pOctaver, adding a scripting language to MOOS

Arjan Vermeij and Thomas J. Pastore

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About NURC

Our vision

- To conduct maritime research and develop products in support of NATO's maritime operational and transformational requirements.

- To be the first port of call for NATO's maritime research needs through our own expertise, particularly in the undersea domain, and that of our many partners in research and technology.

One of three research and technology organisations in NATO, NURC conducts maritime research in support of NATO's operational and transformational requirements. Reporting to the Supreme Allied Commander, Transformation and under the guidance of the NATO Conference of National Armaments Directors and the NATO Military Committee, our focus is on the undersea domain and on solutions to maritime security problems.

The Scientific Committee of National Representatives, membership of which is open to all NATO nations, provides scientific guidance to NURC and the Supreme Allied Commander Transformation.

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This document, which describes work performed under Unmanned Surface Vehicles for Defence against Terrorism (EPOW 2009) has been approved by the Director.
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Executive Summary: NURC uses MOOS-IvP in a scientific research and rapid prototyping environment. Contributions to the open-source suite of MOOS-IvP software is readily made by programmers adept at C++ programming. However, the utility of MOOS-IvP’s benefits can be expanded to additional users who normally develop their work in Matlab.

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Of course there is always a place for well-written and computationally more efficient C++ programs, and Octave/Matlab can never compete with C++ if computation times are critical. The advantage of pOctaver from an organizational standpoint is that the efforts of the researchers and programmers can be decoupled and are no longer serially dependent prior to a first in-water test of a new concept.

The design and implementation of pOctaver is discussed, along with some examples of how it has been used at NURC in recent months.

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Keywords: Autonomy, computer programming, software design.
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Arjan Vermeij
Tom Pastore

August 25, 2010
Software is good ...

- it adds functionality
  - interfaces to external actuators/sensors
  - behaviours
  - simulation
- it's at the heart of every trial/experiment
Software is bad ...

- it has to be
  - downloaded
  - compiled by everybody
  - maintained
  - rewritten
  - discarded

- it requires software engineering skills
Software

• is a **means** to and end
• we want to have as little software as possible
• how much software do we have?
Source files

distribution of source files, total is 942
Source text lines

distribution of source text lines, total is 143051

number of MOOS applications

number of source text lines
Two 'Solutions'

- **NurcMoosApp**
  - may reduce the amount of bookkeeping code
  - aims to help improve the quality of the code

- **pOctaver**
  - higher level scripting language
NurcMoosApp

- a subclass of MOOSApp
- has a somewhat simpler interface
- avoids some common pitfalls
- provides some functionality potentially useful to MOOS applications
  - initialisers
  - configurable variable names
bool readMissionParameters (CProcessConfigReader&);
bool registerMoosVariables ();
void onNewMessage (const CMOOSMsg&);
bool Iterate ();

template <typename T> static T getConfigParameter
    (const std::string name, const T defaultValue);
const VariableNames& variableNames () const;
NurcMoosApp

- a subclass of MOOSApp
- has a somewhat simpler interface
- avoids some common pitfalls
- provides some functionality potentially useful to MOOS applications
  - initialisers
  - configurable variable names
NurcMoosApp — Mission File

ProcessConfig = someNurcMoosApp

{
    initialiser.string = FAVOURITE_COLOUR = red
    initialiser.string = CPU_TEMPERATURE = 30

    variable-name.colour = FAVOURITE_COLOUR
    variable-name.temperature = TEMPERATURE
}

m_Comms.Register (variableNames ().get ("colour"), 0);

if (moosMessage.GetKey ()
    == variableNames ().get ("colour"))
    ...

m_Comms.Notify (variableNames ().get ("colour"), ...
Octave

- an open source Matlab® clone
- offers
  - matrices, strings, regular expressions
  - solving linear equations
  - solving nonlinear differential equations
  - plotting
- lacks
  - many advanced toolboxes
Example — negate

ProcessConfig = ANTLER
{
    Run = pOctaver @ NewConsole = false ~ pOctaver.negate
}

ProcessConfig = pOctaver.negate
{
    OctaveFunction = negate
    argument.in = negate.in
    argument.out = negate.out
}
Example — negate

negate.m

```matlab
function negatedValue = negate (value)
    negatedValue = -value;
end
```

input/output

<table>
<thead>
<tr>
<th>negate.in</th>
<th>negate.out</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.00000</td>
<td>-3.00000</td>
</tr>
<tr>
<td>-5.00000</td>
<td>5.00000</td>
</tr>
</tbody>
</table>
Example — multiplier

ProcessConfig = pOctaver.multiplier
{
    OctaveFunction = multiplier
    argument.in = multiplier.factor
    argument.in = multiplier.in
    argument.out = multiplier.out
    initialiser.double = multiplier.factor = 3
}
Example — multiplier

```matlab
function result = multiplier (factor, value)
    result = (factor * value);
end
```

<table>
<thead>
<tr>
<th>multiplier.factor</th>
<th>multiplier.in</th>
<th>multiplier.out</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.00000</td>
<td>3.00000</td>
<td>9.00000</td>
</tr>
<tr>
<td>-5.00000</td>
<td>-15.00000</td>
<td></td>
</tr>
<tr>
<td>4.00000</td>
<td></td>
<td>-20.00000</td>
</tr>
</tbody>
</table>
Example — accumulator

```matlab
function result = accumulator (value)
persistent accumulated = 0;
accumulated += value;
result = accumulated;
end
```

<table>
<thead>
<tr>
<th>input/output</th>
<th>accumulator.in</th>
<th>accumulator.out</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00000</td>
<td>1.00000</td>
<td></td>
</tr>
<tr>
<td>2.00000</td>
<td>3.00000</td>
<td></td>
</tr>
<tr>
<td>3.00000</td>
<td>6.00000</td>
<td></td>
</tr>
</tbody>
</table>
function headingUpdates = maintainRelativeBearing
  (relativeBearing, contactX, contactY, navX, navY)

  contactAngle
    = atan2 ((contactY - navY), (contactX - navX));
  desiredRelativeAngle = - (relativeBearing / 180.0 * pi);
  desiredVehicleAngle = (contactAngle - desiredRelativeAngle);
  heading = mod
    ((90.0 - (desiredVehicleAngle * 180.0 / pi)), 360.0);
  headingUpdates = sprintf ('heading = %.2f', heading);
end
Example — behaviour

```
Behavior = BHV_ConstantHeading
{
    name = BHV_ConstantHeading_LowPower
    pwt = 100
    condition = (MODE == LOWPOWER)

    heading = 0
    updates = bhv-constant-heading-lowpower-updates
    duration = no-time-limit
}
```
Example — behaviour
Example — behaviour
Example — JANUS

- software defined acoustic modem
- FSK modulation / demodulation
- interleaving / de-interleaving
- convolutional encoder / Viterbi decoder
- runs on PC 104 stack on board OEX
pOctaver — when to use

- quick and dirty glue code
- behaviours
- rapid prototyping
- simulation
pOctaver — pros

• small, powerful, robust code snippets
• no compilation required
• no knowledge of C++ required
• testing directly in Octave
• increased productivity
• better workflow
• no license fees
pOctaver — cons

- yet another language ...
- more resource intensive than C++
- less portable
- not good on embedded systems
Question:

is it possible to design a similarly simple interface for 'any' C++ function?

Answer:

yes, it's called pAny, and I'm working on it.
Distribution

- pOctaver is a 'finished' product
- distributed to workshop participants
- please use it
- open to suggestions for improvement
- please give feedback!
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