Convergence at Prominent Agents: A Non-Flat Synchronization Model of Situated Multi-Agents (Short Paper)

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ABSTRACT

This paper presents a novel *non-flat* synchronization model where the synchronization capacity of each agent is different regarding its social rank and strategy dominance. In the presented model, the prominent agents may have higher synchronization forces, and finally the collective synchronization results may incline to converge at such prominent agents' strategies, which is called *prominence convergence in collective synchronization* and proved by our experimental results. The presented model can well match the peculiarities of real multi-agent societies where each agent plays a different role in the synchronization, and make up the restrictions of related benchmark works that only concerned about the *flat* synchronization.

Categories and Subject Descriptors

I.2.11 [**Distributed Artificial Intelligence**]: Multiagent Systems.

General Terms

Theory, Design, Performance.

Keywords

Multiagents, Collective Synchronization, Convergence, Prominence, Field Situated Agents.

1. INTRODUCTION

The collective motion of multi-agents has been achieving much attention in many research fields [1][2][3][4][5][6][7]. In the collective motion, each agent can select any arbitrary initial strategies to behave; but with the time going, there always emerges a popular phenomenon that most agents may converge on certain behavior strategy finally, which is called *collective synchronization*.

The related works about the collective synchronization of multi-agents always follow several assumptions. First, the collective synchronization is flat, i.e., the effects of all agents in the synchronization are identical and all agents have the same synchronization capacity, and no preferred agent strategy is picked out a priori in the model [4]; second, the collective synchronization is implemented by locally neighboring imitation of individual agents: each agent acts solely on the basis of its own local perception of the world and imitate the average strategy of its neighbors [1][3][6][7]; third, the synchronization result is the convergence on a common average strategy: at last all agents' strategies will always converge to a common average strategy of the system [7].

However, in many circumstances the above assumptions do not match the peculiarities of real multi-agent societies. First, the social ranks of agents and the performances of agent strategies are always different from each other in real multi-agent community, so different agents may have different synchronization capacities and some agent strategies may be preferred due to their characteristics or their adopters' rankings in the collective synchronization [8][9]; second, in the collective synchronization, the individual agents may sense the influences from the agents in the global contexts as well as the local neighbors, so agents will make trade-off between the influences of the local neighbors and the ones of the global counterparts [10]; third, in reality, the agents sometimes may not converge to the common average strategy of community, e.g., the collective synchronization results may converge at more than one special strategy since those strategies are dominant and influential [8].

To make up the restrictions of three assumptions in the related work about collective synchronization, we present the concept of *non-flat collective synchronization* in this paper, i.e., the effects of all agents and strategies are different in synchronization, and the synchronization result does not merely converge on a common average strategy simply. In our model, the synchronization capacity of each agent is determined by its social rank and its strategy prominence; an agent may sense the synchronization forces not only from its neighbors but also from other agents in the synchronization field.

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Moreover, with our model, we find an interesting phenomenon that is always seen in real multi-agent societies: if some agents' social ranks are higher than the ones of other ordinary agents, or their behavior strategies are more dominant than the ones of other ordinary agents, then the collective synchronization results may converge at such prominent agents' strategies, which is called *prominence convergence* phenomenon in this paper.

2. MULTI-AGENTS SITUATED IN A SYNCHRONIZATION FIELD

In this paper, we let all agents be situated in a collective synchronization field by referring the idea of field-based coordination [11][12.

A strategy is the action that agent adopts to behave in the multi-agent society. For example, in a flock of birds, the flying direction and velocity is the strategy of a bird. In this paper, for the reason of simplicity, we define the strategy as a simple natural number; moreover, we assume that the higher a strategy value is, then the more dominant such strategy is in the collective synchronization.

In the community, to achieve a harmonious collective motion, the agents will coordinate to synchronize their strategies. In this paper, we let the collective synchronized agents be situated in a synchronization field.

Definition 1. *A collective synchronization field of multi-agents* is a tuple $<Z, A, D, C, U>$, where:

1). Z denotes a two-dimensional geographical zone where the multi-agents are situated. $Z=\{(x,y)\}|\ _1\ x\ \ _2,\ \ _1\ y\ \ _2\}$, where $_1$, $_2$, $_1$, $_2$ prescribe the scope of agent locations.

2). $A=\{a_1, a_2, \ \ , a_n\}$ denotes the set of agents, where n is the number of agents.

3). D: $Z \times A\ \ \{true, false\}$ is a mapping from the geographical localities to the agents, which denotes the geographical distribution of the agents, e.g., if the mapping value from (x_i,y_i) to a_i is true, then it shows that there is an agent, a_i, which locates at the place of (x_i,y_i).

4). C: $A\ \ \mathbb{R}$ is the set of agent synchronization capacities, $C=\{c_1, c_2, \ \ , c_n\}$, where c_i denotes the synchronization capacity of agent a_i in the field, which is a real number.

5). U: $A \times Z\ \ \mathbb{R}$ is the agent synchronizations force function, which denotes the synchronization force of each agent at different place of the field, which is a real number.

In the system, each agent has different social rank. The agents with different social ranks in the system may take different effects; the superior agents may easily influence the strategies of junior agents.

Definition 2. *Social ranking of agent* a_i can be a function: $p_i\ \ \mathbb{R}$, $p_i\ \ p_j$ denotes that a_i has superior rank to a_j. The set of the social ranks of all agents in the system can be denoted as: $P=[p_i]$, where $1 \le i \le n$, and n denotes the number of agents in the system.

Definition 3. *Synchronization capacity of individual agents*. Obviously, the higher an agent's social rank is, then the more capable that such agent will take effect in the collective synchronization; on the other hand, according to our assumption in this paper, the higher a strategy value is, then the more dominant such strategy is in the collective synchronization. Therefore, the synchronization capacity of an agent is determined by its social rank and strategy together. Let s_i denote the strategy of agent a_i, p_i denote the social rank of a_i, A denote the set of agents in the field, then the synchronization capacity of a_i, c_i, can denote the set of agents in the field and s_i be the strategy of agent a_i, then the strategy prominence degree of agent a_i is defined as:

$$_i \quad \frac{1}{\frac{1}{|A|}{}_{j \quad A} s_j}(s_i \quad \frac{1}{|A|}{}_{j \quad A} s_j)$$

ordinary agents after the synchronization; thus the ordinary agents always incline to imitate the strategies of prominent agents, and the prominence convergence phenomenon emerges finally.

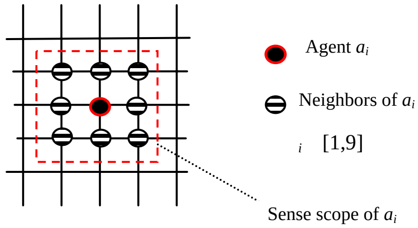

Figure 1. The sense scope of agent while sense radius is 1

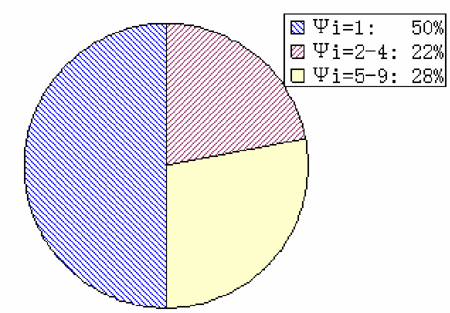

Figure 2. The ranks of convergence degrees for prominent agents in the sense scopes

5. CONCLUSION

This paper presents a non-flat collective synchronization model for multi-agents, which can make up the restrictions of the related works: 1). Each agent may have different synchronization capacity regarding its social rank and strategy; 2). Each agent may sense the synchronization forces from the scope more than the closest neighbors; 3). With the synchronization, more than one final strategy value may be converged. With our presented model, the agents always incline to converge on the prominent agents' strategies in the collective synchronization, which is called prominence convergence phenomenon.

The experimental results prove the correctness of our model; through the experimental results, we can see that the prominent agents generally have higher convergence degrees than other ordinary agents.

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