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Optimizing the Nano Technology in Defence System for the Future War Figther

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***Abstract**: Nanotechnology is the understanding and control of matter at dimensions of roughly 1-100 nm, where unique phenomena enable novel applications. A nanometer is 10^{-9} of a meter; a sheet of paper is about 100,000 nm thick. In this paper we present the concept of the future war fighter who is indomitable. The future war-fighter concept is about to come into reality in 20 years. The fighter is equipped with powerful tools to cause drastic damage or to neutralize the opponents. He is in a smart uniform and smart helmet, which has sensors to protect him from ballistic elements, a toxic chemical and bio- agent. He identifies objects or enemies through RFID tags and Body Area Networks. The war-fighter has the ability to monitor his position, his physical and mental condition, status of equipment such as PDAs, watch, RFID-reader, heart rate monitoring. The smart helmet consists of a helmet as platform system equipped with an intelligent sensor system for various tasks: positioning, RF and audio communication, B/C sensing, EEG monitoring, sniper detection and digital signal processing. The fighter has powerful lethal and non-lethal weapons. He is equipped with micro vehicles that give information about enemy troops and thus he can analyze, interpret and decides the action to be taken. Advantages of small highly integrated modular satellites for military purposes are that they can be used as destruction satellites and spy satellites.*
***Keywords:**Nanotechnology, PDA, RFID, B/C Sensing, Nanometer, DSP.*

I. Introduction:

Nanotechnology for the soldier is directly related to new functionalities in his suit, helmet or other portable equipment. Technologies with potential use for the soldier are: integrated sensors (RFID) and actuator arrays, body, health & environmental monitoring, directed RF tracking-tracing-identification, anti-ballistic protection (flexible, lightweight), BC-sensing and protection, adaptive: switchable insulation, camouflage
Six concepts have been defined for further discussion and elaboration:
i. Smart helmet
ii. Smart suit, BC sensing and health monitoring
iii. Health monitoring and wound treatment
iv. Adaptive insulation and ventilation in suit

The key elements of the future soldier will be his equipment and in particular his helmet, his uniform and the intelligent systems he is wearing on or in his uniform and helmet.
Nanotechnology is an area, which has highly promising prospects for turning fundamental research into successful innovations. Not only to boost the competitiveness of our industry but also to create new products that will make positive changes in the lives of our citizens, be it in medicine, environment, electronics or any other field. Nano sciences and nanotechnologies open up new avenues of research and lead to new, useful, and sometimes unexpected applications.

II. Impact of nanotechnology on defense

With the highly promising expectations of nanotechnology for new innovative products, materials and power sources it is evident that nanotechnology can bring many innovations into the defense world. In order to assess how these nanotechnology developments can or will impact upon future military operations, the NL Defense R&D Organization has requested to compile a nanotechnology roadmap for military applications, including:
a. Survey of current micro and Nano system technology developments in both the civil and defense markets.
b. Clarification of the impact on future military operations and organization, 10-15 years from now.
c. Guidance on how to translate and adapt such Nanoand micro system technologies into a military context.

III. Nanotechnology Over Weapons

Developments in weapon technology take place both in the direction of more lethal as well as non-lethal weapons. For lethal weapons the focus is on precision targeting, minimum weight and signature, optimal impact damage. Cheap, onboard intelligence is needed. Non-lethal weapons, to neutralize the enemy

temporarily, are relatively new and evolving. Materials for making weapons have light weight, adaptive structures and super penetrating capacity. Weapon systems are expected to be equipped with the following Information Control Technology features such as sensors(µ-radar) and RFID tags for identification of objects or persons.

REMOTE AND UNMANNED GUIDANCE:

With nanotechnology advanced sensor and wireless communication capabilities are becoming possible, e.g. via distributed ad-hoc distributed sensor networks. This enables new functionalities:

i. Tele Weapons: Expanding sensor capabilities and wireless communication enables remotely operated weapons

ii. Self-Adaptive Targeting: based on feedback from previous impacts

iii. Nano And Microbots: Miniaturized, autonomous or remote controlled robotic systems with firing capability

The military use of nanotechnology should lead to higher protection, more lethality, longer endurance and better self supporting capacities of future soldiers. Nanotechnology for defense applications seems to concentrate mainly on five areas according to NRL:

a. The future war fighter or combat soldier

b. Information dominance

c. Weapons of mass destruction:

d. Weapons / countermeasures

e. Platforms

IV. Future Scope Of War Fighter

The future war fighter needs nanotechnology to reduce the weight per unit or per volume unity and needs lower electric power demand per specific function. The future combat soldier should be self-supporting, highly lethal, equipped with additional and supportive intelligence, protected against all kinds of impacts (ballistics, bio agents and chemical agents). Nanotechnology will probably lead to solutions in the areas of body armor, insulation and ventilation, camouflage (IR, visible), integrated sensing devices and enhanced body monitoring and care systems.

a. Information dominance:

Nano electronics will lead to a lower power consumption per process on microchips, to a better signal transduction (signal to noise ratio will be improved), to higher processing speeds and shorter transit times and to a higher function density. Dominance on informatics and information control technology

can thus be reached by developing and using Nanoelectronics for devices with high computing power at small scale and low-power consumption (for sensor networks, artificial intelligence, brain-machine interfaces etc.) and micro or Nano sensor arrays for fast recognition of NBC threats on the battlefield by soldiers and sensor networks.

b. CBNRE-sensors:

Nanotechnology is needed for improved detector sensitivities (signal to noise ratios), to miniaturize sensor arrays for selectivity, to tailor-make high-surface area materials for detection / absorption / deactivation and to create selective catalysts. Microsystems technology and nanotechnology will therefore enable small portable sensor systems capable of identifying Chemical, Bio, Nuclear, Radiation or Energy threats. This will enhance the flexibility of deployment, operations and increase the safety of soldiers and civiliansand will enhance the environmental security.

Dominant impact on future defense:

Based on the evaluation criteria for future defense operations and the current nanotechnology developments in the civil domain, a short list has been made of the most important nanotechnologies we now expect to have a foreseeable essential impact on future defense systems and applications. These nanotechnologies are:

i. Tracking, tracing and remote identification systems via RFID tags (goods, vehicles, people)

ii. µ-Power(necessary for future miniaturization, portable power for the soldier)

iii. µ-Vehicles& robotics, remote & autonomous

iv. Wireless sensors, ambient intelligence for the soldier, network centric operations

Based on the technology radars, a number of future platform concepts for the INDIAN defense organization have been created:

a. Wireless soldier

b. Smart uniform

c. Weapon

d. Micro vehicles/robots

e. Micro/small satellites

f. Smart Helmet

a. Wireless Soldier:

The future soldier-concept wireless soldier is equipped with a Body Area Network consisting of a number of wireless products communicating with each other: PDA/mobile phone, helmet / visor with head display, watch, weapon, supplies of cartridges, sensors on body or garment. All these systems can gather data, exchange data with each other and can give the soldier the essential info via his PDA, earplug, display, watch etc. The wireless soldier is connected via phone and PDA to the centric warfare system, his commander, the distributed sensor network on the battlefield and his fellow soldiers.

Essential part of the wireless soldier is the ability to monitor his position, his physical and mental condition, supplies and status of equipment. His watch or other personal device (PDA/Phone/ Smart helmet) will have basic functions like positioning, wireless communication, RFID-reader, heartrate monitoring (wireless), accelerometers but in the future also enhanced body function monitoring can be expected such as dehydration level, glucose level and targeted drug and functional food delivery.

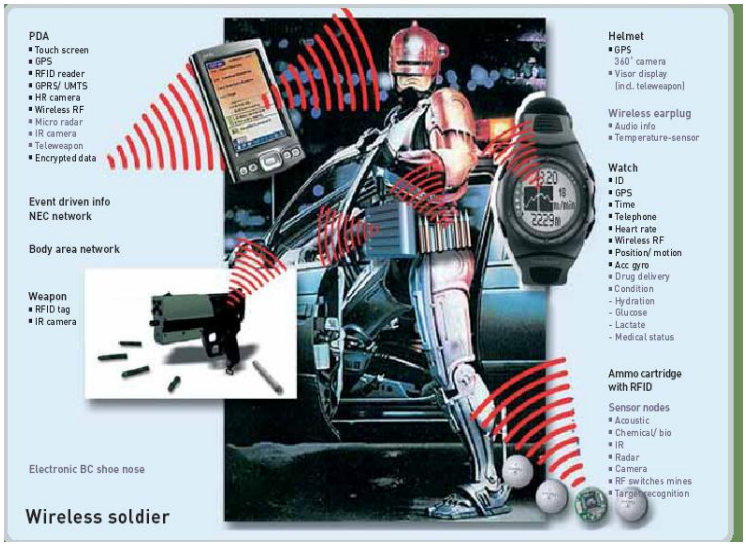

Fig1: Wireless Soldier

Finally the soldier can also distribute sensor modes (nodes or smart dust) to gather and distribute information via micro IRsensors, microradar, and gas sensors, Nanobiosensors that form adhoc networks and function as an ambient intelligence system. He will get info via his PDA, phone, and watch and via flexible thin film displays on his uniform or in his visor.

b. Smart Uniform:

The future soldier will have an all-impact suit enabled by Nanomaterials combined with micro or macro fibers, offering protection against bullets, fragment of grenades, bioagents, chemical agents and the influences in combination with the physical status of the body (insulation, ventilation, local cooling).

c. Weapons:

Nanomaterials can create a better control of energy release and can create shorter diffusion paths for high-intensity energy blasts. They will improve the grain-boundary effects on a mechanical level. Nano particles in or on materials can result in sophisticated scattering of visible and infrared light, enabling stealth functionality.

d. Micro vehicles / robots

Micro vehicles and robotic systems will become more dominant and versatile in the future, due to the increasing computing power and memory capacity of Nano-electronics, the reduced weight of the mechanical structures (use of Nano composites, adaptive structures for movement) and the increasing endurance of portable power. The ultimate goal will be to create Nanorobots or Nanobots for activities on

Land and NUAV (Nano unmanned aerial vehicles) for reconnaissance and sensor activities in the air (flying artificial insects). Also uninhabited combat vehicles (fighter, submarine, vehicle) with a higher performance and a lower casualty risk can be expected. A crucial factor is the weight of the portable

Power Ideally all micro vehicles and robots should be less visible for enemy troops (bromidic structures), should last long enough to gather essential information and should be low cost and therefore redundant.

e. Micro / small satellite

Major advances in the microsystem technology, in particular microprocessors and microsystems, have made smaller satellites a feasible alternative for large satellites. The use of micromachined devices can revolutionize the way in which satellites are designed and built. Besides reducing their size, weight and power consumption, the use of micromachined devices would give far better component integration in areas such as propulsion, communication, data processing, power generation and navigation.

Essential for all small and micro satellites is the durability, the protection against radiation and other particles and the position in orbit.

For military use the swarms of microsatellites can fulfill functions such as observation, inspection, anti-satellite communication etc. and will be connected to the information gathering and control system. Advantages of small highly integrated modular satellites for military purposes are that they can be used as destruction satellites; spy satellites and they can be part of a swarm of satellites, launched at the same time.

Swarm formation flying can give high-resolution observations. This platform shows that military small satellites can be used for the detailed observation of the enemy (e.g. where is the enemy, how many people, human search, house observation of potential terrorist), which can be communicated to eachmilitary partner. Thereby, small satellites can be used as space systems.

f. Smart Helmet:

The smart helmet consists of a helmet as platform system equipped with an intelligent sensor system for various tasks: positioning, RF and audio communication, B/C sensing, EEG monitoring, sniper detection and digital signal processing. The helmet is a form-stable object, so therefore a good base for sensor arrays. In general, it is even the only firm base, the garment is usually flexible. The second advantage of thesmart helmet is its position, it is usually the highest point of the soldier.

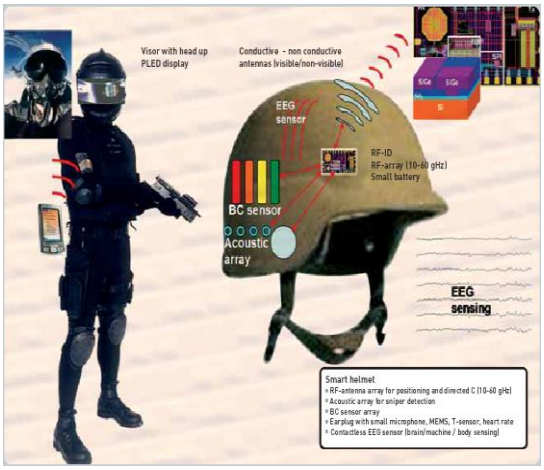

Fig2: Smart Helmet

The major parts over the smart helmet are clearly determined below. There are:

i. Optical or IR camera array

ii. Array Antennas

iii. BC Sensing and Health Monitoring in Suit

i. Optical/IR camera array

a. 360 degree coverage (6 camera's)

b. Useful for detection of laser designators, night vision, surveillance.

ii. Array antennas

The helmet can take advantage of conformal array technology Using conformal array technology, antennas no longer need to be "flat" but can follow the curvature of the helmet. The satellite array should be combined with the GPS antenna. The RF and microwave electronics, as well as the beam-steering electronics, can be integrated with the helmet. Switchable antenna arrays will be less visible for the enemy and can be possibly created with conductive materials.

iii. BC Sensing:

For soldiers in the field it is essential to get an early warning when they are under a bio, chemical, nuclear or radiation threat. For immediate detection and response, a mobile and preferably wearable system is needed. Chemical species to be detected are:

a. VX
b. Soman
c. Musterdgas
d. Lewisite

The next generation of B/C sensing system is supposed to be put on credit-card-sized semi-active or passive sensor tags with reactive large area surfaces (electrodes with carbon Nanotubes, Nanofibers on sensor surfaces, reactive dielectric materials in capacitor rf-sensors etc.). The idea is to read and scan these sensors wirelessly with the soldiers PDA or watch.

iv. Health Monitoring and Wound Treatment:

For medics it is essential to know which soldier needs immediate care and which soldier is not directly in danger. A modular sensor tag card system can gather data, e.g. combined with acoustic info regarding sniper hits and transmit these data via the BAN system and PDA to the medic and commander for monitoring of the health condition the following functions are needed:

a. Heart rate and Heartrate variability (ECG, stress monitoring)
b. Internal Body Temperature
c. Respiration Rate
d. Blood Pressure

Wounds can be dressed with intelligent band aids which monitor the moisture level, the bacterial activity and which release anti-microbails on Nanoparticles to kill bacteria. Part of this health monitoring system can be a portable sample preparation and lab-on-chip analysis kit enabling the soldier to test his own body fluids when he needs more specific data and water and food.

V. Conclusion

In this paper we present the concept of the future war fighter who is indomitable. The future war-fighter concept is about to come into reality in 20 years. The fighter is equipped with powerful tools to cause drastic damage or to neutralize the opponents. He is in a smart uniform and smart helmet, which has sensors to protect him from ballistic elements, a toxic chemical and bio- agent. He identifies objects or enemies through RFID tags and Body Area Networks. The war-fighter has the ability to monitor his position, his physical and mental condition, status of equipment such as PDAs, watch, RFID-reader, heart rate monitoring. The smart helmet consists of a helmet as platform system equipped with an intelligent sensor system for various tasks: positioning, RF and audio communication, B/C sensing, EEG monitoring, sniper detection and digital signal processing. The fighter has powerful lethal and non-lethal weapons.With the artificial muscles and brain realized in the next 20 years, the human soldier can be replaced with robot with the potentialities of nanotechnology and its products.

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