Pedestrian Meta-Strategy Analysis of Collision Avoidance with Two Autonomous Agents

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***Abstract*— In this paper, we have build an agent model that enables coordinated behaviors by estimating human intention. We have targeted collision avoidance as an example of a simple cooperative behavior. We have set two agents of Meta-Strategy model to a virtual environment SIGVerse. We have analyzed subject's walking trajectory, when the agents have different behavior strategies. It was confirmed that subjects switch their avoidance behaviors by strategies of agents. We believe that it is possible to realize the cooperative collision avoidance.**

Keywords— Meta-Strategy Analysis; Collision Avoidance; Virtual Environment;Walking Trajectory Analysis

I. INTRODUCTION

As robots spread in the home, it is thought that cooperative task of human and robot increases. To realize cooperative robots, it is necessary for the robot to estimate intention of human and take actions depending on the estimation.

Therefore, in this study, we aim at making an agent which enables a cooperative action by estimation the intention of human. Specifically, we took up collision avoidance as an example of cooperative task and analyzed the trajectory of human avoidance. We tested on SIGVerse [1] simulator and agents act according to Meta-Strategy [2] theory.

II. META-STRATEGY MODEL

We don't decide our behavior by looking others all the time. We show explicit action for example, when others intention is not clear. Meta-Strategy Model is one of internal model of human robots interaction process[2]. Meta-Strategy Model formulated passive and active strategy of action decision as a computational model.

We estimate other people intention first in passive. We decide own action to adapt other people purpose. Passive strategy is classified in some levels. Yokoyama defines a strategy level 1 that we decide own action by estimation of other people intention. The simplest strategy, decide own action with no estimation, is defined level 0 strategy.

On the other hand, we make sure of own purpose in active strategy. To achieve the purpose, we should choose the action which is the easiest to understand own intention. There are differences in action value for the purpose in each action. The differences let us choose the best action. In this strategy, we will not change own objective, so the strategy is defined level 0* because it's considered as improved strategy of level 0.

Between these strategies, there is difference in usage of the state action value function. By applying the function to the state of opponent, we estimates opponent intense. Meta-Strategy is an overarching strategy determining which strategy to use in a given situation.

III. COLLISION AVOIDANCE EXPERIMENT BASED ON META-STRATEGY MODEL

In this study, we analyze human behavior when they interact with an agent based on Meta-Strategy model. We examined 3 subjects who are 20s.

Subjects avoid two agents in SIGVerse simulator. SIGVerse is a simulator that combines dynamics, perception and communication simulations for synthetic approaches to research into the genesis of social intelligence. Subject's movement is reflected in the virtual space by motion capture (Opti Track Trio). Virtual subject's sight is showed by head mount display (Video Eye-wear Wrap1200).Vertical field of view is 45 degrees, and horizontal is 70 degrees.

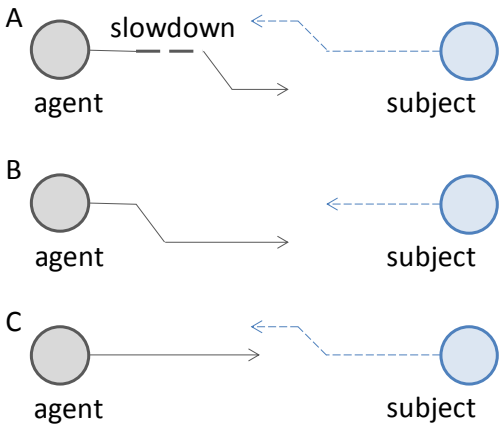

Fig. 1. Movement according to Meta-Strategy Model (A: passive strategy, B: active strategy, C: simple strategy)

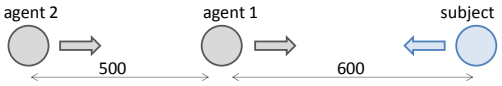

Fig. 2. Initial coordinates of subject and agents

Wheel robot model is used as agent. Each agent movement was selected by 3 strategies (passive strategy, active strategy and simple strategy) (Fig. 1). In passive strategy, agent becomes slow to show the agent is waiting. After subject's avoiding, agent changes direction. In active strategy pattern, agent changes direction before subject's movement for avoiding agent. In this experiment, agent changes direction when the distance between a subject and agent becomes 500 in SIGVerse. In simple strategy, agent goes straight on regardless of the subject's action. In this strategy, subjects should avoid agent.

In previous study[3], subjects don't have to switch own strategy. In this study, we prepared two agents in SIGVerse. Each agent takes the 3 pattern. So, pair of the agent strategies has 9 patterns. But we excluded patterns "both agents have simple strategy" and "both agent have passive strategy" because a problem like previous study occurs in these patterns.

Figure 2 shows initial coordinates of subject and agents model in simulator. Value is distance in SIGVerse coordinate space.

IV. Result

Table 1 shows subject's avoidance and relative distance at avoiding timing toward agent 2 when agent 1 takes active strategy. All subjects avoid the least distance in active strategy agent 2.

We compare two relative distance about each subject. One is "distance to passive strategy agent 1". The other is "distance to passive strategy agent 2 with active strategy agent 1". Distance to agent 2 is bigger than distance to agent 1 for all subjects. For example, subject 1's relative distance for agent 1 was 373.62, for agent 2 was 427.45. It is similar about simple strategy.

All value is average of 3 trial.

V. Discussion

By difference of strategy of agent 2, subjects change their behavior. We speculate that subjects switched their strategy toward passive and simple agent.

The subject took longer relative distance for agent 2 than agent 1 when agents have passive and simple strategy. We think the reason why it is subject's estimation of agent 1 strategy affected estimation of agent 2 strategy.

It was revealed that all subjects didn't recognize agent becomes slow from an interview. But there are difference between subject's distance toward passive agent and simple agent. The strategy might not be switched consciously.

VI. Conclusion

We have experimented collision avoidance between human and agents in virtual environment.

In collision avoidance, we reported that agent movement based on Meta-Strategy can affect subject's decision of strategy. However, it's not clear whether it was conscious. We are planning next experiment that subject can recognize agent passive strategy.

References

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TABLE I. SUBJECTS' AVOIDANCE AND RELATIVE DISTANCE TOWARD AGENT 2

Strategy of agent 2	**Active strategy**	**Passive strategy**		**Simple strategy**	
	Avoidance distance	***Avoidance distance***	***Relative distance***	***Avoidance distance***	***Relative distance***
Subject 1	11.63	45.53	427.45	55.01	362.25
Subject 2	17.77	33.07	443.65	44.07	406.92
Subject 3	10.32	35.41	418.87	39.95	447.04

SIGVerse coordinate space value