Talking to Robots

Speech-Directed Motion Planning

Anil Venkatesh
SUNFEST 2008
Project Goals

- Economy of spoken commands
- Customization with little programming
• Spoken Language Understanding Shell (SLUSH)
• Interactive language model
• No training or learning
What SLUSH does

- Most Likely Sequence (MLS) output every 10ms


1  2
Linear Temporal Logic

- $\circ \varphi$: True if $\varphi$ is true in the next state
- $\varphi_1 \mathcal{U} \varphi_2$: True if $\varphi_1$ is true until $\varphi_2$ becomes true
- $\Diamond \varphi$: True if $\varphi$ is true in some next state
- $\square \varphi$: True if $\varphi$ is true in every next state
• Linear Temporal Logic Motion Planner (LTLMop)
• Structured English => Controller

If you are sensing Sandwich then do Eat
Linking SLUSH and LTLMop

- Grammar and Lexicon files
- Pronunciation file
- MLS processing
Grammar and Lexicon

Go to the room.

G N -> (ROOM) room
G NP -> the N
G Simp -> go to NP (GO)

L GO : (source-set)
L ROOM : (set-of-all i in (source-set) s-t ((ilk of i) is (room)))
If-Then grammar and lexicon

If you see the sign, go to the room.

G Sind -> you see NP
G PPcond -> if Sind (IF)
G Simp -> PPcond Simp
G N -> (SIGN) sign

L IF : (context-set)
L SIGN : (set-of-all i in (source-set) s-t ((ilk of i) is (sign)))
MLS processing

- Throw away phonetic transitions
- Cross-reference in pronunciation file for words
- Extract referents and locations

[GO,e0.e1]STA/N_PP*;[IDENT,e0]N/room;;/R_UW_M_SIL? 2
...
Linking to LTLMop

- Identify the kind of command
- Choose appropriate template sentences

If you are in Location1, go to Location2

1. If you are in Location1 then do Location1Flag
2. If you activated Location1Flag and you were not in Location2 then do Location1Flag
3. {If you are activating Location1Flag then visit Location2}
4. If you were in Location2 do not Location1Flag
If you see the alarm in the office, catch the convict in the forest.

If you catch the convict in the forest, lock him up in the jail.

Environment starts with false
Robot starts with false
Visit yard
Visit forest
Visit office
Visit jail
Visit bridge

Environment starts with false
Robot starts with false
Visit yard
Visit forest
Visit office
Visit jail
Always not bridge
Results

- **Expressivity**

<table>
<thead>
<tr>
<th>IF</th>
<th>THEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>SENSOR [in LOCATION_1]</td>
<td>go to LOCATION_2</td>
</tr>
<tr>
<td>in LOCATION_1</td>
<td>ACTION_2 [in LOCATION_2]</td>
</tr>
<tr>
<td>ACTION_1 [in LOCATION_1]</td>
<td></td>
</tr>
</tbody>
</table>

- **Objectives met**
Acknowledgments

My advisors
William Schuler (University of Minnesota)
The SUNFEST program

Images from
http://b-bcs.com/
http://scary-manilow.livejournal.com/