



## Cloud Robotics

- **Limited onboard resources**
- **Utilize cloud for non-safety tasks**
  - ✓ Speech recognition
  - ✓ Map database
  - Object learning and detection
  - Manipulation learning
- **Fault-tolerant cloud integration**
  - Seamless transition to local resources
  - Gradual capabilities degradation
  - Capabilities transparent to user

## Natural Interaction

- **Intuitive user interface**
  - ✓ Interprets natural language speech
  - ✓ Synthesizes speech
- **Safe interaction with bystanders**
  - ✓ Executes predictable behaviors
- **Knowledge & intent transparency**
  - ✓ Panning head follows user
  - ✓ External tablet conveys state
  - ✓ Robot speaks actions
  - Projector indicates knowledge & intent

## Situational Awareness

- **Rich semantic map**
- **Object-level awareness**
  - ✓ Depth & color segmentation
  - ✓ One-shot reacquisition
  - Pose tracking
- **Human detection and tracking**
- **Knowledge acquisition**
  - ✓ Learns map via human-guided tour
  - Builds semantic map from speech

## Asking for Assistance

- **Requests help for unachievable tasks**
  - ✓ Opening doors
  - ✓ Operating elevators
- **Learns from user to perform tasks**
  - Increases independence over time
  - Interactive guided tour of manipulation