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Target Search and Detection

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Search and detection are two everyday jobs of many biological systems, performed almost innately, either consciously or subconsciously and necessary for survival. Search and target detection, in particular, are the first stages in visual observation tasks associated with military target acquisition, industrial inspection, traffic control, and many more applications. These tasks currently are often performed with the aid of an electro-optic viewing system. In these tasks, search is defined as the process by which an observer surveys his surroundings, and detection is the process of successfully declaring a desired target as such—more precise interpretations of these terms will be found in what follows and in the included papers.

For more than fifty years, the military, industry, and academia have been studying, developing, and refining the modeling of target search and detection using imaging sensors. Search and detection modeling is used by both sensor system designers to select sensors to accomplish a desired task, and by war gamers to include sensor performance in predicting the outcome of battles between opposing forces. Basically, these models attempt to predict target detection probabilities and search times for a sensor system with the human in the loop. Yet the interactions between target; background; clutter; sensor characteristics such as sampling, blur, noise and field of view; and the human perceptual and cognitive capabilities are extremely complex and must be considered. In addition, the inherent stochastic nature of the search process complicates the collection of accurate empirical validation data. For instance, a rule of thumb to keep in mind when performing a search experiment is that the mean search time and its standard deviation are equal (Toet et al., 2003).[1]

The focus of this special section is on practical application with electro-optical viewing instruments, often situated in a military environment. It is our aim to bring together a summary of some of the recent and past work on search and detection modeling and empirical validation methodology to provide an overview useful to specialists in the field and engineers who will apply the technology. To those specifically interested in the fundamentals and visual search mechanisms of the human visual system, we refer to the abundant academic material available in archival vision research journals. The papers in this issue address a broad range of topics on both the empirical and modeling side for a variety of sensor systems, including daylight vision, image intensifiers, and thermal imagers, with or without signal processing. These include a historical overview of NVESD-associated search and detection modeling (Maurer, Wilson, and Driggers, *Opt. Eng.* 52 (4), 041108); a model extension to a variety of complex conditions, such as field of regard (FOR) search, search by multiple observers, search from a moving vehicle, and multi-target search (Friedman, *Opt. Eng.* 52 (4), 041107); an improved clutter metric (Camp, Moyer, and Moore, *Opt. Eng.* 52 (4), 041104); saliency modeling and experimental assessment of urban camouflage (Toet et al., *Opt. Eng.* 52 (4), 041103); assessment of the effect of signal processing on search performance through the measurement of conspicuity (Dijk et al., *Opt. Eng.* 52 (4), 041105); extensive empirical assessment of FOR search performance under a variety of conditions (Hogervorst, Toet, and Bijl, *Opt. Eng.* 52 (4), 041106); and (biologically inspired) automated detection (Schachter, *Opt. Eng.* 52 (4), 041102).

References

1. A. Toet and P. Bijl, "Search experiment example," *Encyclopedia of Optical Engineering* R. G. Driggers, Ed., pp. 2566–2576, Marcel Dekker Inc., New York, USA (2003).

Piet Bijl currently works as a research program leader and senior research scientist at TNO in The Netherlands. He received his PhD in physics from the University of Utrecht in The Netherlands in 1991. He has published over 60 articles and TNO reports on target acquisition, visual search, and characterization of electro-optical (EO), and infrared (IR) system performance with the human-in-the-loop. Presently, he is involved in the development of new standard video and thermal camera system performance specification methodologies. In 2010, he was elected a Fellow of SPIE.

Tana Maurer received a BS in chemical engineering from North Carolina State University and an MS in electrical engineering from George Mason University. She has worked at the U.S. Army Night Vision and Electronic Sensors Directorate (NVESD) for over 18 years, with a majority of that time spent in the Modeling and Simulation Division.

David L. Wilson received a PhD in mathematics from Kent State University in 1982. Currently a member of the Air Systems Division at the U.S. Army Night Vision and Electronic Sensors Directorate (NVESD), his interests include target discrimination modeling and spectral differences of electro-optical sensor imaging. He is a member of SPIE, AFCEA, AMS, and the MAA.