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Research on the Fish Behavior Simulation based on Swarm Intelligence

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Abstract

Swarm intelligence is an intelligence emergent phenomenon aiming at the interaction of the simple intelligent individuals of nature biological groups having complex intelligent behavior. The vector model is based on the multi-Agent fish swarm environment, and the main body and the behavior regulation has been established in the article during the analysis of school fish moving, looking for food and so on, and the complex behavior of fish swarm under the joined conditions, such as food, fishhook, predator, and reproduction and so on, is studied by using the emulation technique.

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Keywords: Swarm intelligence, Fish swarm behavior, Agent, Simulation formatting

The research on swarm intelligence theory has appeared since the 1980s and has obtained more and more attention as an emerging domain. The swarm intelligence mainly studies the group behavior of the group living creatures such as ants, birds and so on. Being inspired by the intelligent phenomenon of group behavior in natural biology community, it is a specific research pattern studying the simple biological community's intelligence, namely the characteristic of the simple intelligent individual displaying the complex intelligent behavior through interaction [1].

In view of the formation of fish swarm, and its structure and behavior, the researchers have advanced some theories and models from different angles. Some researchers devote in the research on how the fish swarm carries on the cooperation to escape danger and to prey by interacting with their neighbors. Partridge has proposed that from the partial angle, fish sense the neighboring fish's movement through vision, and change their own movement according to this information. Niwa regards the formation and the structure of the fish swarm as an interactive granule system, and describes individual fish with Langevin's equation. Simon Hubbard thinks that the fish swarm is an interacting self-organized granule, and the individual fish is controlled by two factors (one is imitating the movement of other fish in neighborhood; the other is the influence of external environment). Breder defines the fish swarm as a kind of specific moving state of fish, and each of the school goes toward the same direction at a unified speed. He thinks the factors that decide the mutual individual distance of the fish swarm are that when the distance is bigger than the marginal value, attraction is shown while when it is smaller repulsion. Steven researches the influence of the quantity to fish swarm behavior and the interaction between individual fish.

This article studies the group behavior of fish swarm through the multi-Agent system in which the individual fish is regarded to be Agent, and the fish swarm is a multi-agent system. Agent can sense local environment and information in the field of vision scope, thus making a decision to instruct its motion [2].

1. The analysis of the flock behaviour of fish swarm

The behavior description of the fish swarm is composed of the environment, the main body and the behavior rule, mainly including food, fishhook and the two kinds of fish. The environment is the space of individual existence in which the agent

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moves and collects resources (food) [3]. The total sum of the individual constitutes the community object of the research. The individual's evolutionary process is controlled by its behavior rule. The behavior rule has decides the interacting methods between the individuals and between the individual and the environment. The individual survives depending on food resources and the consumption of its own energy. At any time there always is a set position for the individual in the environment.

The position is determined by the direction it occupies [4]. Since the individual of the community intelligence research only has simple intelligence or does not have intelligence at all, their ability to sense the environment is very limited, therefore the individual should also have certain perception area, in which each individual can sense other individual's acting situation as well as the resources distribution in the environment and knows nothing outside the perception area [5]. The individual collects resources to prepare for energy consumption in the future. The individual may die of hunger or may be fished by fishhook and dies (ordinary fish are also possibly preyed on by others). Between fish swarm, they interact according to the respective behaving rules, hence creating a macroscopic phenomenon and result. The relationship between various main bodies interaction can be shown in Fig 1.

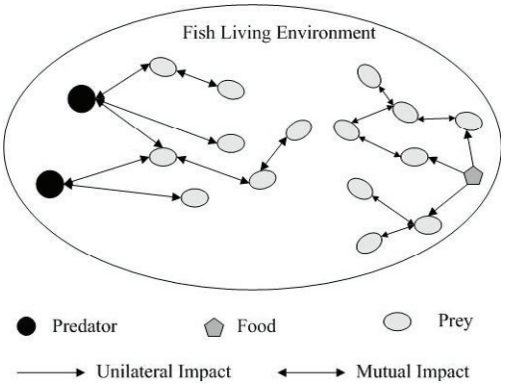

Fig.1. Fish living environment

2. The description of the behavior of fish swarm in their environment

When the simulation is carried on by the computer to study the behavior of fish swarm, the activity environment of fish swarm may be defined as a limited two-dimensional surface region, using reflective boundary, to which the fish tours to and then bounces back. The concrete environment description is like the following: in a two-dimensional flat world constructed by width and length, a series of movement spot replaces the individual fish through the contact surface on computer. When the parameters of coordinates, speed, and so on are established for those movement spots, the real fish can be mapped in the virtual environment, and then it is possible to describe the fish swarm individually to move about and seek food in this region.

The description of the position and the direction of individual fish swarm are as follows:

$$\begin{cases} v_x = v \cdot \cos(direct) \\ v_y = v \cdot \sin(direct) \end{cases} \qquad \begin{cases} x' = x + v_x \\ y' = y + v_y \end{cases} \tag{1}$$

Here v_x is expressed as the individual velocity component in the direction of x, v_y is expressed as the individual velocity component in the direction of y, direct is expressed as the swimming direction, namely the included angle of the swimming direction and x axis. (x, y) is expressed as the coordinate of target location.

The simulation environment on computer also includes information of food, bait and so on. This kind of information may be stored by defining an array variable world[x] [y]. World[x][y]=0 expresses this spot has no element, world[x][y]=1 expresses this spot is food, world[x][y]=2 expresses this spot is bait.