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**Incorporation of acoustic level analysis with sonar operator  
workstation workflow using hierarchical hidden Markov models**

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Future Anti Submarine Warfare (ASW) systems will be highly automated, and utilize multiple sonar signal processing, non-acoustic information, off platform information, and environmental information to maximize the detection, tracking, and classification of undersea threats. Recently, a hidden Markov model (HMM) was developed to describe and characterize the workflow strategies that expert sonar operators used during the IUSW-21 (Integrated UnderSea Warfare for the 21st Century) Sea Test. Abandoning the normative workflow designed into the system, the sonar operators developed and utilized unanticipated strategies to gather evidence to confirm or disconfirm automated classifications or to manually classify contacts. The workflow included detailed visual inspection of and listening to the sonar return. This initial HMM did not include a characterization of the auditory processing. Hidden Markov models are well suited to this purpose. Adding this component to the operator workflow was achieved by a hierarchical HMM which represents the acoustic processing as an embedded HMM in the overall workflow HMM. The resulting model is not just an operator workflow but defines a system processing model that could be used as a framework to develop automated processing of selected components.