

A Neurorobotics Approach to Investigating the Emergence of Communication in Robots



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RESEARCH OBJECTIVES

BUILDING AN ARTIFICIAL AGENT WITH COMMUNICATIVE SKILLS

BASED ON

- Stochastic Neural Dynamics
- Prediction Error Minimization (PEM)

KEY FINDINGS

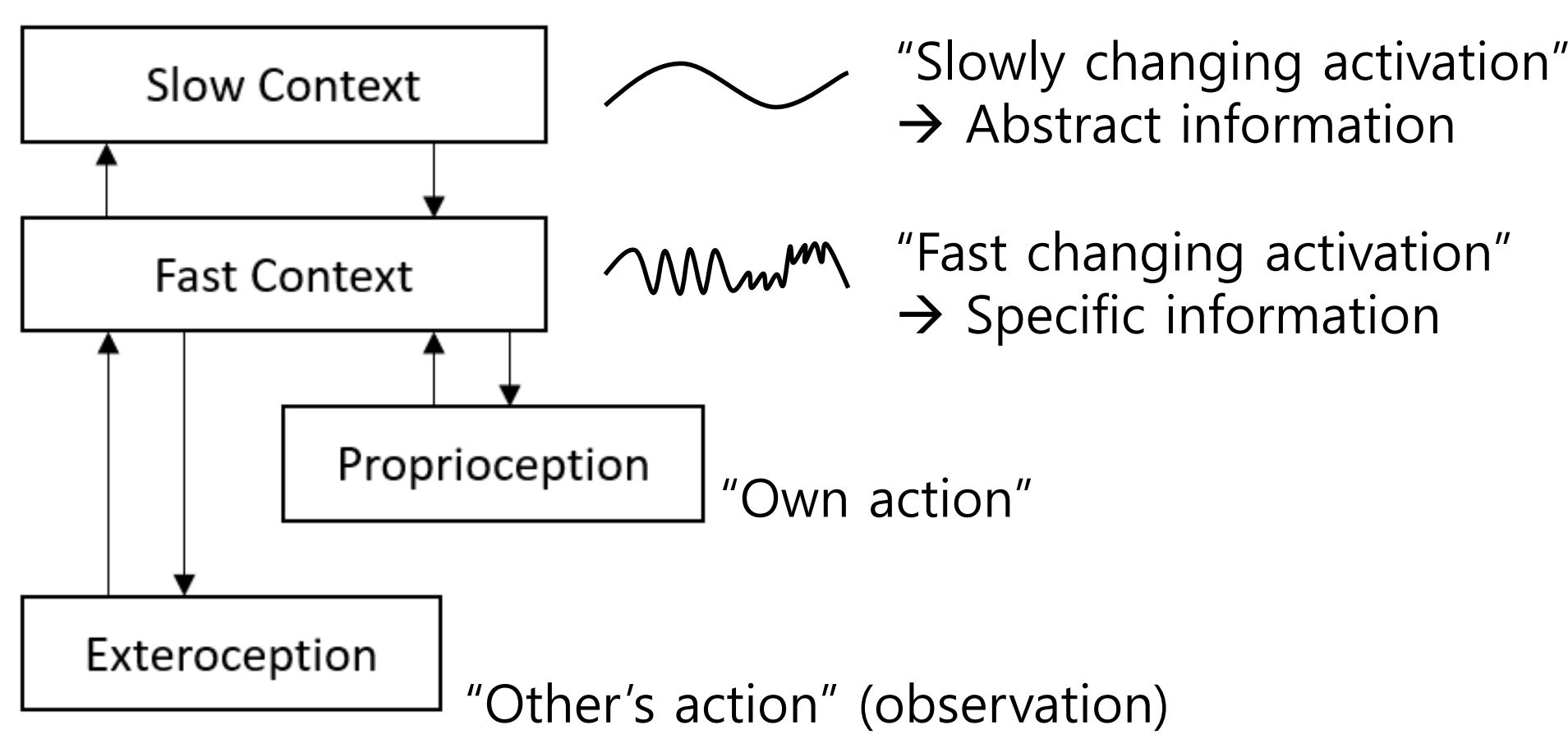
STOCHASTIC DYNAMICS IMPROVES GENERALIZATION

- Helps dealing with fluctuating communication patterns in HRI setting

PEM INDUCED EMERGENCE OF COMMUNICATION

- Intention recognition through PEM
- Emergence of communication between two artificial agents

HIERARCHICAL RNN (MTRNN)



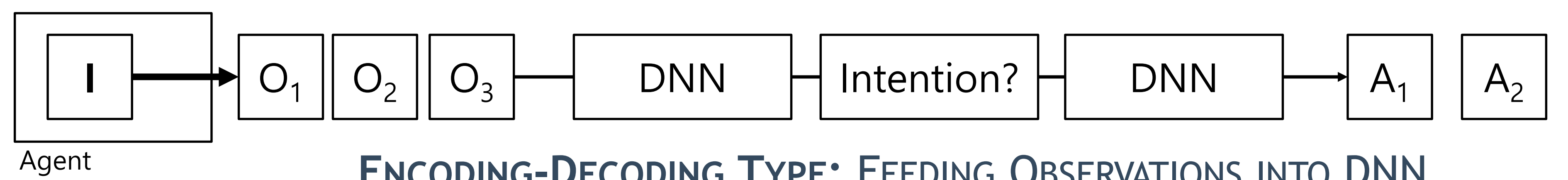
PREDICTIVE LEARNING

- Trained to predict next time step's Prop. & Exteroception

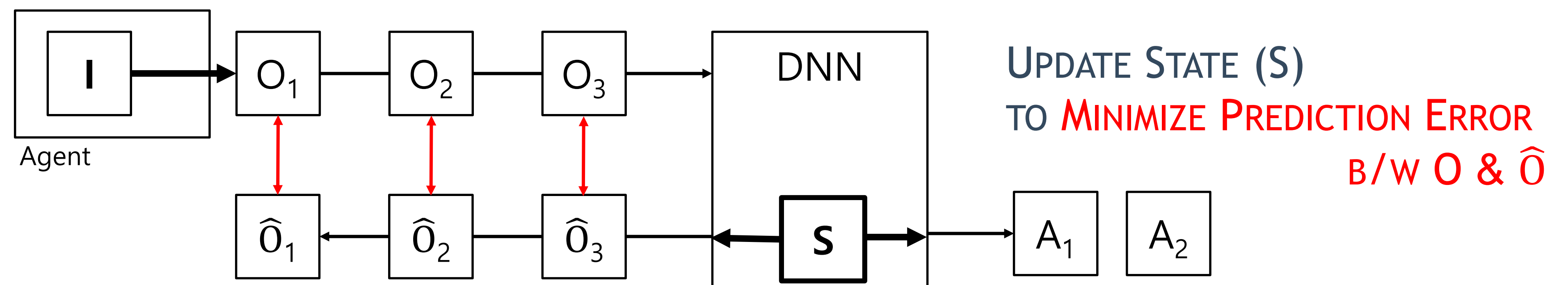
CONTROLLING LEVEL OF STOCHASTICITY

- For each context layer
- W : Higher \rightarrow More stochastic ($N(0|1)$)

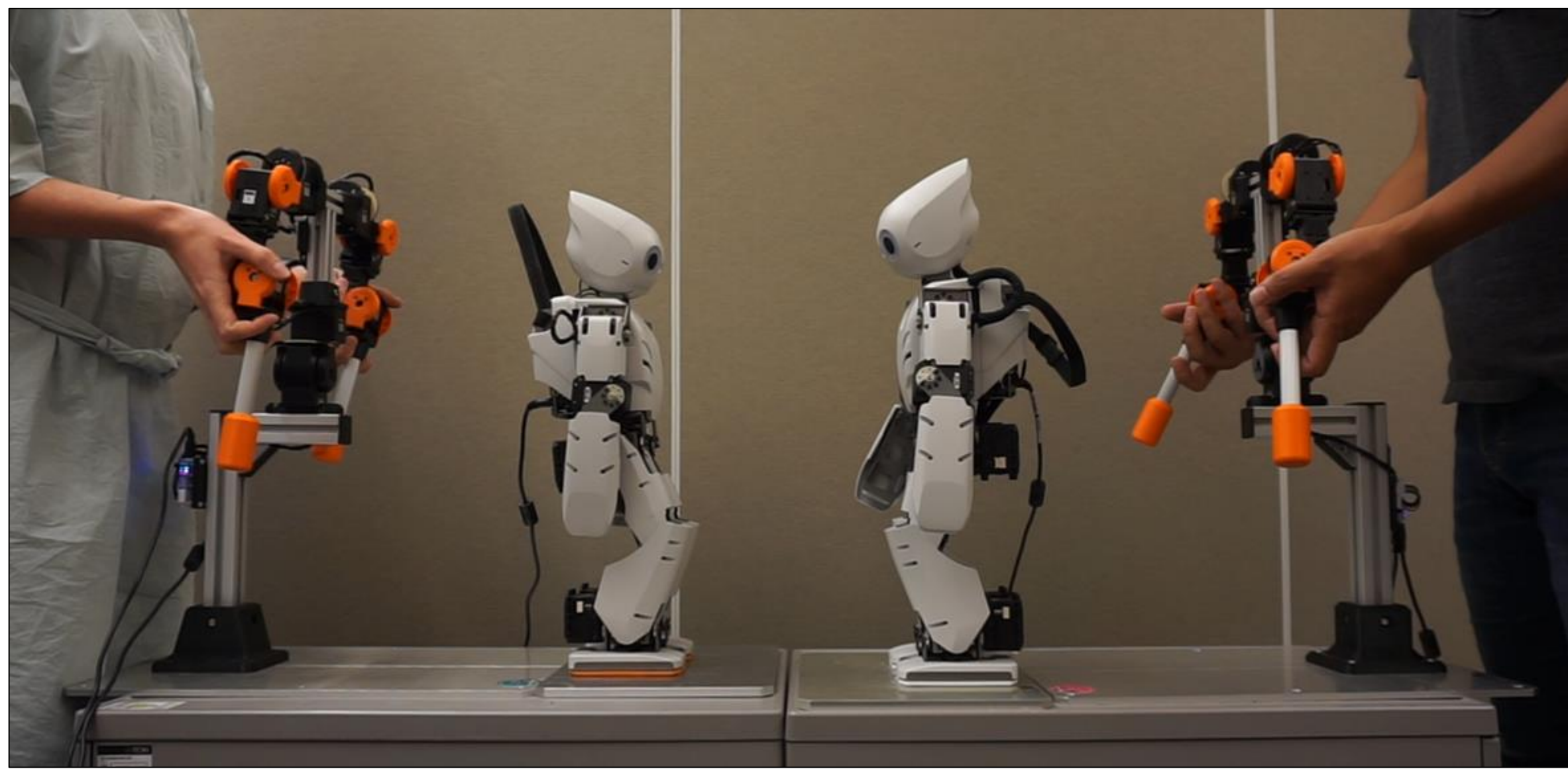
INTENTION RECOGNITION AS A CLASSIFICATION TASK



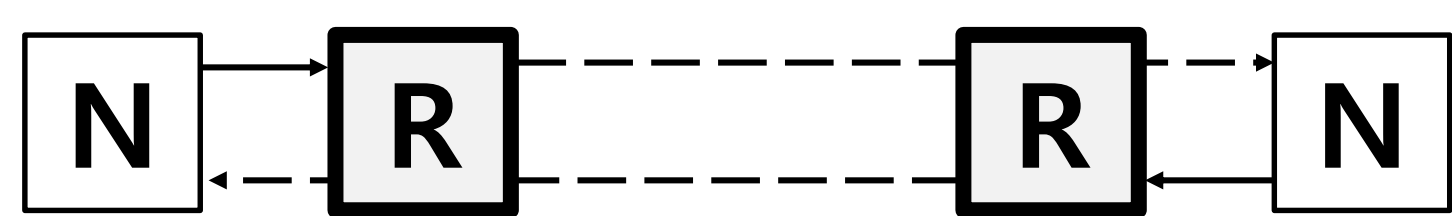
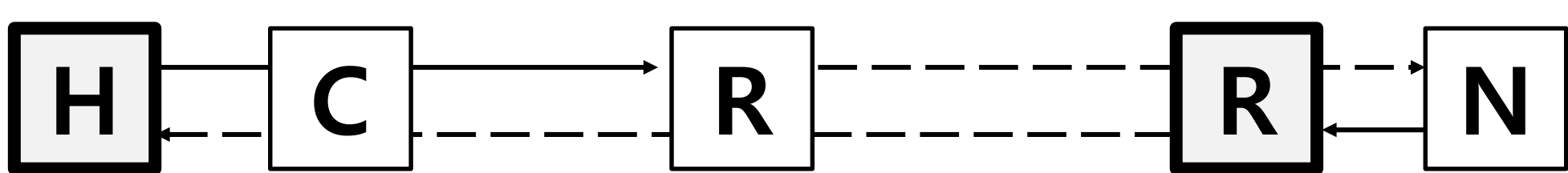
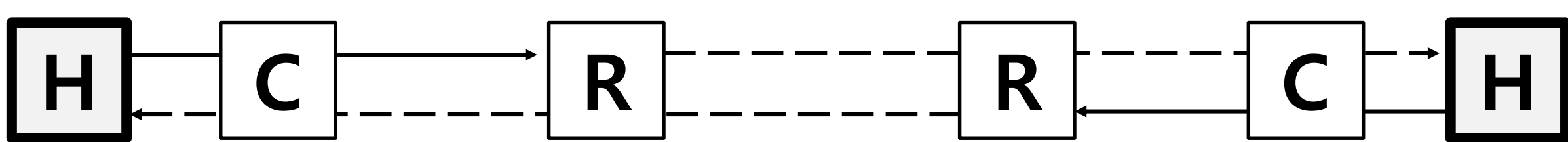
INTENTION RECOGNITION THROUGH PREDICTION ERROR MINIMIZATION



EXPERIMENT SETTING



- H** Human
- C** Controller
- R** Robot
- N** DNN



HHI. Data collection, robot as proxy

HRI. Imitation task b/w human & robot

RRI. Imitation task b/w robot & robot



Video

STOCHASTIC DYNAMICS

IMPROVES GENERALIZATION

TABLE I. THE IMITATION PERFORMANCE OF THE MODEL

		Network Conditions					
		(H) 0.0 (L) 0.0	(H) 0.0001 (L) 0.0001	(H) 0.01 (L) 0.01	(H) 0.01 (L) 0.0001	(H) 0.0001 (L) 0.01	
		ID	1	2	3	4	5
Short Data	NO PEM		0.48	0.65	0.67	0.66	0.68
	PEM		0.61	0.66	0.68	0.67	0.69
Long Data	NO PEM		0.55	0.68	0.69	0.68	0.69
	PEM		0.65	0.68	0.69	0.69	0.70

ESP. DETERMINISTIC HIGHER LEVEL
STOCHASTIC LOWER LEVEL

PEM INDUCED EMERGENCE OF COMMUNICATION IN RRI

