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**Declarations under Rule 4.17:**

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(U))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(Ui))*
- *of inventorship (Rule 4.17(iv))*

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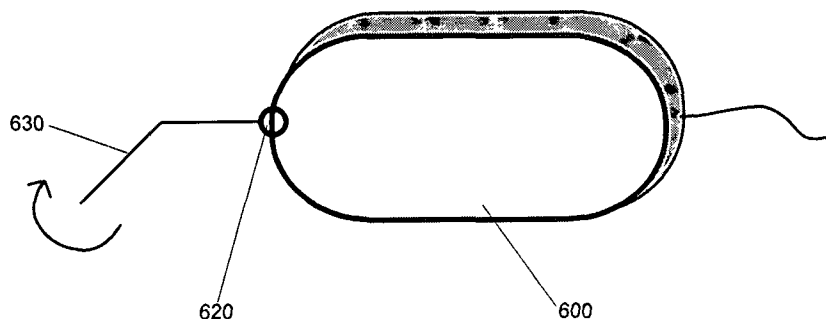
- *with international search report*

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(54) **Title:** NANOROBOTICS SYSTEM

FIG. 6



(57) **Abstract:** The invention pertains to hybrid control systems for collectives of nanorobots that exhibit intelligence, social behavior and environmental interaction. The collectives of nanorobots (CNRs) use software agents and metaheuristics, such as hybrid genetic algorithms, to solve optimization problems in evolving environments involving resource constraints.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2007/023775

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B82B 1/00 (2008.04)

**USPC - 977/701**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - B82B 1/00 (2008.04)

USPC - 977/701-733

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Nanosystems: Molecular Machinery, Manufacturing, and Computation, K.E. Drexler, 1992

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

USPTO EAST System (US, USPG-PUB, EPO, JPO, DERWENT), GoogleScholar, Micropat

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,632,175 B1 (MARSHALL) 14 October 2003 (14.10.2003) entire document	1
Y	FREITAS, Jr. Current Status of Nanomedicine and Medical Nanorobotics. Journal of Computational and Theoretical Nanoscience. Vol. 2, No. 1, 2005 pages 1-25	1, 3
Y	CAVALCANTI et al. Nanorobotics Control Design: A Practical Approach Tutorial, Robotics Today, Vol. 18, No. 4, 2005 pages 1-23	3
A	MARTEL et al. Large-Scale Nanorobotic Factory Automation Based on the NanoWalker Technology Proceedings of the 8th IEEE International Conference on Emerging Technologies and Factory Automation. Vol 2, pgs. 591-597, 2001	1, 3

☐ Further documents are listed in the continuation of Box C.
**D**

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"F" document published prior to the international filing date but later than the priority date claimed	

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Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer <b>Blaine R. Copenheaver</b> PGT H§lpdesk 571-272-4300 PCTOSP 571-272-7774

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2007/02377S

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2Xa) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, **this** Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:  
1. 3

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JS2007/023775

## Continuation of Box III.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1, 3, drawn to a nanorobot device in which nanofilaments are provided as communication antennae or for communication.

Group II, claim 2, drawn to a nanorobot device with NEMS sensors structured in arrays.

Group III, claim 4, drawn to a system for constructing nanorobot devices including stamping nanorobot devices onto a frame.

Group IV, claims 5, 6, drawn to a system for a nanoballoon or nanosail apparatus including a nano-scale inflatable balloon or sail structure.

Group V, claim 7, drawn to a system for collective nanorobotics with a plurality of interconnected system layers including layers for evolutionary computation and artificial neural networks.

Group VI, claims 8, 21, 22, drawn to a system for managing a nanorobotic sensor network wherein all nanorobots are configured to track each other and share sensor data.

Group VII, claim 9, drawn to a nanorobotic network including a plurality of intelligent mobile software agents comprising software means using hybrid genetic algorithms to co-evolve with the nanorobot environment.

Group VIII, claims 10, 11, drawn to a system for using collective nanorobots to identify and apply a chemical to mutated genes.

Group IX, claim 12, drawn to a system for managing collective nanorobots to target MBD proteins.

Group X, claim 13, drawn to a system for managing collective nanorobots to scavenge free radicals and ROIs in targeted cells, deliver cerium and nanoceria particles to cells, and limit the aging of cells.

Group XI, claims 14, 15, drawn to a system for managing collective nanorobots wherein the nanorobots map cellular differentiation and compare the results of a specific mapping sequence with general human anatomy and physiology.

Group XII, claim 16, drawn to a system for managing collective nanorobots wherein the nanorobots self-organize to emulate a human pancreas.

Group XIII, claims 17-20, drawn to a system for managing collective nanorobots in which network behavior is coordinated using traveling salesman optimization algorithms.

Group XIV, claim 23, drawn to a system for managing collective nanorobots wherein collective nanobiodynamics is used to promote concealment and a system of intelligent ubiquitous munitions is deployed by engaging the nanorobots.

Group XV, claims 24-27, drawn to systems for aggregating or organizing nanorobots wherein the nanorobots re-aggregate or re-organize their structure based on environmental information.

Group XVI, claims 28-34, drawn to a system for organizing a photovoltaic cell using multiple layers.

Group XVII, claims 35-38, drawn to a system for managing collective nanorobots in a human immune system wherein the nanorobots are configured as antibodies.

Group XVIII, claims 39-41, drawn to a system for organizing a nano-scale semiconductor including logic arrays containing a multiply-accumulate-convert component.

Group XIX, claim 42, drawn to a system for organizing multiple FPGAs in accordance with environmental changes.

Group XX, claim 43, drawn to a system for optimizing a nanoscale semiconductor wherein the semiconductor activates an actuator in a nanorobot.

Group XXI, claims 44, 45, drawn to systems for anticipatory immunocomputing wherein data from an anticipatory model is forwarded to a collective nanorobots.

Group XXII, claim 46, drawn to a system for managing a distributed computer network using three dimensional cellular automata.

Group XXIII, claims 47-49, drawn to a system for managing nanorobots wherein the nanorobots are configured into specific assemblies of artificial proteins custom configured based on backward engineering of protein structure.

The inventions listed as Groups I-VIII do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The special technical feature of the Group I invention: nanofilaments provided as communication antennae or for communication as claimed therein is not present in the invention of Groups M-XXIII.

The special technical feature of the Group II invention: NEMS sensors structured in arrays as claimed therein is not present in the invention of Groups I, III-XXIII.

The special technical feature of the Group III invention: stamping nanorobot devices onto a frame as claimed therein is not present in the invention of Groups I, II, IV-XXIII.

The special technical feature of the Group IV invention: a nano-scale inflatable balloon or sail structure as claimed therein is not present in the invention of Groups I, II, III or V-XXIII.

The special technical feature of the Group V invention: a plurality of interconnected system layers including layers for evolutionary computation and artificial neural networks as claimed therein is not present in the invention of Groups MV, VI-XXIII.

The special technical feature of the Group VI invention: managing a nanorobotic sensor network wherein all nanorobots are configured to track each other and share sensor data as claimed therein is not present in the invention of Groups I-V, VII-XXIII.

The special technical feature of the Group VII invention: a plurality of intelligent mobile software agents comprising software means using hybrid genetic algorithms to co-evolve with the nanorobot environment as claimed therein is not present in the invention of Groups I-VI, VIII-XXIII.

The special technical feature of the Group VIII invention: a system for using collective nanorobots to identify and apply a chemical to mutated genes as claimed therein is not present in the invention of Groups I-VII, IX-XXIII.

The special technical feature of the Group IX invention: managing collective nanorobots to target MBD proteins as claimed therein is not present in the invention of Groups I-VIII, X-XXIII.

The special technical feature of the Group X invention: a system for managing collective nanorobots to scavenge free radicals and ROIs in targeted cells, deliver cerium and nanoceria particles to cells, and limit the aging of cells as claimed therein is not present in the invention of Groups MX, XI-XXIII.

The special technical feature of the Group XI invention: a system for managing collective nanorobots wherein the nanorobots map cellular differentiation and compare the results of a specific mapping sequence with general human anatomy and physiology as claimed therein is not present in the invention of Groups I-X, XII-XXIII.

The special technical feature of the Group XII invention: a system wherein the nanorobots self-organize to emulate a human pancreas as claimed therein is not present in the invention of Groups I-XI, XIII-XXIII.

The special technical feature of the Group XIII invention: network behavior is coordinated using traveling salesman optimization algorithms as claimed therein is not present in the invention of Groups I-XII, XIV-XXIII.

The special technical feature of the Group XIV invention: wherein collective nanobiodynamics is used to promote concealment and a system of intelligent ubiquitous munitions is deployed by engaging the nanorobots as claimed therein is not present in the invention of Groups I-XIII, XV-XXIII.

The special technical feature of the Group XV invention: wherein the nanorobots re-aggregate or re-organize their structure based on environmental information as claimed therein is not present in the invention of Groups I-XIV, XVI-XXIII.

The special technical feature of the Group XVI invention: a system for organizing a photovoltaic cell using multiple layers as claimed therein is not present in the invention of Groups I-XV, XVII-XXIII.

The special technical feature of the Group XVII invention: a system for managing collective nanorobots in a human immune system wherein the nanorobots are configured as antibodies as claimed therein is not present in the invention of Groups I-XVI, XVIII-XXIII.

The special technical feature of the Group XVIII invention: a nano-scale semiconductor including logic arrays containing a multiply-accumulate-convert component as claimed therein is not present in the invention of Groups I-XVII, XIX-XXIII.

The special technical feature of the Group XIX invention: organizing multiple FPGAs in accordance with environmental changes as claimed therein is not present in the invention of Groups I-XVIII, XX-XXIII.

The special technical feature of the Group XX invention: optimizing a nanoscale semiconductor wherein the semiconductor activates an actuator in a nanorobot as claimed therein is not present in the invention of Groups I-XIX, XXI-XXIII.

The special technical feature of the Group XXI invention: anticipatory immunocomputing wherein data from an anticipatory model is forwarded to a collective nanorobots as claimed therein is not present in the invention of Groups I-XX, XXII-XXIII.

The special technical feature of the Group XXII invention: managing a distributed computer network using three dimensional cellular automata as claimed therein is not present in the invention of Groups I-XXI, XXIII.

The special technical feature of the Group XXIII invention: wherein the nanorobots are configured into specific assemblies of artificial proteins custom configured based on backward engineering of protein structure as claimed therein is not present in the invention of Groups I-XXII.

While most of the above groups share the concept of nanorobotics in common, this is not a novel linking special technical feature and has been discussed in Martel et al. "Large-Scale Nanorobotic Factory Automation Based on the NanoWalker Technology" and Freitas, Jr. "Current Status of Nanomedicine and Medical Nanorobotics". In addition, the concepts of nanorobots related to the presented claims have also been extensively discussed in varying degrees of enablement by Eric Drexler in the book Nanosystems.

Since none of the special technical features of the Group I-XXIII inventions are found in more than one of the inventions, unity of invention is lacking.