Make it so: The Situated Language Understanding Robot Platform

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SUBTLE MURI Year 5 Review

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Goal: Natural language to a logical controller

Commander's instructions

Parsed sentences

Semantic representation

MetaPAR/LTL

Automaton

Make it so: SLURP - C. Lignos
Progress

• Year 3: Fixed search plan, able to give simple standing orders
  • New: LTL generation from natural language, keyword semantics

• Year 4: Flexible plans via natural language in an end-to-end system
  • New: Verbnet-based transformational semantics system, natural language control of real robot, changing plans on the fly

• Year 5+: Robust, easily integrated language components
  • New: SS-RICS integration, LTLMoP integration, ROS interface to language components
  • Planned: Semantics robustness improvements, tools for easy domain adaptation
Introducing SLURP

• Situated Language Understanding Robot Platform

• Provides:
  • Easy access to Penn NLP tools (tagger, parser, null element restoration)
  • Semantic analysis of parsed sentences
  • LTL plan generation

• Already open sourced (GPLv3) and ready to go:
  https://github.com/PennNLP/SLURP
  • Automatically downloads models, etc.
  • All you need is Python, Java, and sed
  • OS X, Linux, and Windows supported
SLURP Components

- **Interfaces:**
  - Natural language $\rightarrow$ LTL (LTLMoP)
  - Natural language $\rightarrow$ ACT-R style productions (SS-RICS)
  - Natural language $\rightarrow$ robot control over ROS and tablet interface (UMass Lowell’s Jr)
Packaging the pieces

• Focus for NL this year:
  • Polish existing components
  • Easy to use interfaces for integrating our work
  • Public code release
Better LTL generation

• Developed more general mappings from action representations to linear temporal logic (LTL)

• Building blocks:
  • ALO: do an action X At Least Once during execution
    • Goal: have a persistent memory of performing X
  • AE: do an action always eventually (infinitely often)
    • Goal: do X as much as you can

• Some examples:
  • Go to the hallway → (Action: go, Location: hallway)
    ALO(in hallway)
  • Patrol the hallway → (Action: patrol, Location: hallway)
    AE(in hallway)
Better LTL generation

• Building block:
  • CIC: complete an action X in a context Y
    • Goal: do X in context Y until X is done

• Example:
  • Search the hallway \(\rightarrow\) (Action: search, Location: hallway)
    ALO(CIC(search, in hallway))

• Goals able to be subdivided
  • Will allow for better reporting of what the robot is doing

• Simple, compact LTL generation based on parameterized actions
Feedback on understanding

**Commander:** Tell me if you see any hostages.
**Robot:** I’ll let you know if I see a hostage.
**C:** Defuse all the bombs you see.
**R:** Got it. I’ll defuse all bombs.
**C:** Search the library, classroom, and lab.
**R:** Got it. I’ll search the library, search the classroom, and search the lab.
**C:** Make it so.
**R:** Understood. I’m carrying out your orders now.
**R:** I see a hostage.
**R:** I’m now going to defuse in the library.
**R:** I’m done, and I’m in the classroom.
Feedback on understanding

01 Commander: Tell me if you see any hostages.
02 Robot: I’ll let you know if I see a hostage.
03 C: Look for User 2 in the library and the classroom.
04 R: Got it. I’ll search the library and search the classroom.
05 C: Get the defuser from User 2 and come back here.
06 R: Got it. I’ll retrieve the defuser from user 2 and go to the hall.
07 C: Make it so.
08 R: Understood. I’m carrying out your orders now.
The robot searches the classroom and does not find the user. It then searches the library, identifies the user, and begins to get the defuser.
09 R: I’m now going to get the defuser in the library.
In addition to the language notification, an icon showing the location of the user is shown on the operator interface along with a picture of the user captured by the robot. After getting the defuser, the robot returns to the hall.
10 R: I’m done, and I’m in the hall.
11 C: Disarm the dynamite.
12 R: I’m sorry, I didn’t understand that at all.
13 C: Defuse the dynamite.
14 R: Sorry, I don’t know anything about dynamite.
15 C: Defuse the bombs.
16 R: Got it. I’ll defuse all bombs.
17 C: Search the lab.
18 R: Got it. I’ll search the lab.
19 C: Make it so.
20 R: Understood. I’m carrying out your orders now.
The robot drives to the lab and searches it, finding a hostage but no bombs. The robot displays a picture of the hostage on the operator’s interface.
21 R: I see a hostage.
22 R: I’m done, and I’m in the lab.
23 C: Search the office.
The robot drives to the office and searches it, finding a bomb during the search. It displays a picture of the bomb on the operator’s interface.
24 R: I’m now going to defuse in the office.
The robot defuses the bomb and then completes its search of the room.
25 R: I’m done, and I’m in the office.
Summary

- SLURP provides a reusable core of features for situated language understanding
- Code publicly released
- Improvements in progress:
  - Improving robustness of semantics
  - Improving feedback quality
  - Additional features: quantifiers, filling in plan details from knowledge base, multi-robot control