

Innovative technologies are developed by the Canadian Space Agency (CSA) for the Canadian Space Program and many of these are available to industry for licensing. CSA's Commercialization Office has prepared this guide to highlight a number of exciting business opportunities for pioneering companies.

Companies who wish to explore market opportunities and develop business and commercialization plans for these technologies can apply to CSA's Technology Diffusion Program.

CSA plays a key role by investing in industry research and development. Agency programs support technologies in the advanced development to near-market stages and contribute to world-leading innovation in the space sector.

Approximately 80% of the CSA budget is contracted out for projects involving industry, universities, and specialized research institutes. Key indicators that CSA investment is working for Canada are seen in economic growth, skills development, partnership alliances, enhanced Canadian industrial competitiveness, and excellence in research and development. For more about the CSA, please visit www.space.gc.ca.

For more information on CSA programs or on any technology contained within this guide, please contact the CSA Commercialization Office. We look forward to discussing business opportunities for your organization.

Jean-Marc Chouinard
Head of the Commercialization Office
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CONTENTS

- 1 System and Method for Operator Training Control and Analysis Using Operator Mental Workload Measures as Feedback
- 2 Method of Establishing Communication through Free Space between a Pair of Optical Communication Devices
- 3 Multidimensional Data Compression in Real Time Using Vector Quantization: Three Technologies
- 4 A Zero-G Emulating Test Bed for Spacecraft Attitude/ Translation Control System
- 5 Dynamometer with Active Load for Testing Manipulator's Joint Prototypes
- 6 Design of a Load Cell with Large Overload Capacity
- 7 Identification and Torque/Force Control of Hydraulic Actuators
- 8 Adaptive Output Force Control of Hydraulic Cylinders
- 9 Adaptive Control of Harmonic Drives
- 10 High Sensitivity Fibre-Optic Sensor for Measurement and Control of Liquid Mixtures
- 11 Hybrid Power Panel/Hybrid Power Membrane
- 12 Autonomous Rendezvous Simulator (ARES)
- 13 Method of Damping Torque Rod Disturbances in Satellite Control System with Magnetometers and Torque Rods
- 14 Method of Asymmetrical Control of Satellite Attitude
- 15 Patented Technologies

The Business Opportunity

Operator performance reliability and effectiveness are key to the safety and success of complex systems that involve both human and machine operations. However, performance differs with each operator and depends on a number of factors including the operator's mental workload.

The innovative system and method are capable of assessing the performance, that is, the proficiency level, of the human operator in "human-in-the-loop" systems during initial training, recovery training, or ongoing operations. The system could also be applied to system usability analysis.



SYSTEM AND METHOD FOR OPERATOR TRAINING CONTROL AND ANALYSIS USING OPERATOR MENTAL WORKLOAD MEASURES AS FEEDBACK

THE TECHNOLOGY

The system characterizes the mental workload level of a human operator by analyzing the specific parameter of rapid eye movements during the performance of operational tasks. This information is used to assess the overall performance of the human operator during operation of the simulator or during on-the-job training.

COMMERCIAL POTENTIAL

This system could be useful in the modeling, simulation, and training market as either an integral part of, or an adjunct to, a full functionality, dynamic, real-time operator training simulator.

The system can be applied to the performance assessment of operators of complex vehicles. These would include civil and military aircraft pilots, astronauts, tugboat operators, and heavy construction vehicle operators as well as operators of heavy industrial equipment, such as cranes. It is also applicable to operators of complex industrial facilities, such as nuclear and fossil power station operations, chemical plants and refineries, gas and oil exploration rigs, refuse incineration plants, and pulp and paper facilities. Furthermore, this technology has wide-ranging applications in the fields of education, sports, and medicine.

Technology Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50715.

Commercialization Contact

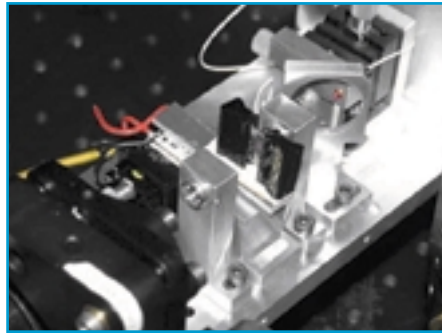
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The Business Opportunity

This communications technology can be applied to various types of optical systems such as commercial terrestrial free space optical (FSO) communications and intersatellite and satellite-to-ground optical communications. It offers all-optical beam steering and automatic pointing-correction mechanisms, eliminating the need for opto-mechanical beam control and computer-aided beam-addressing subsystems that limit the link transmission bit rate and operability in both intersatellite and ground optical communications.

This technology provides stable, high bit rate communications between moving parties—near or far—and reduces the complexity, cost, weight, and power requirements of fine light-beam control subsystems.



METHOD OF ESTABLISHING COMMUNICATION THROUGH FREE SPACE BETWEEN A PAIR OF OPTICAL COMMUNICATION DEVICES

THE TECHNOLOGY

There are difficulties with FSO communications links, whether on Earth or in space, such as the alignment of the light beam among the communicating elements, and the performance of the enabling subsystem for beam pointing, acquisition and tracking. This method addresses these issues, and can improve the performance and design of automatic beam-tracking systems. Any optical communications system, including conventional optical fibre and terrestrial FSO communication systems, include beam handling/addressing modules ("cross"). Solving some of today's FSO high bit-rate issues—in particular, pointing signal beams to a moving party or feeding the signal beam into a fibre—require sophisticated electromechanical and computing subsystems. This invention is based on a non-linear, all-optical beam handling concept, which eliminates the need for separate electromechanical and computer subsystems to maintain fine control of the optical communication beam. Furthermore, this technology allows self-aligning, automated feeding of high bit rate optical signals into fibres. It provides for high-speed optical communications between two or more stationary or fast-moving parties over short or great distances.

COMMERCIAL POTENTIAL

In addition to FSO (including intersatellite) communications, there are potential applications for this technology in the design and implementation of high-speed optical switches for use in terrestrial fibre-optic communication networks.

Use of this technology on the ground could lower the cost of terrestrial systems, increase transmission speed, extend range of high data rate links, and improve service quality (availability). For satellite communications, this technology is competitive because it can radically improve the stability and performance of satellite-borne optical communications links while reducing their complexity.

Technology Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50561.

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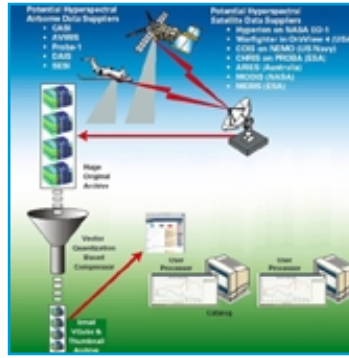
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The Business Opportunity

These are technologies for data compression of a continuous flow of multidimensional data in real time using vector quantization. Originally created for use on limited hardware, such as onboard a hyperspectral satellite, these three inventions are improvements upon existing, patented CSA technologies. The three are related but are undergoing patent protection separately as, first, "method and system for compressing a continuous data flow in real time using recursive hierarchical self-organizing cluster vector quantization" (Recursive HSOCVQ); second, "method and system for compressing a continuous data flow in real time using cluster successive approximation multi-stage vector quantization" (Cluster SAMVQ); and third, "data compression engines and real-time wideband compressor for multi-dimensional data.

The technologies were developed for facilitating hardware fabrications of existing patented technologies, to allow data compression technology to be implemented with limited hardware, which can be costly. They also significantly reduce computational complexity for software. Therefore, these innovations are competitive because they require fewer hardware and software resources to perform near-lossless data compression.



MULTIDIMENSIONAL DATA COMPRESSION IN REAL TIME USING VECTOR QUANTIZATION: THREE TECHNOLOGIES

THE TECHNOLOGY

The original inventions, on which these three technologies are based, have been patented in the United States with issue numbers: 6,546,146, 6,724,940, and 6,701,021. They apply near-lossless data compression to a data cube. The disadvantages are that this requires large storage capacity, and that it takes time to create such a data cube for a satellite. Moreover, a satellite requires massive hardware to compress a data cube. These three new technologies not only resolve these disadvantages but also improve the compression performance with higher compression ratio, improved data fidelity, and faster processing time. The resilience of the compression technologies to single bit errors has also been explored in all three technologies.

COMMERCIAL POTENTIAL

This invention results from the development of the spaceborne data compressor for three-dimensional hyperspectral imagery in real time onboard a satellite. It provides a method and system for near-lossless data compression of a continuous data flow with a high compression ratio, high data throughput, and information preservation.

For fields with data of three or more dimensions and vector correlation, these technologies have applications in areas such as airborne/space-borne hyper-spectral imaging, and medical imaging (CAT scans and MRI).

Technology Transfer Details

Commercialization licenses for the multi-dimensional data compression technologies are available, either together or separately.

These opportunities may be referred to by the CSA case IDs: 50690 (Recursive HSOCVQ), 50691 (Cluster SAMVQ), and 50692 (Data compression engines).

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The Business Opportunity

In the aerospace industry, there is a well-defined need to test and verify spacecraft attitude/translation control systems while all components are integrated. The risks associated with faulty components and the faulty integration of such a complex system is high. Failure is costly.

This zero-gravity emulating test bed can provide an efficient facility for verification and testing of a spacecraft control system after all components have been integrated.



A ZERO-G EMULATING TEST BED FOR SPACECRAFT ATTITUDE/TRANSLATION CONTROL SYSTEM

THE TECHNOLOGY

This technology is used for zero-gravity emulation of a spacecraft in an Earth laboratory environment (1 g) using a controlled manipulator which holds a flight spacecraft or satellite. The control system changes the dynamic behaviour of the testing spacecraft to emulate the behaviour of the target spacecraft in orbit. Such an arrangement also makes it possible not only to be able to scale the inertia of the testing spacecraft, but also to create the motion perturbation induced by the flexible element of flight spacecraft, even if test spacecraft lack such elements.

COMMERCIAL POTENTIAL

The greatest challenge in implementing a control system for spacecraft is that ground-based testing must take place in a 1-g environment, whereas the eventual hardware will operate in a zero-g environment. Present research shows that this innovation is of vital importance to be able to test and validate the system performance under realistic conditions and through maximum usage of hardware. This technology has the potential to significantly improve the reliability of operational performance of satellite attitude/translation control systems in orbit.

Adoption of the invention could confer comparative, competitive advantages by improving the design and effectiveness of terrestrial testing of satellite attitude/translation control systems.

A receptor company could apply this technology to: testing attitude control systems (ACS) of commercial satellites; investigating the disturbance effect of a deployment mechanism (e.g. solar panel or antenna) of commercial satellites; and testing the gas-jet propulsion system and translation control system of free-flying inspection robots, constellation satellites, and orbital formation satellites.

Technology Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50689.

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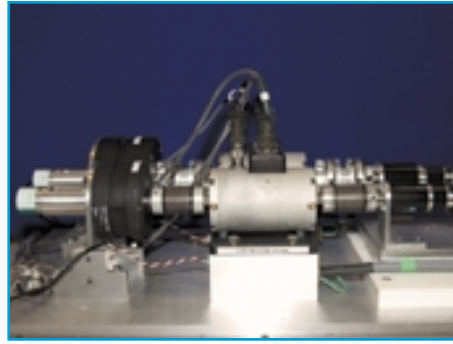
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The Business Opportunity

The need for new actuators in robotics and automation is pervasive. However, any newly developed actuator must undergo extensive mechanical, electrical, control and thermal tests. Currently, actuator tests can be performed on a robot prototype built with the newly developed actuators. However, the prototyping process is expensive, inflexible, and not applicable for space robots, since they do not operate in the thermal and gravity conditions of Earth.

This invention is for a specialized test-bed facility that develops and tests electromechanical actuators for robotics and automation applications. Its design innovations allow for less expensive and more cost-effective development and testing of actuators.



DYNAMOMETER WITH ACTIVE LOAD FOR TESTING MANIPULATOR'S JOINT PROTOTYPES

THE TECHNOLOGY

A product derived from this invention could be used as a development tool for manufacturers of electromechanical actuators for robotics applications, in various industrial sectors. The mechanical load of a mechatronics system can be replaced with an active load system and the actuators of a mechatronics system can be tested before the rest of the mechanical system is fabricated.

COMMERCIAL POTENTIAL

The demand for development of new actuators for mechatronics systems is established and growing. Yet prototyping of the complete system for testing is often an expensive and inflexible process. A product derived from this invention would be a cost-effective replacement for traditional prototyping.

This invention is for a facility for testing space or terrestrial robot actuators under their end-use thermal and mechanical conditions. Unlike the conventional dynamometer, which has a brake to apply friction torque, this invention uses active load that generates the torque dynamics of a target manipulator.

Technology

Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50706.

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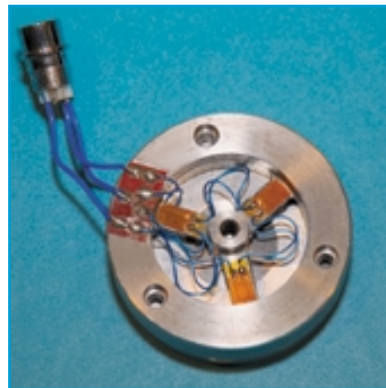
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The Business Opportunity

The overload capacity of the commercial load cell is not high enough for many industrial and laboratory applications. Therefore, in practice, an oversized sensor is used to increase the margin of overload safety. However, the larger sensors are usually less accurate.

This invention has an overload capacity several times that of a sensor. This is its competitive advantage. It could ensure that sensors will not break when overloaded and that load cells do not require recalibration or replacing after overload testing.



DESIGN OF A LOAD CELL WITH LARGE OVERLOAD CAPACITY

THE TECHNOLOGY

Load cells (force sensors) are fragile devices. Commercially available load cells generally have an overload capacity up to one and a half times full-scale range. Exceeding this limit damages the sensor structure. This load cell provides large overload protection capacity without compromising the sensitivity or affecting the characteristics of the sensor. A special design feature is that it becomes virtually rigid after the sensor flexures reach their maximum deflection.

COMMERCIAL POTENTIAL

This sensor features high stiffness and good extraneous load rejection that makes it ideal for robotic laboratories. It is mainly for the single-point load cell type.

Commercial load cells are widely used in the aerospace, agriculture, automotive, aviation, construction, forestry, freight transportation, maritime, mining, and waste management markets. These devices are embedded in industrial-weighing and materials-handling equipment in dynamic and stationary weighing systems, load-handling and moving systems, measurement devices, instrumentation, and operations control and information systems.

Technology Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50705.

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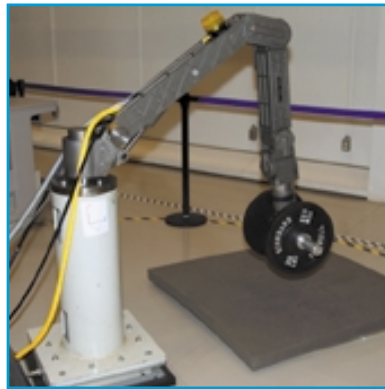
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The Business Opportunity

In practice, it is difficult to control a hydraulic actuator precisely—and, thus, also a mechatronic system—because the force/torque generated by the actuator is affected by the actuator's own motion and that of the load. This technology innovation allows rotary and linear hydraulic actuators to generate a precise amount of torque, regardless of the actuator motion.

Commercial hydraulic actuators incorporating the invention will improve in performance significantly where high torque/force and precise control are required, such as in industrial robotics and automation. In certain applications, this invention would have a competitive advantage over existing hydraulic actuators in the marketplace.



IDENTIFICATION AND TORQUE/FORCE CONTROL OF HYDRAULIC ACTUATORS

THE TECHNOLOGY

This invention employs sensors to measure selected physical variables of an operating hydraulic actuator for identification and control purposes. The commercial product derived from this invention would use a hydraulic actuator with additional sensors (that is, a pressure transducer and motion sensors to capture position and velocity) and a controller with embedded proprietary software. The actuator would be part of an industrial system with sufficient onboard processing hardware to accommodate the controller.

COMMERCIAL POTENTIAL

This technology is a combined scheme of identification and torque control for rotary hydraulic actuators. It can readily be applied to linear hydraulic actuators.

Hydraulic actuators are widely used in industrial applications such as robotic manipulators, forestry, earth moving, mining, material handling, construction sites, and manufacturing automation where large power-to-mass ratio is required.

Technology Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50719.

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The Business Opportunity

Canadian Space Agency engineers have developed an innovative method for the emulation of electrical actuation by using hydraulic actuators for robotic systems. From this invention a commercial product could be created that has a control algorithm, including a software package. It also offers a sophisticated parameter tuning procedure for adaptive control of hydraulic actuators and ancillary equipment for robotic applications.

It can be used to significantly increase the output force control performance of hydraulic actuators by compensating 95% of the piston friction. It has applications for both free-motion and contact tasks.



ADAPTIVE OUTPUT FORCE CONTROL OF HYDRAULIC CYLINDERS

THE TECHNOLOGY

Commercial hydraulic actuator testing systems are available and in-house designed hydraulic testing systems are employed in the industry. Furthermore, test beds for hydraulic actuators have been developed for research purposes in universities. However, these commercial and research test systems do not seem to use an approach based on the adaptive output force control of hydraulic cylinders. This technology establishes the dynamic equivalency between electrically driven motors and hydraulically driven cylinders.

COMMERCIAL POTENTIAL

The demand for hydraulic actuators is established and growing. They are used in a variety of industrial applications.

The product derived from this innovation may be in the form of a software module together with a sophisticated parameter tuning procedure; it would be implemented by the end-user within the user's test facility. Alternatively, it could be a fully functional test bed with load sensors, electronic cabling, microprocessors, displays, software, and ancillary mechanical elements. This test bed could support and drive the actuator during testing and automatically implement the testing procedures.

Technology Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50699.

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The Business Opportunity

Harmonic drives are widely used in robotic applications due to their compactness and ease of use. However, performance is always limited because of friction and flexibility issues.

This innovative adaptive controller is able to take into account the flexspline dynamics, to compensate for the friction, and to handle the uncertainties of dynamic parameters simultaneously. It would confer competitive advantage to a harmonic drive manufacturer with its improved motion and torque control performance, particularly for demanding robotic applications.



ADAPTIVE CONTROL OF HARMONIC DRIVES

THE TECHNOLOGY

This innovation significantly improves the control performance of harmonic drives by using a proprietary control algorithm (that is, software and a sophisticated parameter tuning procedure) together with a flexspline torque sensor. The conventional adaptive controller is modified to use torque sensor measurements and has been tested on four types of harmonic drives.

This technology can be easily incorporated with the motion/force control of robot manipulators based on either the torque control interface, or the virtual power flow principal that defines each dynamic coupling between a joint and a robot.

COMMERCIAL POTENTIAL

Various technologies are currently used to control harmonic drives in industrial applications. Each of these technologies has limitations that result in imperfect robotic motion control performance.

This invention offers a competitive control system for harmonic drives that are used in robotics and mechatronic systems.

Harmonic drives are used to control motion in applications requiring precise positional accuracy and repeatability, such as in precision machining, factory automation, robotics, and aerospace applications.

Technology

Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50718.

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The Business Opportunity

Refractometers are precision optical instruments designed to measure fluid concentration in liquid mixtures. A commercial product derived from this technology could be used for real time, on-line detection and measurement of liquid concentrations. The invention could have applications in various sectors, including spacecraft propulsion systems, heating, ventilation, and air conditioning (HVAC) applications, industrial process control, and medical applications where high precision on-line fluid concentration measurements are required. With an easily-operated, flexible, miniaturized, liquid-concentration sensor this robust technology is poised to meet the increasingly competitive demands of these industries.



HIGH SENSITIVITY FIBRE-OPTIC SENSOR FOR MEASUREMENT AND CONTROL OF LIQUID MIXTURES

THE TECHNOLOGY

This innovative fibre-optic sensor is based on a simple miniaturized concept. It has much greater sensitivity and reliability when compared to current fibre-optic refractometers. A prototype of the sensor has been built and tested by the inventors. The creation of the final product will require the development of a system that includes a housing for the instrument with signal calibration and display.

COMMERCIAL POTENTIAL

The demand for simple, reliable, sensitive on-line liquid concentration measurement is increasing. Far exceeding existing off-line or batch measuring systems in convenience and precision, this compact technology can be used in on-board propulsion systems for space applications, in HVAC systems in the building, industrial process control, and medical sectors, where reliability is a high priority.

Refractometers are widely used in industrial applications: food and beverage production, chemical and petrochemical processing, automotive manufacturing, air conditioning industries, pulp and paper production, monitoring antifreeze/water solutions, monitoring battery acid, monitoring chemical migration through soil, aircraft de-icing, measuring water soluble oils in machine tool coolant, high-end ink jet printing, controlling the concentration of methanol in fuel cells, and pollutant monitoring in ground surrounding landfills, gas stations and chemical storage depots.

Technology Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50568.

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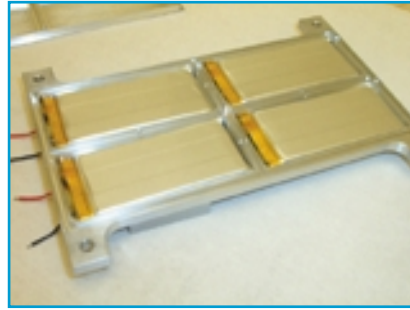
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The Business Opportunity

Commercial solar power technology requires the consumer to purchase the components separately. Moreover, many of the currently available products are incompatible with one other. Therefore, assembling the products into a working and safe system requires electrical and mechanical skills. The hybrid power panel/hybrid power membrane (HPP/HPM) developed by the Canadian Space Agency would solve this problem by packaging batteries, photovoltaic cells, and charge–discharge electronics all in a single, lightweight structure. Thus, solar power technology would become more accessible.

This innovation provides a power source that is compact, lightweight, low-cost, stand-alone, and has a high power density. It could be used by a variety of off-grid consumers and it has commercial and military applications.



HYBRID POWER PANEL/HYBRID POWER MEMBRANE

THE TECHNOLOGY

The HPP/HPM was devised for the commercial micro- and small-satellite market. It has application for multifunctional, onboard, compact, lightweight solar power arrays. However, the invention also has potential for non-space uses as a portable, compact, solar powered, photovoltaic power panel for off-grid consumer/commercial applications in the form of a stand-alone structural panel comprising rechargeable battery cells, photovoltaic cells, and inter-connect circuitry. A prototype is undergoing development at the CSA.

COMMERCIAL POTENTIAL

This technology integrates rechargeable battery cells, photovoltaic cells, charging/discharging electronics and support, into a single, lightweight panel for off-grid consumer/commercial applications. It is its novel method of integrating the packaging that gives this technology its competitive advantage.

The off-grid solar power market represents a commercial opportunity. Off-grid industrial systems are widely used for remote and stand-alone commercial applications such as in unmanned telecommunications installations, navigation systems, traffic signals, weather or pollution monitors, remote lighting, and wastewater treatment plants. Off-grid consumer systems are inhabited sites that do not have practical access to the power grid such as cabins, clinics, farms, as well as portable electronic devices.

Technology Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50702.

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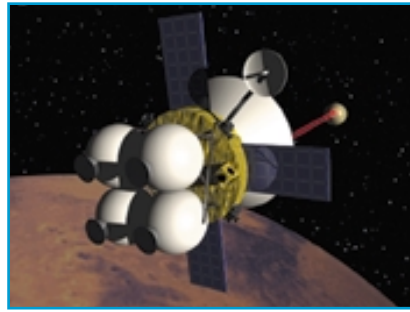
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The Business Opportunity

The United States has been performing shuttle–station rendezvous for many years, but has always operated from ground control or through direct control by an astronaut.

The autonomous rendezvous simulator (ARES) by the Canadian Space Agency solves this problem by performing the navigation, guidance and, potentially, control required for the autonomous rendezvous of two spacecraft in orbit based on lidar ("light detection and ranging") observations. No commercial product like this is currently available, although there is commercial interest in the development of a product for the emerging in-orbit spacecraft servicing industry.



AUTONOMOUS RENDEZVOUS SIMULATOR (ARES)

THE TECHNOLOGY

This invention is for a software/simulator that performs the navigation, guidance and control operations required for the autonomous final rendezvous of two spacecraft in orbit using scanning lidar rangefinder data. Final rendezvous operations typically start when spacecraft are a few kilometres apart, within the operating range of the scanning instrument—in this case, lidar. The product derived from this invention comprises Matlab/Simulink-based simulation software capable of processing lidar observations, a navigation module to determine the relative motion between the two spacecraft, and the guidance and control module to compute and execute manoeuvres for a rendezvous between an approaching spacecraft and a target satellite.

COMMERCIAL POTENTIAL

The in-orbit spacecraft service market is emerging within the space industry. It is in its early development phase, and currently, there is no entity for the in-orbit servicing of satellites.

ARES has immediate applications in the early-stage development phase of various government and commercial development programs. It is directly and immediately applicable to the development of systems for robotic, autonomous, in-orbit refuelling and reconfiguration of satellites.

Technology

Transfer Details

A commercialization license for this technology is available.

This business opportunity may be referred to by its CSA case ID: 50712.

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The Business Opportunity

This is a method for reducing magnetic disturbances in satellite attitude control systems which employ torque rods and magnetometers—many military, commercial, and scientific satellites use this attitude control system design. Magnetic residuals (hysteresis effects) remaining in the torque rod cores may affect the operation of the magnetometer adversely. This causes parasite feedback that can lead to oscillations in the attitude of the satellite and may significantly degrade the pointing accuracy of the satellite. The implications of the problem depend on the attitude control system design.

This innovative method greatly improves the performance of the attitude control system and pointing accuracy of the satellite. Thus, it could be valuable for satellites that require high-performance attitude control systems.



METHOD OF DAMPING TORQUE ROD DISTURBANCES IN SATELLITE CONTROL SYSTEM WITH MAGNETOMETERS AND TORQUE RODS

THE TECHNOLOGY

This invention is an algorithm (that is, attitude system software) that compensates for residual magnetic effects in the torque rods and avoids resonance effects within the attitude control system by determining non-resonance parameters. It protects satellite control systems from the negative effects of magnetic residuals in torque rods.

COMMERCIAL POTENTIAL

The invention is applicable to commercial imaging or low Earth orbit (LEO) weather satellites with attitude control systems employing torque rod and magnetometer devices.

The invention significantly improves the performance of the attitude control system and pointing accuracy of the satellite. Potential customers are satellite manufacturers who require high fidelity in attitude pointing and have experienced attitude control anomalies due to magnetic disturbances. Satellite operators who wish to improve performance in flight by uploading modified software can also use the invention.

Technology Transfer Details

A commercialization license for this innovative technology is available.

This business opportunity may be referred to by its CSA case ID: 50710.

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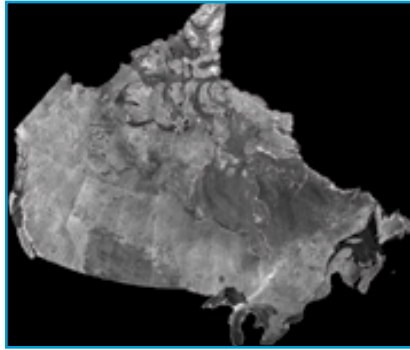
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The Business Opportunity

This invention is for designing high-precision satellites with three-axis attitude control systems. It replaces the momentum wheel by magnetic torque rods; alternatively, the control law is reconfigured in flight, so that the torque rod, rather than the momentum wheel, controls attitude in one axis. Replacement of the momentum wheel with a magnetic torque rod, which is much less prone to failure, significantly extends the operating life of the satellite while maintaining pointing accuracy.

Incorporated into the design of high precision, momentum-biased systems for low Earth orbit (LEO) satellites, this will reduce cost and complexity and increase operational life. Potential customers are satellite designers and manufacturers.



METHOD OF ASYMMETRICAL CONTROL OF SATELLITE ATTITUDE

THE TECHNOLOGY

The high-speed momentum wheel is susceptible to failure, and the result is loss of attitude control for the satellite. The maximum expected life of a momentum wheel is about five years. Currently, redundant wheels are included in the design, resulting in a satellite that's heavy, complex, and expensive. This innovation eliminates the momentum wheel while maintaining high-precision control.

COMMERCIAL POTENTIAL

Potential demand for this invention is with manufacturers of satellites that use high precision, momentum-biased, satellite attitude control systems.

Satellite manufacturers who require high fidelity in attitude pointing and have experienced attitude control anomalies are potential customers. Satellite operators who wish to prolong satellite life after a momentum wheel failure would be able to do so by uploading the modified software this invention offers. Designers and operators of commercial imaging or low Earth orbit satellites for weather would find this innovative technology useful. It would be of particular benefit to the emerging market in optical communication (lasercom) satellites that require precise pointing to maintain intersatellite and satellite-to-ground communication links.

Technology Transfer Details

A commercialization license for this satellite attitude control technology is available.

This business opportunity may be referred to by its CSA case ID: 50711.

Commercialization Contact

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PATENTED TECHNOLOGIES

The Canadian Space Agency (CSA) owns a number of technologies not described in this guide that are patented in Canada and the United States. Copies of the patents are available at the Canadian Intellectual Property Office and the United States Patent and Trademark Office.

Some of these may already be licensed to companies. Therefore, please contact the CSA Commercialization Office for more information about licensing these technologies.

Technologies patented in Canada

Protection title	Issue date	Canadian patent number
Pressure sensor based on illumination	22/06/2004	2226137
System and method for modulating a carrier frequency	16/12/2003	2165420
Topological and motion measuring tool	02/12/2003	2284085
Interface for orbital replacement units	06/05/2003	2069425
Vision system and proximity detector	08/04/2003	2195359
Mechanism for control of position and orientation in three dimensions	01/01/2002	2176899

Technologies patented in the United States

Protection title	Issue date	U.S. patent number
System and method for encoding multidimensional data using hierarchical self-organizing cluster vector quantization	20/04/2004	6,724,940
System and method for encoding/decoding multidimensional data using successive approximation multi-stage vector quantization	02/03/2004	6,701,021
Method and apparatus for automatically inoculating culture media with bacterial specimens from specimen containers	09/09/2003	6,617,146
Advanced ship autopilot system	26/08/2003	6,611,737
Distance tracking control system for single pass topographical mapping	13/05/2003	6,563,130
Topological and motion measuring tool	13/05/2003	6,563,107
System for interactive visualization and analysis of imaging spectrometry	08/04/2003	6,546,146

Protection title	Issue date	U.S. patent number
datasets over a wide-area network		
Intrinsic console with positionable, programmable, multi-function, multi-position controllers	25/03/2003	6,538,637
Vibration control apparatus	31/12/2002	6,501,203
Mid-spatial frequency digital boost filter	22/01/2002	6,341,181
Isokinetic resistance apparatus	31/07/2001	6,267,709
Topological and motion measuring tool	03/10/2000	6,127,672
Satellite attitude sensor using thermal imaging*	23/05/2000	6,066,850
Pressure sensor based on illumination of a deformable integrating cavity	29/06/1999	5,917,180
Mechanism for control of position and orientation in three dimensions	08/12/1998	5,847,528
Soft docking interface	08/09/1998	5,803,751
Rotational torque sensor	07/10/1997	5,675,095
Four-degree-of-freedom manipulator	07/10/1997	5,673,595
System and method for modulating a carrier frequency	07/01/1997	5,592,131
Article converging/diverging, chamfered walls gripping anvils	27/02/1996	5,494,325
Bifurcated, orbital replacement unit interface	17/10/1995	5,458,384
Tether and foot restraining device, securing handrail bracket	07/03/1995	5,395,083

* This patent is jointly owned by the Canadian Space Agency, Centre for Research in Earth and Space Technology, and Thomson-CSF Optronics Canada, Inc.