self-determination/exhaustively), stochastic dependence(dependent/independent). Under appropriate expermental conditions, interaction contrasts of the mean (MIC) and survivor function (SIC) of response times can be applied to measure architecture and stopping rule. The capacity coefficient measures workload capacity, that is, it indicates the efficiency of observers processing multiple sources of information relative to processing them in isolation. The efficiency comparison is between the predicted performance assuming unlimited-capacity, independent and parallel (UCIP) processing and the actual performance. We applied SFT to image processing covering images with different complexities: Landolt C, direction (left/right) decision, and a more applied weapon/non-weapon discrimination. Each stimulus was imaged with a long-ware infrared (LWIR) sensor and a standard visible-spectrum sensitve camera. Any time multiple source images were presented side-by-side, the information was redundant, meaning the observer could respond as soon as the discrimination was made using either source. In the single display, images were fused using Laplacian Pyramid Transform as a combination of information from both sensors.

Results

All observers were limited capacity indicating they were less efficient with two image types than with single-sensor images. Across observers, there was evidence of different strategies, inicated by differences in architecture and stopping rule. Based on our results, for visible and LWIR images in these tasks, we suggest side-by-side display is a better choice.

Conclusions

Given our success with assessing performance in that domain, we believe SFT is a promising tool for future assessemnt of radiologists' workstation configurations.