Cognitive Consumer Robot for Elderly-Care: HomeMate

Ministry of Knowledge Economy

SUNGKYUNKWAN UNIVERSITY 1398

ISRC INTELLIGENT SYSTEMS RESEARCH CENTER

YUJIN ROBOT

Bonavision The Intelligent Robot Company

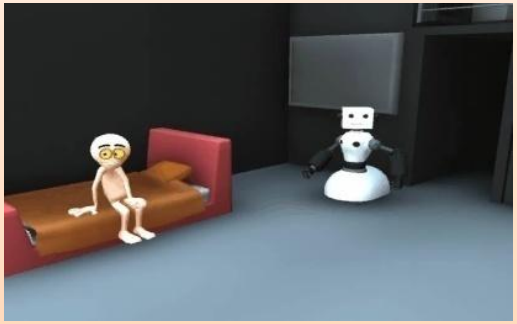
Contents

- **HomeMate**
  - Cognitive Consumer Robot
  - Dependability
  - Self-Learning of Evidence Structure
  - Sociability
  - Deployment in Elderly Care Center
  - Service Scenarios
- **Conclusion**

HomeMate: Cognitive Consumer Robot

HomeMate: Next Generation of Consumer Robot Capable of Errand/Manipulative Services

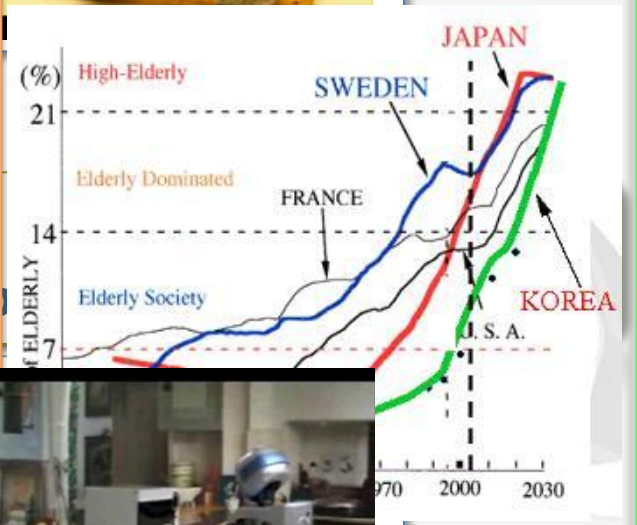
Targeted for Caring Elderly or Disabled with Three Major Service Scenarios: Errand, Medicine Delivery and Video Chatting



Errand

Medicine Delivery

Video Chatting



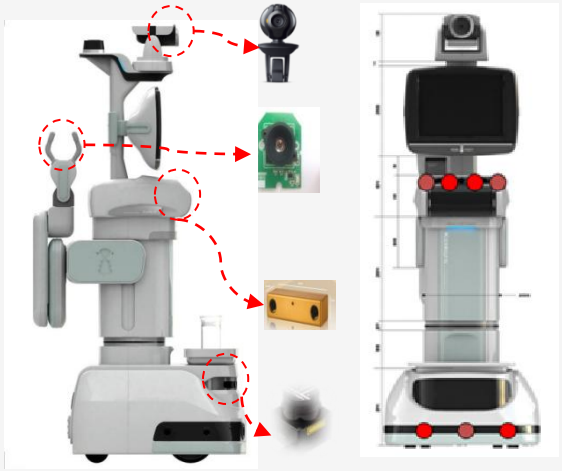
Problem to Solve:

To introduce HomeMate to Consumer Market with an order of magnitude improvement in Value > Price > Cost criteria

Dependability, Sociability, and Affordability

Elderly Care Robots: HomeMate

❖ISRI/SKKU with Yujin, BonaVision, GT and PSU



Low-cost Sensor, Actuator, Platform!!
Performance compensated by dependability!!

Harmony in appearance with functionality:
to overcome Uncanny Valley

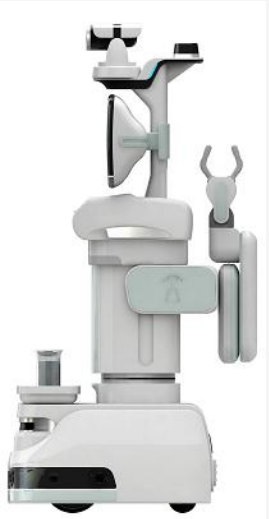
Targeting for U.S and Korean Markets in consideration of Environment and Culture

Visual Recognition Problems for Service Robots in Consumer Market

Dependable Recognition Invariant to Environmental Variations and Uncertainties

Self-Learning Knowledge Structure for Recognition

HomeMate: Dependability



Approach: Fundamental Principle for Dependability

Human visual recognition is dependable as it can self-define its mission and has will to accomplish it by mobilizing its resources with Collective Cognitive Processes and Behaviors

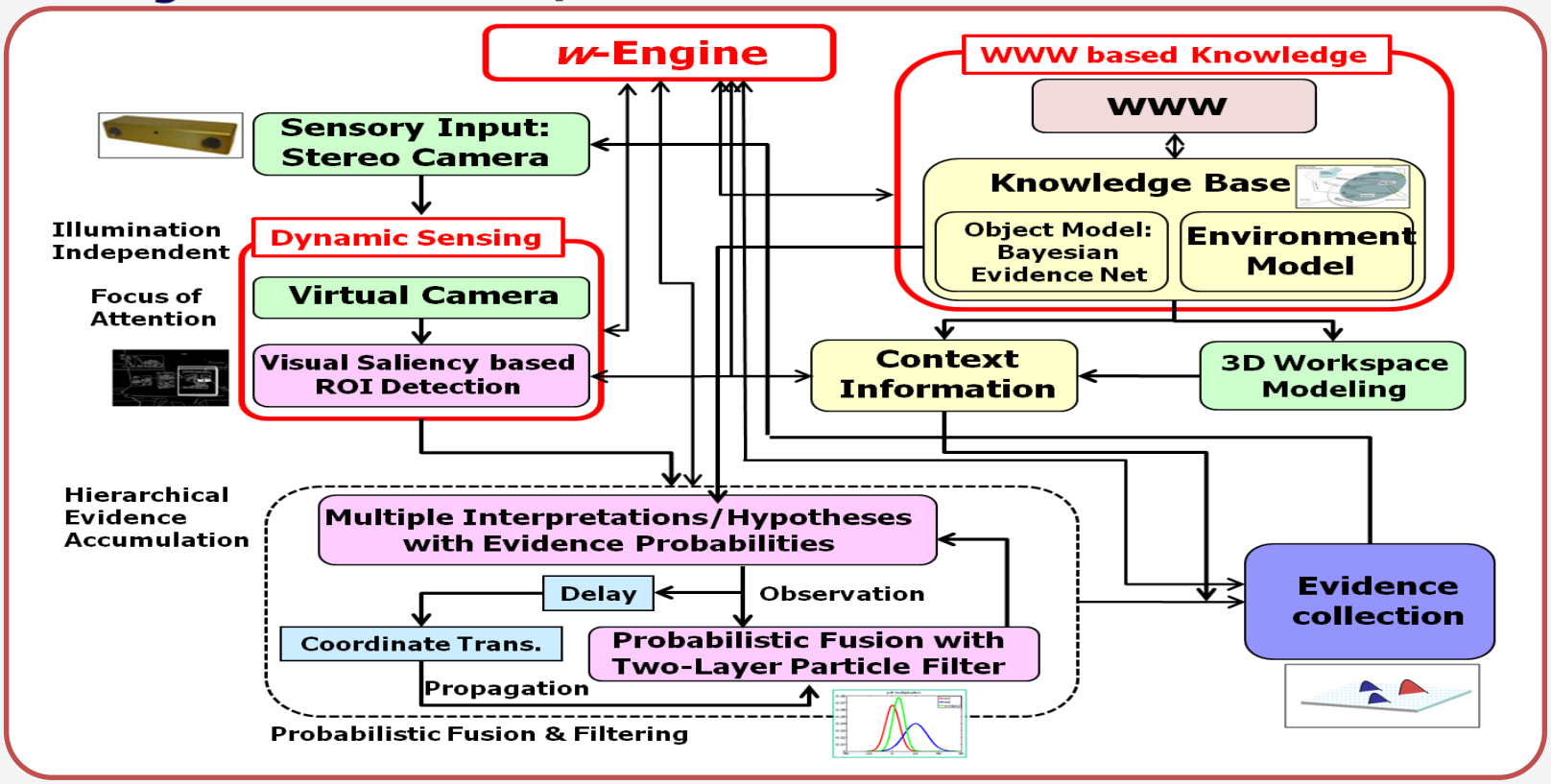
Dependability

Collective Cognitive Processes and Behaviors

Dynamic Sensing, Optimal Feature Selection , Evidence Collection, Context Based Search, Multiple Hypotheses, Probabilistic Evidence Reasoning

Cognitive Recognition *w*-Framework

- Virtual Camera for Dynamic Sensing
- Attention based ROI with Bottom-up and Top-down Saliency Detection
- Multiple Hypotheses Generation and their Probabilistic Reasoning with Evidence Collection
- Self-Learning of Evidence Structure in Connection with WWW
- Cognitive Recognition w-Framework that Self-Organizes Mission and Cognitive Processes/Behaviors



Cognitive Recognition: Probabilistic Evidence Reasoning with Multiple Hypotheses

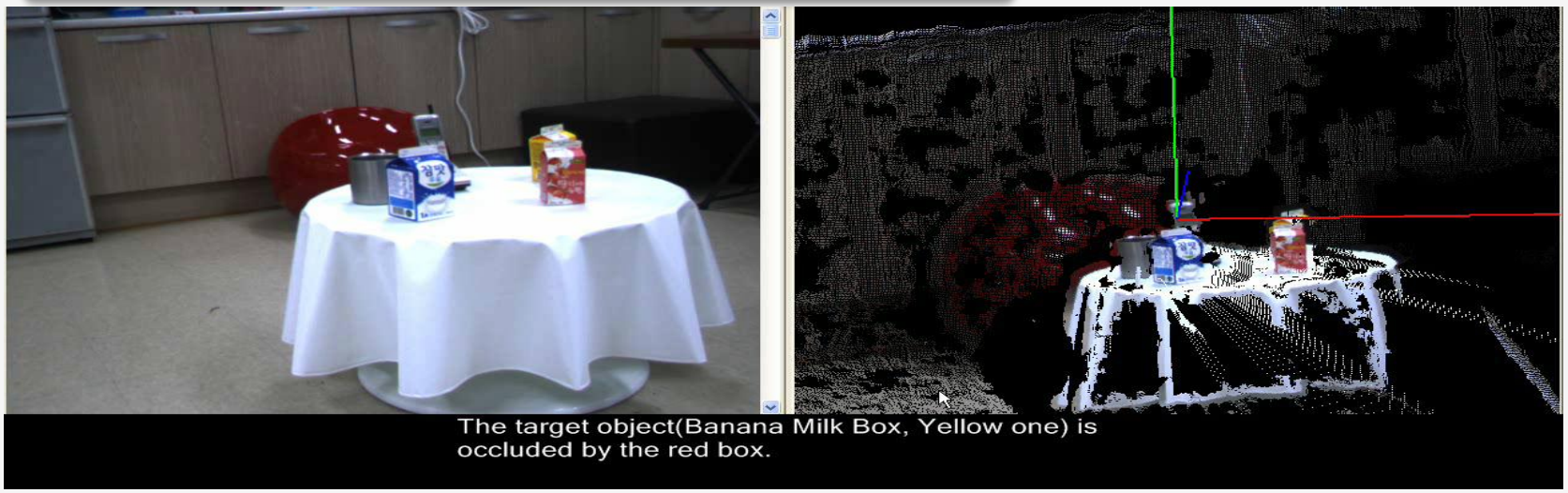
4D Evidence Reasoning and Decision Process with Context to Search for Yellow Milk Box

Probabilistic Evidence Reasoning:
Evidence Collection

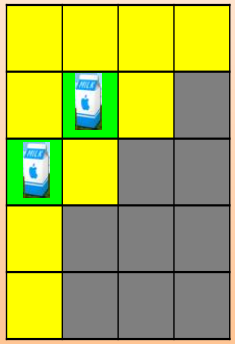
Evidence Collection

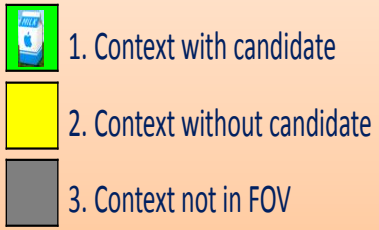
Evidence Collection

Evidence Collection under Occlusion

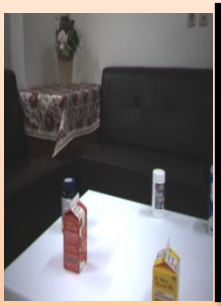


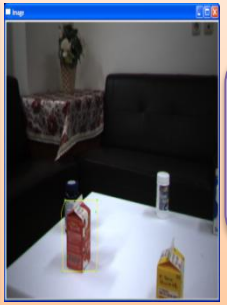
Probabilistic Evidence Reasoning:
Evidence Collection under Occlusion





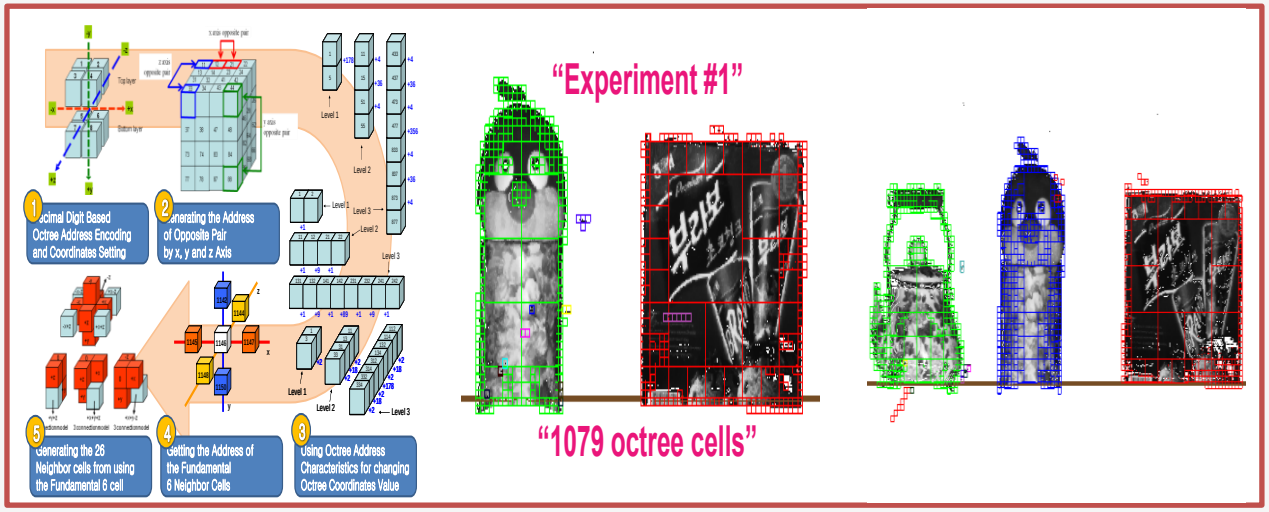
Occlusion



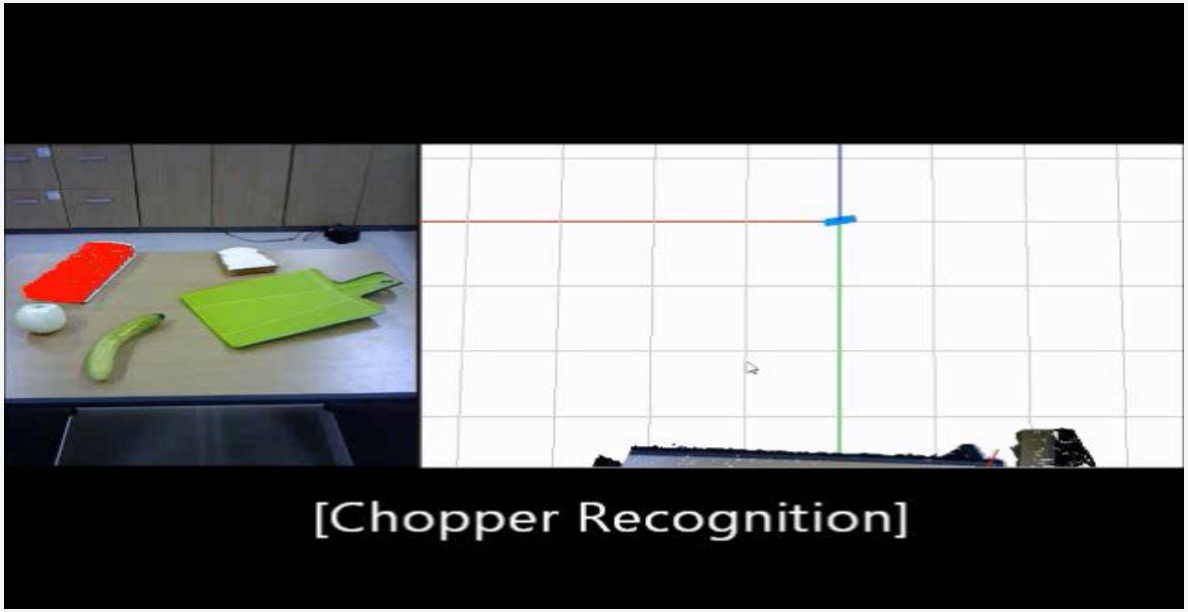


Determine the context is in the convex or not

Octree Generation → Projection onto 2D image → Convex Approximation for the projected points

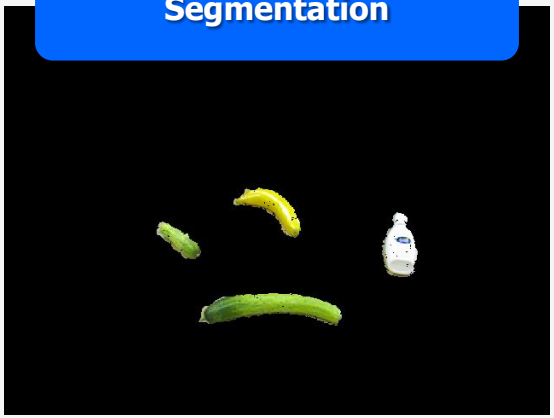


Cognitive Recognition:
Free-Form Target Objects with Extended 2D/3D Features

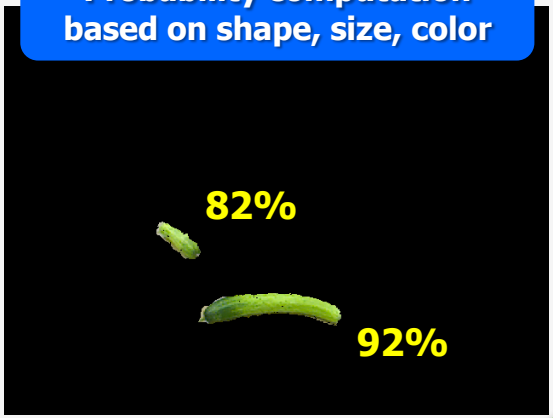


Input image (2D+3D) for Cucumber Recognition

Segmentation

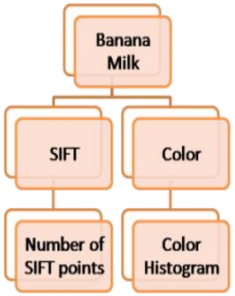


Probability computation based on shape, size, color

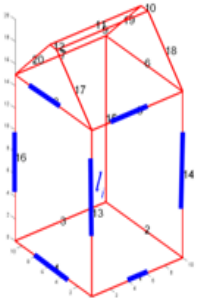


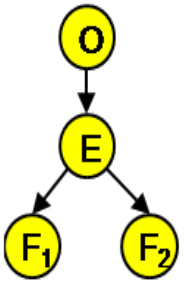
HomeMate: Self-Learning of Evidence Structure

Self-Learning of Evidence Structure Based on WWW: Features and Contexts



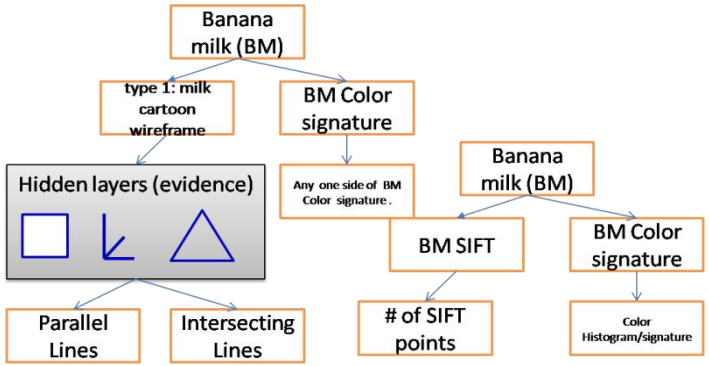
Features	Evidence	Evidence Score



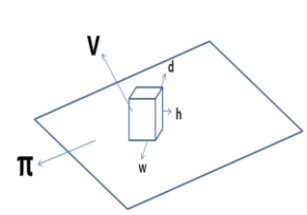


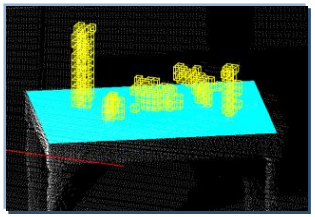
O	E_1	$P(E_1\|O)$
False	False	0.01
False	True	0.99
True	False	0.3
True	True	0.7

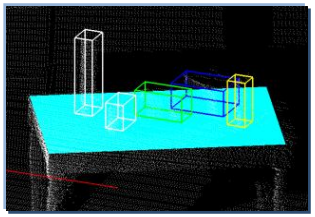
Sufficient Condition of Evidences for Decision

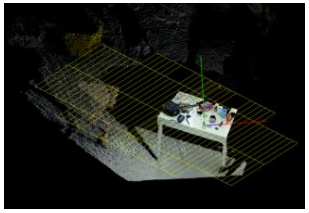


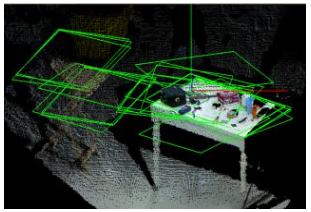
Evidence Structure for Object Recognition

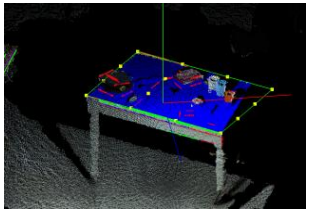






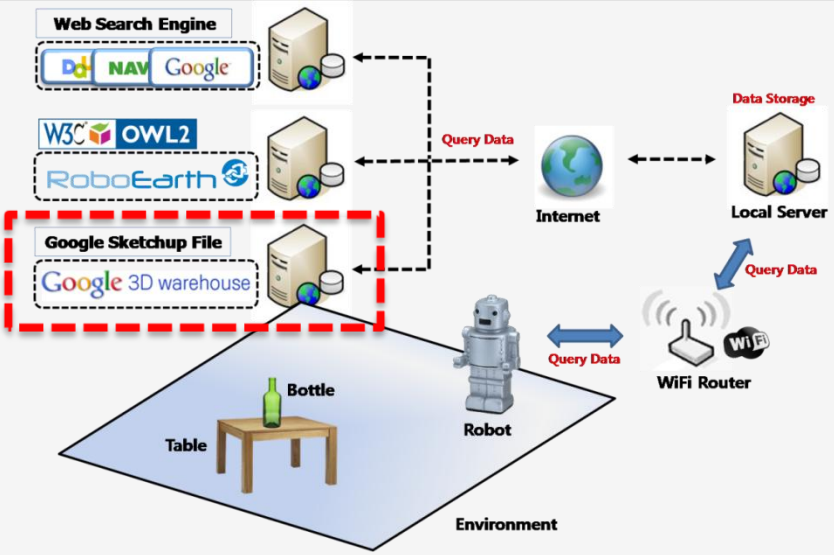


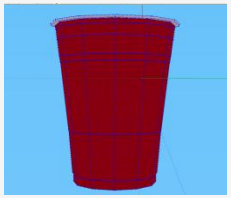


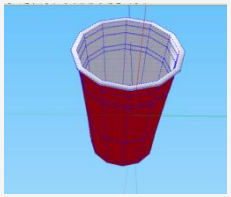


Context Generation for Working Space Modeling

Self-Learning of Evidence Structure Based on WWW: Object Self-Modeling







3D Object Model in Google 3D Warehouse

Self-Learning of Evidence Structure Based on WWW: Work Space Self-Modeling

HomeMate: Sociability

Sociability

- Just like human enjoy as much **Sociability** as intelligence, Service Robots of the Future should be able to be as much **sociable** as Intelligent.

- What is functionally intelligent may be less critical, as long as Service Robots demonstrate **Sociability as Individual Personality.**

The Avatar

- Lipsync for TTS function.
- New communication protocol for Action Script action.
- Syncronization with CCRA for every state in interaction process.
- Debugging and feedback interface.
- Google's TTS Integration in case of external debugging.
- Touching and voice interface activation.

WAIT_forrest

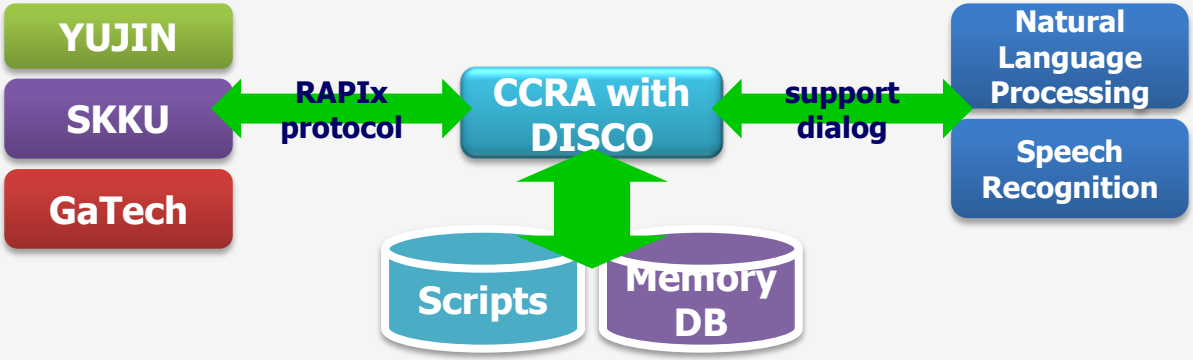
WAIT_wind

WAIT_sleeping

ERRAND SERVICE
Every object that the user wants to reach

Dialog Manager

COGNITIVE ROBOT REASONER INTEGRATION WITH GA TECH'S DIALOG MANAGER



CCRA high level Architecture

Physical Interaction for Building Relationship

- ✓The appearance of an embodied conversational agent can support trust, rapport, and cooperation between the person and the agent.
- ✓Embodied agents also provide a social dimension to the interaction.
- ✓The social structuring of activity leads people to develop relationships with others who are similar to themselves: Errand Service

HomeMate: Deployment in Elderly Care Center

✓**The *HomeMate user evaluation* team designed a questionnaire of 15 items, considering the engineer, the interaction scientist and the care taker points of view**

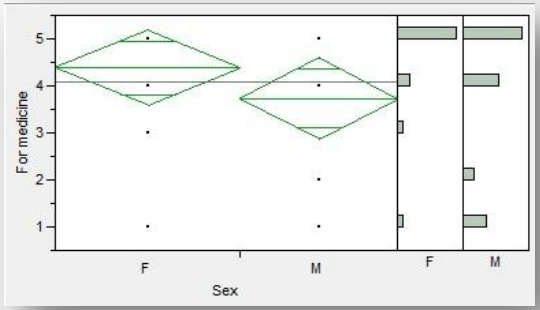
✓**25 elders from the Jongno Senior welfare center participated in a survey**

- ***How old are you?*** ***From 60 to 92***
- ***Female? Male?*** ***14 females 11 males***
- ***How many people do you live with?*** ***Most of them live ALONE.***

Preferred Services:

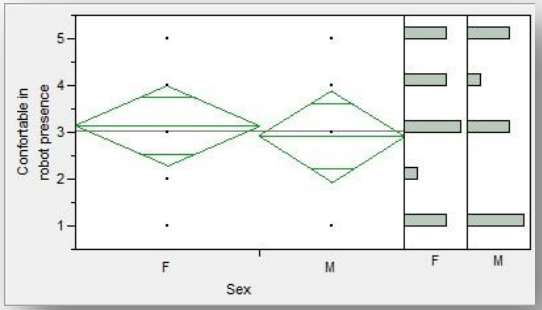
Order taking, Errand Service(Water), Scheduled Medicine, Video Chatting, Game Playing

✓Would you like a robot to bring your medicine?



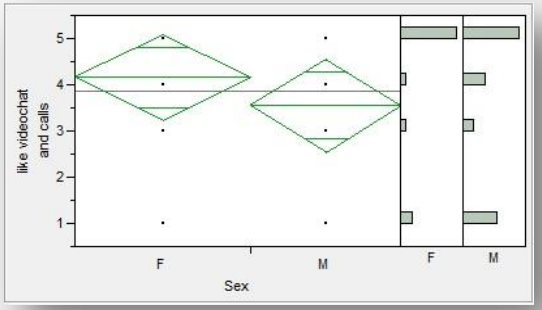
Level	Number	Mean
F	13	4.38462
M	11	3.72727

✓Do you feel confortable in robot presence?



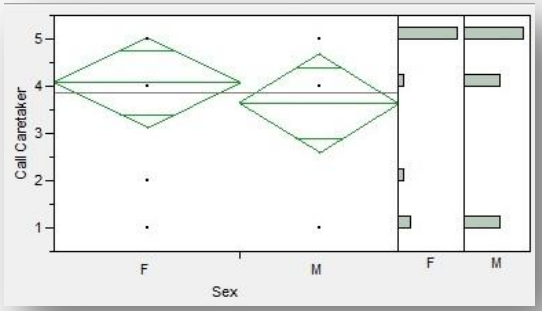
Level	Number	Mean
F	14	3.14286
M	11	2.90909

✓Would you like to communicate with your family through robot?



Level	Number	Mean
F	13	4.15385
M	11	3.54545

✓Would you like to use a robot to call the caretaker?



Level	Number	Mean
F	13	4.07692
M	11	3.63636

HomeMate: Service Scenarios

Scenario 1: Errand Service

Scenario 2: Medicine Delivery

Scenario 3: Video Chatting

Conclusion

- **HomeMate**, as **Cognitive Consumer Robot**, demonstrates a possibility of introducing personal/domestic service robot into **Consumer Market** with a breakthrough in **Dependability, Sociability and Affordability**.

- Especially, a service robot with a **Will** to accomplish self-defined missions by **Cognitive Behaviors** is shown to be **effective for dependability**.

- **HomeMate** will be expanded into the framework of **Robot Cyber-Habitat** for collaborative development of **Knowledge, Skill and Service** in an **Open Environment**.

Thank You!!

Acknowledgement

This project is supported by Ministry of Knowledge Economy under KORUS Tech program. Appreciation is given to the project members including ISRI/SKKU, Yujin Robot, Bonavision, and GeorgiaTech