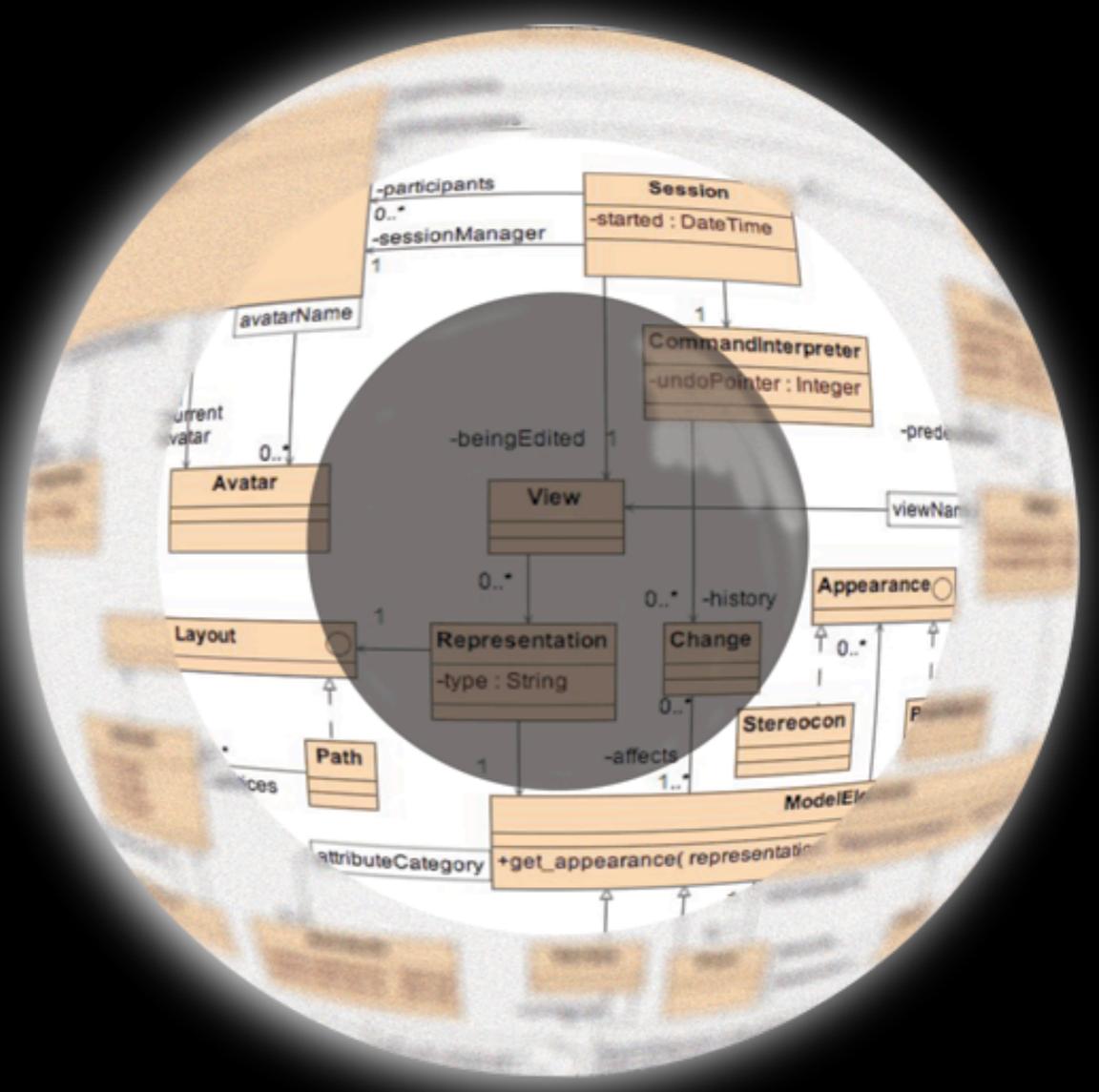


Creating Focus:

Augmented Reality for Better Standards



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About NIST

NIST is a national research laboratory that is part of the U.S. Department of Commerce, more specifically the Technology Administration. Our mission is to improve the quality of life by working with industry to develop and apply technology, measurements, and standards.

now, about Focus...

Standards Development...

- Current information transfer standards (e.g. PDX standards) require substantial knowledge of the domain being addressed
 - Tend to be designed by domain experts
- Due to the complexity of the information being communicated, traditional methods of standards development are breaking down
 - textual descriptions, but also CAD models, diagnostic data, process control data
 - Possible solution: apply existing, rigorous methods for software development to standards

Problem & Solution

- An ad-hoc approach to standards development can result in standards that are:
 - ambiguous
 - redundant and/or missing information
 - overly complex
 - conflicting
 - inefficient

Problem & Solution

- Stems from an attempt to combine two steps of the development process into one
 - What information and interactions are we trying to capture?
 - How will that information be stored and moved around?
 - Domain vs. implementation
- Data modeling
 - Allows automation of much of implementation phase

What are we trying to do?

- Help improve the quality of data exchange standards by allowing domain experts to create underlying data models.
- Allow more productive collaborative data modeling sessions between domain experts
 - For various reasons, people traveling less
 - Support easier consensus-building
 - Existing solutions
 - Audio -- picture is worth a thousand words; modeling tasks are visual
 - Web conference -- interactivity suffers
 - Video conference -- language is similar to audio conference, still one person leading

Focus: a distributed 3D modeling tool

- Uses augmented reality to allow interactive, distributed modeling sessions between experts
 - "...Applications that involve the overlay of virtual imagery on the real world."
-- ARToolkit home page
 - Use specified markers (fiducials) to position rendered 3D objects within a video stream
- Combined with a 3D display device like a head-mounted display, allows more of the model to be viewed and understood at once than with a 2D display

Focus: a distributed 3D modeling tool

Design

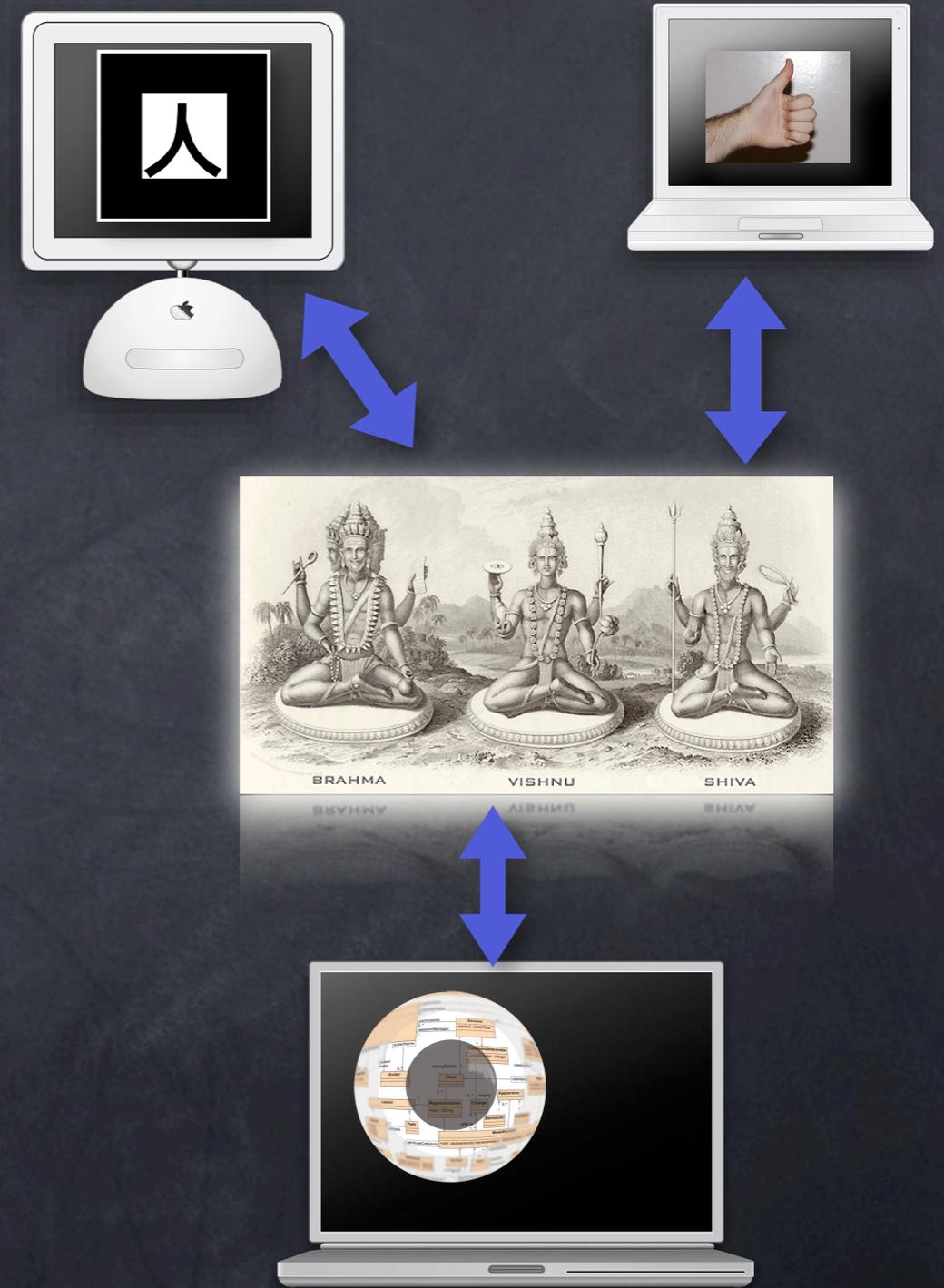
- Aim to keep cost below that of a dedicated video conferencing system
 - Off-the-shelf 640x480 webcams
 - eMagin z800 OLED HMD (less than \$1k)
- Modular and cross-platform
 - Written in Ruby
 - Freely available for further development



Modularity

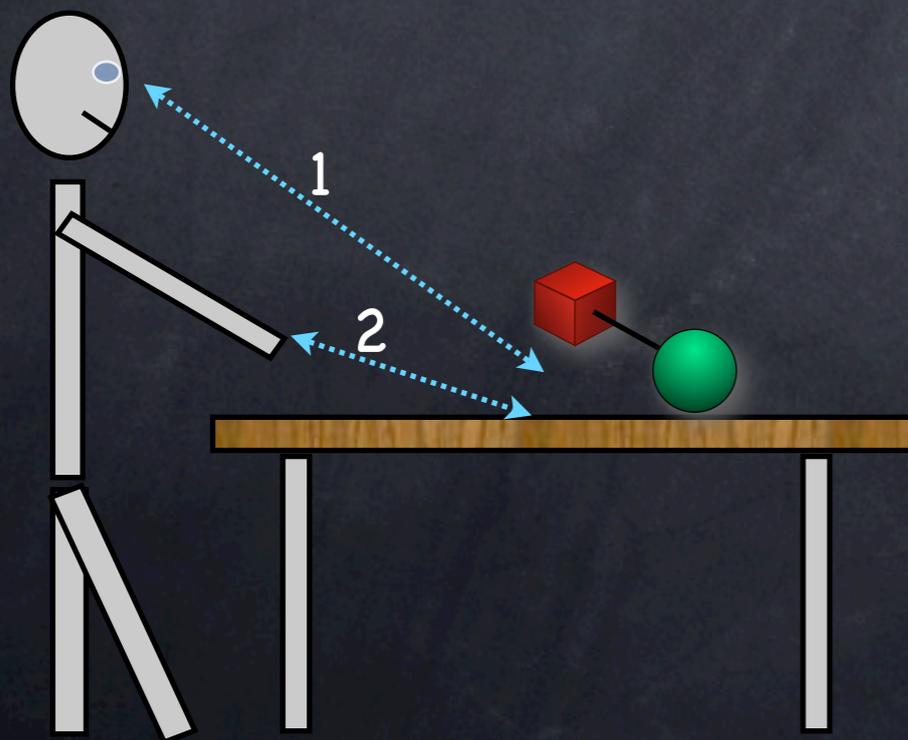
Trimurti

- dependency injection framework
- new modules can be swapped in VERY easily (~4 lines of code)



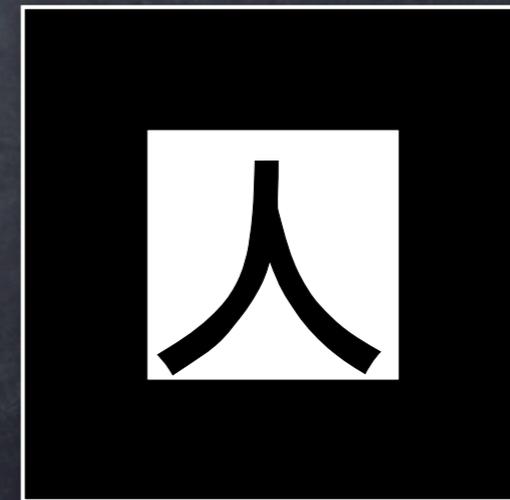
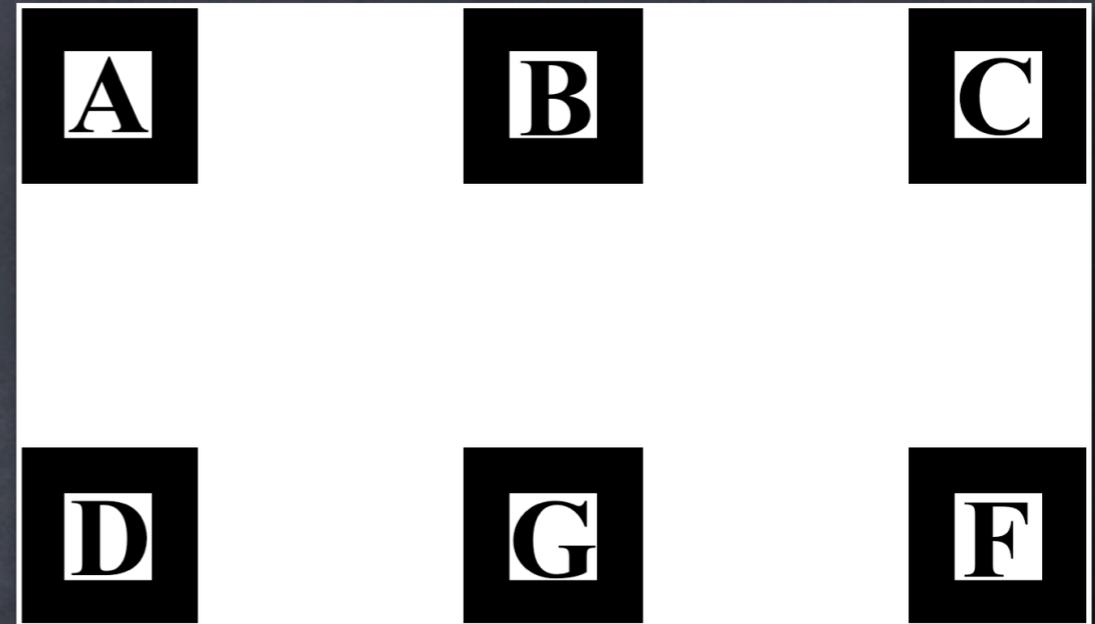
Focus: tracking the user

- In order for a user to interact with Focus, need to know 3 things:
 1. User's position relative to the model
 2. Position of the user's hand relative to the model
 3. Any actions that the user is performing on the model



Focus: tracking the user

- Positions (user and hand) are tracked using **fiducials**
 - Pre-defined shapes that Focus knows to look for in the user's video feed
 - Primary fiducial represents the position of the model
 - Secondary fiducial attached to the user's hand
- Actions are tracked in one of two ways:
 - Gestures
 - Standard mouse clicks



Two sample fiducials

GUI Design

Conventions

- Color: three colors used pervasively (user-selectable)
 - **Green** => valid action or successful result
 - **Yellow** => action requiring further attention or indeterminate result
 - **Red** => invalid action, unsuccessful result, pending deletion
- Actions: triggered by gestures or mouse clicks
 - Create, Select, and Modify

Tool Rack

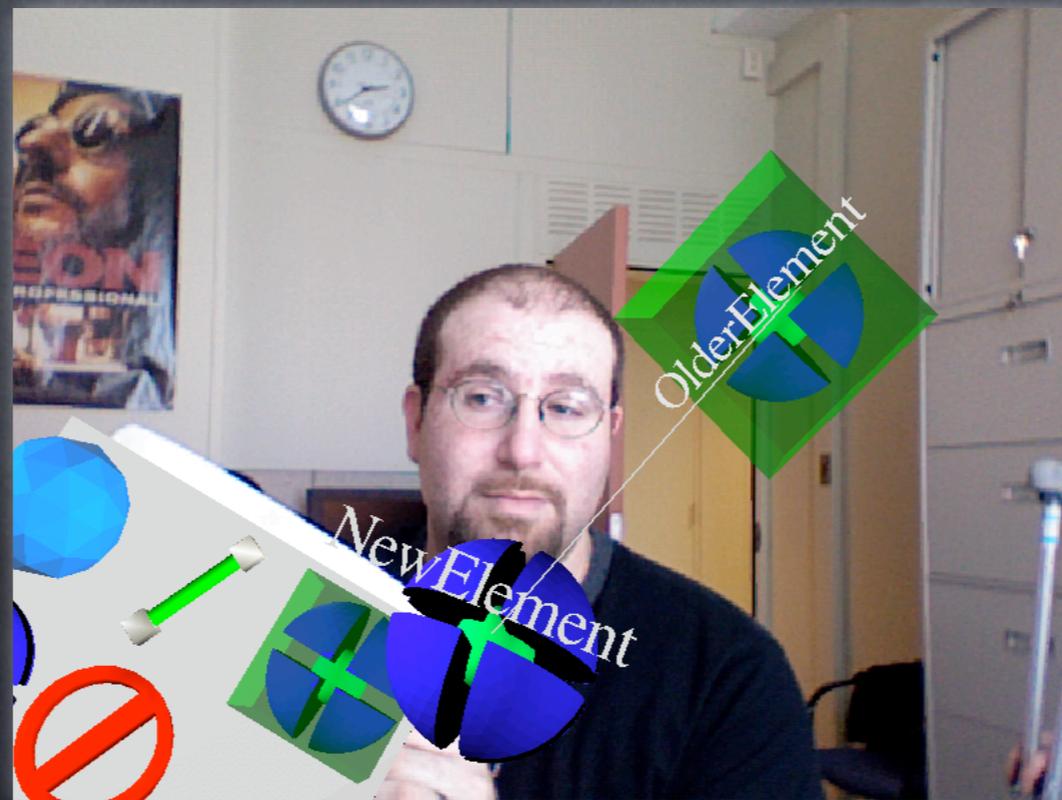
- Flat surface arrayed with available tools
 - Like palette in existing graphical editors, etc.
 - Tools may have attributes, and may be piled together
- One user has the active tool rack at any one time; others are inactive
 - Inactive tool rack shows active user, active tool, button to request control
- When a user requests control, active user is notified
 - When control is released, the new user's tool rack becomes active



A (very) basic tool rack

Object creation

- User selects the desired tool (Vertex, Edge, etc.) and performs the "Create" gesture
- Object created at the position of the user's hand



Selection & Moving

- Selection can be single-element, toggleable, or area-based
 - Selection cuboid
- All tools are capable of selecting objects
- All movement via drag & drop using the Drag Tool
 - Live feedback
 - dragged items become translucent
 - When a drop operation would fail, the selection becomes red.

Updating

- Changes are instant and persistent by default
 - Unlimited undo functionality is handled by the system's command processor.
- Alternate configuration places a green "accept" and red "reject" sphere above and below the changed object.

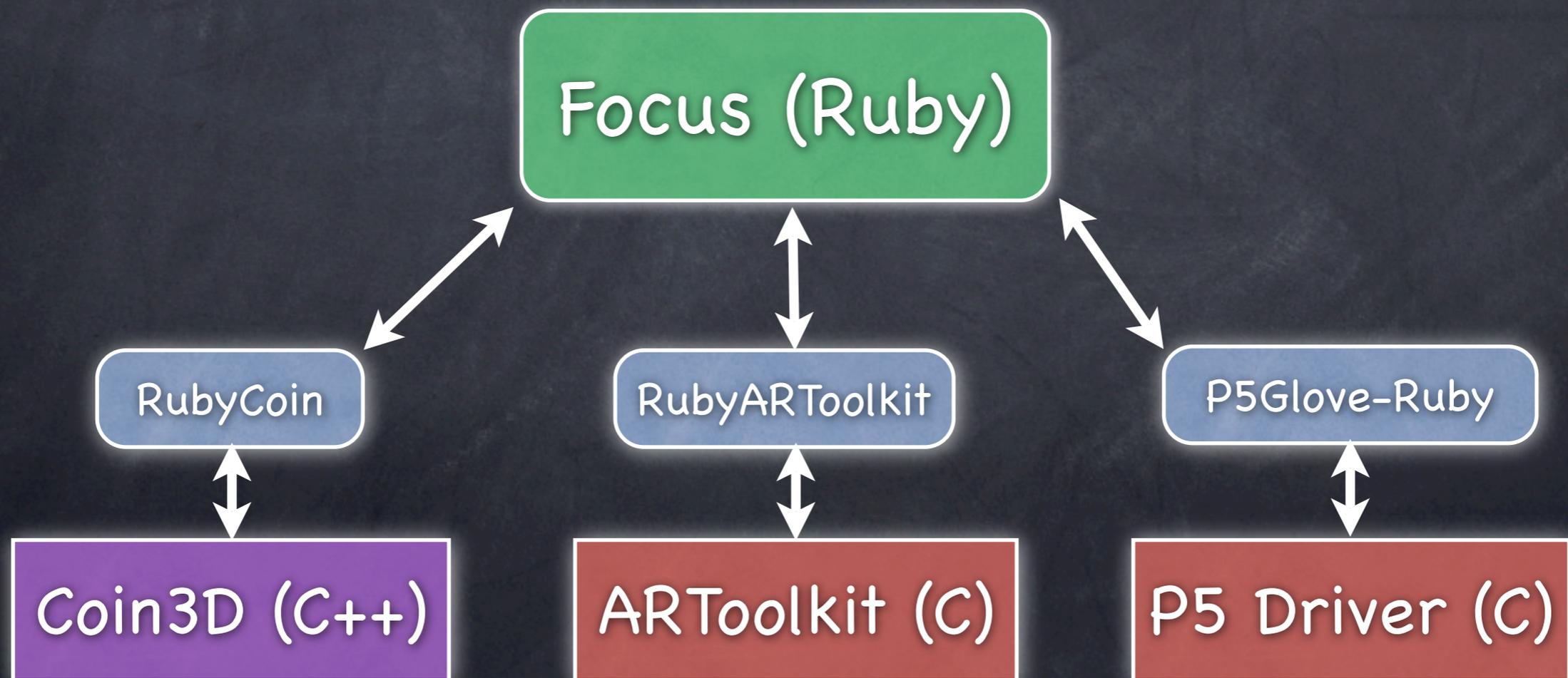
Searching

- Real time
- Type-ahead-find
 - If nothing is selected, the user can begin typing, and matching results will become selected
- Search tool
 - Within entire model
 - Within selection
 - Within a certain number of connections to the current selection

Issues encountered

Language conversion

- Created SWIG bindings
 - could not wrap entire API for some toolkits

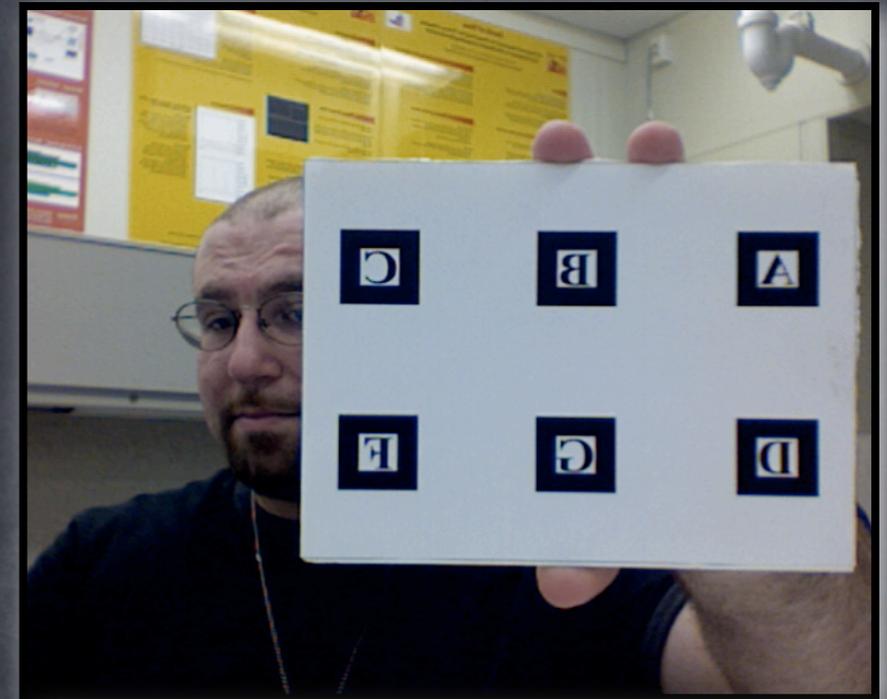


Language conversion

- SWIG doesn't handle arguments passed by reference
- Memory management issues
 - garbage collection
 - Coin3D scene caching
- Layered debugging

Video camera

- Cameras varied widely in autofocus and low light ability
- Resolution restricts maximum distance between the camera and fiducials
 - Fiducial detection does not seem to be a bottleneck
 - Upcoming cameras like the 2.5-ounce Iconix HD-RH1 (1080p resolution) should improve interaction
 - nearly 7x the number of pixels



Video camera

- Driver quality varies
 - MacBook Pro's internal iSight (uses USB) gave crisp image
 - external Apple iSight (uses Firewire) gave slow, darker images
 - In between: Logitech QuickCams (USB), Unibrain Fire-i (Firewire)
- External cameras seemed unable to keep up with the rest of the system
 - interferes with user interaction
 - around 10-15 fps, dragging and new object creation become unreliable

Display devices

- Narrow field of view, even with recent HMDs (less than 40 degrees)
- Blacked-out peripheral vision
- Low resolution video feed
- Better solution: see-through HMD
 - still too expensive

Future steps

Future steps

- Complete next iteration
 - Search tool
 - Networking (partially complete)
 - Interface enhancements (adding feedback)
- Modeling support
 - additional diagram types (currently, only class models are included)
 - improve UML coverage
 - import & export functionality
- Hardware
 - accelerometer-based hand tracking
 - see-through HMD
 - higher resolution cameras

Questions?

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