

인간-로봇 사회적 상호작용을 위한 핵심 기술

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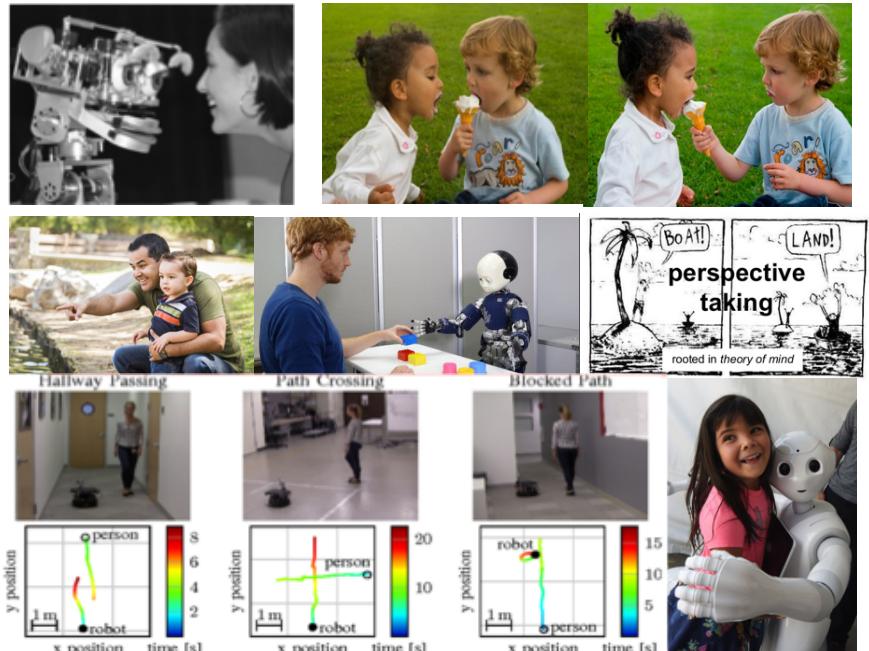
한국과학기술연구원

What is sHRI?

What is sHRI?

- Human-Robot Interaction in **the socially acceptable way** such as

- ✓ Eye contact
- ✓ Turn-taking by intention reading
- ✓ Joint attention
- ✓ Perspective-taking
- ✓ Social navigation behaviors
- ✓ Cooperative planning
- ✓ Proactive behaviors to learn task semantics from demonstration
- ✓ Emotional empathy or sympathy
- ✓ ...



- **Social (Robot) Intelligence** is the key technology for sHRI



Social Robot Intelligence

Motivation

Strong Assumption !

- Human always approach the robot with their attention
- They are all newcomers to the place
- Human don't stop paying attention to the robot until the robot stops its expression.
- ...



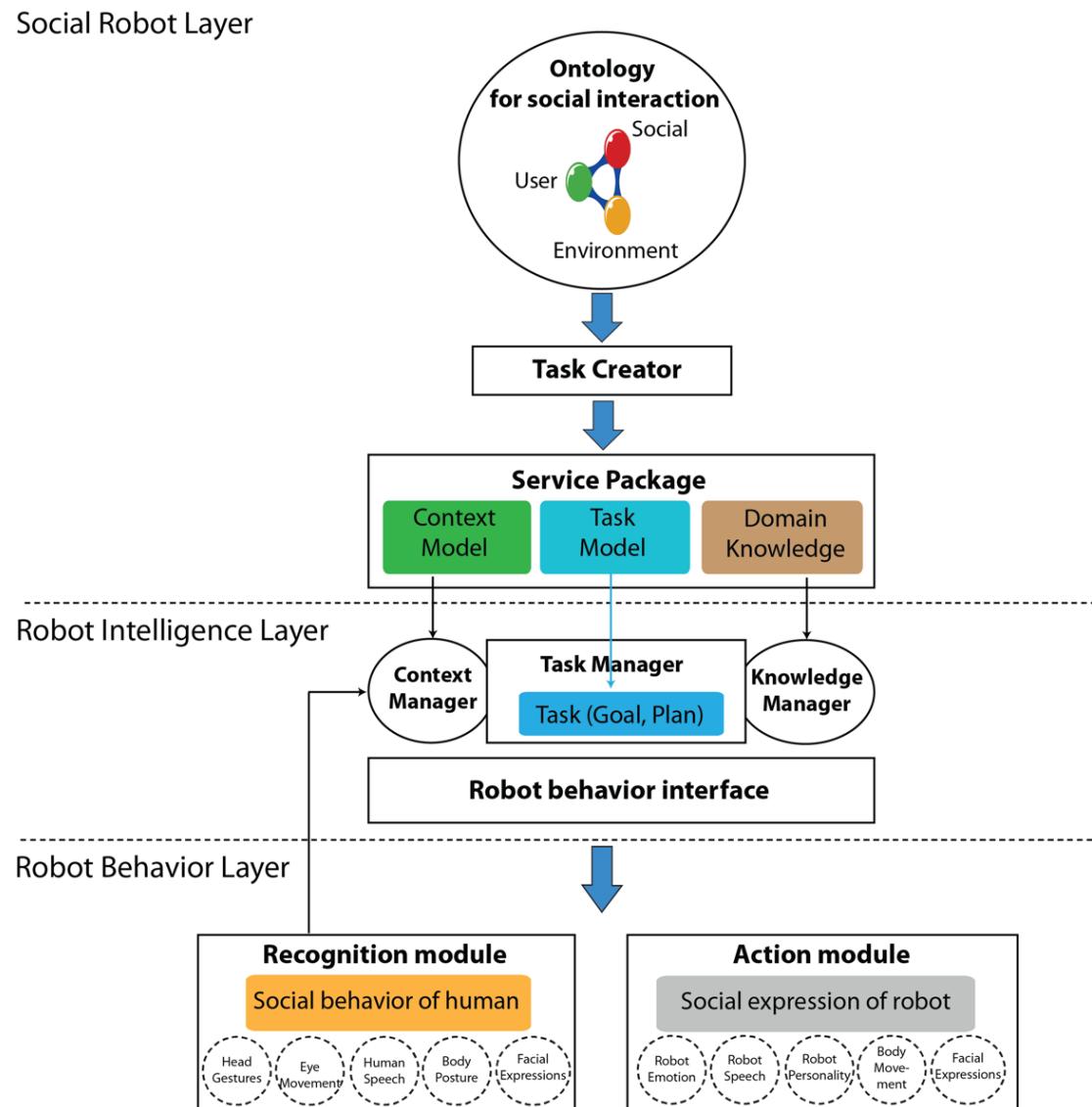
What If ?

- If someone is just passing by w/o attention?
- If someone is already familiar with the place?
 - If someone feels bored and then wants to leave?
 - If the person is not a customer but a clerk?
 - If we change the robot?
 - ...

Social
Intelligence !

Proposed System (from a sHRI-related project *DeepTask*)

“Development of Social Robot Intelligence for sHRI of Service Robots”



Approaches

1. Social behavior recognition

(Electronics and Telecommunication Research Institute,
 Korea Institute of Science and Technology)

- Deep learning based social behavior perception
- Human-Human and Human-robot interaction data acquisition
- Long term human behavior tracking technology
- Social dialogue act model for Korean language



2. Social expression and behavior of robot

(University of Auckland)

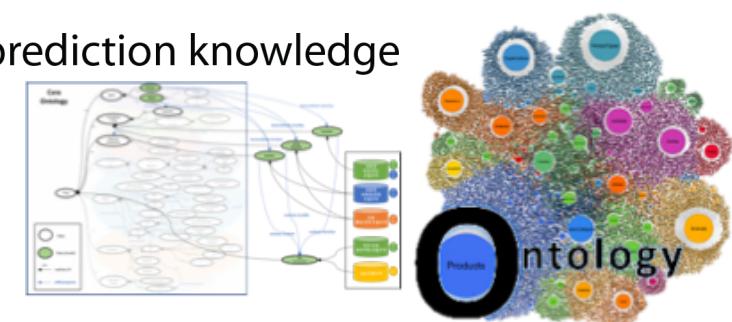
- Robot personality model based on human behavior
- Emotion and speech expression model
- Robot speech and movement coordination



3. Social task knowledge

(Hanyang University and University of Seoul)

- BDI (Belief-Desire-Intention) based user intention prediction knowledge
- Social interaction ontology
- External web data based knowledge expansion



4. User evaluation

(Ewha Womans University)

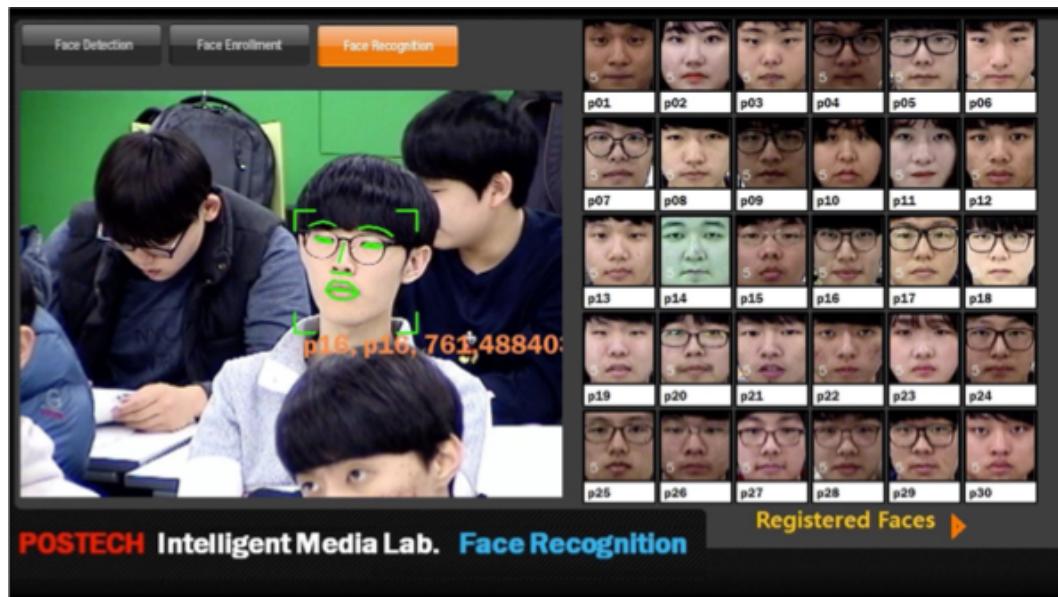
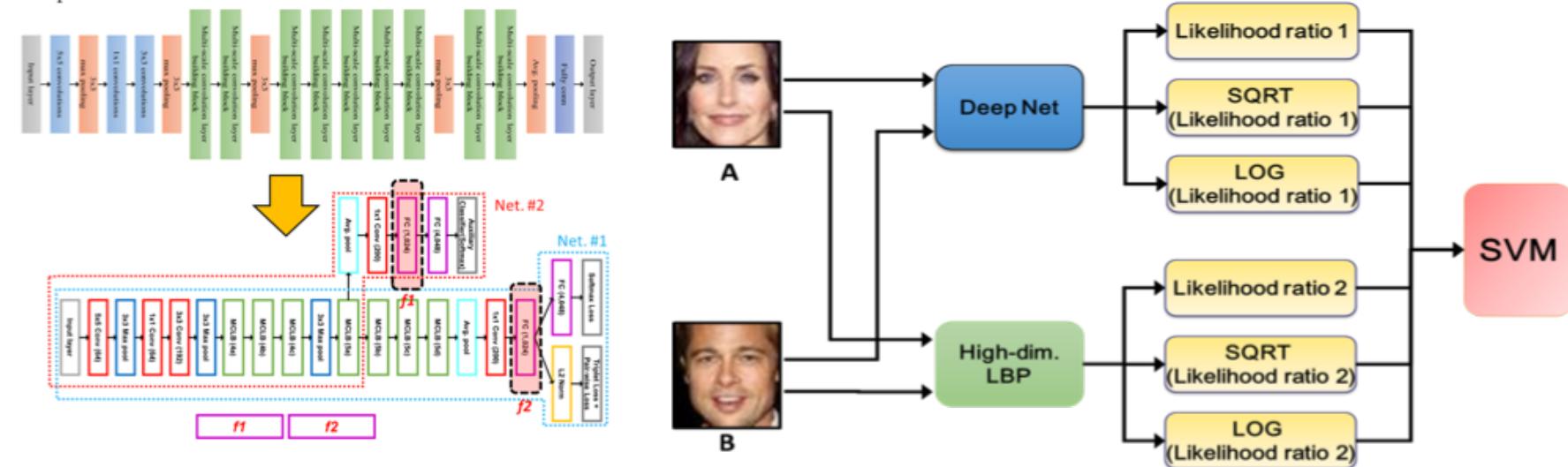
- Social interaction model evaluation
- Social cue based interaction model



[Perception]

WHO (사람의 얼굴 인식)

- Deep Learning 기반 신원 인식



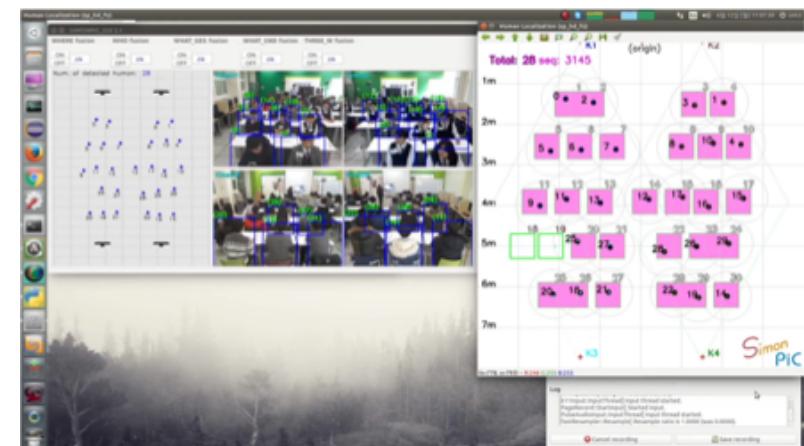
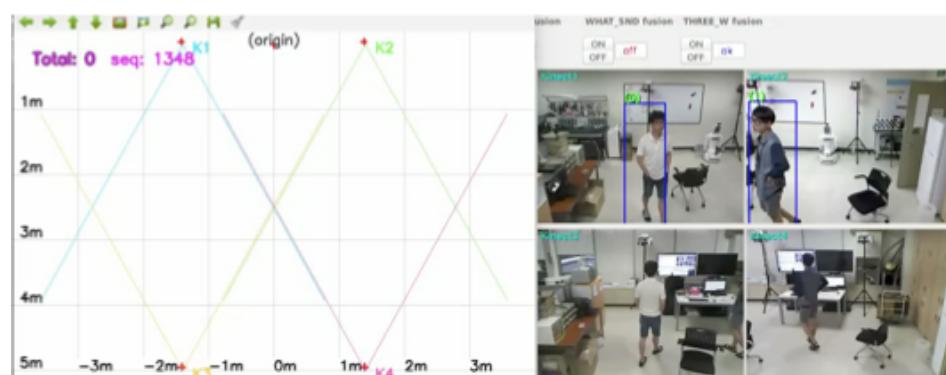
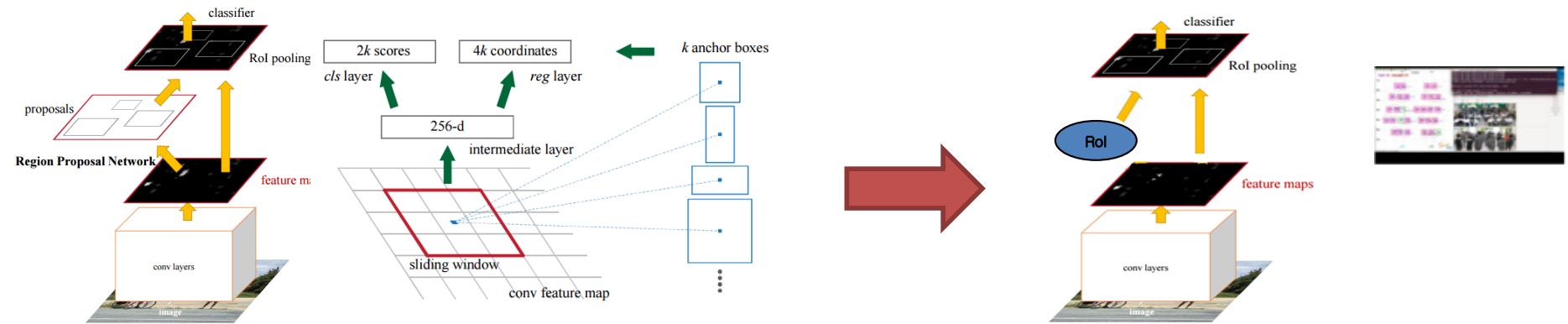
- Deep CNN 기반 얼굴특징추출
- PCA 기반 차원축소
- High-dim. LBP
- SVM 학습

Collaborative research:
KIST & POSTECH, 2017

WHERE (사람의 위치 추적)

- Modified faster R-CNN

- 기존의 ROI를 Modified faster R-CNN (zf)에 활용 → 비휴먼(로봇, 문, 책상, 의자 등) 검출제거
- 30명 인원에 대한 사용자 출입, 검출실패, 가려짐 등에 강인한 다중 객체 추적



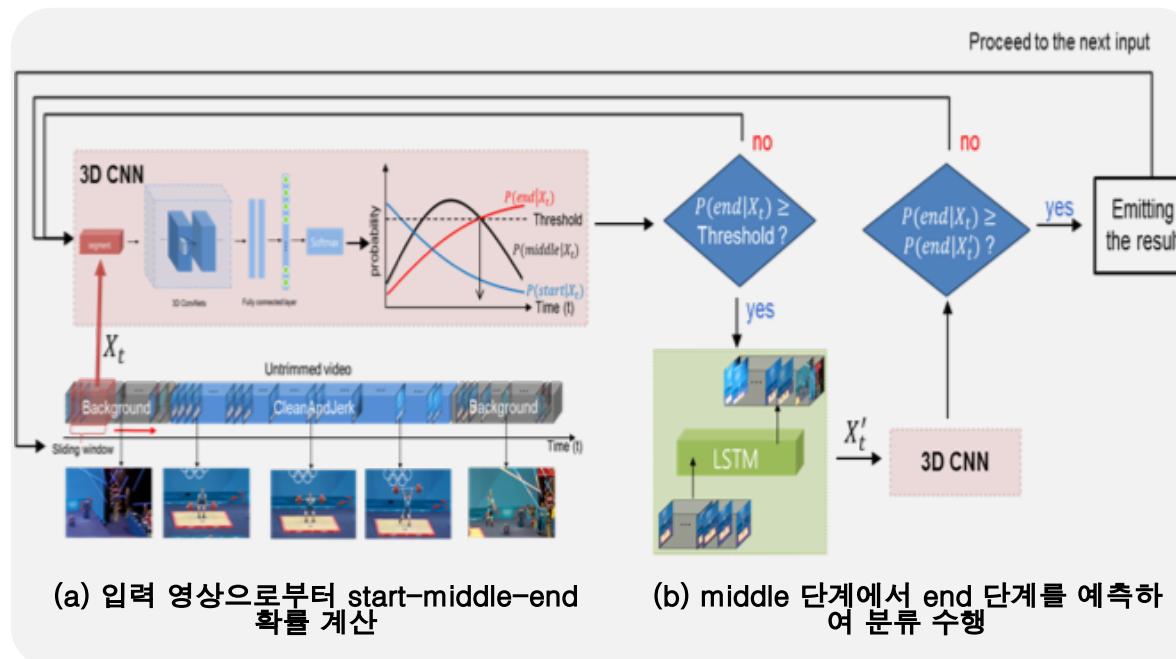
WHAT (사람의 행위 인식)

➤ 제스처 및 행동 인식 프레임워크 개선

- 딥러닝(LSTM) 기반 행동 길이 변화 대응 가능 행동 인식 수행 → 연속적인 행동 인식 프레임워크 개발

- 행동을 "start-middle-end" 단계로 구분지어서 인식
- 3D CNN 구조를 이용하여 각 단계를 학습
- 입력 정보가 불충분한 상태에서의 강인한 행동 인식을 위해 현재의 판단을 기반으로 앞으로의 입력을 예측 수행

➔ LSTM (Long Short Term Memory) 구조를 이용하여 "end" 단계 생성을 통해 분류 성능 개선

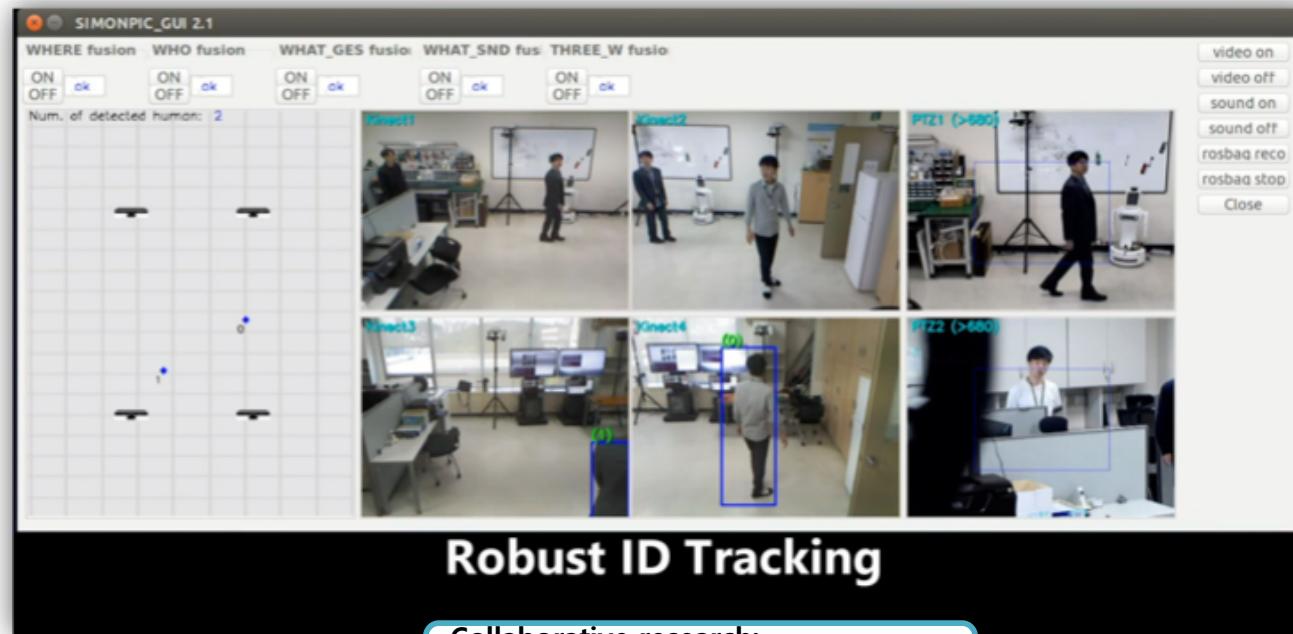


딥러닝 기반 연속적인 행동 인식 프레임워크개념도



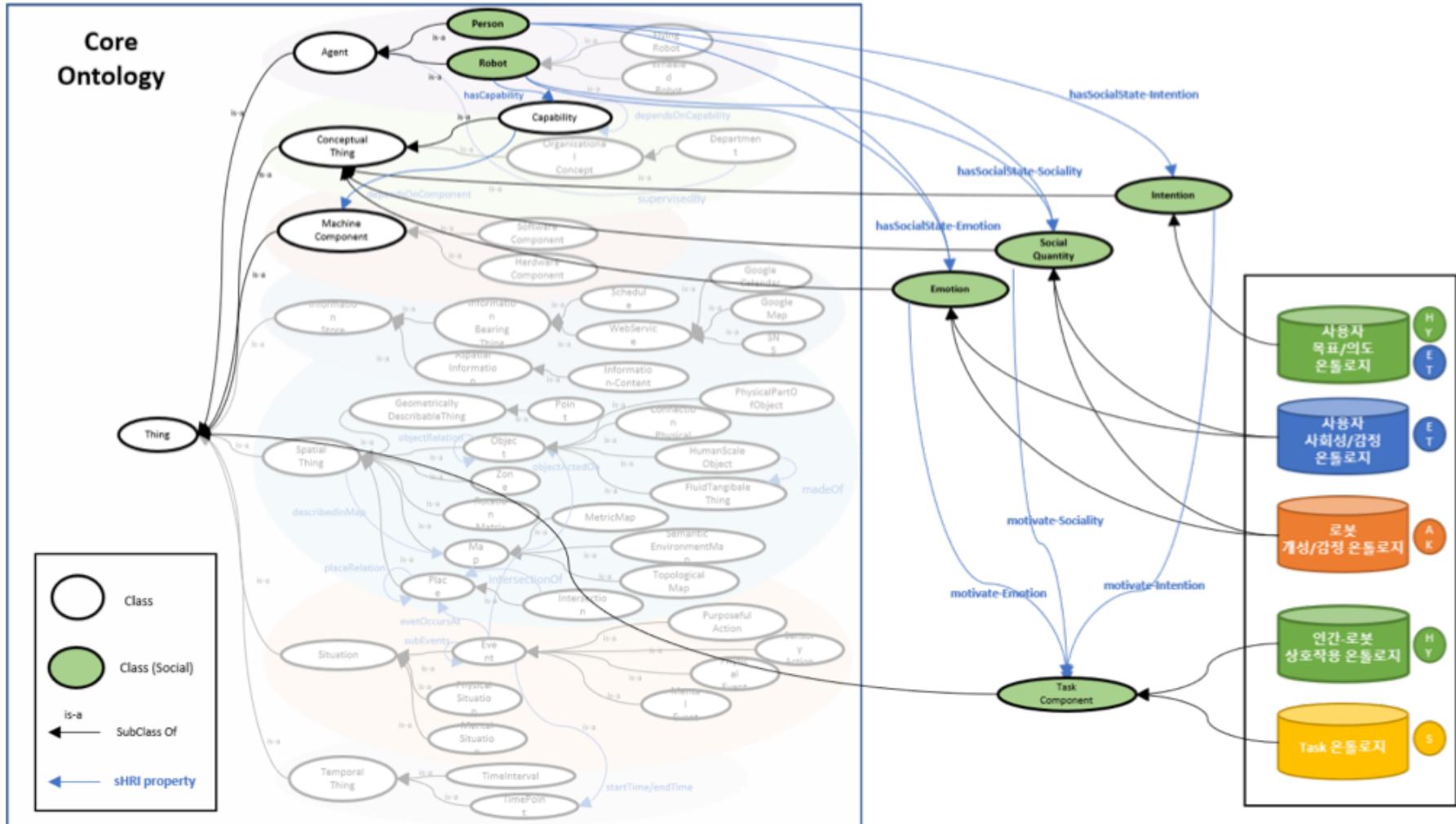
Collaborative research:
KIST & KU, 2017

Results: 3W [WHERE + WHO + WHAT (A/V)]

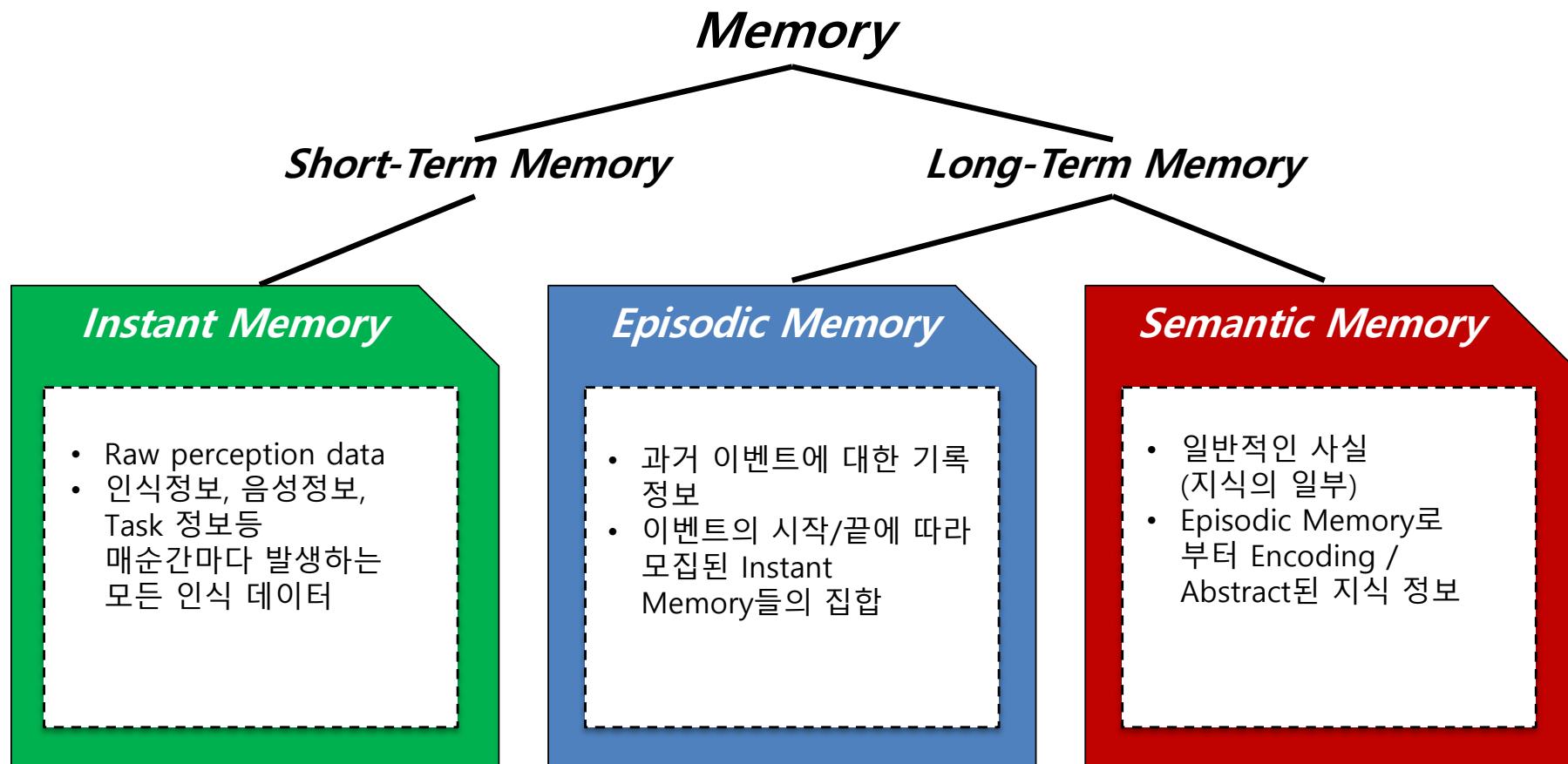


[Cognition]

Knowledge (Ontology)

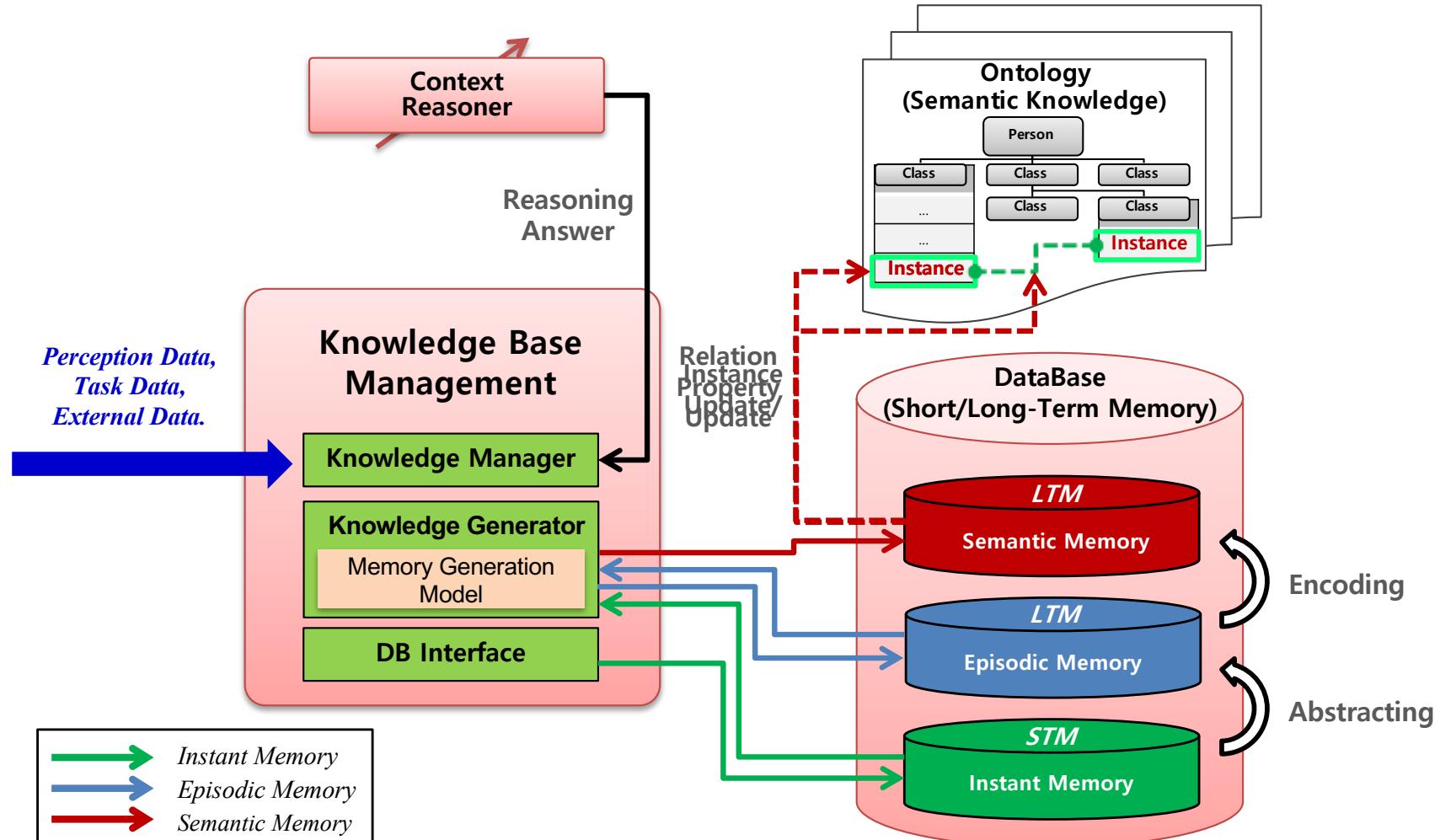


Memory



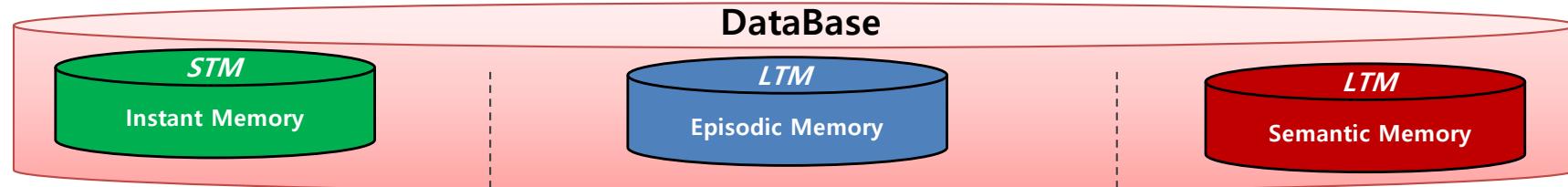
Knowledge Base Management

Memory Generation Process

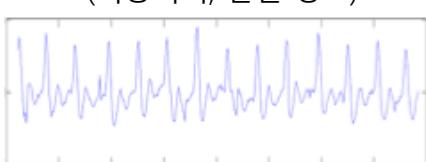


Knowledge Base Management

■ Knowledge(Personality) Generation in Memory System



Thin Slice of Behaviors
(Non-Verbal Features Set)



(목소리 톤, 음압 변화, 발화 간격)
(이동거리, 관절 정보)
(체온, 심박수, 근전도도)

DataBase

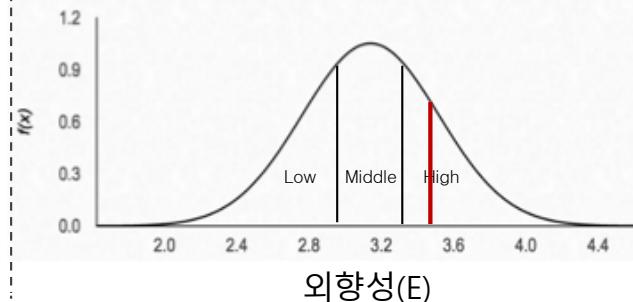
LTM

Episodic Memory

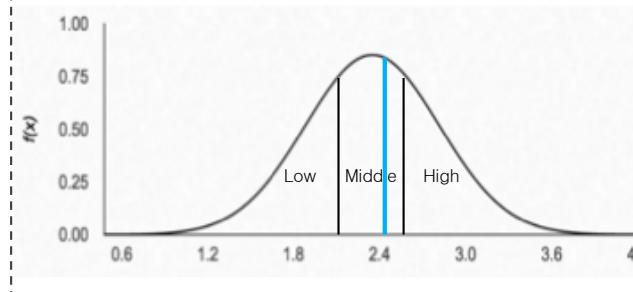
LTM

Semantic Memory

Thin Slice based Personality



외향성(E)



정서불안성(ES)

Long-Term Personality

대표 성격

Category	Subject	Predicate	Object
일반적인	철수(사용자)	의 대표성격은	조금 외향적 신경질적

능력 별 성격

Category	Subject	Predicate	Object
가능한 일	철수(사용자)	의 성격은	외향적 조금 신경질적
불가능한 일	철수(사용자)	의 성격은	조금 외향적 많이 신경질적

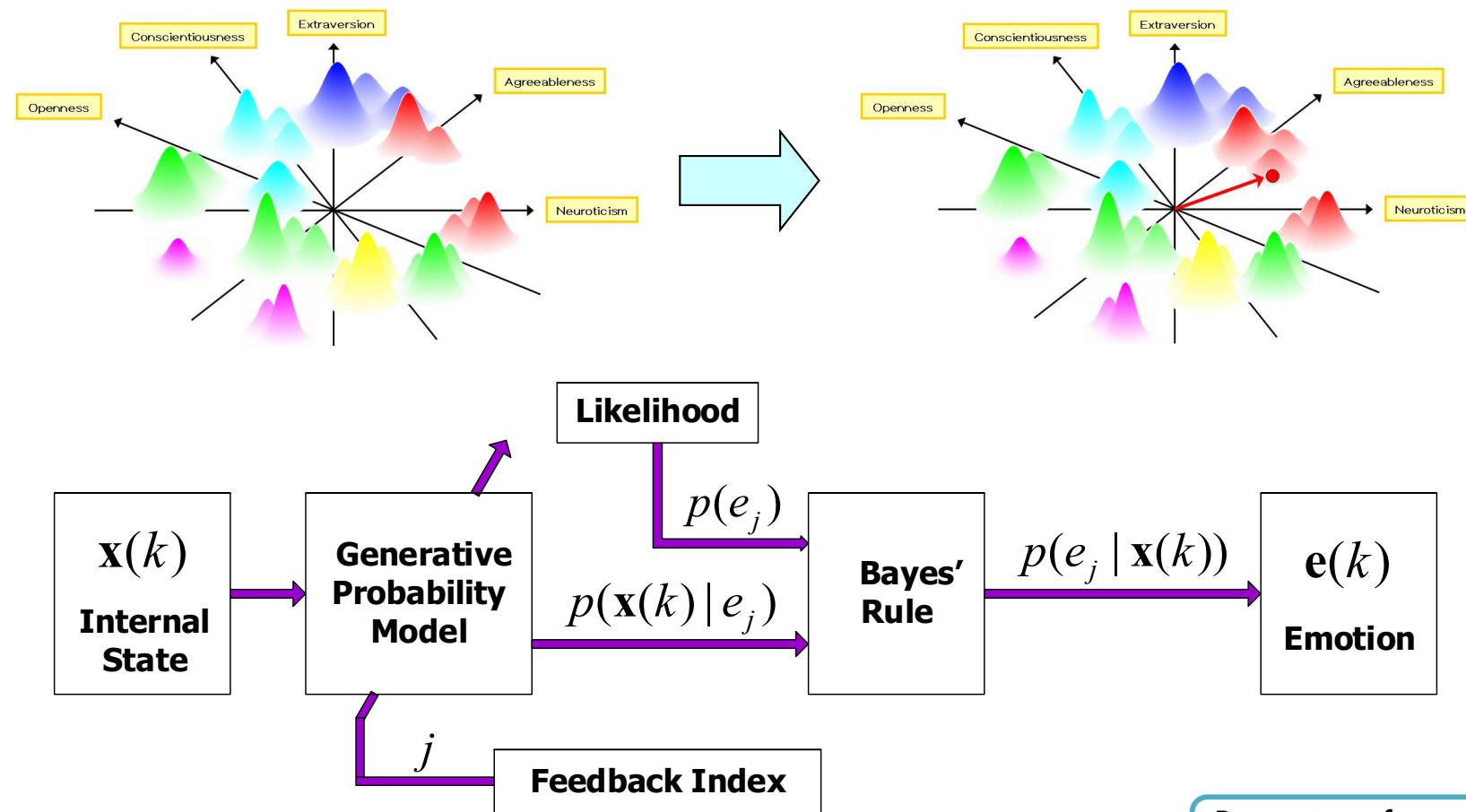
선호 별 성격

Category	Subject	Predicate	Object
좋아하는 일	철수(사용자)	의 성격은	많이 외향적 조금 신경질적
싫어하는 일	철수(사용자)	의 성격은	조금 외향적 신경질적

[Expression]

Robot's characteristics

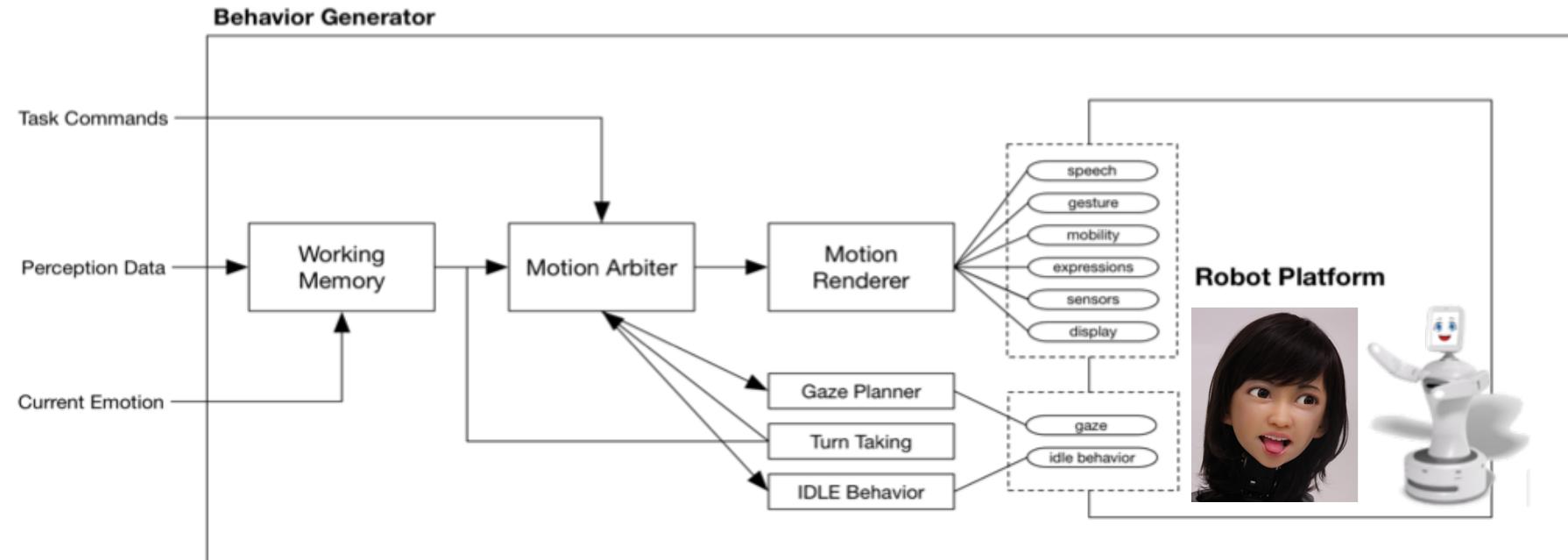
- 5 Factor model + GMM



By courtesy of
 Prof. Ho Seok Ahn, UoA

Robot's behavior generation

- Platform independent, multi-modal expression



<병원 내 안내 서비스>

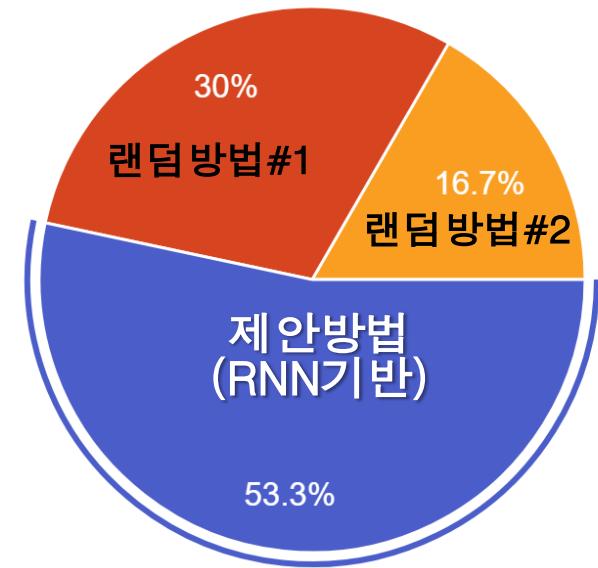
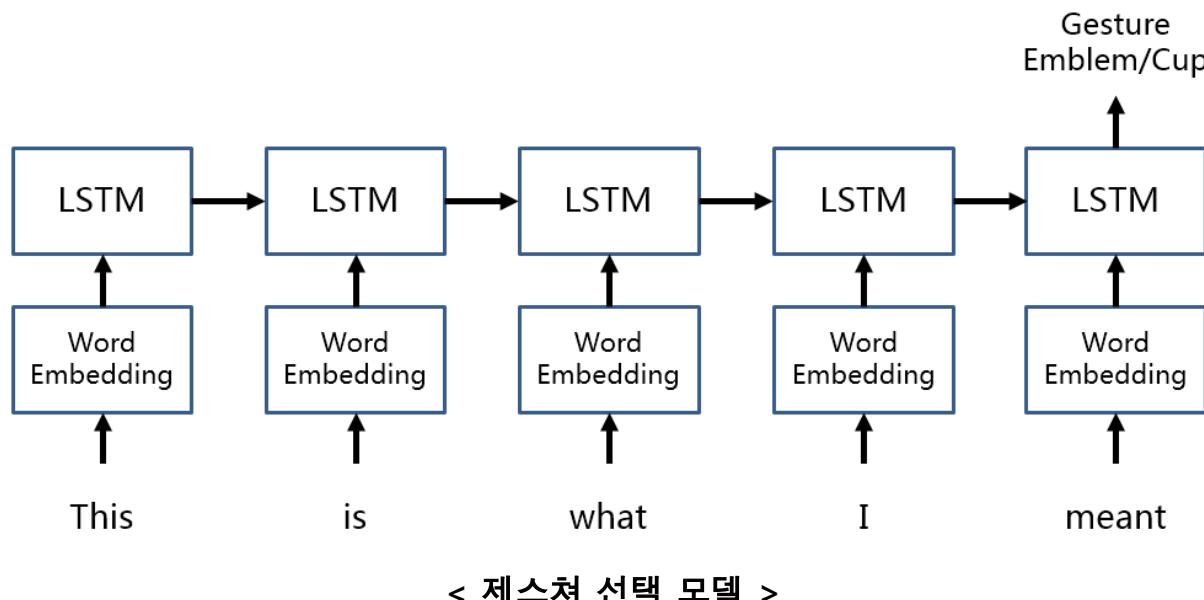
By courtesy of
Prof. Ho Seok Ahn, UoA

Speech-Gesture Behavior

대화 상황에 적절한 로봇 제스처 생성 기술 개발

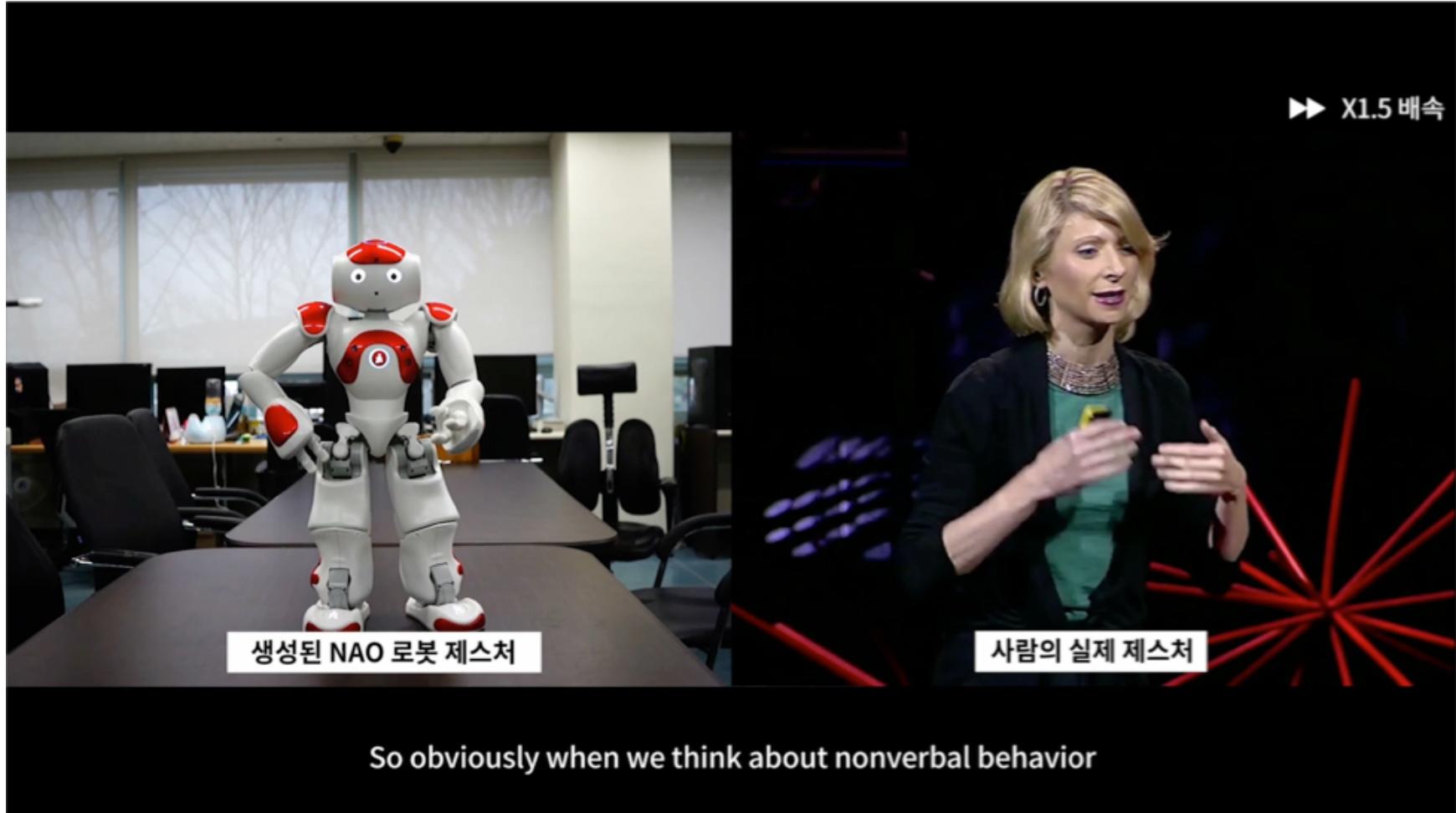
By courtesy of
Dr. Minsoo Chang, ETRI

- 로봇 제스처 생성 모델 설계 및 구현
 - Recurrent Neural Network 기반 제스처 분류 모델
 - 언어 해석을 위해 Twitter로부터 학습된 Word Embedding 사용
 - 수집된 TED 영상 및 자막으로 Network 학습
 - NAO 로봇에서 발화 문장에 대한 제스처 생성 시스템 개발
 - 31명을 대상으로 한 설문 평가 결과, 학습된 모델을 가장 선호 함 (학습된 모델과 랜덤 선택을 포함한 3개 모델 간 비교)



< 사용자 대상 평가 결과 (선호도) >

Speech-Gesture Behavior



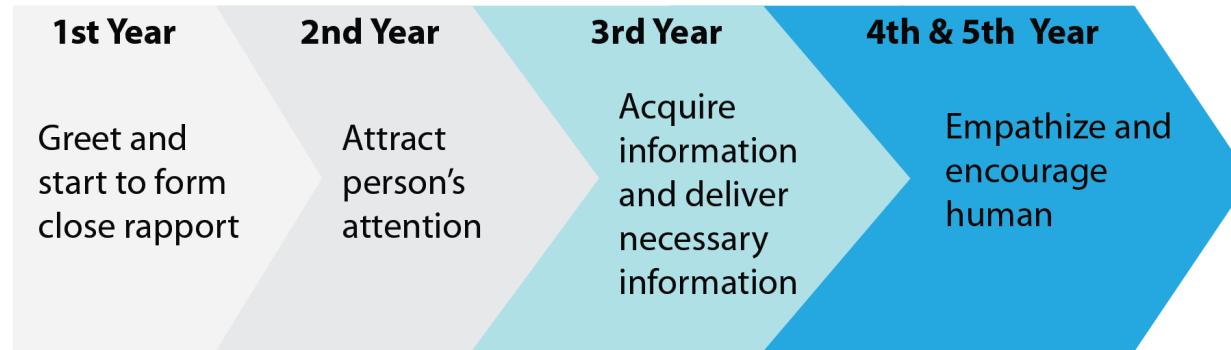
[Simple Integration]

Social HRI: *Encounter*



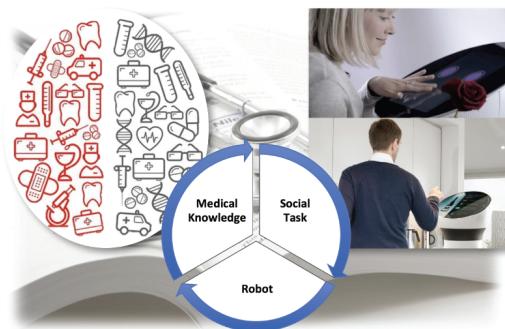
Project plan and applications (from *DeepTask*)

Project Plan



Social interaction applications

Healthcare service



- Deliver basic medical information to elders
- Understand the social relation with users especially with elder people

Reception service



- Reception service for department store, university library, etc

Conclusion

- **sHRI: HRI in the way of social acceptance**
 - ✓ Eye contact
 - ✓ Turn-taking by intention reading
 - ✓ Joint attention
 - ✓ Perspective-taking
 - ✓ Social navigation behaviors
 - ✓ Cooperative planning
 - ✓ Proactive behaviors to learn task semantics from demonstration
 - ✓ Emotional empathy or sympathy
 - ✓ ...
- **sRI (Social Robot Intelligence) is the key technology for sHRI**
 - ✓ Perception
 - ✓ Cognition
 - ✓ Expression
- **sDS (Social Domain Services) need to be set-up to show the necessity of sRI**
 - ✓ Healthcare service
 - ✓ Reception service
 - ✓ ...
- **Multi-disciplinary Research**
 - ✓ AI, Robot, Psychology, Human-Factor, UI/UX, ...

Thank You