Agent Perception within CIGA:

Performance Optimizations and Analysis

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GATE Game research for training and entertainment

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Motivation

- Create intelligent virtual agents that can cope with complex, dynamic virtual environments for use in real-time (serious)games and simulations

- How can agents perceive their environment efficiently?

Outline

- CIGA
- Agent Perception within CIGA
- Issues and Optimizations
- Conclusion

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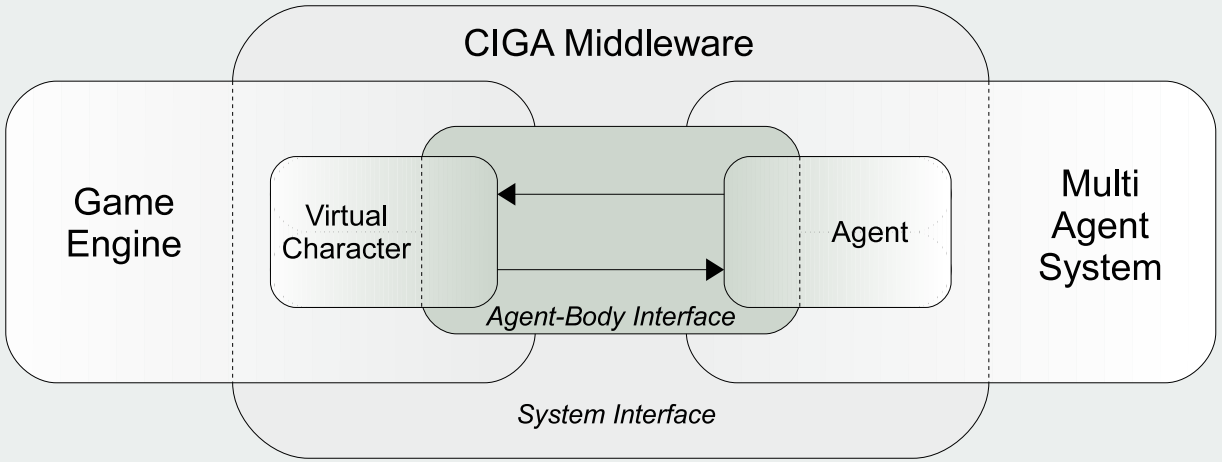
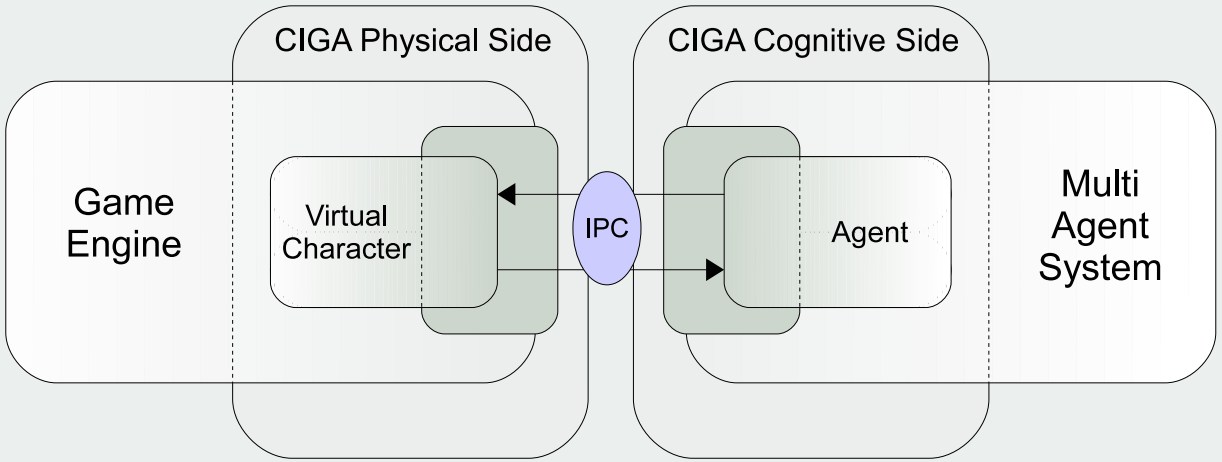
CIGA Middleware

- Agent technology for decision-making in virtual humans
- Technology gap between game engines and MASs
- Generic middleware to bridge the gap and tackle design issues in a structured way



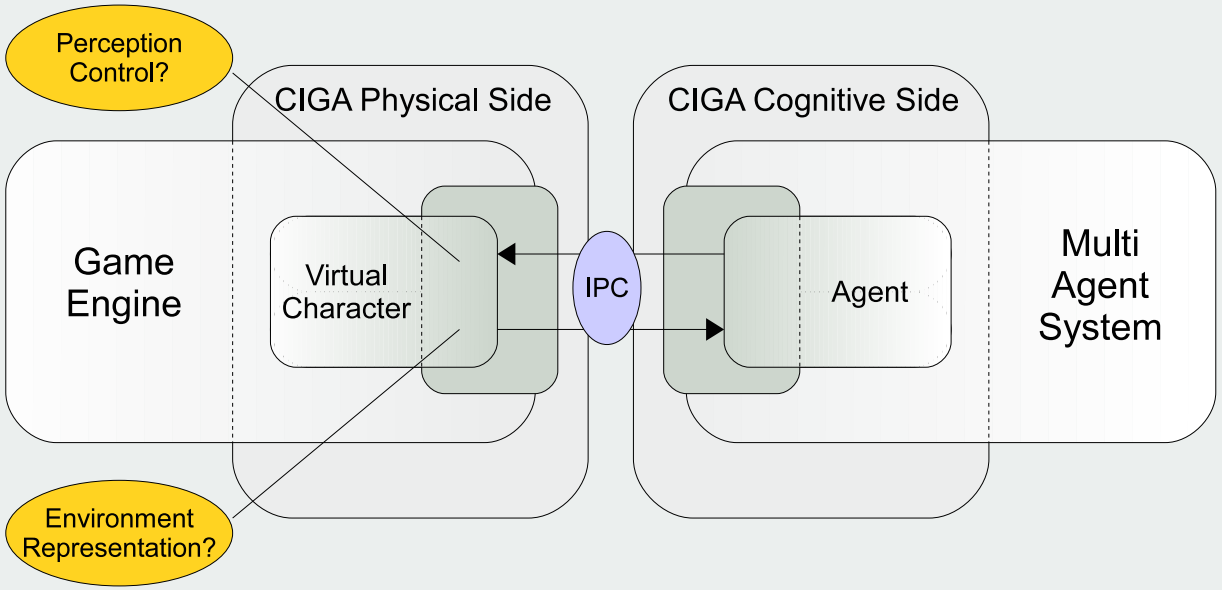
CIGA Middleware

- Distributed design



CIGA Agent Perception

- Design Issues
  - Environment Representation
  - Perception Control



Environment Representation

- Introducing a Semantic Environment Model
  - Strategic abstraction level at which agents perceive their environment
  - Based on meaningful concepts for efficient decision-making
  - Design contract between a game engine and MAS
- Ontology-based model
  - *Object classes* with *properties* and *parameterized events*
- Agents request object properties during sensing
- Mapping rules to convert game state data to ontological concepts

- Example:
  - *Fire* concept with properties *location*, *type* and *intensity*

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Perception Control

- Introducing Subscription-based Filtering
  - Subscription represents an agent's cognitive interest for certain environment information
  - Subscriptions reference ontological concepts from the environment model
  - Agents can adopt and drop subscriptions allowing full control over the flow of sensory information
- Example: Frequency-based subscription on *location* and *intensity* of fires

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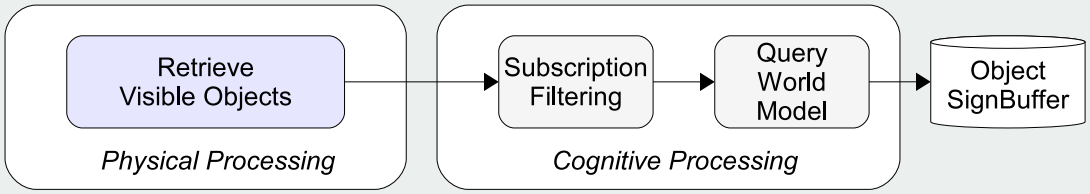
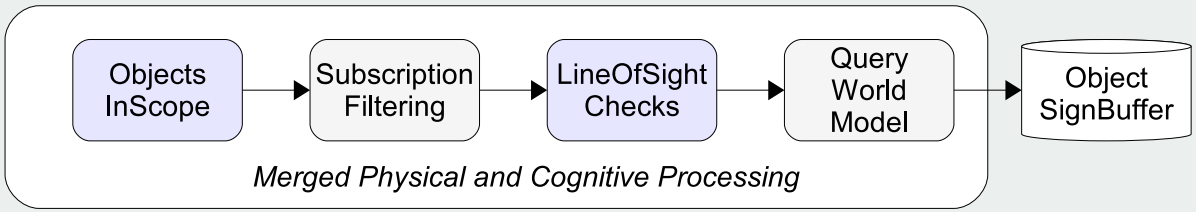
Visual Sensory Algorithm

- Physical processing phase
  - (1) Determine objects within scope
  - (2) Perform line-of-sight checks
- Cognitive processing phase
  - (1) Filter using agent's subscriptions
  - (2) Query Semantic Environment Model and create percepts



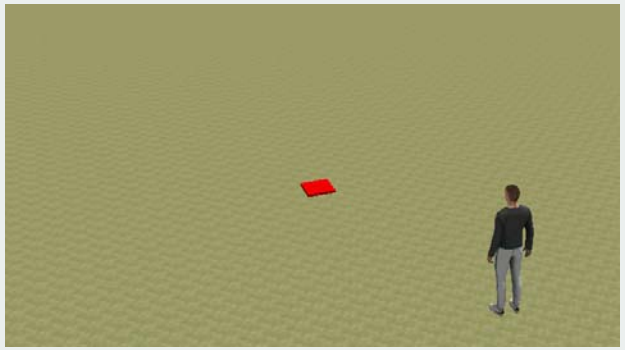
Optimization 1

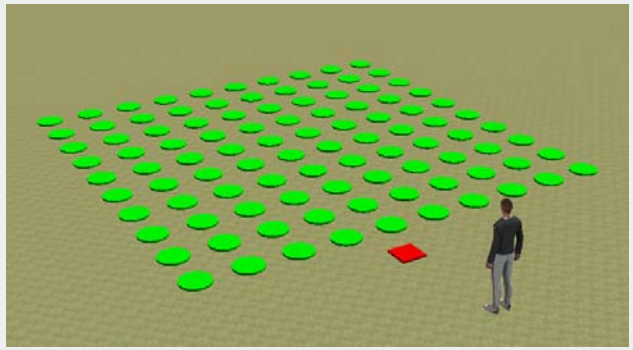
- Merge physical and cognitive processing
  - Filter based on subscriptions before performing line-of-sight-checks
- Eliminates all irrelevant processing

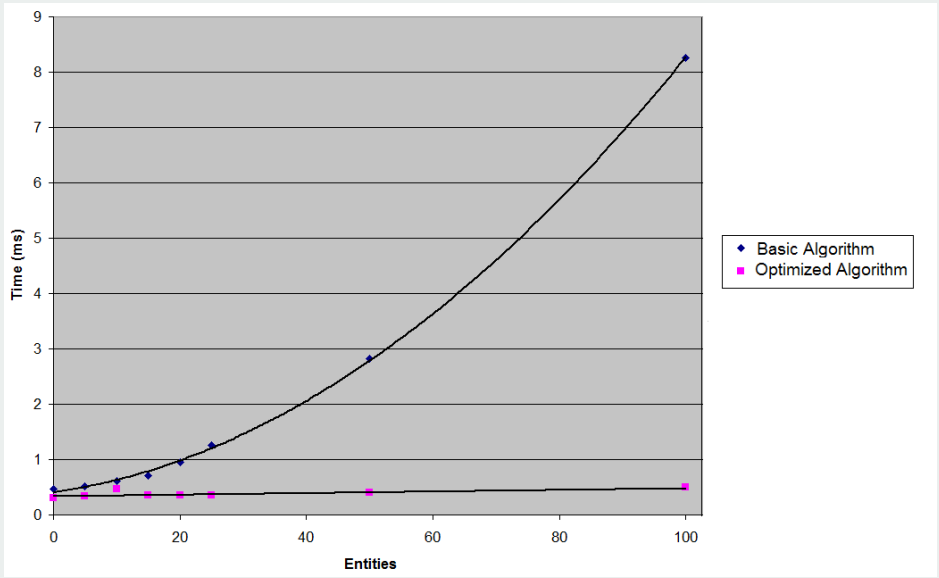


- Advantage: Cope with more complex environments
- Disadvantage: Loose clear conceptual separation between physical and cognitive processes

Experiment 1







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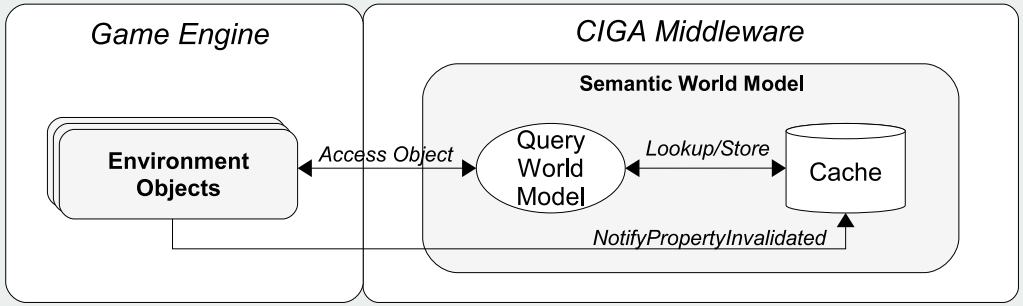
Optimization 2

- Cache data in the Semantic Environment Model
  - Apply mapping rules only when necessary
- Eliminates redundant processing for unchanged objects
- Requires notifications from objects upon state change



- Advantage: increase efficiency, no redundant translations
- Disadvantage:
  - Programming burden to dispatch notifications
  - Game engine and the middleware become more dependent

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Experiment 2

- Scenario:
  - Static objects (employ full use of cached data)
  - Subscriptions on all these objects
- Performance gain: 13-14%
- Conclusion:
  - Relatively small performance gain
  - Depends on the complexity of the translations
  - Less or no gain for highly dynamic objects

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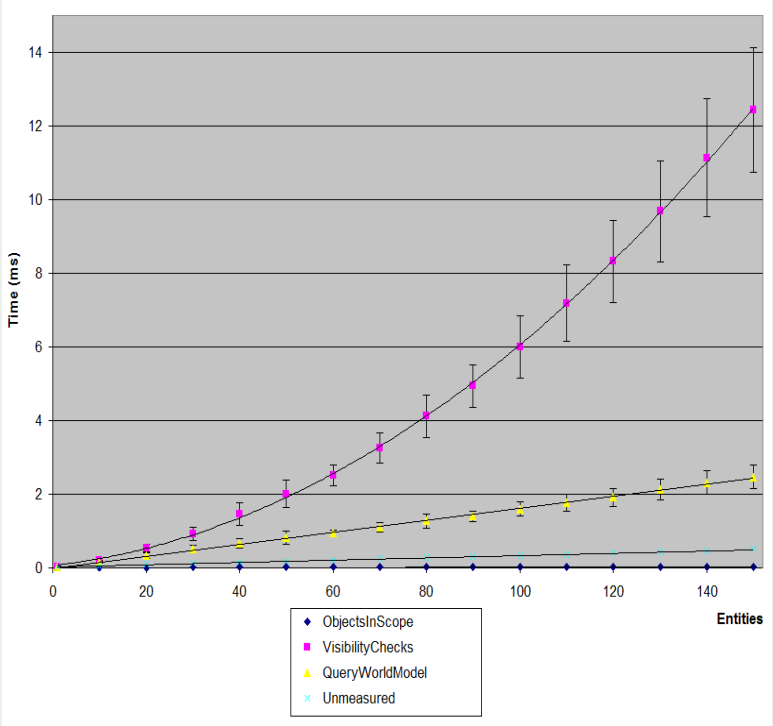
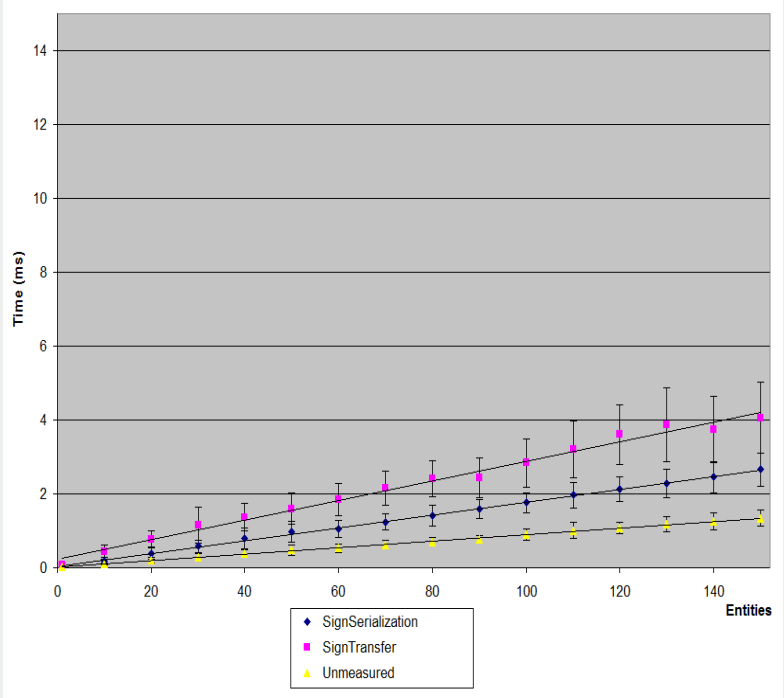
Framework Performance Analysis

- Analysis of processs involved in perception
- Experiment: High demand for sensory information





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Conclusion

- Proposed optimizations for agent perception framework
- Optimization 1: Control sensing process based on cognitive demands for sensory information
- Optimization 2: Caching within the Semantic Environment Model
- Advantages: Increased efficiency
- Disadvantages: Increased design complexity and increased system dependency
- Framework Analysis
  - Agents can deal with heavily populated environments but one has to be careful in controlling an agent's cognitive interests.
  - Performing line-of-sight checks will become the primary performance bottleneck

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Thank You!

Any Questions?

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