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Canada

Sensitive Technology Research Areas

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Introduction

The list of Sensitive Technology Research Areas consists of advanced and emerging technologies that are important to Canadian research and development, but may also be of interest to foreign state, state-sponsored, and non-state actors, seeking to misappropriate Canada’s technological advantages to our detriment.

While advancement in each of these areas is crucial for Canadian innovation, it is equally important to ensure that open and collaborative research funded by the Government of Canada does not cause injury to Canada’s national security or defence.

The list covers research areas and includes technologies at various stages of development. Of specific concern is the **advancement of a technology during the course of the research**. This list is not intended to cover the use of any technology that may already be ubiquitous in the course of a research project. Each high-level technology category is complemented by sub-categories which provide researchers with further specificity regarding where the main concerns lie.

The list will be reviewed on a regular basis and updated as technology areas evolve and mature, and as new information and insights are provided by scientific and technical experts across the Government of Canada, allied countries, and the academic research community.

1. Advanced Digital Infrastructure Technology

Advanced digital infrastructure technology refers to the devices, systems and technologies which compute, process, store, transmit and secure a growing amount of information and data that support an increasingly digital and data-driven world.

Advanced communications technology

Technologies that enable fast, secure and reliable wireless communication to facilitate growing demand for connectivity and faster processing and transmission of data and information. These technologies could also enable communications in remote environments or adverse conditions where conventional methods are ineffective, or in spectrum-congested areas. Examples include: adaptive/cognitive/intelligent radios; massive multiple input/multiple output; millimeter-wave spectrum, open/virtualized radio access networks, optical/photonic communications and wideband high frequency communications.

Advanced computing technology

Computing systems with high computational power that enable the processing of complex calculations that are data- or compute-intensive. Examples include: context-aware computing, edge computing, high performance computing and neuromorphic computing.

Cryptography

Methods and technologies that enable secure communications by transforming, transmitting or storing data in a secure format that can only be deciphered by the intended recipient. Examples of emerging capabilities in cryptography that may replace or enhance current encryption methods include: biometric encryption, DNA-based encryption, post-quantum cryptography, homomorphic encryption and optical stealth encryption.

Cyber security technology

Technologies that protect the integrity, confidentiality and availability of internet-connected systems, including their hardware, software, as well as data from unauthorized access or malicious activities. Examples include: cyber defence tools, cross domain solutions and moving target defence technology.

Data storage technology

The methods, tools, platforms, and infrastructure for storing data or information securely in a digital format. Examples include: five-dimensional (5D) optical storage, DNA storage, single-molecule magnets.

Distributed ledger technology

Digital ledgers or databases that track assets or records transactions in multiple locations at the same time, with no centralized or single point of control or storage. Examples include: blockchain, cryptocurrencies, digital currencies and non-fungible tokens.

Microelectronics

Microelectronics encompasses the development and manufacturing of very small electronic designs on a substrate. It incorporates semiconductors as well as more conventional components such as surface mount technology with the goal of producing smaller and faster products. As microelectronics reach the limit for integration, photonic components are making their way into this field. Examples of semiconductor components include: memory-centric logic, multi-chip module, systems-on-chip and stacked memory on chip.

Next-generation network technology

Fifth and future generations of communications networks that use high frequency spectrums to enable significantly faster processing and transmission speeds for larger amounts of data. Advancements in networking could allow for integrated communication across air, land, space and sea using terrestrial and non-terrestrial networks, as well as increased data speed and capacity for network traffic. It could also pave the way for new AI- and big data-driven applications and services, and its massive data processing capabilities could enable the Internet of Everything.

2. Advanced Energy Technology

Advanced energy technology refers to technologies and processes that enable improved generation, storage and transmission of energy, as well as operating in remote or adverse environments where power sources may not be readily available, but are required to support permanent or temporary infrastructure and power vehicles, equipment and devices.

Advanced energy storage technology

Technologies that store energy, such as batteries, with new or enhanced properties, including improved energy density, compact size and low weight to enable portability, survivability in harsh conditions and the ability to recharge quickly. Examples include: fuel cells, novel batteries (biodegradable batteries; graphene aluminium-ion batteries; lithium-air batteries; room-temperature all-liquid-metal batteries; solid-state batteries; structural batteries) and supercapacitors (or ultracapacitors).

Advanced nuclear generation technology

New reactors and technologies that are smaller in size than conventional nuclear reactors and are developed to be less capital-intensive, therefore minimizing risks faced during construction. Examples include: nuclear fusion and small modular reactors.

Wireless power transfer technology

Enables the transmission of electricity without using wire over extended distances that vary greatly and could be up to several kilometres. Examples include recharging zones (analogous to Wi-Fi zones) that allow for electric devices, such as vehicles, to be recharged within a large radius, as well as for recharging space-based objects, such as satellites.

3. Advanced Materials and Manufacturing

Advanced Materials

Advanced materials refer to high-value products, components or materials with new or enhanced structural or functional properties. They may rely on advanced manufacturing processes or novel approaches for their production.

Augmented conventional materials

Conventional materials such as high strength steel or aluminum and magnesium alloys – products that are already widely used – which are augmented to have unconventional or extraordinary properties. Examples of these properties could include improved durability or high temperature strength, corrosion resistance, flexibility, weldability, or reduced weight, among others.

Auxetic materials

Materials that have a negative Poisson's ratio, meaning that when stretched horizontally, they thicken or expand vertically (rather than thinning as most materials do when stretched), and do the opposite when compressed horizontally. These materials possess unique properties, such as energy-absorption, high rigidity, improved energy/impact absorption and resistance to fracture.

High-entropy materials

Special materials, including high-entropy alloys, high-entropy oxides or other high-entropy compounds, comprised of several elements or components. Depending on their composition, high-entropy materials can enhance fracture toughness, strength, conductivity, corrosion resistance, hardness and other desired properties. Due to the breadth of the theoretically available combinations and their respective properties, these materials can be used in several industries, including aerospace. Additionally, high-entropy oxides are being considered for applications in energy production and storage, as well as thermal barrier coatings.

Metamaterials

Structured materials that are not found or easily obtained in nature. Metamaterials often have unique interactions with electromagnetic radiation (i.e. light or microwaves) or sound waves.

Multifunctional/smart materials

Materials that can transform in response to external stimuli (e.g. heat, water, light, etc.) within a given amount of time. Examples include: magnetorheological fluid, shape memory alloys, shape memory polymers and self-assembled materials.

Nanomaterials

Nanomaterial materials have dimensions of less than 100 nanometers and exhibit certain properties or unique characteristics such as increased durability or self-repair. A subset of nanomaterials, nano-energetic materials are energetic materials synthesized and fabricated at the nano-level that have a small particle size and high surface area between particles, which enable faster or more efficient reaction pathways when exposed to other substances.

Powder materials for additive manufacturing

Powders that typically consist of metal, polymer, ceramic and composite materials. These powders enable additive manufacturing processes, also referred to as 3D printing. Research into novel powder materials can lead to manufactured parts with enhanced mechanical properties and other desired characteristics.

Superconducting materials

Materials that can transmit electricity with no resistance, ultimately eliminating power losses associated with electrical resistivity that normally occurs in conductors. Manufacturing of superconducting electronic circuits is one of the most promising approaches to implementing quantum computers.

Two-dimensional (2D) materials

Materials with a thickness of roughly one atomic layer. One of the most well-known 2D materials, for which there are currently production/fabrication technologies, is graphene. Other examples of 2D materials include: silicene, germanene, stantene, metal chalcogenides and others, which are currently being researched with potential applications in sensors, miniaturized electronic devices, semiconductors and more.

Advanced Manufacturing

Advanced manufacturing refers to enhanced or novel technologies, tools and processes used to develop and manufacture advanced materials or components. This could include using specialized software, artificial intelligence, sensors and high performance tools, among others, to facilitate process automation or closed-loop automated machining and create new materials or components.

Additive manufacturing (3D printing)

Various processes in which solid three-dimensional objects are constructed using computer-aided-design (CAD) software to build an object, ranging from simple geometric shapes to parts for commercial airplanes. 3D printing could be used to accelerate the development through rapid prototyping of customized equipment, spare tools or novel shapes or objects that are stronger and lighter. Approaches are also being developed for multi-material additive manufacturing and volumetric additive manufacturing, as well as additive manufacturing for repair and restoration.

Advanced semiconductor manufacturing

Methods, materials and processes related to the manufacturing of semiconductor devices. Examples of techniques include: advancements in deposition, coating, lithography, ionization/doping, and other core and supporting processes, such as thermal management techniques. Recent technological advancements include developments in Extreme Ultraviolet (EUV) lithography, which is an advanced method for fabricating intricate patterns on a substrate to produce a semiconductor device with extremely small features.

Critical materials manufacturing

Up and midstream technologies necessary to extract, process, upgrade, and recycle/recover critical materials (e.g. rare earth elements, scandium, lithium, etc.) and establish and maintain secure domestic and allied supply chains. More information about critical minerals can be found in Canada's Critical Minerals List.

Four-dimensional (4D) printing

Production and manufacture of 3D products using multifunctional or "smart" materials that are programmed to transform in response to external stimuli (e.g. heat, water, light, etc.) within a given amount of time. Recent developments have also been made in creating reversible 4D printed objects, which can return to their original shape without human involvement.

Nano-manufacturing

Production and manufacture of nanoscale materials, structures, devices and systems in a scaled-up, reliable and cost-effective manner.

Two-dimensional (2D) materials manufacturing

Standardized, scalable and cost-effective large-scale production of 2D materials.

4. Advanced Sensing and Surveillance

Advanced sensing and surveillance refers to a large array of advanced technologies that detect, measure or monitor physical, chemical, biological or environmental conditions and generate data or information about them. Advanced surveillance technologies, in particular, are used to monitor and observe the activities and communications of specific individuals or groups for national security or law enforcement purposes, but have also been used for mass surveillance with increased accuracy and scale.

Advanced biometric recognition technologies

Technologies that identify individuals based on their distinctive physical identifiers (e.g. face, fingerprint or DNA) or behavioural identifiers (e.g. gait, keystroke pattern and voice). These technologies are becoming more advanced due to improving sensing capabilities, as well as integrating artificial intelligence to identify/verify an individual more quickly and accurately.

Advanced radar technologies

Radar is a system that uses radio waves to detect moving objects and measure their distance, speed and direction. Advancements in radar technology could enable improved detection and surveillance in different environments and over greater distances. Examples include: active electronically-scanned arrays, cognitive radars, high frequency skywave radar (or over-the-horizon radar), passive radar and synthetic aperture radar.

Atomic interferometer sensors

Sensors that perform sensitive interferometric measurements using the wave character of atomic particles and quantum gases. These sensors can detect small changes in inertial forces and can be used in gravimetry. They can also improve accuracy in navigation and provide position information in environments where the Global Positioning System (GPS) is unavailable.

Cross-cueing sensors

Systems that enable multiple sensors to cue one another. Cross cueing can be used in satellites for data validation, objection tracking, enhanced reliability (i.e. in the event of a sensor failure) and earth observations.

Electric field sensors

Sensors that detect variations in electric fields and use low amounts of power. They are useful for detecting power lines or lightning, as well as locating power grids or damaged components in the aftermath of a natural disaster.

Imaging and optical devices and sensors

Devices and sensors that provide a visual depiction of the physical structure of an object beyond the typical capabilities of consumer grade imaging techniques such as cameras, cellphones, and visible light-imaging. Such technologies typically make use of electromagnetic radiation beyond the visible spectrum, or use advanced techniques and materials to improve optical capabilities, such as enabling more precise imaging from a greater distance. This sensitive research area also includes sensitive infrared sensors.

Magnetic field sensors (or magnetometers)

Sensors that are used to detect or measure changes in a magnetic field, or its intensity or direction.

Micro (or nano) electro-mechanical systems (M/NEMS)

Miniaturized, lightweight electro-mechanical devices that integrate mechanical and electrical functionality at the microscopic or nano level. A potential use of M/NEMS could be as ‘smart dust’, or a group of M/NEMs, made up of various components, including sensors, circuits, communications technology and a power supply, that function as a single digital entity. Smart dust could be light enough to float in the air and detect vibrations, light, pressure and temperature, among other things, to capture a great deal of information about a particular environment.

Position, navigation and timing (PNT) technology

Systems, platforms or capabilities that enable accurate and timely calculation of positioning, navigation and timing. These technologies are critical to a wide-range of applications, most notably for enabling the Global Navigation Satellite System (GNSS), one of which is the widely-used Global Positioning System (GPS), but also for enabling navigation in areas where GPS or

GNSS do not work. Examples include: chip-scale advanced atomic clocks, gravity-aided inertial navigation system, long-range underwater navigation system, magnetic anomaly navigation, precision inertial navigation system.

Side scan sonar

An active sonar system that uses a transducer array to send and receive acoustic pulses in swaths laterally from the tow-body or vessel, enabling it to quickly scan a large area in a body of water to produce an image of the sea floor beneath the tow-body or vessel.

Synthetic aperture sonar (SAS)

An active sonar system that produces high resolution images of the sea floor along the track of the vessel or tow body. SAS can send continuous sonar signals to capture images underwater at 30 times the resolution of traditional sonar systems, as well as up to 10 times the range and area coverage.

Underwater (wireless) sensor network

Network of sensors and autonomous/uncrewed underwater vehicles that use acoustic waves to communicate with each other, or with underwater sinks that collect and transmit data from deep ocean sensors, to enable remote sensing, surveillance and ocean exploration, observation and monitoring.

5. Advanced Weapons

Emerging or improved weapons used by military, and in some instances law enforcement, for defence and national security purposes. Advancements in materials, manufacturing, propulsion, energy and other technologies have brought weapons like directed energy weapons and hypersonic weapons closer to reality, while nanotechnology, synthetic biology, artificial intelligence and sensing technologies, among others, have provided enhancements to existing weapons, such as biological/chemical weapons and autonomous weapons.

6. Aerospace, Space and Satellite Technology

Aerospace technology refers to the technology that enables the design, production, testing, operation and maintenance of aircraft, spacecraft and their respective components, as well as other aeronautics. Space and satellite technology refers to technologies that enable travel, research and exploration in space, as well as weather-tracking, advanced PNT, communications, remote sensing and other capabilities using satellites and other space-based assets.

Advanced wind tunnels

Technological advancements in systems related to wind tunnel infrastructure. Existing facilities are used to simulate various flight conditions and speeds ranging from subsonic, transonic, supersonic and hypersonic.

On-orbit servicing, assembly and manufacturing systems

Systems and equipment that are used for space-based servicing, assembly and manufacturing. On-orbit servicing, assembly and manufacturing systems can be used to optimize space logistics, increase efficiencies, mitigate debris threats and to modernize space asset capabilities.

Payloads

Lower cost satellite payloads with increased performance that can meet the needs of various markets. This will require several technology improvements, such as light weight apertures, antennas, panels, transceivers, control actuators, optical/infrared sensor and multi-spectral imagers, to meet the growing demand and ever-increasing technical requirements.

Propulsion technologies

Components and systems that produce a powerful thrust to push an object forward, which is essential to launching aircraft, spacecraft, rockets or missiles. Innovations could range from new designs or advanced materials to enable improved performance, speed, energy-efficiency and other enhanced properties, as well as reduced aircraft production times and emissions. Examples include: electrified aircraft propulsion, solar electric propulsion, pulse detonation engines, nuclear thermal propulsion systems, nuclear pulse propulsion systems and nuclear electric propulsion systems, among others.

Satellites

Artificial or human-made, including (semi-)autonomous, objects placed into orbit. Depending on their specific function, satellites typically consist of an antenna, radio communications system, a power source and a computer, but their exact composition may vary. Continued developments have led to smaller satellites that are less costly to manufacture and deploy compared to large satellites, resulting in faster development times and increased accessibility to space. Examples include: remote sensing and communications satellites.

Space-based positioning, navigation and timing technology

Global Navigation Satellite System (GNSS)-based satellites and technologies that will improve the accuracy, agility and resilience of GNSS and the Global Positioning System (GPS).

Space stations

Space-based facility that can act as an orbital outpost while having the ability to support extended human operations. Space stations can be used as a hub to support other space-based activities including assembly, manufacturing, research, experimentations, training, space vehicle docking and storage. Examples of innovations in space stations could include the ability to extend further out into space or enhanced life support systems that can be used to prolong human missions.

Zero-emission/fuel aircraft

Aircraft powered by energy sources that do not emit polluting emissions that disrupt the environment or do not require fuel to fly. While still in early stages, these advances in powering aircraft could support cleaner air travel, as well as enable flight over greater distances and to remote areas without the need for refueling (for zero-fuel aircraft).

7. Artificial Intelligence and Big Data Technology

Artificial intelligence (AI) is a broad field encompassing the science of making computers behave in a manner that simulates human behaviour/intelligence using data and algorithms. Big data refers to information and data that is large and complex in volume, velocity and variety, and as such, requires specialized tools, techniques and technologies to process, analyze and visualize it. AI and big data technology may be considered cross-cutting given how important they are in enabling developments in other technology areas, including biotechnology, advanced materials and manufacturing, robotics and autonomous systems and others.

AI chipsets

Custom-designed chips meant to process large amounts of data and information that enable algorithms to perform calculations more efficiently, simultaneously and using less energy than general-purpose chips. AI chips have unique design features specialized for AI, which may make them more cost-effective to use for AI development.

Computer vision

Field of AI that allows computers to see and extract meaning from the content of digital images such as photos and videos. Examples of computer vision techniques include: image classification, object detection, depth perception and others.

Data science and big data technology

Enables the autonomous or semi-autonomous analysis of data, namely large and/or complex sets of data when it comes to big data technology. It also includes the extraction or generation of deeper insights, predictions or recommendations to inform decision-making. Examples include: AI-enabled data analytics, big data technology (i.e. data warehouse, data mining, data correlation) and predictive analytics.

Digital twin technology

Virtual representations of physical objects or systems that combine real-time sensor data, big data processing and artificial intelligence (namely machine learning) to create an interactive model and predict the object or system's future behaviour or performance. Advancements in digital twin technology could enable the growth and integration of an immersive digital experience (e.g. the metaverse) into daily life.

Machine learning (ML)

Branch of AI where computer programs are trained using algorithms and data to improve their decisions when introduced to a new set of data without necessarily being programmed to do so. Types of ML include: deep learning, evolutionary computation and neural networks.

Natural language processing

An area of AI that allows computers to process and make sense of, or 'translate', natural human language using speech and audio recognition to identify, analyze and interpret human voices and other types of audio. Examples include: syntactic and semantic analysis, tokenization, text classification and others, which enable capabilities like virtual assistants, chatbots, machine translation, predictive text, sentiment analysis and automatic summarization.

8. Human-Machine Integration

Human-machine integration refers to the pairing of operators with technology to enhance or optimize human capability. The nature of the integration can vary widely, with an important dimension being the invasive nature of the pairing.

Brain-computer interfaces

Interfaces that allow a human to interact with a computer directly via input from the brain through a device that senses brain activity, allowing for research, mapping, assistance or augmentation of human brain functions that could enable improved cognitive performance or communication with digital devices.

Exoskeletons

External devices or ‘wearable robots’ that can assist or augment the physical and physiological performance/capabilities of an individual or a group.

Neuroprosthetic/cybernetic devices

Implanted and worn devices that interact with the nervous system to enhance or restore motor, sensory, cognitive, visual, auditory or communicative functions, often resulting from brain injury. This includes cybernetic limbs or devices that go beyond medical use to contribute to human performance enhancement.

Virtual/augmented/mixed reality

Immersive technologies that combine elements of the virtual world with the real world to create an interactive virtual experience. An application of these technologies that several companies are developing is the ‘metaverse’ which is an immersive digital experience that integrates the physical world with the digital one and allows users to interact and perform a variety of activities like shopping and gaming, seamlessly in one virtual ecosystem. While still being explored, this could potentially translate into a digital economy with its own currency, property and other goods.

Wearable neurotechnology

Brain-computer interfaces that are wearable and non-invasive (i.e. do not need to be implanted). These wearable brain devices can be used for medical uses, such as tracking brain health and sending data to a doctor to inform treatment, as well as for non-medical applications related to human optimization, augmentation or enhancement, such as user-drowsiness, cognitive load monitoring or early reaction detection, among others.

9. Life Science Technology

Life science technology is a broad term that encompasses a wide array of technologies that enhance living organisms, such as biotechnology and medical and healthcare technologies.

Biotechnology

Biotechnology uses living systems, processes and organisms, or parts of them, to develop new or improved products, processes or services. It often integrates other areas of technology, such as nanotechnology, artificial intelligence, computing and others, to create novel solutions to problems, including in the area of human performance enhancement.

Biomanufacturing

Methods and processes that enable the industrial production of biological products and materials through the modification of biological organisms or systems. Advances in biomanufacturing, such as automation and sensor-based production, has led to commercial-scale production of new biological products, such as biomaterials and biosensors.

Genomic sequencing and genetic engineering

Technologies that enable whole genome sequencing, the direct manipulation of an organism's genome using DNA, or genetic engineering to produce new or modified organisms. Examples include: Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) and Next Generation Sequencing (NGS).

Proteomics

Large-scale and experimental analysis of protein, proteomes and proteome informatics. Proteomic applications can be used for the identification of unknown bacterial species and strains, as well as species level identifications of tissues, body fluids, and bones of unknown origin.

Synthetic biology

Combination of biology and engineering to create new biological entities, such as cells or enzymes, or redesign existing biological systems, with new functions like sensing or producing a specific substance. Synthetic biology is expected to enable advancements in many areas, such as antibiotic, drug and vaccine development, biocomputers, biofuel, novel drug delivery platforms, novel chemicals, synthetic food, and synthetic life.

Medical and Healthcare Technology

Medical and healthcare technology refers to tools, processes or services that support good health and prevent, or attempt to prevent, disease. Advances in biotechnology, nanotechnology and advanced materials are enabling new methods of delivering medicine or treating injuries, diseases or exposure to toxic substances.

Chemical, Biological, Radiological and Nuclear (CBRN) medical countermeasures

Various medical assets used to prevent, identify or treat injuries or illnesses caused by chemical, biological, radiological or nuclear (CBRN) threats, whether naturally-occurring or engineered. CBRN medical countermeasures include therapeutics to treat injuries and illnesses, such as biologic products or drugs, as well diagnostics to identify the threats.

Gene therapy

Use of gene manipulation or modification in humans to prevent, treat or cure disease, either by replacing or disabling disease-causing genes or inserting new or modified genes.

Nanomedicine

Use of nanomaterials to diagnose, monitor, prevent and/or treat disease. Examples of nanomedicine include nanoparticles for targeted drug delivery, smart imaging using nanomaterials, as well as nano-engineered implants to support tissue engineering and regenerative medicine.

Tissue engineering and regenerative medicine

Methods of regenerating or rebuilding cells, tissues or organs to allow normal, biological functions to be restored. Regenerative medicine includes self-healing, where the body is able to use its own tools or other biological materials to regrow tissues or cells, whereas tissue engineering largely focuses on the use of synthetic and biological materials, such as stem cells, to build function constructs or supports that help heal or restore damaged tissues or organs.

10. Quantum Science and Technology

Quantum science and technology refers to a new generation of devices that use quantum effects to significantly enhance the performance over those of existing, ‘classical’, technologies. This technology is expected to deliver sensing and imaging, communications, and computing capabilities that far exceed those of conventional technologies in certain cases, well as new materials with extraordinary properties and many useful applications. Quantum science and technology may be considered cross-cutting, given that quantum-enhanced technologies are expected to enable advancements or improvements in most other technology areas, including biotechnology, advanced materials, robotics and autonomous systems, aerospace, space and satellite technology and others.

Quantum communications

Use of quantum physics to enable secure communications and protect data using quantum cryptography, also know as quantum key distribution.

Quantum computing

Use of quantum bits, also known as qubits, to process information by capitalizing on quantum mechanical effects that allow for a large amount of information, such as calculations, to be processed at the same time. A quantum computer that can harness qubits in a controlled quantum state may be able to compute and solve certain problems significantly faster than the most powerful supercomputers.

Quantum materials

Materials with unusual magnetic and electrical properties. Examples include: superconductors, graphene, topological insulators, Weyl semimetals, metal chalcogenides and others. While many of these materials are still being explored and studied, they are promising contenders that could enable energy-efficient electrical systems, better batteries and the development of new types of electronic devices.

Quantum sensing

Broad of range of devices, at various stages of technological readiness, that use quantum systems, properties, or phenomena to measure a physical quantity with increased precision, stability and accuracy. Recent developments in applications of quantum physics identified the possibility of exploiting quantum phenomena as means to develop quantum radar technology.

Quantum software

Software and algorithms that run on quantum computers, enable the efficient operation and design of quantum computers, or software that enables the development and optimization of quantum computing applications.

11. Robotics and Autonomous Systems

Robotics and Autonomous Systems are machines or systems with a certain degree of autonomy (ranging from semi- to fully autonomous) that are able to carry out certain activities with little to no human control or intervention by gathering insights from their surroundings and making decisions based on them, including improving their overall task performance.

Molecular (or nano) robotics

Development of robots at the molecular or nano-scale level by programming molecules to carry out a particular task.

(Semi-)autonomous/uncrewed aerial/ground/marine vehicles

Vehicles that function without any onboard human intervention, and instead, are either controlled remotely by a human operator, or operate semi-autonomously or autonomously. Uncrewed vehicles rely on software, sensors and artificial intelligence technology to collect and analyze information about their environment, plan and alter their route (if semi- or fully autonomous), and interact with other vehicles (or human operator, if remotely-controlled).

Service robots

Robots that carry out tasks useful to humans that may be tedious, time-consuming, repetitive, dangerous or complement human behaviour when resources are not available, e.g. supporting elderly people. They are semi- or fully-autonomous, able to make decisions with some or no human interaction/intervention (depending on the degree of autonomy), and can be manually overridden by a human.

Space robotics

Devices, or ‘space robots’, that are able to perform various functions in orbit, such as assembling or servicing, to support astronauts, or replace human explorers in the exploration of remote planets.