TECHNICAL ACTIVITY PROPOSAL (TAP)

ACTIVITY REFERENCE NUMBER	SAS-ET.BX	ACTIVITY TITLE **ROBOTICS UNDERPINNING FUTURE NATO OPERATIONS** (3)	APPROVAL TBA
TYPE AND SERIAL NUMBER	RTG		START April 2011
LOCATION(S) AND DATES		, NATO RTB Stockholm, April 2011 various locations as required	END ??
COORDINATION WITH OTHER BODIES		ACT, NC3A, IMS, IS	
NATO CLASSIFICATION OF ACTIVITY		NATO Unclassified	Non-NATO Invited Yes (all PfP)
PUBLICATION DATA		NATO Unclassified	
KEYWORDS		Military robots, use of robots, cognitive robotics	

I. ORIGIN

A. Background

Robotics builds and uses autonomous embodied intelligent machines (robots) able to perceive outer world, reason about it, and change it using its own actions. Robots are very diverse. Robotics also deals with multiple cooperating robots and also with human-robot cooperation. Robotics has been flourishing both in industry and academia. Mobile robots and autonomous aerial vehicles gave robotics another push. The Exploratory team ET.BX aims mainly at bridging the gap between the military users and the available technology.

The idea of the Exploratory team called Robotics underpinning future NATO operations came from the Czech Armed Forces. Two robotics groups from the Czech Technical University in Prague, Czech Republic started the initiative by a workshop organized in Prague on March 16-17, 2011 which attracted attendees from Canada, the Czech Republic, France, Italy, and the United States. NATO RTO Research and Technology Board approved the activity with the expectation to prepare TOR/TAP for the SAS Panel Business Meeting to be held in October 2011.

The ET.BX team aims at networking activities allowing coordinating and focusing the rather diverse academic and industrial R&D activities in robotics towards defense needs. The coordinated research efforts being built in the bottom-up manner will hopefully propagate new ideas from academic circles into more focused and practically useful activities. Robots are widely deployed in current NATO operations, e.g. in Afghanistan or in Iraq. Within NATO, the activity is a follow-up on JO2030 (Joint Operations) and previous SAS studies. The overall aim of the activity is to create the Task Force and organize a NATO supported symposium. The outcome will be also a Technical Report offering to military users a view where current contributions in robotics could be useful for them.

B. Justification (Relevance to NATO)

The growing use of robotic systems in military operations entails questions such as how to reassess their advances in NATO operations and identify critical areas. Future operating environments will be more complex and uncertain and future NATO forces might look differently when applying robotics. Robotics offers enormous potential while robotics applications embrace a number of necessary interlinked subject areas. Robotic systems can potentially redefine the way modern warfare will be conducted, and may render existing capabilities obsolete.

The challenge with robotic systems is the lack of system theories allowing holistic analysis of the overall systems, involved processes and their interactions. This involves a number of diverse issues in terms of perception, control, actuation systems. In addition, the involvement, control and use of decision level processes are purely understood. All current models of systems suffer for significant scalability problems and the problem of derivation, use and integration of representations for modeling the environment, control, and motivation. Thus, better theories are needed for conceptual evaluation of robot systems in operations.

Robots will be exposed to a wide variety of situations and events; as such, the system must be able to rapidly acquire skills and tasks. The adaptive robotic servant can be considered a robotics “companion” that co-exists and continuously interacts with the military user. For this purpose, it must evolve with the user so as to acquire skills, representations and competences. Robotic systems are programmed to perform certain tasks automatically within a certain set of algorithms. Programming is based on human ways of thinking, human feelings, and weaknesses. A dialog between humans and machines, interactions between physical and emotional features that have moral, ethical, and legal aspects, have not been solved yet completely. There are needs for generating sophisticated criteria for robotic decision-making whereas human abilities are limited, and needs for outline of artificial intelligence applications to legal rules.

They are interested in reaching outside of NATO to SWE, FIN, and possibly Japan. The preliminary goals are to create a symposium or workshop to demonstrate cutting-edge robotics technologies to military users. The activity would help analyze the gap between operational requirements and technical possibilities and how they relate to the LTCRs, and suggests bridging to the European Commission R&D activities such as EuRobotics, EURON and EUROP.

II. OBJECTIVES

The research will focus on deriving key performance indicators of military organizations that support strategic decision-making for individual nations, a subset of which would address NATO requirements.

For this purpose, the proposed activity will bridge the natural gap between cutting edge technology providers (hi-tech companies, universities) and military operational users. The exploratory team will help to bridge the gap between operational requirements and technical possibilities by:

1. Attracting technology providers to participate in the activity.
2. Analyzing the gap between operational requirements and technical possibilities and how they relate to the LTCRs
3. Organizing a NATO supported symposium or workshop to demonstrate cutting-edge robotics technologies to military users and to establish personal links.

4. Trying to make bidirectional working links to the European Commission R&D activities such as EuRobotics, EURON and EUROP
5. Opening possibilities for the new robotics research motivated by military needs and funded by third parties, both public bodies and industries

III. TOPICS TO BE COVERED

1. Robots' cognitive abilities:
   Robots and other intelligent devices need to perceive surroundings during military operations. Planning and control of robots is based on perception-action cycle in most cases. The goal is to develop new perception algorithms applicable in the defense and embed them into the cognitive framework.
2. Self-localization and navigation:
   To achieve fully autonomous and intelligent behaviors of robot systems, their operation relies mainly on uncertain information processing from sensors. Self-localization and navigation capabilities together with building up a proper machine representation of the operating environment belong to generic functionalities of any unmanned mobile robot, and enables autonomous activity planning as well as safe and collision-free guidance of these systems. The objective is to indicate system methods for intelligent sensor data processing applied into mobile robot perception field with a specific focus on investigation of advanced data fusion methods towards real world models capable of handling uncertain and incomplete information.
3. Robotic coordination and teamwork:
   Homogenously teamed unmanned robots boost capabilities and reliability of a single robotic system. Heterogeneous grouping incorporates humans as ordinary team members, sharing common knowledge with robots, and assists each other in a complementary way. The objective is to study mechanisms, design algorithms and propose a development of new technologies for coordinated operations performed by heterogeneous teams of unmanned aerial systems (UASs), unmanned ground systems (UGSs), unattended sensors and human operators. The cornerstone concept of functionality planning and coordination will be agent-based computing, and the theory of multi-agent systems.
4. Scalable robotic simulations:
   The design methods and technologies might be tested on a scalable, high-fidelity computational simulation. The goal is to investigate the methods of agent-based simulation and modeling, and perform its validation on deployment on real hardware platforms. Besides fidelity, it is to investigate the concept of scalability, e.g. ability to perform tests on a very high number of robotic entities - scenarios that can never be executed on real hardware platforms (an experience in modeling the US national airspace in cooperation with the US FAA).
5. Robotics military applications:
   All the afore mentioned research fields are targeted on both a single or multi-robot (teamed up) setups of unmanned ground and/or aerial vehicles operating in large real indoor and outdoor environments. Application field implies major use in unmanned vehicles control area, i.e. in rescue missions, inspection and surveillance robotics, autonomous assistive systems, and many other defense/safety/security applications.

Other areas to be considered:

- Interactions, relations between humans and robots – identification of technological alternatives in communicating with intelligent systems;
- Development of artificial intelligence control tools;
- Interface discrepancies and a lack of compatibility and the absence of common standards;
- Assumptions of the accelerations of technologies and methods and development of more reliable algorithms

IV. DELIVERABLE AND/OR END PRODUCT

- ET leading to the RTG.
- Network of interested academic, industrial and military people and institutions. Informatics support allowing the network to work in a virtual manner.
- Workshop or symposium.
- Technical report.

V. TECHNICAL TEAM LEADER AND LEAD NATION

Chair: Vaclav Hlavac (CZE)

Lead Nation: Czech Republic

CZE RTO SAS representative: Mr. Miroslav SVEJDA, CZE MOD Prague

VI. NATIONS WILLING TO PARTICIPATE

NATO Nations and Bodies: Canada, Czech Republic, France, Italy, NATO ACT, USA

PfP Nations: none identified yet

VII. NATIONAL AND/OR NATO RESOURCES NEEDED

Participating nations are expected to fund reasonable travel needs and allow time for researchers to fulfill the tasks of this study.

Participating nations should also be prepared to provide respective unclassified data related to objectives of the study.

VIII. RTA RESOURCES NEEDED

Funds for the workshop or symposium..