# Towards Commanding UGV Movement In Unlearned Environments Using Unconstrained English

## Initial Research Results

Robin Kowalchuk Burk
U.S. Military Academy

# Contributors

U.S. Military Academy (Dept. of EE&CS):

Robin Burk

Frederick Moxley

MAJ Benjamin Ring

State University of NY (Albany):

Andrew Haas (Dept. of CS)

Kevin Knuth (Dept. of Physics)

# Motivation

- Robotic systems such as UGVs will play a key role in Network Centric Warfare
- How best to command them?
- How best to network them?
- **How can we predict their impact? (network science question)**

# Agenda

- Situational Awareness and Sensemaking: key activities
- Sensemaking in Autonomous Vehicles
- Unconstrained English Navigation Commands for UGVs
  - Why it's valuable
  - Challenges to implementing it
  - Research results to date
  - Next steps

# Situational Awareness & Sensemaking

U.S. Army War College case study:

OIF = nascent Network Centric Warfare

- *Extended reach communications*
- *Integrated information flows*
- *Synchronized joint fires*
- *Networked sensors & platforms (UAVs)*
- *Common operational picture for commanders*

# Situational Awareness & Sensemaking

- Shared situational awareness in OIF
  - Real-time sensor data (incl. from UAVs)
  - Integrated into common operational picture
- Sensemaking in OIF
  - Implications of situation
  - Validated through verbal communications
- Outcomes:  agility, people-centric

# Situational Awareness & Sensemaking

- Integrated information flows facilitate shared situational awareness
- Shared situational awareness benefits
  - Sensemaking
  - Ability to substitute information and material for personnel
  - **Ability to substitute unmanned systems for personnel under some conditions**

# Sensemaking in UGVs

- Future Combat Systems UGV roles
  - Driverless trucks
  - Robotic mules (soldier, squad aid)
  - Intelligent munitions
  - And more!
- Some degree of autonomy required for these roles
- **Autonomy requires sensemaking, not just information exchange**.

# Natural Language for UGVs

- Ideal UGV would
  - Be **easy to integrate** into operations
  - Require **minimal operator training**
  - **Resemble a good soldier**
    - Accept commands
    - Interpret them intelligently
    - Execute them reliably
    - Ask questions when something is unclear
    - Alert when significant events occur

# Natural Language for UGVs

- NL communicates **intent** (commands) and **the sense we make of situations** (features we key on)
- NL is the most natural way for humans to interact
  - Adaptable rich interface
  - Suited to a wide range of situations
  - **Language skills persist under stress**

# Natural Language and UGVs

"*Go down this road to the first cross-street. Turn left and go two blocks. Stop in front of the second building on the right.*

*Radio if you see any white Toyotas parked along the streets."*

# Challenges

- Natural language challenge
- Cognitive robotics challenge
- Integration with the Global Information Grid
  - Desireable to minimize load on GIG (autonomy for most decisions)
  - Desireable to contribute useful information to GIG (intelligence)

# Sensemaking in UGVs

Autonomous UGVs must:

- *Fuse sensor inputs*
- *Recognize objects in the environment*
- *Interpret events in light of task*
- *Adjust task execution as required*

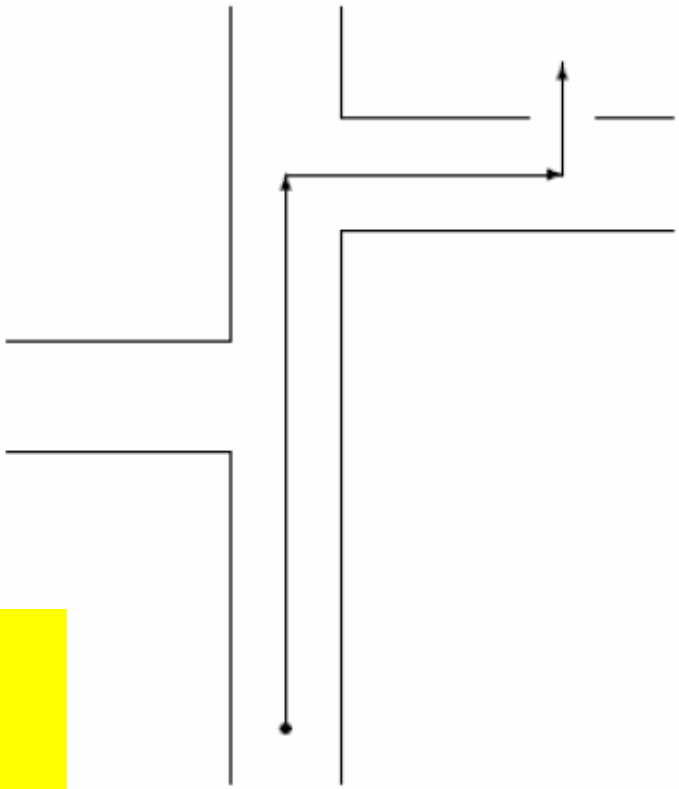
***This is sensemaking!!!***

# Research Results to Date

- Executed in a simulated environment
- Approach = find minimum of NL features and interpretation needed to understand & execute navigational commands
- Results:  80% accuracy
  - Better than human interpretation in some experiments
  - Possible due to ***pragmatics*** approach, i.e. language as a tool to accomplish a task

# Ambiguities in Language

**Turn right at the ???? hallway**



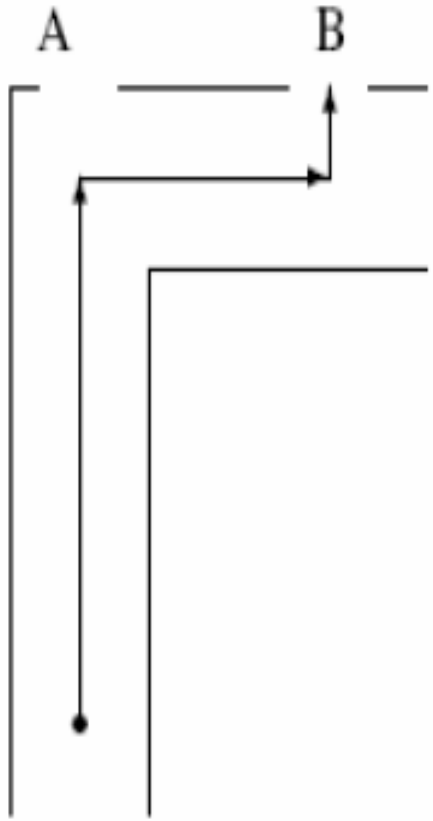
**1st or 2nd?**

# Ambiguities in Language

**To get to B:**

**Turn right and stop at the 1st door in the hallway?**

**Or the 2nd?**



# Cognitive Robotics

- Mapping perception (sensor input) to concepts (attributes described in language)
- Cognitive object recognition is key to a rich language capability in robots
- Probabilistic!!! (for both humans and robots)

# Next Steps

- Replicate simulation experiments in physical robots
- Quantitatively characterize robustness and computational requirements in more complex environments
- Expand language interpretation strategies

# Other Considerations

- Non-native English speakers
  - Cognitive structures differ between languages
  - Under stress, reversion to native structures
  - Clarifying questions can bring learned (English) context back to the foreground
- Gender differences in spatial perception and language

# Summary

- Sensemaking will be a valuable attribute of unmanned systems in NC
  - Not the same thing as shared situational awareness / information sharing
- Sensemaking in unmanned systems requires many of the same abilities as natural language processing
- Natural language for commanding UGVs would be valuable and may be possible

# Questions?