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Extended Abstract Open Access

Towards Global Nanosystems Under High-Level Networking Technology

Peter Simon Sapaty

Institute of Mathematical Machines and Systems National Academy of Sciences, Ukraine

The paper describes high-level distributed simulation and control technology based on parallel navigation of physical and virtual worlds by recursive spatial scenarios, which may be useful for a global application of advanced nanosystems in both terrestrial and celestial environments.

Introduction: *Nanotechnology***,** which is based on manipulation of matter on atomic, molecular, and supramolecular scale [1], is rapidly covering many areas of human activity, from Earth to outer space. For example, future space missions aim to reach Mars and beyond, where nanomaterials are expected to play a critical role [2]. Planned space applications of nanotechnology also include propulsion systems, radiation shielding, space instrumentation, and anti-satellite weapon countermeasures [3]. Its wide application is also expected by the latest trends of space conquest[4-6].

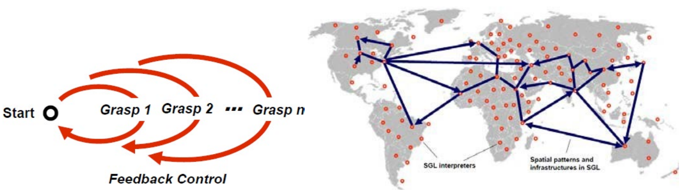
In our true belief, global applications of nanotechnologies can be assisted by the patented high-level Spatial Grasp Technology (SGT) already tested on numerous networked applications [7-12], which allows us to find holistic solutions by treating the whole distributed world as an integral spatial brain. The current project is investigating the use of SGT in different areas, including:

- New, evolving, space economy covering the area from Earth and up to Cislunar space, Mars, andbeyond
- Advanced space robotics with integration of AI technologies into space systems and collective behavior of multiple swarmedsatellites
- Global security on Earth and in space under the Space Development Agency's Next-Generation Space Architecture, with numerous satellites to belaunched
- Global missile defense, with tracking hypersonic threats from space, also arming satellites with lasers to shoot downmissiles

Spatial Grasp TechnologyBasics

General SGTIdea

Within SGT, a high-level scenario for any task to be performed in a distributed world is represented as an *active self- evolving pattern* rather than traditional program, sequential or parallel. This pattern, written in a high-level Spatial Grasp Language (SGL) and expressing top semantics of the problem to be solved, can start from any world point. It then *spatially propagates, replicates, modifies, covers and matches* the distributed world in parallel wavelike mode, while echoing the reached control states and data found or obtained for making decisions at higher levels and further space navigation (see Fig. 1,a). The self-spreading & self-matching SGL patterns-scenarios can create *knowledge infrastructures* arbitrarily distributed between system components which may cover any regions, the whole world including, as in Fig. 1,b.



A B

Fig. 1. Controlled navigation of distributed spaces with creation of distributed infrastructures

Many spatial processes in SGL can start any time and in any places, cooperating or competing with each other, depending on applications. The created infrastructures, which may remain active, can effectively support or express distributed databases, advanced command and control, situation awareness, autonomous and collective decisions, as well as any existing or hypothetical computational and or control models.

Spatial GraspLanguage

General SGL organization is as follows, where syntactic categories are shown in italics, vertical bar separates alternatives, parts in braces indicate zero or more repetitions with a delimiter at the right if multiple, and constructs in brackets may be optional:

grasp	constant | variable | [rule] [({ grasp,})]
constant	information | matter | custom | special | grasp
variable	global | heritable | frontal | nodal | environmental
rule	type | usage | movement | creation | echoing | verification | assignment | advancement | branching | transference | exchange | timing | qualifying | grasp

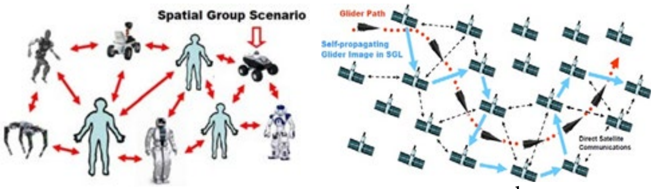
An SGL scenario, called *grasp*, applied in some point of the distributed space, can just be a *constant*, a *variable*, and can also be a *rule* (expressing certain action, control, description or context) optionally accompanied with operands separated by comma (if multiple) and embraced in parentheses. These operands can be of any nature and complexity (including arbitrary scenarios themselves) and defined recursively as *grasp*, i.e. can be constants, variables or any rules with operands (i.e. as grasps again), and so on. Rules, starting in some world point, can organize navigation of the world sequentially, in parallel, or any combinations. They can result in staying in the same application point or can cause movement to other world points with obtained results to be left there, as in the rule's final points. Such results can also be returned to the rule's starting point. The final world points reached after the rule invocation can themselves become starting ones for other rules. The rules, due to recursive language organization, can form arbitrary operational and control infrastructures expressing any sequential, parallel, hierarchical, centralized, localized, mixed, and up to fully decentralized and distributedalgorithms.

SGLInterpreter

The SGL interpreter [7-12] consists of a number of specialized functional processors working with and sharing specific data structures. SGL interpretation network generally serves multiple scenarios or their parallel branches simultaneously navigating the distributed world, which can cooperate or compete with each other, depending on applications. Each interpreter can support and process multiple SGL scenario code which appears in its responsibility at different moments of time. Implanted into any distributed systems and integrated with them, the interpretation network (having potentially millions to billions of communicating interpreter copies) allows us to form spatial world computer with unlimited power for simulation and management of the world itself.

Some ApplicationExamples

Some examples of collective solutions are shown in Fig. 2 and explained further in SGL.



a b

As in Fig. 2,a, where communicating humans and robots (all treated as "units) are randomly swarming and eliminating the discovered unwanted objects (as "targets"), also informing their close neighbors about the targets seen, thus prompting cooperative actions. SGL scenario can be initially injected into any unit (human or robotic).

hop(all_units); repeat (Shift = random(*dx_dy*);
if(empty(WHERE + Shift), shift(Shift));
append((own, direct_neighbors); Targets), seen(targets));
impact(Targets); sleep(*delaytime*))

Tracing moving objects by sensornetworks

Distributed sensor networks operating under SGT can catch and follow moving objects like cruise missiles or hypersonic gliders (as in Fig. 2,b for the sensors on satellites), then shift by visibility to other sensors after being lost by the current one. Object's tracing & analysis is provided by SGL mobile spatial intelligence individually assigned to this object and following its physical move electronically via the sensor network, wherever it goes, despite its possible complex and tricky route.

hop(all_nodes);

frontal(Object, Threshold = …); whirl(

Object = search(aerial, new)); visibility(Object) >= Threshold; free_ repeat(

loop(visibility(Object) >= Threshold); max_destination(hop(all_ neighbors); visibility(Object))))

Conclusion

SGL can be quickly implemented even within standard university environments, similar to its previous versions in different countries under the author's supervision, and efficient implementation can also benefit from nanotechnologies and nanosystems. SGT continues its development in different areas, including advanced mosaic- type operations in distributed systems, and simulation of such complex features as awareness and consciousness.

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