

## Secure Communication among Robots and Humans with a Human Voice

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### Previous (Background) Research Experience

- Optimizing Controls over Quad-rotor
- Socket Communication
- Communication among Human, Agent, Robot, Machine, and Sensor

### Current Research

- Secure communication in HARMS (Human, Agent, Robot, Machine, and Sensor)

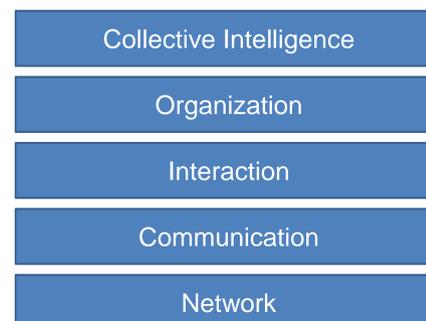


Figure 1. HARMS Layers

### Security in Firefighting Robot Communication

As firefighting situations are urgent, the demand of firefighting robots communicating with a human in a natural language is increasing as it is efficient in that there is no need an commander to get trained for operating a controller. However, when communicating with a human in a natural language, there is an issue regarding security; firefighting robots are supposed to operate according to commands by an authorized commander, it is difficult that firefighting robots verify authentication with a human voice. However, it is still important to keep the communication between a human (a commander, not an adversary) and a firefighting robot secure due to any potential situation of a person setting fire on purpose and wanting to hinder firefighting tasks. Thus, I am currently researching to realize a secure and accurate communication in a human language.

### Voice Authentication

As previously mentioned, it is not easy to verify authentication with a human voice. However, fortunately, human voices are vary and, at the same time, significant. It is a similar method to a digital signature shown in an email to ensure a sender of the email. As each person has different pitches of voice, the way of talking and wording, and accents, verifying authentication can be possible; according to "Voice Signature" written by Shafran, Riley, and Mohri, members in AT&T Labs, how a person speaks and what a person specially says can be used to detect personal traits. If the voice signature is used, once a robot learns unique or significant characteristics of a commander, it is possible for a firefighting robot to distinguish between a real commander and an adversary by matching data which the robot already has in it and data which the robot just received as a command.

### Ontology-based Communication

In communication between a human and a robot, when an operator gives a command to a robot, it is not difficult for a firefighting robot to execute the order if the operator uses commands that are already declared in the robot. However, if a robot is more intelligent, the robot can still execute an order when an operator give a command using different words or in a different way. In order to realize it, ontology can be used. As ontology is a world model containing information that a robot should know to operate in the environment, it classifies functionalities of a robot and what potential words can be connected to what functionality; when a person give a word as a command, the robot will look up the ontology as a person looks a dictionary to find out what a word means, and then figure out what the person asks to do.



Figure 2. Firefighting Robot from DRB Fatec

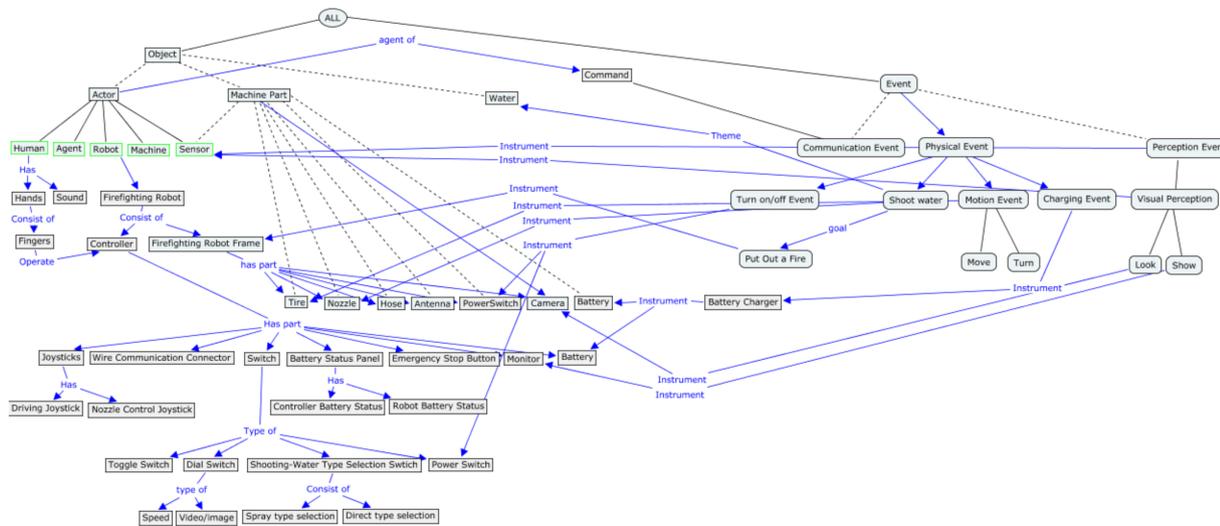


Figure 3. Ontology of Firefighting Robot

### Advancement in the future

The above information is a basic idea to realize a secure and intelligent communication between a human and a robot. In order to actually distinguish a commander's voice, a firefighting robot should have criteria and data of personal traits to match; then, each distinct characteristic of a human voice can be verified, and the robot can decide what operation it has to do. Prototypes will be built in the future, and through more tests and implementation of programs, there will be more progresses, challenges, and new ideas.

### Reference:

Shafran, I., Riley, M., and Mohr, M. (2003, November 30 – December 3) Voice Signatures. *Automatic Speech Recognition and Understanding*. Retrieved from [http://ieeexplore.ieee.org/xpl/freeabs\\_all.jsp?arnumber=1318399](http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=1318399)