

Tekkotsu Behaviors & Events

15-494 Cognitive Robotics
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Behaviors

- Behaviors are *classes* defined in .h files
 - Add them to the ControllerGUI “Mode Switch” menu by calling `addItem` in `StartupBehavior_SetupModeSwitch.cc`
 - Double click on the “Mode Switch” menu item to instantiate
 - Instantiated by `BehaviorSwitchControl()` when requested by the ControllerGUI
 - When you stop a behavior (double click on the menu item), the instance is deleted

Five Behavior Components

```
#include "Behaviors/BehaviorBase.h"
```

```
Class PoodleBehavior : public BehaviorBase {
```

- **Constructor**

```
PoodleBehavior() : BehaviorBase("PoodleBehavior") {}
```

- **DoStart() activates the behavior**

```
virtual void DoStart() {  
    BehaviorBase::DoStart();  
    cout << getName() << " is starting up." << endl;  
}
```

Five Behavior Components

- DoStop() deactivates the behavior

```
virtual void DoStop() {  
    cout << getName() << " is shutting down." << endl;  
    BehaviorBase::DoStop();  
}
```

- processEvent processes requested event types

```
virtual void processEvent(const EventBase &event) {  
    cout << getName() << " got event: "  
        << event.getDescription() << endl;  
}
```

Five Behavior Components

- getClassDescription() returns a string displayed by ControllerGUI pop-up help

```
virtual std::string getClassDescription() {  
    return "Demonstration of a simple behavior";  
}
```

```
}; // end of PoodleBehavior class definition
```

Behaviors are Coroutines

- Behaviors are coroutines, not threads:
 - Many can be “active” at once, but...
 - Only one is actually running at a time.
 - No worries about mutual exclusion.
 - Must voluntarily relinquish control so that other active behaviors can run.
- BehaviorBase is a subclass of:
 - EventListener
 - ReferenceCounter
- Behaviors will be deleted if they are deactivated and the reference count goes to zero.

Tekkotsu Releases

- Tekkotsu.org holds the current **stable release** and accompanying documentation.
- tekkotsu.no-ip.org holds the latest (**bleeding edge**) version of Tekkotsu, and the latest version of the documentation.
- This class will be using bleeding edge software.
- The “Reference” link on the course home page points to the bleeding edge documentation.

Browsing the Documentation

- “Class List” in left nav bar
 - Click on class name (`BehaviorBase`) to see documentation page
 - Click on method name (`DoStart`) to jump to detailed description
 - Click on line number to go to source code
- “Directories” in left nav bar shows major components
 - Look at the `Behaviors` and `Events` directories

Searching the Source

- Use the search box in the documentation pages to search for any identifier.

- Example: `NearIRDistOffset`

- Use the “ss” shell script to grep the source code:

- > `cd ~/Tekkotsu`

- > `ss NearIR`

Events

- Events are subclasses of `EventBase`
- Three essential components:
 1. Generator ID: what kind of event is this?
`buttonEGID`, `visionEGID`, `timerEGID`, ...
 2. Source ID: which sensor/actuator/behavior/thing generated it?
`RobotInfo::HeadButOffset`
 3. Type ID, which must be one of:
`activateETID`
`statusETID`
`deactivateETID`

Where are these Defined?

- EventGeneratorID_t defined in EventBase.h
- EventTypeID_t defined in EventBase.h

```
enum EventTypeID_t {  
    activateETID,  
    statusETID,  
    deactivateETID,  
    numETIDs  
};
```

- Event source ids are specific to the event type:
 - HeadButOffset defined in ERS7Info.h
 - visPinkBallSID defined in ProjectInterface.h

Subscribing to Events

`addListener(listener,generator,source,type)`

```
#include "EventRouter.h"
```

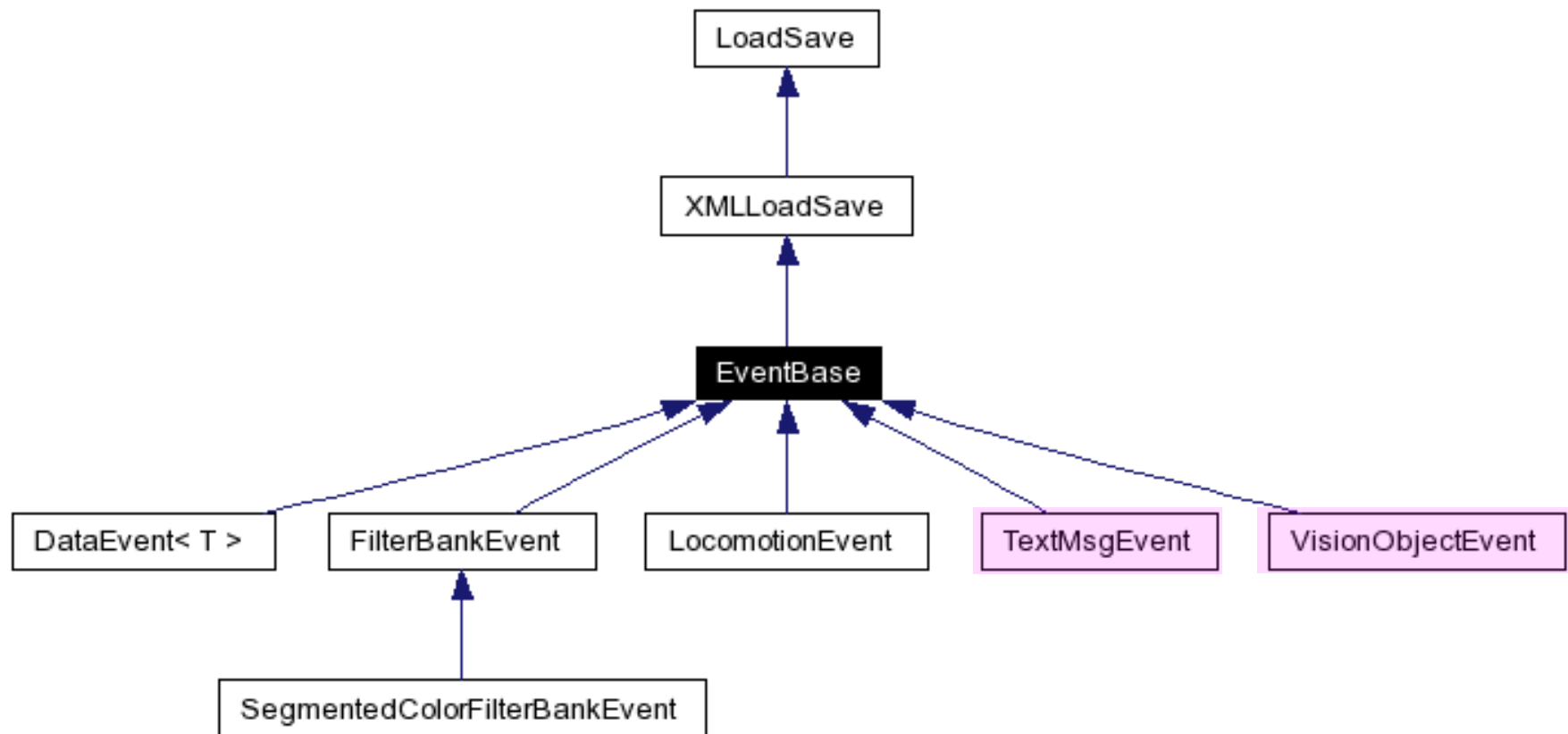
```
virtual void DoStart() {  
    BehaviorBase::DoStart();  
    erouter->addListener(this,  
                          EventBase::buttonEGID,  
                          RobotInfo::LFrPawOffset,  
                          EventBase::activateETID);  
}
```

Processing Events

```
virtual void processEvent(const EventBase &event) {  
    switch ( event.getGeneratorID() ) {  
  
        case EventBase::buttonEGID:  
            cout << "Button press: " << event.getDescription()  
                << endl;  
            break;  
  
        default:  
            cout << "Unexpected event: "  
                << event.getDescription() << endl;  
    }  
}
```

Types of Events

- What are some subclasses of EventBase?



Vision Object Events

- VisionObjectEvent is a subclass of EventBase
- The vision pipeline includes an “object detector” that looks for pink blobs, like the AIBO's ball.
- The center and area of the largest blob are reported by posting a VisionObjectEvent (if anyone's listening.)
 - visObjEGID
 - visPinkBallSID
 - activate, status, deactivate ETIDs

Subscribing to Vision Events

```
#include "Events/VisionObjectEvent.h"
#include "Shared/ProjectInterface.h"

virtual void DoStart() {
    BehaviorBase::DoStart();
    erouter->addListener(this,
                          EventBase::visObjEGID,
                          ProjectInterface::visPinkBallSID);
}
```


Casting VisionObject Events

```
void processEvent(const EventBase &event) {
    switch ( event.getGeneratorID() ) {

case EventBase::visObjEGID: {
    const VisionObjectEvent &visev =
        dynamic_cast<const VisionObjectEvent*>(event);
    if ( visev.getTypeID() == EventBase::activateETID ||
        visev.getTypeID() == EventBase::statusETID)
        cout << "Saw pink ball at ("
                << visev.getCenterX() << ", "
                << visev.getCenterY() << ")" << endl;
    else // deactivate event
        cout << "Lost sight of the ball!" << endl;
    };
    break;

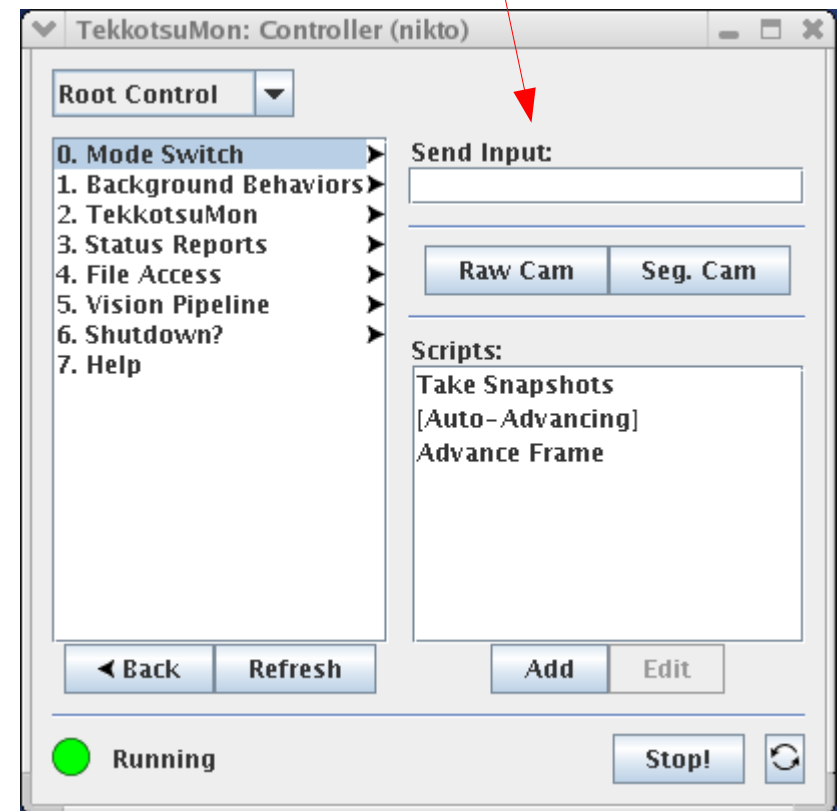
case EventBase::buttonEGID:
    ...
}
```

Text Message Events

You can send text messages to the AIBO via the ControllerGUI's "Send Input" window:

```
!msg Hi there
```

This causes the behavior controller to post a `textmsgEvent`.



Subscribing to TextMsg Events

```
#include "Events/TextMsgEvent.h"

virtual void DoStart() {
    BehaviorBase::DoStart();
    erouter->addListener(this, EventBase::textmsgEGID);
}
```

The source ID is meaningless (it's -1).

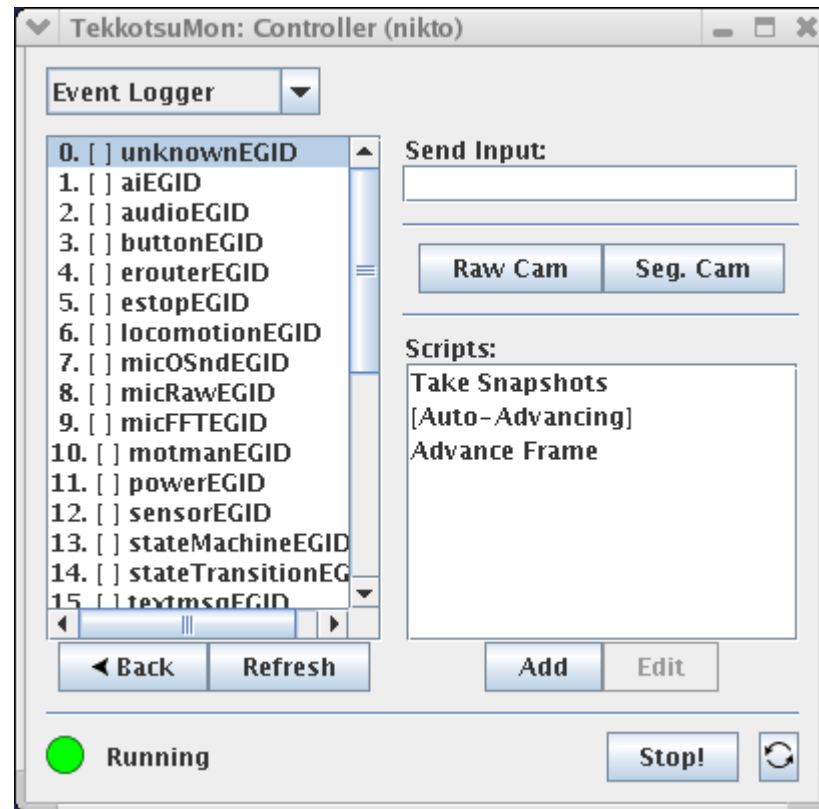
The type ID is always statusETID.

Casting TextMsg Events

```
void processEvent(const EventBase &event) {  
    switch ( event.getGeneratorID() ) {  
  
        case EventBase::textmsgEGID: {  
            const TextMsgEvent &txtev =  
                dynamic_cast<const TextMsgEvent&>(event);  
            cout << "I heard: '" << txtev.getText() << "'" << endl;  
        };  
        break;  
  
        case EventBase::buttonEGID:  
            ...  
    }
```

The Event Logger

- Root Control
 - > Status Reports
 - > Event Logger
- Outputs to console:
telnet to port 59000
to see the log



Timers

Timers are good for two kinds of things:

- Repetitive actions: “Bark every 30 seconds.”
 - Whenever a timer expires and a timer expiration event is posted, the timer should be automatically restarted.
- Timeouts: “If you haven't seen the ball for 5 seconds, bark and turn around.”
 - One-shot timer. Will need to be cancelled if we see the ball before the time expires.

addTimer

- Timers are specific to a behavior instance.
- No behavior can receive another's timer events.
- addTimer(*listener, source, duration, repeat*)
 - source is an arbitrary integer
 - duration is in milliseconds
 - repeat should be “true” if a sequence of timer events is desired
- removeTimer(*listener, source*)

Timer Example

```
#include "Behaviors/BehaviorBase.h"
#include "EventRouter.h"

virtual void DoStart() {
    BehaviorBase::DoStart();

    erouter->addListener(this,
                        EventBase::buttonEGID,
                        RobotInfo::LFrPawOffset,
                        EventBase::activateETID);

    erouter->addListener(this,
                        EventBase::buttonEGID,
                        RobotInfo::RFrPawOffset,
                        EventBase::activateETID);
}
```


Timer Example

```
virtual void processEvent(const EventBase &even) {  
    switch ( event.getGeneratorID() ) {  
  
        case EventBase::buttonEGID:  
            if ( event.getSourceID() == RobotInfo::LFrPawOffset )  
                erouter->addTimer(this, 1234, 5000, false);  
            else if ( event.getSourceID() == RobotInfo::RFrPawOffset )  
                erouter->removeTimer(this, 1234);  
            break;  
  
        case EventBase::timerEGID:  
            cout << "Timer expired!" << endl;  
        }  
    }  
}
```

What does this behavior do?

The Tekkotsu Simulator

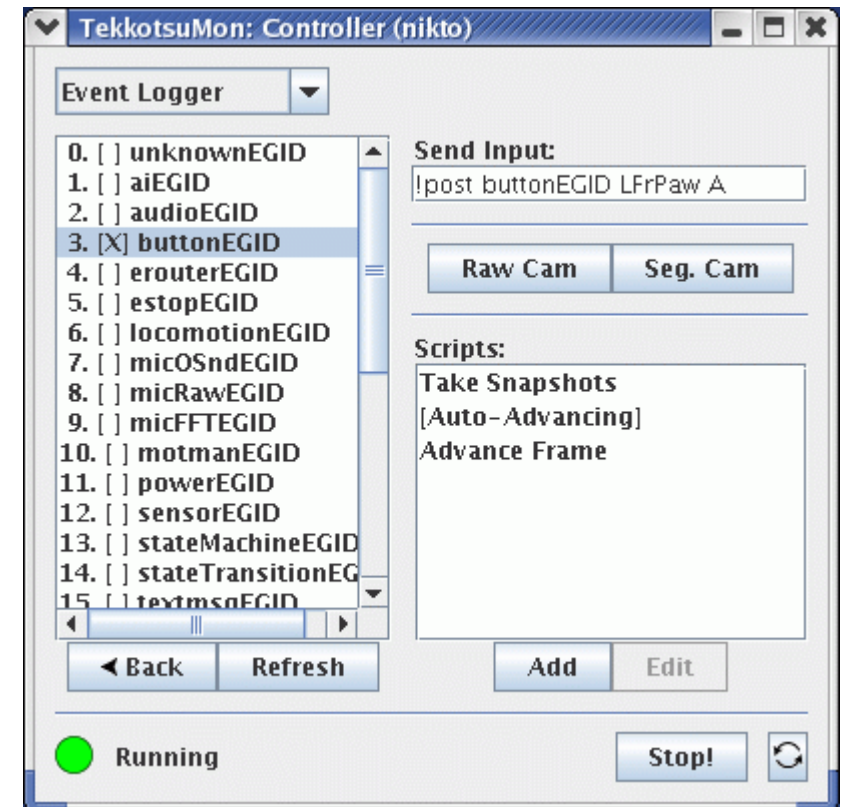
- Really useful for debugging vision code, but...
 - > `cd ~/project` (or whatever your project name is)
 - > `make sim`
 - > `./sim-ERS7`
- In another terminal tab:
 - > `ControllerGUI localhost`

ControllerGUI Can Post Events to the Simulator

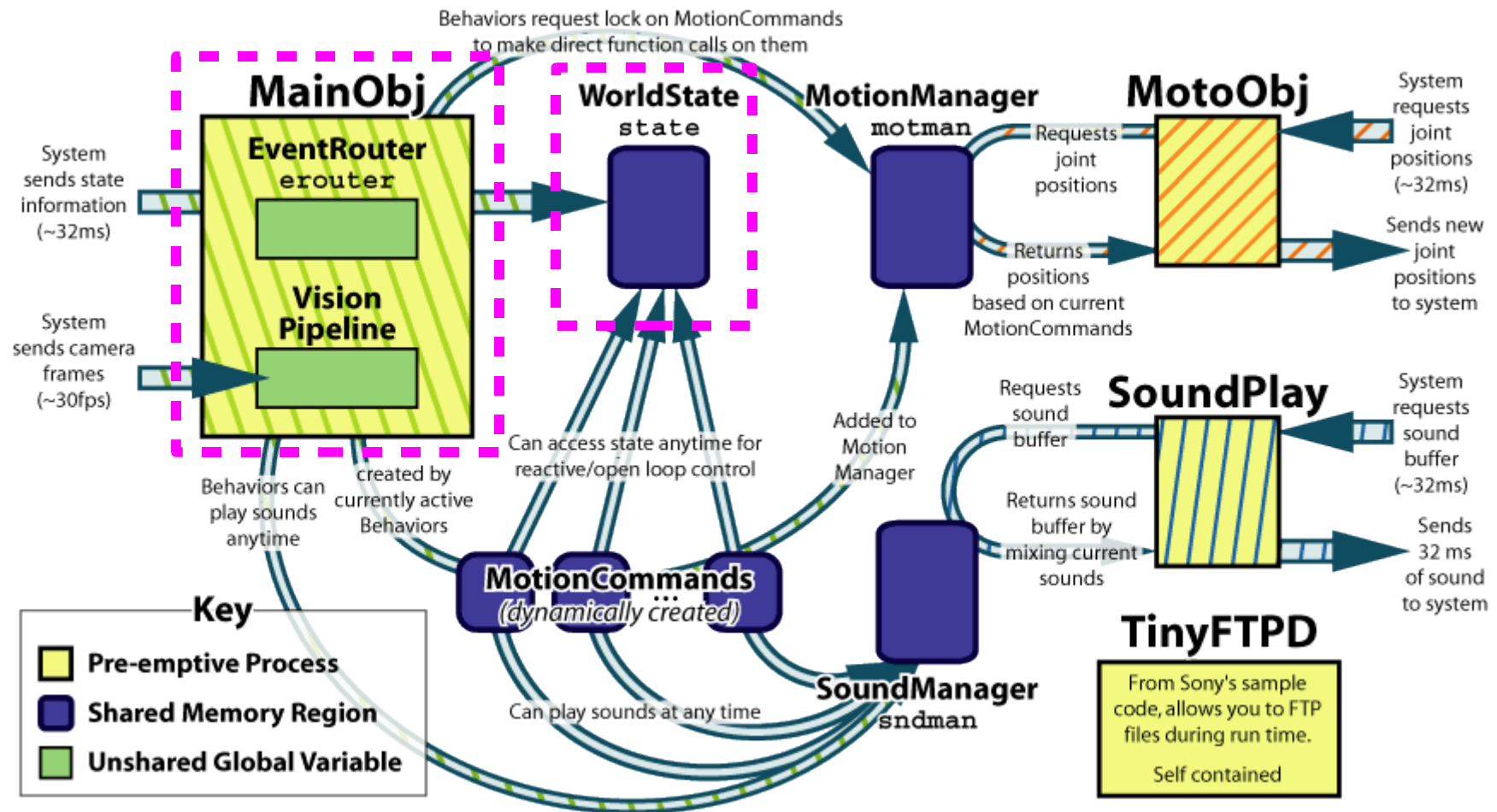
- Type this command in the “Send Input” box:

```
!post buttonEGID LFrPaw A
```

- Monitor the result using the Event Logger
- Can't post timer events yet



Tekkotsu Architecture: Main

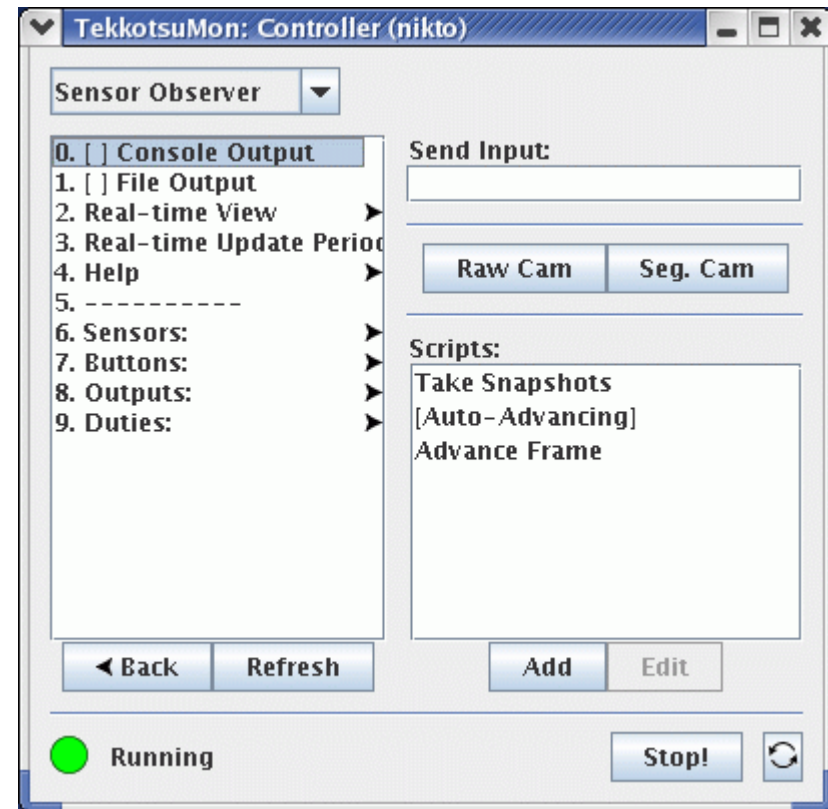


World State

- Shared memory structure between Main and Motion
- Updated every 32 msec
- sensorEGID events announce each update
- Contents:
 - joint positions, duty cycles, and PID settings
 - button states: `state->buttons[LFrPawOffset]`
 - IR range readings: `state->sensors[NearIRDistOffset]`
 - accelerometer readings
 - battery state, thermal sensor
 - commanded walking velocity (x,y,a)

Sensor Observer

- Root Control
 - > Status Reports
 - > Sensor Observer
- Try monitoring the accelerometers.
- Then pick up the dog and wave it around.



Control of Effectors

- How do we make the robot move?
- Must send commands to each device (head, leg, and tail joints, ear servos, LED display, etc.) every 32 ms.
- This is real-time programming.
- Can't spend too long computing command values!
- Best to do all this in another process, independent of user-written behaviors, so motion can be smooth.

Tekkotsu Architecture: Motion

