Cognitive Mine Sweeping driven by KEEL Technology

Compsim LLC

The Opportunity:

Facilitate mine sweeping / clearing with autonomous systems.

Problem decomposition:

The problem space has been decomposed into three (3) parts:

Adaptive Navigation: In this area, we have assuming that a preferred "lawn mower" pattern has been manually selected. Wind and current can cause the USV to deviate from the pattern. For a human driven boat, the human pilot would be able to adapt to take into account deviation from plan. Similarly, the KEEL cognitive model will recognize deviation from plan and provide corrective navigation.

Action Selection: In this area, the USV will be in a search mode, an investigate mode, or a disposal mode. Driving this decision will be inputs from the Detection system (next). Thresholds are adjustable to configure when the USV transitions from state to state.

Detection System: In this area I am assuming a sensor system that has the potential to detect complete "man-made objects", AND "clusters of geometric shapes" that may not be validated as "man-made" objects. Configuration parameters are provided for "object size", "cluster size", "Number of lines in cluster"; the combination/integration of which can provide an "interesting object value". The object value can drive the USV to ignore (continue searching), investigate, or dispose (Action Section).

Deployment:

These three models have been published as web services and can be accessed remotely. At this point, no "user interface" has been developed, as might be appropriate. It might be appropriate to build a "configuration tool" so you could tune the configuration parameters similar to built in features of the KEEL Toolkit. For example: a bell shaped curve has been included to define the "size" of an object that might be considered as a mine. Smaller than a bread box, probably not; the size of a basketball, maybe yes; the size of a house, probably not…

Web Access:

Navigation Section: http://www.keeltechnology.com/N1/Service.asmx (think and think1)

Action Section: http://www.keeltechnology.com/N2/Service.asmx (thinkA and thinkA1)

Detection Section : http://www.keeltechnology.com/N3/Service.asmx (think and think1)

These are "standard web services" that have been packaged using Microsoft Visual Studio 2008. All code was automatically generated by Compsim's KEEL Toolkit. By using your browser you can access

their description with links to two different ways to access each of the models, depending on your preference. A “Service Description” provides an xml file explaining the parameters that need to be supplied to access the engines. “Think{x}” provides the response as an xml file with symbol name value pairs, while “Think{x}1” provides an xml file with tagged values.

Operation:

During normal operation, one would be calling the Navigation service on a periodic basis to control the path. When objects are detected, the attributes would be sent to the Detection engine to determine what to do about them. This would trigger the decision to ignore, inspect, or destroy them.

Other Documents Available:

Web Page Web Services Client.pdf - To create a web page application that is a client for the KEEL-based “web service”.

Web Services Client.pdf - To create a Windows .exe application that is a client for the KEEL-based “web service”.

Other Work:

Once the system decides to “inspect” what “could be” a mine, there may be several named approaches that might be considered: from a side, from underneath, from the top… all driven by various factors (topology characteristics, timeliness, risk….). Domain expertise and an understanding of the equipment and options are necessary to create and test these models.

Summary:

KEEL Engines can be deployed in C, C++, C#, Flash, Java, Octave, Python, Visual Basic and other languages for deployment on any platform and in any system architecture. They have been provided here as “web services” so they can be actively tested. Ultimately if they were embedded in USVs / UUVs they would probably be deployed as C or other language based on the USV / UUV architecture. In some cases parts of the overall system may remain as a web service and accessed directly by the USV/UUV during the mission and thus provide a centralized “rules of engagement”.

It is likely that additional documentation will be needed to “tune / configure” the system to match the sensors and capabilities of the USVs/UUVs. This can most effectively be done using the KEEL Toolkit where no additional tools may be necessary.