The general rules should include the fact that the elements of the text constructs do not use special characters if their application not stated in special agreements for the interpreter.

VII. CONCLUSIONS

Design of model of behavior of a control system is a first step to achievement of a goal. And if when performing this work it is possible to reach reduction of quantity of mistakes of "a human factor" and it can happen only at introduction in process of design of formal language to high extent of visualization, as shows the solution proposed in article.

As the created model has all signs of a scripting programming language that obviously that with use of such representation of model of behavior it is possible to check correctness of implementation of key decisions in a control system.

When obtaining such conclusion, it is possible to start the following phase of implementation of the project – generation of a code of the operating program according to the formal description of model of behavior of a control system.

It is supposed that the solution proposed in article will allow to introduce new approaches to design of the software of control systems, and it will allow to reduce significantly as terms of performance of work, and will increase reliability of a created product.

References

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REVIEW OF GROUP CONTROL ALGORITHMS

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Problem of distributing task between some systems and coordination interaction this systems is actual problem. In this article will review main methods of task distribution between different system elements and adjustment interaction these elements.

algorithm; behavior; swarm; multiagent system

I. MAIN TERMS

Agent – it is object that solves narrow range of specific tasks. In this role can be: processor, microcontroller, computer, robot and other. Typically, single agent performs a specific simple operation. For example, defining readings of sensor and sending these

data in machining center (usually, other agent); monitoring perimeter, limited by means of technical vision; transportation object on a given route; other tasks.

Multiagent system – it is system, that consists from several interact agents. This system can solve difficult tasks, by distributing these tasks between agents. Examples these tasks are: machining information, which receive from several remote sensors, and decision-making based on this information; monitoring area beyond the capabilities of means of technical vision of single agent, and coordination agents, which perform monitoring different parts of this area; other tasks. Main difficulty in designing of the multiagent system is development and realization effective algorithms of interaction of agents, which lead to effective solution of the whole task. In this article will review several approaches to designing of such algorithms.

Static multiagent system – it is multiagent system, whose architecture and configuration does not change during system work. Such system is designed once in case of implementation. Subsequently, changes of systems are minimal and, typically, not effect the system architecture.

Behavior of static multiagent system is deterministic and defines by precise rules. In case, when system make management decision, use heuristic algorithms and/or neural networks. However, one must understand, that these algorithms uses for controlling of small number (in most cases, one) of agents from whole system. Behavior of other agents is strictly deterministically.

Such systems well suited to manage system, working in static environment. For example, monitoring system the technically complex object (manufacturing, nuclear power plant, other).

Static multiagent systems poorly suited for cases, when system working in little-known and unpredictable environment. Of course, such systems uses for research unknown area (for example, American system MSSMP or Israeli system Avantguard). But, such system capabilities in these cases are severely limited, versus capabilities of dynamic multiagent systems.

Dynamic multiagent system – it is multiagent system, whose architecture and configuration continuously changes during system work. In such systems, connections between particular agents has temporary nature. Behavior of such system has random nature and defines with help behavior algorithms.

These systems well suited for work in unknown, unpredictable and ever-changing environment. However, It are ineffective during work in static conditions, when changes of environment are minimal.

"Collective" – it is multiagent system, in which every agent "know" about other agents in same system.

Main advantage of "collective" is deterministic behavior. Typically, all connections between agents in "collective" defined and debugged on design and implementation

stage. Agents in "collective" guided by simple and strict rules. Their behavior is strict documented and predictable.

Main disadvantage of "collective" is difficulty of maintaining base of "friends" in actual condition in memory of every agent. In ever-changing environment it is difficult. Similarly, there is problem of adding new agent in "collective". "Newcomer" must become acquainted with all other "members of collective".

Therefore, "collective" model used in designing of static multiagent systems.

"Swarm" – it is multiagent system, in which every agent "familiar" only with small count of other agents of same "swarm". For example, if "swarm" consists from N agents, then every agent in this "swarm" does not "familiar" with N-1 agents (like in "collective"), but it "familiar" with M agents; at that $M < N-1$.

Agents, with which concrete agent A is "familiar", will call "friends" of agent A. Necessary understand, that during work of "swarm", amount and composition of "friends" for every agent in "swarm" ever-changing.

Idea of organization agents in "swarm" taken from wildlife. Therefore, many behavior algorithms developed by monitoring the swarms, flocks, colonies, shoals. Examples of such algorithms are SWARM (also known as "birds"), formic algorithm, bees algorithm and other.

Main advantage of "swarm" is it's dynamism. Behavior of agents in "swarm" has random character. Therefore, behavior of whole "swarm" also is random and unpredictable. It allow use "swarm" for solve tasks, initial data in which is contradictory and insufficient for solve task with help deterministic algorithms (for example, with help "collective"). Example of such task is task of research unknown area.

Other advantages of "swarm" are its resistance to failure of one or some agents (other agents does not "notice" the disappearance of "friends", because does not keep a list of agents in "swarm", so it occurs in "collective") and scalability (ability to easily add new agents in "swarm").

Inapplicability of "swarm" for solve a number of problems, for which already developed deterministic algorithms, is consequence of random behavior of "swarm". Examples of tasks solved with help "swarm" are: patrolling the area, research unknown area, search in little-known area, other tasks. Examples of tasks, in solving which "swarm" is inapplicability, are: accumulating and machining information, which receive from several remote sensors; manage complex system consisting from several interact subsystems (for example, manage the robot, machine); monitoring and control of production processes; other tasks. System, developed on base of "collective" model, more effective solves such tasks.

Therefore "swarm" model applicability only for organization dynamic multiagent systems.

II. "COLLECTIVE" MODELS

Logic of agent behavior in "collective" determined by list of challenges facing the "collective" and architecture of "collective". The most widely used architectures are centralized and hierarchical architectures. It show on picture below.

Simple static multiagent systems developed on base of centralized architecture. For complex systems use hierarchical architecture.

Main feature of these architectures is availability of main agent, which responsible for management all other agents.

III. "SWARM" MODELS

In this part enumerate main "swarm" algorithms. They are rarely used in its pure form. In most cases use different combinations of these algorithms.

A. SWARM algorithm

This algorithm was formulated by Craig Reynolds for definition of birds behavior in flock. Behavior of every bird in this algorithm must comply with three rules.

1. Rule of separation: every bird must try to avoid a collision with other birds.
2. Rule of alignment: every bird must move in the same direction as nearby birds.
3. Rule of solidarity: birds must try move the same distance from each other, moving to mass center of flock.

Computer modeling of flock behavior, managed by these rules, performed by Reynolds, showed that it is similar to behavior of bird flock.

Advantages of algorithm.

1. Simple logic of separate agents.
2. Equivalence and interchangeability of agents.

Disadvantages of algorithm.

1. Lack of leader in swarm leads to difficulty of managing move direction of swarm.

Need to monitor position of mass center of swarm. It is difficult if swarm consist from many agents.

B. Formic algorithm

Initially, ants move in random direction and, finding food, return to their colony, paving the pheromone trail. If other ants find such trails, they will go on these trails. Instead of storing trail, ants strengthen trail, if they find food. Pheromone trail eventually evaporates and its attractive force weakens. The more time needed for traversing the path to the target and back, the stronger evaporate pheromone trail. For short trail, traversing the path will quicker and, whereupon, pheromone density remains high. Thus, when ant find short way from colony to food, other ants will go to this way and pheromone trails leads all ants to shortest way.

This algorithm used for searching some resource (food, in case of ants) in unknown environment. For its adaptation to task of bypass area propose following changes.

- Ants do not return to colony, but keeps a given distance from colony.
- Ants move in random direction.

These changes help achieve "swarming" ants in place.

Advantages of algorithm.

1. Equivalence and interchangeability of agents.
2. Simple logic of separate agents.
3. Simple scalable.
4. For estimate the distance to colony separate agent must evaluate the distance to their "friends". It's easier, than tracking position of colony mass center, as in case of SWARM algorithm.

Disadvantages of algorithm.

- Lack of leader in colony leads to difficulty of managing move direction of swarm.

C. Bees algorithm

Initially, from hive in random direction takes few bees, which search areas having nectar. After returning in hive, these bees tell other bees about position and amount of nectar. Thereafter, other bees fly to these areas. More than a predetermined area expected to find nectar, the more bees flies to the area.

This algorithm, as well as formic algorithm, used for searching some resource (nectar, in case of bees) in unknown environment.

Advantages of algorithm.

1. Equivalence and interchangeability of agents.
2. There is no need to track position of colony mass center, as in case of SWARM algorithm.
3. Simple scalable.

Disadvantages of algorithm.

- Lack of leader in colony leads to difficulty of managing move direction of swarm.

D. Movement algorithm shoal of fish

This algorithm was proposed by B. Filho and L. Neto in 2008.

Movement fish shoal determined by activity of more purposeful zooids. If they move somewhere, then their "friends" can move with them. This movement can cover the entire shoal.

This mechanism is fairly balanced. As rule, zooid just having escaped from shoal, immediately return to it.

Advantages of algorithm.

1. There is no need to track position of colony mass center, as in case of SWARM algorithm.
2. Simple scalable.
3. Ability to easily control the direction of movement of entire shoal.

Disadvantages of algorithm.

- Lack of uniform distribution of agents in the study area.

E. Fireflies algorithm

This algorithm was proposed by X. Sh.Yang in 2007.

All fireflies attract each other. Attractiveness of firefly is proportional to its brightness. Less attractive fireflies move to more attractive fireflies. Brightness of firefly for other glowworm decreases with increasing distance between them. If firefly do not see more bright firefly than it, then it move in random direction.

Advantages of algorithm.

1. Equivalence and interchangeability of agents.
2. There is no need to track position of colony mass center, as in case of SWARM algorithm.
3. Simple scalable.

Disadvantages of algorithm.

1. Lack of leader in colony leads to difficulty of managing move direction of swarm.

PATHFINDING ALGORITHMS EFFICIENCY ESTIMATING IN DISCRETE LABYRINTH BASED ON SOFTWARE SIMULATION

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Abstract – This article continues the research, started in the first article – «Strategy of analyzing most common algorithms for path finding in discrete labyrinth using software statistic data collector» [1]. It is dedicated to experiment's overview and summarizing its results. The common structure of the experiment, its stages, collecting data and methods of its processing are described. The main conclusions are made at the end of this article.

Keywords – algorithms, maze solving, data analyzing, software simulation

I. INTRODUCTION

Statistics was collected via special simulation software, previously described in the first article. It was improved in ways of usability, results' displaying, but not in way of changing calculation methods, described in the first article [1]. The detailed description of the software will be given below.

II. SOFTWARE DESCRIPTION

The software, used in the experiment, is meant to be run on Microsoft Windows • platform. It is a sort of «sandbox» for creating two-dimensional discrete labyrinths