Kilix: Heterogeneous Modeling of Gesture-Based 3D Applications

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Goals of our research

- Reduce complexity of developing HCI applications
  - By using visual modeling instead of programming

- Assess the usability of heterogeneous modeling for this purpose

- Evaluate the strengths and shortcomings of ModHel’X, a heterogeneous modeling environment
  - Explore and improve its notions of semantic adaptation

wwwdi.supelec.fr/software/ModHelX
wwwdi.supelec.fr/software/ModHelX/Kilix
Case study

- Gestural interaction with a graphical 3D application
  - Using the *Kinect* controller to interact with virtual books using hands only
• Client-server architecture
  • Low coupling between I/O devices and user interaction models

• Combining different models of computation (MoC)
  • choose the most appropriate formalism for the task at hand
    • discrete events (DE)
    • synchronous data flow (SDF)
    • timed finite state machines (TFSM)
• **Client-server architecture**
  • Low coupling between I/O devices and user interaction models

• **Combining different models of computation (MoC)**
  • choose the most appropriate formalism for the task at hand
    • *discrete events (DE)*
    • *synchronous data flow (SDF)*
    • *timed finite state machines (TFSM)*
Heterogenous modeling

- Hierarchical architecture
- Top-level model contains 4 blocks
  - MoC is discrete events (DE)
  - communication through timestamped events containing data
Semantic adaptation

- **Interface blocks** adapt the **semantics** between outer and inner models using different models of computation.

- Adaptation can be made to:
  - **Data** (which may be represented differently)
  - **Time** (e.g., different time units, different time scales, continuous vs. discrete time)
  - **Control** (trigger observations of the internal model at instants requested by the internal MoC)
- Receives data from *Kinect* and converts it into hand gesture events
- MoC = synchronous data flow (SDF)
  - Processes a chain of sampled signals received from *Kinect* at a fixed rate
  - Semantic adapter generates DE events when non-null SDF tokens are produced
• Interprets and converts hand gestures into meaningful actions for 3D object manipulation
  • MoC = timed finite state machines (TFSM)
  • DE/TFSM adapter converts between DE events and symbols for the state machine
Virtual Scene block

- Represents graphical 3D objects (e.g., book) that interpret the actions as object-specific behaviour (e.g. opening or closing the book)
- MoC = TFSM
• General overview revisited
• Heterogeneous modeling is useful for HCI applications

• Semantic adaptation can be used
  • To adapt between models of computation
  • To map application actions (e.g., swipe) to object behaviors (e.g., open or close)
  • To use the same component differently in different applications
    • Leads to less coupling and higher component reusability

• Dynamic modeling is difficult to achieve
  • e.g. variable number of users and books at runtime
Future work

• Compare strengths and weaknesses of *homogenous* and *heterogenous* modeling
  • Based on common case study
  • Expressed using statecharts only
  • Expressed using high-level Petri nets
    • Joint work with Ph. Palanque, Toulouse (PetShop tool)
  • Expressed using ModHel’X

• ModHel’X improvements
  • Performance issues
  • Add support for visual editing of models
  • Support domain-specific languages to match the application domain better (work in progress)
  • Extend existing MoC (TFSM++)
For homogeneous modeling


For heterogeneous modeling

• B. Baudry et al. Bridging the Chasm between Executable Metamodeling and Models of Computation. SLE 2012