An Approach to Generating Human-computer Interfaces from Task Models

Matthew L. Bolton, Ph.D.
Department of System and Industrial Engineering
State University of New York at Buffalo

Samaneh Ebrahimi
Department of Mechanical and Industrial Engineering
University of Illinois at Chicago

Meng Li
Department of System and Industrial Engineering
State University of New York at Buffalo

Introduction
- Human-computer interaction (HCI) can occur in situations unanticipated by designers and thus not always be usable or support operator tasks.
- The proposed method uses existing work, which shows that formal methods and L* machine learning can be used to analyze and design robust HCI, to automatically generate interface designs from task models guaranteed to usable support operator task goals.

Task Model
- Human task behavior is represented using the Enhanced Operator Function Model (EOFM).
- Human behavior is captured as a hierarchy of goal-directed activities and actions.
- Strategic knowledge describes when activities are relevant.
- Decomposition operators define the ordinal relationships between activities and actions.

“Alphabet” Extraction
- Task models are parsed to find the events that trigger changes in the human-computer interface.
  - Human actions
  - System conditions from task strategic knowledge
- These are treated as characters in the alphabet accepted by a finite state machine representing the interface design.

L* Learner
- An L* algorithm iteratively learns a finite state automata representation of an interface design by issuing queries and producing candidate designs that are examined by other processes in the approach.
- Queries represent execution sequences ("strings" of "alphabet" characters).
- The L* Learner receives inputs indicating if a produced execution sequence is valid or not.
- Candidate interface designs represent learned interfaces consistent with previous inputs.
- The L* Learner receives inputs indicating if the candidate is valid or not and, if not, an illustrative unacceptable execution sequence (a counterexample).

Interface Design
- The produced finite state machine will represent a human-computer interface design guaranteed to always support the human behavior in the task model and adhere to the checked usability properties.
- The formal model can then be used in the design, implementation, and testing of the actual human-computer interface.

Future Work
- The implementation of this approach is currently underway.
- If successful, the approach has the potential to improve the usability of human-computer interfaces and encourage user-centered design.
- The implemented approach will be tested and validated using artificial examples as well as a PCA pump application.

This material is based upon work supported by the National Science Foundation under Grant No. IIS-1429910.