Security-Policy NET Nexus of Emerging Technologies

BRIEFING NOTES

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PUBLIC POLICY CHALLENGES, REGULATIONS, OVERSIGHT, TECHNICAL, AND ETHICAL CONSIDERATIONS FOR AUTONOMOUS SYSTEMS

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SUMMARY

- A system that reacts intelligently and flexibly to changing operating conditions and demanding processes is an autonomous system (AS).
- AS, which have been booming in the civilian and military industry in recent years, can modify their behavior in response to unpredictable events throughout various operations. The railway industry, shipbuilding, aircraft industry, and robot construction develop their new products towards self-driving or AS.
- One of the main features of autonomous control systems is solving complicated optimization problems without human intervention in the presence of uncertainty in real-time [1]. AS must have the recognition and discretion potency, evaluation and estimate authority, and decision-making power to independently perform various tasks in a dynamic environment [2].

CONTEXT

- It is evident that the design and implementation of any AS faces various challenges. According to new research by the National Engineering Policy Centre under the auspices of the Royal Academy of Engineering, generally, the critical challenges posed by the advent of AS are [3]:
  - **Technical:** In addition to simulation and real-world trials, new validation and verification techniques are needed to ensure AS's safety and reliability.
  - **Professional Responsibility:** Given the new challenges caused by AS, the right standards and regulations are required to create a culture alongside the generated challenges.
  - **Regulation:** With the proliferation of AS, a fast, responsive, and advanced monitoring system is needed that can communicate with regulators of various sectors to ensure that regulations for the proper implementation of standards are carefully considered and enforced.
  - **Oversight:** A surveillance expert must exist to consider the advantages of an AS if there are uncertainty and risk in the mentioned system.
  - **Public Acceptance:** Before deploying a new AS, it must be possible to make trust and public acceptance between system users and service providers.
  - **Ethics:** There should be mechanisms in the process design of AS that can have a collective, effective, and transparent decision-making to solve moral uncertainty, address the absence of human oversight, and inform about extending AS.

Different countries' roles in the production and development of various AS for protection and defense on land, air, and the sea are:

- **Autonomous Maritime Vehicles (AMVs):**
  - **The United States**, **Germany**, **China**, **Japan**, **France**, **United Kingdom**, **South Korea**, **Russia**, **Canada**, and **Australia** have been prominent in AMVs' output, including a military application. The discussed countries have invented payloads for installation on AMVs. These equipment types are essential for AMVs' autonomous missions and allow them to interact and communicate with the environment. The invented payloads are navigation payloads, sensors payloads, communications payloads, and finally, weapons payloads [4].

- **Autonomous Aerial Vehicles (AAVs):**
  - **The United States:** This country has considered the most massive budget for research, upgrade, and production of the "MQ-9 Reaper", the first offensive strike drone for the United States military. This drone is equipped with advanced infrared sensors, laser range finders, cameras, and several possible ordinances. Moreover, ALPHA, a fuzzy logic artificial intelligence (AI), is developed in the United States. This AI can simulate the most skilled pilots in simulated aerial combat, where fighter jets and unmanned aerial vehicles (UAVs) shoot at each other [5].
  - **Israel:** The military has developed a Heron family of drones using a broad spectrum of sensors; for instance, Super Heron, including Autonomous Flight and Automatic Take-Off and Landing (ATOL) system. "Drone Dome" is one of the anti-drone systems developed in Israel. This drone uses radar to detect targets and then utilizes a laser to disassemble or neutralize them several kilometers away [5].
  - **China:** This country has developed "Cai Hong 5" (CH-5) drone, which in terms of technology is equal to "MQ-9 Reaper". Furthermore, China declared that it had developed drones that fly with ad hoc networks and are under autonomous group control [5].

- **Unmanned Ground Vehicles (UGVs):** The UGVs utilized in a wide variety of civilian and military applications are robotic systems that operate on the ground without a human onboard operator. Russia and the United States are leading the way in developing, testing, or evaluating UGVs, especially in the military sector.

  - **Russia:**
    - "Uran-6", the Russian tracked demining robot, aids identify and clear minefields.
    - The Russian, first combat UGV termed "Platforma-M" is designed and developed for intelligence gathering and identification roles.
    - Armored "Uran-9" is explicitly produced to fire "Ataka" anti-tank missiles and "Igla" surface-to-air missiles for combat operations.

- Armored "Udar" or "Vihr" (Hurricane), a tank-sized vehicle based on the BMP-3 armored vehicle chassis for combat, engineering support, and transportation/evacuation.
- Mid-sized unmanned "Nerehta" armed with weapons for combat, intelligence gathering, and transportation/logistics support.
- "Soratnik" that can operate either at varying levels of autonomy or direct control was designed for combat, patrol, and security roles.
- "Prohod-1" ("Pathway") to create safe corridors for soldiers and equipment in both manned and unmanned configurations.
- Wheeled system termed "Argo" is designed for patrol, intelligence gathering, logistics support.
- Infantry support platform named Mobile Autonomous Robotic System (MARS) which able to carry six fully equipped soldiers and provide battery charging for the military squad.
- Humanoid military robot "Fedor" or "Russian Terminator" for civilian use, such as for work abroad space stations.
- Russia's goal is to replace all armored vehicles and manned tanks with their autonomous counterparts [6].

- **The United States:**
  - The "RCV-M," as an infantry booster, is a direct-fire unmanned ground system, including various sensors that help the infantry autonomously and in parallel [7].
  - The "Titan" proposed by the United States army is a multi-mission system. This hybrid UGV contains a battlefield-tested robotic system, controller, and modular mission payloads [8].
  - "TALON Tracked Military Robot" that operates remotely can receive radio signals up to 800 meters on the battlefield [9].
  - "Squad Multipurpose Equipment Transport (SMET)" can be attached to a soldier and imitate his/her behavior for a combat operation, or it can be controlled remotely [10].

CONSIDERATIONS [11], [12], [13], [14]

- The specifications of AS are:
  - Sensing ability, including advanced technologies.
  - Cognitive ability containing perceptual integration, pattern recognition, learning, reasoning, etc. to achieve self-defined goals, make strategy adjustment, allocate resources, etc.
  - Execution ability inclusive autonomous activation and independent execution.

    - Adaptive ability to unpredictable environments.
    - Non-deterministic operation outcomes.
    - There is no need for manual intervention during operations; however, humans should be the final decision-maker per human factors design.
- The Advantages of AS are:
    - Saving time and spending it on other tasks.
    - Enhancing safety due to the lack of human error.
    - Increasing the use of these systems by people with disabilities.
    - Reducing the rate of collisions and crashes in mobile AS due to possessing various sensors.
- However, the disadvantages of AS are:
    - Being extremely expensive, especially after the first release,
    - Leading to unemployment, which is catastrophic for the economy,
    - Worrying about computer crashing or malfunctioning and resulting in a major collision [11], [12], [13], [14].

NEXT STEPS (If applicable)

- In the future, different image processing methods can be used to control various types of AS using cameras and deep neural networks (DNN), especially the convolutional neural network (CNN).
- In the future, various AS can be designed to sense the feelings of the people around them using image processing methods. Using this feature, each AS is able to identify the enemy from the rest by recognizing the presence and absence of fear, stress, or anxiety in individuals and perform appropriate action in different situations.

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