
**Abstract**

This report presents an overview of a program of speech recognition research that was initiated in 1985 with the major goal of developing techniques for robust, high-performance speech recognition under the stress and noise conditions typical of a military aircraft cockpit. The work on recognition in stress and noise during 1985 and 1986 produced a robust Hidden Markov Model (HMM) isolated-word recognition (IWR) system with 99 percent speaker-dependent accuracy for several difficult stress/noise databases, and very high performance for normal speech. Robustness techniques that were developed and applied include multi-style training, robust estimation of parameter variances, perceptually motivated stress-tolerant distance measures, use of time-differential speech parameters, and discriminant analysis. These techniques and others produced more than an order-of-magnitude reduction in isolated-word recognition error rate relative to a baseline HMM system. An important feature of the Lincoln HMM system has been the use of continuous-observation HMM techniques, which provide a good basis for the development of the robustness techniques, and avoid the need for a vector quantizer at the input to the HMM system. Beginning in 1987, the robust HMM system has been extended to continuous speech recognition for both speaker-dependent and speaker-independent tasks. The robust HMM continuous speech recognizer was integrated in real time with a stressing simulated flight task, which was judged to be very realistic by a number of military pilots. Phrase recognition accuracy on the limited-task-domain (28-word vocabulary) flight task is better than 99.9 percent. Recently, the robust HMM system has been extended to large-vocabulary continuous speech recognition, and has yielded excellent performance in both speaker-dependent and speaker-independent recognition on the DARPA 1000-word vocabulary resource management database. Current efforts include further improvements to the HMM system, techniques for the integration of speech recognition with natural language processing, and research on integration of neural network techniques with HMM.