Hui Huang & Elena Messina

ALFUS 3rd Workshop Summary

Workshop Date: November 20, 2003
Location: SRS Technologies, Arlington, VA.

1. Actions:

1.1 Terminology Document. Responses to Hui by 12/3/03

a. Verify that all the definitions are good for public distribution.
Assigned to: Kerry, please review those that were adopted from O&O or the like. Others, please respond if your submitted definitions (back in September) were adopted from restricted documents.

It is desirable to keep the document open as opposed to an additional "restricted" version to include, if existent, definitions that have distribution restrictions.

b. Change Mode of Control to Mode of Operation and redefine Control as authority/permission oriented.

Assigned to Hui.

c. Genericize the Levels of Control Definitions.
Assigned to Kerry.

d. Robotic follower: to change UGV to UMS and remove "manned" from vehicle or put period after "route previously traversed." The rationale for "manned" vehicle was recognized as an implementation option.

e. Please forward any other comments to Hui by 12/3/03. Would be helpful if you indicate whether the comments are to be addressed prior to publishing Version 1 or can be waited until version 2.

f. Published as a NIST Special Publication, use the NIST standard editorial process.
Assigned to Hui, to complete by mid January, as we decided to include the publication as an attachment to the invitation to LSI.

1.2 Next Meeting Date and Length. Responses to Hui by 12/3/03

Two separate weeks were identified as the candidates, February 9 – 13 and 23 – 27. Please check your calendar and respond. There were also discussions on whether to extend the length of the meeting to 1 ½ days. The group seemed to want to defer the decision and "let's see how much we are able to progress between now mid January." Please respond, nevertheless, if you do have a preference.

1.3 Interactions with the NASA SMART project.

a. Consider the NASA model during the committee metrics development efforts (see section 1.4).

Assigned to Everyone.

b. Review the NASA model and send your comments and suggestions to Hui regarding future collaborations. Let's see if we can establish some concerted effort.

Assigned to Everyone.

1.4 Metrics development.

See section 3 below, all the members/past participants, regardless of whether attending this 3rd workshop, are urged to join any of the groups, as described in section 2.1a.i.2.23.2, and contribute.

1.5 Publicizing our work

Publish conference papers. SPIE abstracts due soon. Hui to send Woody/Robert abstract and earlier papers.

2. To-Be-Decided Issues

2.1 Issues Related to Goals/Approaches/Outside Interactions

a. Should we pursue a higher level standards with our results? A Government standard to be signed off by DHS, DOC, DOD, DOE, etc.? An ISO or IEEE type of standard?

b. How to get industry involved? CBD to invite RIA, AUVSI, AIAA? Invite by areas of expertise? Participation in subgroups? via inviting comments?

c. Should also make the Testing community aware of our work.

2.2 When to invite Boeing LSI

Group decided to wait and see how much we have progressed by mid January before making the decision. A desirable situation would be to attach the updated results, i.e., terminology and metrics, to the invitation.

Should also consider briefing LSI our work.

3. Meeting Discussions on Metrics Development

Woody presented a set of measurable and categorized metrics that sprouted a significant level of effort during the meeting in identifying metrics for four categories, the three axes of autonomy plus system dependency. The list is attached. We decided to defer the system dependency category (which might evolved into the fourth axis) and focus on the three axes that we have agreed to. Three subgroups were formed and participants have signed up to further develop the metrics. The next steps are identified, as described in section 3.1.

3.1 Further steps for metrics and autonomy level development

a. Continue building the list: expand, consolidate, categorize, etc.
b. Define the terms associated with the metrics, unless already defined in Version 1 of the terminology. Adopt existent definitions when suitable.
c. Forward the definitions to Hui as parts of Version 2 of the terminology.
d. Develop measurement methods for each metric or group of metrics. Units of measure.
e. Develop methods to transform all the measurements to a zero-to-ten autonomy level scale.
f. Do all the above with references to the NASA model.
g. Share approaches/thoughts with other groups.
h. Test against current systems.

3.2 The teams

It was determined that, to expedite progress, the teams should be lead by members representing agencies that have mission, commitment, or strong interests in the area of unmanned systems. **Nevertheless, all**

the members/past participants or other interested government practitioners, regardless of whether attending this 3rd workshop, are urged to join any of the groups and contribute.

a. The H (HRI axis) Team, co-lead by Brian Novak and Dennis Overstreet. Joined by (no particular order) Tome Weber and Elena Messina.
b. The M (mission complexity axis) Team, lead by Hui Huang. Joined by Caesar G. Mamplata, Kerry Pavek/LTC Kent Schvaneveldt, Peter Huang, Ray Higgins, and Keith Arthur.
c. The E (environmental difficulty axis) Team, lead by Woody English. Joined by Jim Albus, Jeff Rowe, Robert Wade, and Marsha West.

3.3 Proposed Schedule

Version 1 of the metrics list – December 12.
Definitions of the terms – January 16, 2004
Measures for metrics – January 30, 2004
Conversion to autonomy level 0 – 10 scale – by the next meeting time.

Please comment on this schedule.

4. Session on NASA teleconference

- Shuttle Abort Flight Management provides crew with improved situational awareness regarding abort status
- SMART is meant to spacecraft mission assessment and replanning tool
- Identify the level of autonomy for each desired function based on a recognized autonomy definition
- Levels of autonomy assessment tool
- NASA interested in learning more about DOD levels of autonomy and assessment.
- 135 functions identified. Prototype process to define appropriate levels of autonomy. 135 functions have been run through tool. Prototyping will begin with around 5 functions
- systems requirements and interface specification document: example on rank available launch targets
- 2 types of autonomy
    - trust limit (see Sheridan book on Telerobotics, autonomous and human supervisory control)
    - cost-benefit limit
- spreadsheet takes all answers and computes trust and cost benefit. Questionnaire is from 1-5 versus autonomy scale is 1-8. Apparently this is a psychology issue for how people answer questions….
- separate scale for each function type (observe, orient, decide, act). Management prefers having just a single number; “my vehicle is a 5” but developers resist rolling it up into 1 number. Developers have been asked to develop a shortcut
- method to evaluate single autonomy level number.
- all 1-8 ;
    - 1-2 human is prime; computer acts as a tool
    - 3-5 computer and human interact with varying degrees of autonomy
    - 6-8
- interested in collaborating on performance metrics for measuring autonomy
- NASA effort started in 2002 with task decomposition for vehicle launch. Were slowed down for the accident for a while. They’ve started back up with 10-15 function to prototype by Feb-Mar 04. Plan to get online with orbital space plane milestones. Ready for when proposals come in so that the requirements can be aided by their tool. Collaborating with Draper Laboratories in development of autonomy for UUV’s. 5FTE’s for prototype. Tool development is separate…
- Incorporation of performance metrics very important to them in Feb-Mar timeframe.

Suggested that we review what they presented and send them a set of actions.

5. Other discussions

a. Planning is a factor captured in all the 3 axes. How much interaction with human needed to plan a mission. If planning is complex for a simple mission, this leads to a low level of autonomy.

b. Discussion regarding whether we want to restrict our discussion to bot-resident autonomy. Argument against this is that it should be left to the implementation. So for instance, the NASA folks seem to have a lot of the “intelligence” or “autonomy” offboard (on the ground). Jim’s counter-argument is that there be consideration of having as much intelligence/autonomy resident on robot to limit bandwidth comms back to human. Performance metric includes how many contingencies were handled before you couldn’t complete the mission, how efficient are the generated solutions, success rate, as opposed to “did you accomplish the mission.” Robert Wade: Mission planning system on separate computer/location can have a level of autonomy that is different than that of the robot that executes the mission. Kerry: the mission planning tools are not regarded as autonomous systems, but rather as automation capabilities. Is unmanned system just the embodied one? Yes – by our definition. NASA’s effort is broader than ours, including humans as well. Therefore our definitions and constructs ought to apply to unmanned space vehicles.

c. Need to look at OODA as framework for defining autonomy…. Jim says that OODA is analogous to 4D/RCS as opposed to the 3 axes that we are suggesting as candidate dimensions: mission complexity, human-robot interaction, environment difficulty. For each element of the OODA loop, they are looking at each of these dimensions. We should do it the other way around.

d. For NASA, ground-based mission control is prime decision maker for most shuttle decisions. Crew just executes the decision. If communications are lost, the crew has a stack of paper that they leaf through to make decisions. They consider this teleoperation?? There is no teleop in the sense that we think of it (remote control).

e. Human-robot intervention: Vocabulary that system understands is part of the autonomy, this relates to HRI as well as mission complexity. “Level of discourse??” In terms of OODA – how much babysitting do you have to do—monitoring, human workload? Dennis likes the terminology that NASA uses: when human is prime versus the robot. Is NASA’s “decide” scale close to our HRI?

f. ASB scale originally came from ARL air (Higgins). It was meant to be a measure of autonomous behaviors rather than autonomy overall.

g. Note that scales are non-linear. At higher levels, the leap/cost between single levels is much greater than for lower levels. That’s why NASA did this on a function-by-function basis.

h. Cesar: criticality view of HRI is a subset of mission complexity? NASA agrees.

i. Pre/post interactions with robot need to be factored in as well. How much time did you spend programming it? How much data do you have to sift through after it completes its mission? Does it just give back raw data or a something more directly useful by a human?

j. Kerry is concerned that the HRI discussion is veering towards human factors versus autonomy. Jim’s response is that is appropriate. Looking at a benefit of autonomy involves looking at human factors. What about user interface ease of use as opposed to autonomy? System has capability but its HRI implementation is really bad. Robert: intervention is something that you can measure.