

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.

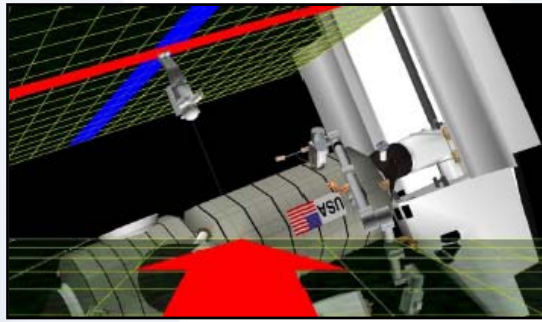
For more information on CSA programs or on any technology contained within this guide, please contact the CSA Commercialization Office. We look forward to discussing business opportunities for your organization.

Jean-Marc Chouinard
Head of the Commercialization Office
Canadian Space Agency

Contents

1	BORIS (Basic Operational Robotic Instructional System)
2	Cortex, a Software Toolbox for On-Board Reactive Autonomy Using Hierarchical Finite State Machines (HSFM)
3	Four Degree of Freedom Manipulator
4	GPS/Galileo Interoperable Navigation Receiver
5	Inference Techniques for Diagnosis Based on Set Operations
6	An Efficient Algorithm for Computer Simulation of Constrained Mechanical Systems
7	Intelligent Friction Compensation (IFC) Techniques
8	Light Beam Modulator
9	Low Voltage Piezoelectric Positioning System for Space Optics (LVPZT)
10	Mechanism for Control of Position and Orientation in 3D
11	System for Autonomous Training
12	Method for Evaluating Vestibular Response
13	Multidimensional Real-Time Data Compression Using Vector Quantization: Three Technologies
14	Adaptive Self-Tuning Controller of Manipulators Using Uncalibrated Joint Torque Sensing
15	Multi-Polarimetric SAR Products for Operational Sea-Ice Monitoring
16	Photosolubilization of Polymer Films
17	Protein Crystal Growth Facility
18	SAR Polarimetric Post Processor (SARP3)
19	A Stirrup Assembly For Securing a Cargo
20	Satellite Attitude Sensor Using Thermal Imaging
21	Symofros Software
22	System for Interactive Visualization and Analysis of Imaging Spectrometry Datasets over a Wide-area Network
23	Vision Skin Technology
24	Operator Training Control and Analysis Using Operator Mental Workload Measures as Feedback
25	Method of Establishing Communication through Free Space between a Pair of Optical Communication Devices
26	Zero-G Emulating Test Bed for Spacecraft Attitude/ Translation Control System
27	Dynamometer with Active Load for Testing Manipulator's Joint Prototypes
28	Method of Asymmetrical Control of Satellite Attitude
29	Design of a Load Cell with Large Overload Capacity
30	Identification and Torque/Force Control of Hydraulic Actuators
31	Adaptive Output Force Control of Hydraulic Cylinders
32	Adaptive Control of Harmonic Drives
33	High Sensitivity Fibre-Optic Sensor for Measurement and Control of Liquid Mixtures
34	Hybrid Power Panel/Hybrid Power Membrane
35	Autonomous Rendezvous Simulator (ARES)
36	Method of Damping Torque Rod Disturbances in Satellite Control Systems
37	Advanced Ship Autopilot System (ASAS)
38	Laser Camera System (LCS) and Advanced Space Vision System
39	High Speed Proximity Tracking Control System
40	Hollow Bore Optical Rotary Joint Technology
41	Method and Apparatus for Automatically Inoculating Culture Media With Bacterial Specimens (InocuLAB)
42	Smart Structures
43	Selective Application of Weed Control Chemicals
44	Very Short Range Radar Vision System based on Phase-Array Antenna Technology
45	Optimized Methodology for Groundwater Mapping using RADARSAT-1 Imagery
46	Object Recognition and Pose Estimation Software Toolkit

47	Scanning Laser Ranging/Imaging System
48	Small Cell Lithium Ion (Li-Ion) Batteries
49	TMG Thermal Analysis Tool
50	Spacecraft Attitude Determination Using Dyad Method
51	Tactile and Proximity Sensors
52	Integrated Miniature Optical Spectrometer
53	Plasma Processing Facility for Large Substrates
54	Patented Technologies



The Business Opportunity

The Basic Operational Robotic Instructional System (BORIS) Simulator was developed to support Generic Robot Training (GRT) course requirements.

The invention provides a competitive advantage by reducing costs and timeline requirements associated with the development of complex system simulations. Moreover, reliance on generic PC's affords wider access to these simulations to the public. Additional novelties include the portability of the robotic simulator, customizable software configurations, and a distributable Graphical User Interface (GUI.)

BORIS (Basic Operational Robotic Instructional System)

The Technology

The BORIS simulator is composed of three distinct modules: a Graphical User Interface (GUI), a visual renderer, and a simulator. The robot is located in a virtual cargo terminal in space, and handles payloads attached to standard palettes using 6 degrees of freedom. Fixed and pan-tilt cameras located on the robot and in the environment allow the operator to maneuver the robot, which may be controlled in joint or Cartesian mode by using a pair of hand-controllers. The GUI allows the operator to monitor data such as the robot joint position, end-effector position, and safety status.

Commercial Potential

Commercial products for training and educational purposes represent very real spin-off opportunities for this technology:

- Training of machine operators (e.g. mining, forestry, construction, nuclear, etc.);
- Training and teleoperation for robots, planetary and undersea exploration, and telemedicine;
- Education and entertainment (e.g. computer games, interactive simulators for science and educational centers, etc.); and
- Training and teleoperation for anti-personnel mine removal, ammunition disposal, and law enforcement.

Technology Transfer Details

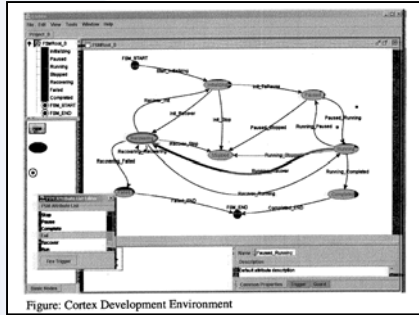
A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50566

Commercialization Contact

Commercialization Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

Autonomous machines such as space robots, satellites, and unmanned vehicles require on-board autonomy to deal with situational uncertainties. However, existing solutions fail to provide a stable, user-friendly environment with all of the necessary features to address this problem of reactive autonomy.

CORTEX allows for the creation and seamless assembly of modular state machines, the capacity to dynamically load states at run-time, and an integrated environment to create, test, execute, and monitor FSMs. This invention eliminates the development time dedicated to low-level implementation of logic and removes the requirement for detailed knowledge of software engineering practices.

Cortex, a Software Toolbox for On-Board Reactive Autonomy Using Hierarchical Finite State Machines (HSFM)

The Technology

The subject invention provides an integrated development environment for the development, testing, debugging, execution, and monitoring of Hierarchical Finite State Machines (HSFM). Users are able to assemble a series of logic rules in on-board software to encode reactionary complex behaviors to various discrete events. It also offers automatic generation of clean, efficient, and stand-alone FSM implementation source code, including the automatic generation of HTML format documentation.

Commercial Potential

Potential commercial applications exist where on-board reactive autonomy is required. These applications include, but are not limited to, the following:

- Autonomous land vehicles for military and civilian applications (i.e. military and disaster intervention robotics, humanitarian de-mining, among other applications);
- Mining automation and other service robotics applications such as forestry, agriculture and infrastructure maintenance;
- Space robotics (including planetary and orbital applications); and
- Autonomous satellites, unmanned vehicles.

Technology Transfer Details

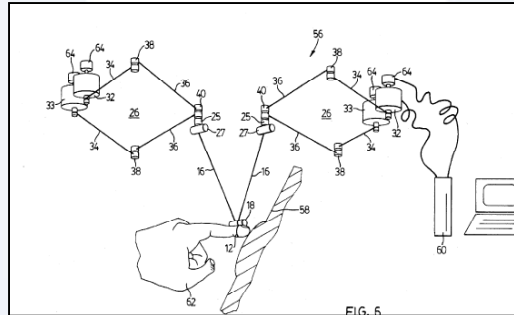
A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50736

Commercialization Contact

Commercialization Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

There are many applications for manipulators in which the position and orientation of an end-piece must be controlled.

The *Four Degree-of-Freedom Manipulator* provides a number of advantages over alternative solutions. Firstly, the number of parts (including joints) is fewer. When coupled with the nature of the arrangement of the positioning mechanisms, the chance of mechanical interference is reduced, increasing system reliability. The manipulator has high rigidity and therefore higher bandwidth and greater positioning repeatability than that offered by prior art serial mechanisms.

Four Degree of Freedom Manipulator

The Technology

Developed in 1995 and currently patented in the United States, the *Four Degree-of-Freedom Manipulator* represents a four-degree of freedom manipulator comprising a pair of elongate rigid legs connected by a joint, which acts as an end-effector. The position and orientation of the end-piece are controlled in a three-dimensional space with one axis of rotation. Actuators are located at the base and are stationary, thereby reducing the mass and inertia of the system and providing for greater payload capacity and potential speed.

Commercial Potential

The main commercial applications for this technology are those applications relating to robotics, hand controllers (control of aircraft, robotic manipulators, and mechanical systems in general), haptic devices, and force-reflecting mechanisms. These devices are used in a variety of further application domains, including robotic applications, automated industrial applications, and virtual reality applications.

Technology Transfer Details

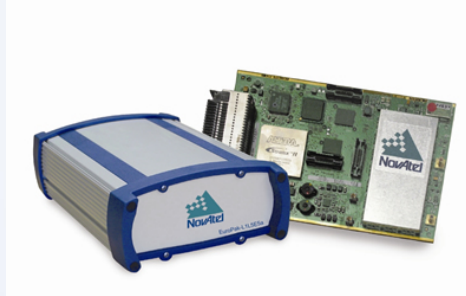
A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50377

Commercialization Contact

Commercialization Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

The subject invention provides competitive advantage in that it achieves improved signal reliability coverage by combining the GPS and Galileo systems. The user of the combined GPS/Galileo navigation receiver will have access to improved positioning accuracy, integrity, and reliability due to the larger number of visible satellites, and the advanced signal structure to be broadcast by Galileo. Multi-frequency GPS/Galileo receivers will have additional advantages including faster and more reliable carrier phase ambiguity resolution, and mitigation of common mode failures through the use of separate frequencies.

GPS/Galileo Interoperable Navigation Receiver

The Technology

The European Commission and the European Space Agency (ESA) are developing a new Global Navigation Satellite System (GNSS) known as Galileo, which will operate alongside GPS. GNSS receives signals transmitted by navigation satellites and uses them for accurate position, velocity, and time determination. The Galileo system is designed to be interoperable with the current US Global Positioning System (GPS), which represents the principal satellite navigation system in use today, transmitting signals from a constellation of 27 satellites orbiting at an altitude of 20,000 km in space. The technology offers a receiver capable of receiving signals from both GPS and Galileo Systems.

Commercial Potential

The improved performance, availability, reliability and integrity will be important for all market areas currently using GPS receivers. These include personal and vehicle guidance, safety of life receivers for airborne, land and sea, precise timing applications, surveying applications, and local and wide area augmentation systems.

Market studies undertaken in Europe indicate that sales of the Galileo receiver and related applications will be promising during the two decades following deployment.

Technology Transfer Details

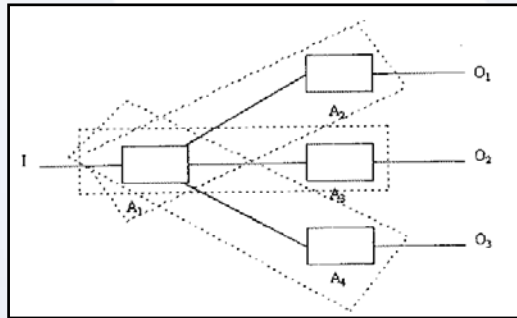
The subject technology is owned by NovAtel, a leading provider of precise global positioning and augmentation technologies.

The business opportunity may be referred to by its CSA case ID: 50680

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

Components of a complex system are subject to possible and probable faults during operation. A means of identifying a subset of components that most likely include the faulty component(s) is required since it is impossible and impractical to examine all system components. Probing techniques are then required to identify the exact faulty component(s) from the suspected subset of components. The main limitation of traditional approaches is poor scalability to the number of components in the underlying system. In addition, traditional approaches suffer from high computational memory and processing usage.

Instead of pure reliance on logic reasoning (which is characteristic of traditional approaches), the subject invention uses set operations for inference. The techniques are scalable to the number of components in the system and require very little memory and computational resources, providing great commercial value.

Inference Techniques for Diagnosis Based on Set Operations

The Technology

The subject invention provides inference techniques for diagnosis based on set operations that aim to find a set of all possible faulty components in a complex system. It further attempts to find the exact faulty component(s) through the use of probability-based fault probing. The techniques encompassed by the subject invention are scalable to the number of components in the system and require very little memory and computational resources.

Commercial Potential

The subject technology has commercial applications in any industry that includes the use of complex systems that can have faulty components. Generally, these techniques may be applied to maintenance and testing applications (or any application requiring fault detection and isolation) within the automotive industry, aircraft industry, navy, medical and pharmaceutical fields and other manufacturing industries.

Within the armed forces and military, the subject invention may have further applications in implementing software and hardware. The implementation may be also embedded in a health-monitoring module for complex army systems (e.g. tanks, unmanned air vehicles, jet fighters, helicopters).

Technology Transfer Details

A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50743

Commercialization Contact

Commercialization Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca

An Efficient Algorithm for Computer Simulation of Constrained Mechanical Systems

The Business Opportunity

Many industries, including manufacturing, robotics, automation, and the automobile industry, are developing sophisticated computer simulators that are essential tools for the design and analysis of mechanical systems. In general, existing algorithms used for computer simulation of constrained mechanical systems suffer from numerical instability and inaccuracy when there are redundant constraints and/or singular configurations present.

The subject invention not only overcomes these limitations, but it requires smaller computations, which contributes to minimizing the computational cost of performing a simulation. The proposed algorithm has application in such simulators, in that it facilitates both speed and accuracy in simulating complex dynamic systems in real-time.

The Technology

The subject invention represents an efficient algorithm for solving differential algorithmic equations of constrained mechanical systems based on the concept of linear operator equations. Unlike many other algorithms, the formulation provides numerical stability and accuracy with redundant constraints and/or singular configurations. Experimental results have demonstrated that the proposed formulation can proceed smoothly and accurately in the vicinity of a singular configuration. No iteration is required to compute acceleration. Furthermore, the equation of motion is expressed in a relatively compact form which offers computational efficiency.

Commercial Potential

Application of the proposed algorithm in a commercial product has the potential to boost simulator performance and increase numerical stability in fields as diverse as: virtual reality, vehicle and car suspension and steering systems, aircraft, manipulators (e.g. manipulators interacting with the environment, manipulators with a closed-kinematic chain, parallel manipulators, etc.) and robotics.

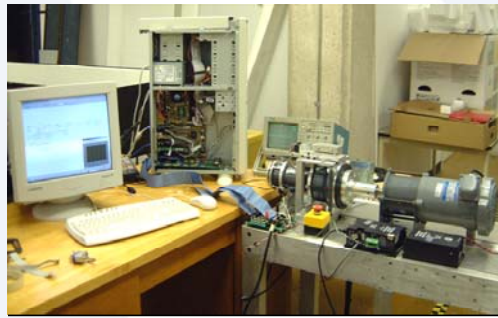
Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50734

Commercialization Contact

Commercialization Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

In the field of robotics, joint friction is an impediment that can have a significant negative impact on robot performance, including limiting positional accuracy, causing a loss of energy, and creating potential instability in teleoperation and force control applications. While there have been a number of friction models and compensation techniques developed to address the effects of friction, all such models and techniques have been custom-developed for select cases. To overcome these universal limitations, a general friction compensation mechanism capable of identifying key parameters of the friction model, adapting to physical changes, and applying a control signal to compensate for friction effects has been developed.

Intelligent Friction Compensation (IFC) Techniques

The Technology

InCoreTec developed a Proof-of-Concept friction compensation technique for a single DC servo actuator with harmonic drive gearing under CSA contract. The technique provides a general solution on designing an intelligent friction compensator for harmonic drives from scratch. A unique and innovative aspect of the technology is that it employs a Genetic Algorithm (GA) to identify the highly nonlinear friction model and linear motor model at the same time.

Commercial Potential

Within the general motion control industry, IFC will best fit in applications that require high speed, repeatable and accurate servopositioning of tools, work pieces, components (in automated assembly) and vehicles or platforms (autonomous robots). Another excellent fit for IFC and a large area of application is the servovalve. Whereas servopositioning applies to the discrete manufacturing sector, the servovalve applications address the processing industries such as chemical, pulp and paper, hydraulics, oil and gas, water treatment and many others.

Commercial applications of the technology may include, but are not limited to, the following:

- Space-Based Manipulators and Servomechanisms;
- Ultra-high precision electronic controls;
- Micro-assembly;
- Electronic control assembly;
- Micro-surgery;
- Very large robots-with large gantries and loads; and
- Other assembly-based applications where a high degree of precision and tactile control is required.

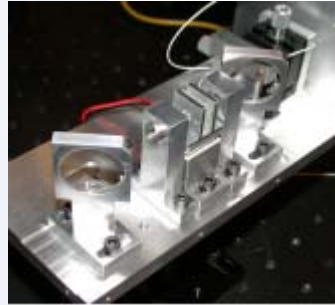
Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50674

Commercialization Contact

Commercialization Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

Communicating devices move relative to each other through a bumpy orbit. Therefore, it is necessary to predict their positions precisely such that the narrow beam of a communications laser does not miss its moving remote target. Challenges of free space optical (FSO) communications links, whether on Earth or in space, include the alignment of the light beam among the communicating elements and the performance of the enabling subsystem for beam pointing, acquisition and tracking.

Conventional electro-mechanical beam-deflecting techniques limit communication performance in terms of bit rates and do not quickly adjust to compensate for relative displacement between the communication devices.

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.

Light Beam Modulator

The Technology

The subject invention is an all-optical approach in beam control/deflection/tracking techniques based on a combination of optical wave phase conjugation and optical dynamic holography. It enables automatic, self-controlled coupling of beam emitters and receivers, thereby achieving high-speed, controlled, optical communications between two or more stationary or fast-moving parties. This technology eliminates 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.

Commercial Potential

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. 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 fiber-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).

Technology Transfer Details

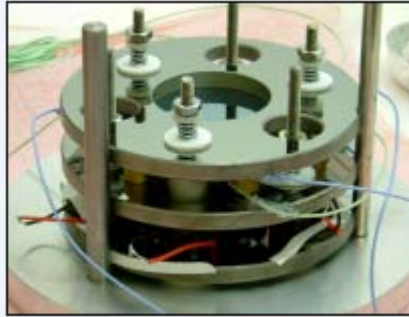
A commercialization license for this technology is available.

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

Commercialization Contact

Commercialization Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

The subject technology has been demonstrated as a programmable controller for a space-based optical instruments. This product offers significant advantages in terms of field of view and scanning range over standard air-gap tunable filters, which would give a performance edge over existing devices where wide fields of view with low spectral dispersion are required. This technology is expected to allow field angles of four times larger than any other tunable etalons currently available.

Low Voltage Piezoelectric Positioning System for Space Optics (LVPZT)

The Technology

EMS has developed a low voltage piezoelectric positioning system for space-based optical instruments based on space-qualified capacitive sensor technology.

The technology is a control system for space optics based on low voltage lead zirconium titanate piezoelectric stack actuators (LVPZTs), with all of the associated benefits of a low voltage drive circuit. This new system incorporates a capacitive displacement sensor in a programmable digital feedback control loop. The LVPZT system has been demonstrated as the programmable controller for a high etendue scanning Fabry-Perot (FP) etalon.

Commercial Potential

The high speed and resolution available with the proposed LVPZT controller allows for its use in the driving of fine beam-steering mirrors in optical inter-satellite link (OISL) communications applications. In addition, astronomical applications of tunable FP imagers may exist in terms of providing velocity slice images of galaxies and other astrophysical targets. This new technology could be used to provide 400% higher velocity resolution, or 1600% larger image area. These high performance etalons will be useful in multiple planned Canadian space missions and may open up certain airborne and terrestrial markets that rely on the detection of individual spectral lines.

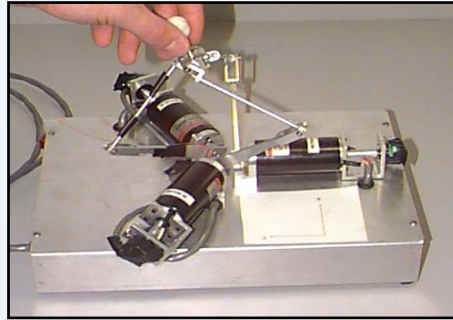
Technology Transfer Details

The FIP associated with the development of this technology is owned by the CSA. EMS has been granted a sole license with the right to sublicense the technology. The business opportunity may be referred to by its CSA case ID: 50681

Commercialization Contact

Commercialization Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

The demand for lightweight, cost-effective, simple, user-friendly and force-reflecting human machine input devices is projected to grow as a result of dramatic increases in computing power, advances in robotics and remotely controlled vehicle technologies, and the development of numerous Virtual Reality (VR) applications. In VR applications, the user must feel as little of the structural properties (e.g. friction, weight, inertia, flexibility and backlash of the device) of the device as possible, and should primarily feel the forces arising from interaction with the virtual world.

The subject invention is an improvement over existing devices because it is structurally light and nearly free of friction and other mechanical characteristics that would otherwise taint the fidelity of the feedback. In addition, the kinematic arrangement and the design of the upper stage of the mechanism provides a simplified kinematic model which results in improved performance in terms of accuracy and speed of response of position and force control.

Mechanism for Control of Position and Orientation in 3D

The Technology

The subject invention (United States patent no. 5,847,528) represents a three-degree of freedom parallel or closed-loop mechanism that can be used as an input controller or device for moving and positioning a member in space. The invention represents a key component of the human-machine interface because it permits a user to manipulate three-dimensional objects, virtual or real, under computer control. As such, the user is able to experience the sensation of mechanically interacting with virtual objects that reflect the forces of operational or mechanical constraints.

Commercial Potential

Applications of the subject technology can be differentiated by the mode of operation, either passive or force-reflecting. The device operating in passive mode can either be as a hand controller or as a robotic mechanism. As a hand controller, the device records the displacement of a user's hand. As a robotic mechanism, it can be used as a device to position an object from one place to another, as in assembly operations. The force-reflecting applications are those more related to the remote control of objects, such as in telerobotics, or the human interaction in a virtual environment where the physical sensation of virtual objects are conveyed to the human.

Technology Transfer Details

A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50383

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



The Business Opportunity

The subject technology bases proficiency training on individual profiles and objective skill dynamics measurement, thereby allowing for more objective, accurate, focused and customized training, feedback, and performance analysis and evaluation. Alternative methods and devices for such training use generic training programs, require greater on-board training time, do not provide feedback on training efficacy, and require significant crew time for assembly and setup.

The principles and methods of the technology open up opportunities in application areas wherein there is a need to mitigate Operator Performance Degradation and wherein critical skills can be identified.

System for Autonomous Training

The Technology

Developed within the framework of the Operational Space Medicine Program, this technology represents an on-board system capable of mitigating and compensating for factors that are known to play a role in the skill degradation of Mobile Servicing System robotic operators on-board the International Space Station. These factors include psychological and physiological stress, pre-flight training program fidelity and adequacy, lack of practice and individual differences. The subject technology uses a PC, connectors, hand controllers, and software as a stand-alone system to monitor on-board and pre-selected operator skills, identify degraded skills and their level of degradation on a per operator basis, and track the dynamics of training and skill recovery through feedback on skill level proficiency and performance analysis.

Commercial Potential

This performance monitoring and training method can be leveraged to obtain competitive advantage in commercial industries such as mining, drilling, and nuclear plants. This method will not only serve to identify degraded critical skills, but will also provide feedback on operator proficiency and progress in a time and cost-efficient manner. Similarly, this technology has a wide array of possible applications in the armed forces (e.g. pilot training, ship and tank operations, etc.), where operator performance is critical. The method could also be useful for proficiency and regular training of the use of robots in medical applications.

Technology Transfer Details

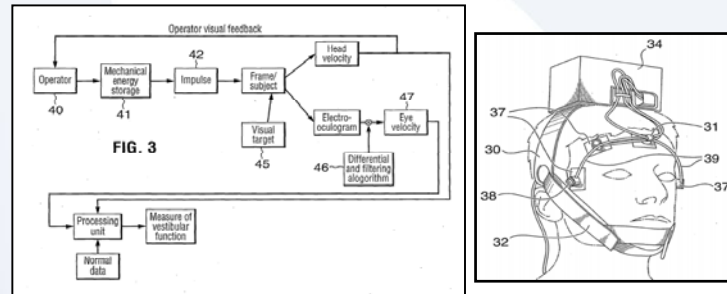
A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50695

Commercialization Contact

Commercialization Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

Evaluating and managing dizziness can be extremely difficult, and vestibular testing often requires high-powered turntables and highly trained technicians and support personnel.

This technology provides for a low-cost, simple mechanical means for delivering the stimulus and automating the diagnostics. It removes the need for such turntables, technicians and support personnel, while providing the sensitivity and reliability required for intended applications.

Method for Evaluating Vestibular Response

The Technology

The invention consists of a method and apparatus for clinical evaluation of the balance organs of the inner ear. The subject is constrained in a substantially erect position so that the head moves in unison with the rest of the body. A controlled stimulus in the form of a sudden angular acceleration is imparted to the body by way of a controlled mechanical device that includes mechanical energy storage capability such as a flywheel. The subject's head velocity and ocular response to the controlled stimulus is measured. During this time, the subject is provided with a visual target on which to gaze. The vestibular function is evaluated from the ocular response and the angular velocity of the head.

Commercial Potential

The subject invention can best be employed in clinical diagnosis of dizziness and balance disturbances. This involves taking a careful history, performing an appropriate physical examination, and testing vestibular function and hearing. A significant change in the eye movement response to sudden rotation with all other tests being normal would suggest a peripheral vestibular disturbance. In general, the subject invention can be applied for effective vestibular testing, which in turn, could help to localize abnormalities.

Technology Transfer Details

A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50593

Commercialization Contact

Commercialization
Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
 Fax: (450) 926-4449
 E-mail:
iptt@space.gc.ca



The Business Opportunity

These technologies allow data compression technology to be implemented with limited hardware (which can be costly) and software that is characterized by significantly reduced computational complexity. As such, fewer hardware and software resources are required to perform the near-lossless data compression. Moreover, the size of codebook in Successive Approximation Multi-Stage Vector Quantization (SAMVQ) is over two orders of magnitude smaller than that in conventional vector quantization compression technology, thereby avoiding long-codebook training times. In addition, Hierarchical Self-Organizing Cluster Vector Quantization (HSOCVQ) guarantees that the reconstruction fidelity of each spectrum in the compressed data cube is better than a given threshold, so that it can well preserve "golden" spectra or smaller targets.

Both SAMVQ and HSOCVQ can compress data with reconstruction fidelity better than the level of the intrinsic noise (caused by instrument noise and pre-processing uncertainties, etc.) of the original data to achieve so-called "lossless" compression in the sense of the intrinsic noise of the original data.



Multidimensional Real-Time Data Compression 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, 6,701,021 and 6,798,360. Together, they provide a method and system for real-time near-lossless data compression of a continuous data flow of multidimensional data with a high compression ratio, high data throughput, and information preservation. Recursive Hierarchical Self-Organizing Cluster Vector Quantization (HSOCVQ) and Cluster Successive Approximation Multi-Stage Vector Quantization (SAMVQ) revolutionarily improve conventional vector quantization (VQ) compression technology. HSOCVQ eliminates the heavy computational burden by training only a few of, rather than thousands of, codevectors in a way of hierarchically splitting and adaptively reorganizing clusters. It compresses a data cube until each of the spectral vectors is encoded with fidelity better than a given threshold. SAMVQ is a multi-stage VQ compression technology, which compresses a data cube using small codebooks in a manner of successive approximation and optimal convergence. It achieves a fidelity that approaches or exceeds the full search VQ method.

Commercial Potential

Possible commercial applications of the inventions include:

- Airborne hyperspectral imaging;
- Medical imaging (CAT scans and MRI);
- Military applications (particularly with regards to surveillance); and
- Other applications involving 3D (or higher) data characterized by vector correlation.

Technology Transfer Details

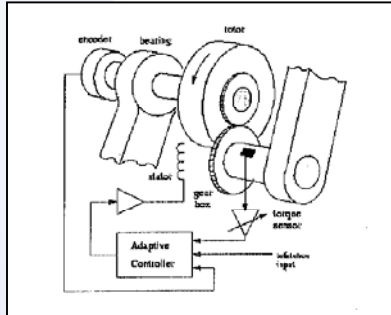
Commercialization licenses for the multidimensional data compression technologies are available, either together or separately.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



The Business Opportunity

Many applications of manipulators depend on a high degree of precision in position tracking in spite of load dynamics. The subject invention addresses this need by providing a robust control algorithm capable of achieving precise position tracking irrespective of load dynamics (e.g. link dynamics of manipulators, cutting force in a CNC machine tool, or wind force in a radar-tracking antenna). In order to accomplish this, the invention uses uncalibrated joint torque sensors without the need for an accurate link dynamics model, which may or may not be available.

Adaptive Self-Tuning Controller of Manipulators Using Uncalibrated Joint Torque Sensing

The Technology

The subject invention represents an adaptive controller for robot manipulators that uses signals received from joint torque sensors to adaptively compensate for the effects of robot link dynamics. In particular, the invention uses a self-tuning control algorithm that adaptively tunes the gains and offset of the torque sensor in addition to other parameters (including inertia of the motor's rotors, link twist angles, friction parameters of the joints, etc.), to achieve zero tracking error.

Commercial Potential

The subject technology has applications in areas requiring high degrees of precision in position tracking, including the following:

- Arc welding;
- Laser cutting;
- Fixtureless assembly;
- CNC machine tooling;
- High-speed tracking and positioning servo systems for precision weapons;
- Radar-tracking antennae; and
- Missile interception systems.

Technology Transfer Details

A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50740

Commercialization Contact

Commercialization
Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
 Fax: (450) 926-4449
 E-mail:
iptt@space.gc.ca



The Business Opportunity

The Canadian Ice Service and other northern countries rely on spaceborne SAR data as their most important operational source of information on sea ice extent. Currently, operational sea ice monitoring is based on single polarized data from RADARSAT-1 and other SAR satellites. While data collection and geocoding is highly automated, image analysis for generating daily ice charts is based largely on visual interpretation by ice experts.

It is expected that the main near-term operational benefits of multi-polarization SAR data for sea ice monitoring will include: improved information retrieval, improved ice edge detection (particularly over different incident angles and sea states), better ice type discrimination, improved detection of icebergs, and a better capability to estimate ice roughness (particularly with fully-polarimetric data).

Multi-Polarimetric SAR Products for Operational Sea-Ice Monitoring

The Technology

Contrary to single polarized Synthetic Aperture Radar (SAR) data, dual-polarized and fully polarimetric data contains multiple channels, each representing the surface radar reflectivity at a different polarization. Dual-polarized data provides additional capability for identifying the ice edge and distinguishing ice types (e.g. between first and multi-year ice). Fully polarimetric data uses all four polarizations including their relative phases to decompose the signal into cardinal physical scattering mechanisms (i.e. surface and volume scattering), which facilitates the use of automatic classification tools. However, since fully polarimetric data will only be available for narrow swaths (25 km) it cannot provide the wide area coverage required for operational monitoring. Multi-polarization data provides for wide area coverage modes and is therefore expected to have greater utility than fully polarimetric data for ice monitoring.

Commercial Potential

The subject invention has applications focused in the domain of marine surveillance, which includes sea ice monitoring. The new capabilities provided by multi-polarization provide sea ice centers with more information retrieval and potentially greater efficiency. An expanding market for monitoring sea ice may further enhance the commercial potential of multi-polarimetric data and products.

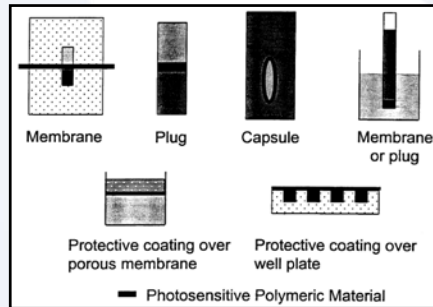
Technology Transfer Details

This technology is owned by MacDonald, Dettwiler and Associates Ltd. (MDA) and may be referred to by CSA Case ID # 50656.

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



The Business Opportunity

Mechanical means to control conditions allowing two aqueous solutions to contact each other are often clumsy and prone to malfunction. The subject invention uses an aqueous photosolubilizable membrane/coating that becomes completely soluble in aqueous media under the influence of a controlled external input (e.g. energy) and thereby eliminates the need for movable parts. Complete dissolution of the polymer membrane by photochemical means yields greater reliability and control.

Photosensitive membranes open up a wide array of practical opportunities through their potential incorporation into films/membranes, plugs, and capsules.

Photosolubilization of Polymer Films

The Technology

The subject invention relates to a photosensitive and photo soluble polymeric material capable of forming a liquid-impermeable membrane, and to a method of manufacturing that material. In particular, a polymer membrane/coating that can be photosolubilized in aqueous media has been developed in order to achieve the following properties:

- The ability to keep two aqueous solutions/media separate for a specific time; and
- The use of a photoacid generator in the membrane that serves to release a strong acid upon irradiation in order to reverse acetal linkages, thereby dissolving the coating in the aqueous media and allowing the two solutions/media to be in contact and/or mix.

Commercial Potential

Potential applications of the technology include:

- Encapsulation (biological materials, chemical reagents, labeled materials, radioisotopes, fluorescent dyes, drugs and assay-specific reagents). Temporary storage and/or controlled-release of these materials may assist in therapeutic, diagnostic, analytical, and chemical detection, or monitoring and control applications;
- Light and radiation sensor devices (monitoring and control of UVA/UVB light exposure);
- Storage and usage of solar energy;
- Surface protection applications, including biological surfaces such as skin, that could be unprotected on demand;
- Protection and/or sealing of images, art and archeological pieces; and
- Protein crystallization in space.

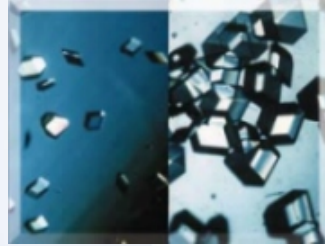
Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50506

Commercialization Contact

Commercialization
Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
 Fax: (450) 926-4449
 E-mail:
iptt@space.gc.ca



The Business Opportunity

Protein crystal growth is essential to the understanding of protein structure and function. Currently, the structure of a protein can be determined using protein crystals in X-ray crystallography or linear accelerator (cyclotron) applications.

However, protein crystals grown in microgravity conditions can be larger and of better quality than crystals grown on Earth. These characteristics have a decisive effect on the study of their structure. The quality of structural information is important because it enables researchers to produce better medication with fewer side effects by allowing the rational development of therapeutic substances. Overall, a microgravity environment promotes better crystallization, in part due to the lack of turbulence and mixing with the sample during crystal formation.

Protein Crystal Growth Facility

The Technology

The subject invention is an apparatus and method for the formation of a protein crystal in a microgravity environment. The method involves a protein-containing solution in an open vessel; a region of reduced temperature spaced apart from, and in closed fluid communication with, the open vessel; and the de-watering of the solution until a protein crystal is formed in the open vessel.

The apparatus consists of a cold-generating unit (cold finger) and an open vessel (microcapillary tube) in which the protein containing solution is placed. The cold finger maintains a lower temperature level than the temperature of the microcapillary tube, but does not equilibrate, thereby creating a temperature differential and accordingly, a vapor pressure differential. The latter causes a flow of water vapor out of the protein-carrying solution (de-watering), forming a protein crystal. The protein crystals can then be prepared for 3D structural analysis using technologies such as X-ray crystallography or cyclotron imaging.

Commercial Potential

The apparatus and method are not restricted to a microgravity environment. The technology also has applications in the pharmaceutical industry. In particular, drug companies interested in rational drug design would be interested in the physical shape and folding of a protein. The crystalline characteristics of the proteins used are relevant to applications from cancer and diabetes treatments to the control of antibiotic-resistant bacteria.

Technology Transfer Details

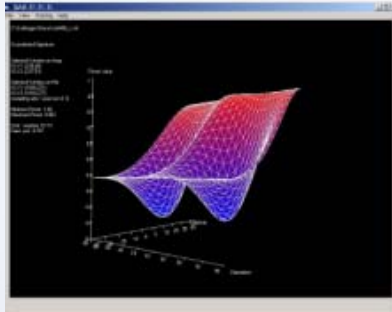
A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50638

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



The Business Opportunity

The Synthetic Aperture Radar (SAR) Polarimetric Post Processor (SARP3) was developed within the framework of the RADARSAT-2 tool to allow the use of data from SAR missions such as RADARSAT-2, Convair, AIRSAR and others. The technology provides a flexible and robust tool environment for processing polarimetric SAR images while being both easy to upgrade and maintain at a low cost. Typically, such tools require significant resources to produce and are often too costly for certain user segments.

SAR Polarimetric Post Processor (SARP3)

The Technology

The invention is a shareware tool to process polarimetric Synthetic Aperture Radar SAR images and perform polarimetric synthesis and signatures using a flexible and robust tool environment. Interested individuals will be able to explore the enhanced information content of polarimetric SAR data. The technology simplifies the introduction of further algorithms to perform polarimetric decomposition, filtering, and classification, thereby encouraging stakeholders and industry to develop tools to process SAR images.

Commercial Potential

Permission to use external shareware components of the product were obtained with the intent not to commercialize this product. Rather, the shareware makes available an executable file to stimulate and facilitate further research and development in RADAR polarimetry, leading to commercial tools with very advanced capabilities to extract geophysical information from SAR data.

In a fully developed form and using well-calibrated data, the tool could be used in such applications as ship detection by armed forces or other government agencies.

Technology Transfer Details

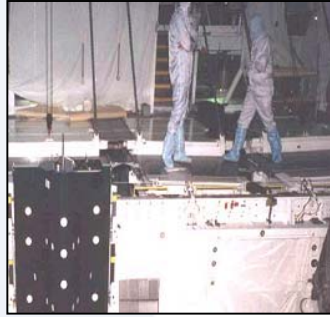
A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50622

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



The Business Opportunity

Transportation of cargo by land, sea, or air often requires cargo mountings that can hold the cargo substantially rigid, yet allow for easy removal of the cargo upon reaching the destination. In addition, cargo mountings must be able to accommodate thermal expansions that may arise as a result of temperature differences across the cargo or relative to the room temperature.

Originally designed for the space shuttle, the subject invention represents a cargo mounting that is able to hold the cargo substantially rigid, allows the cargo to be gently released without the use of excessive force, and allows for distortions to accommodate temperature variations.

A Stirrup Assembly For Securing a Cargo

The Technology

The subject technology allows for a cargo payload to be mounted in the cargo bay of a space shuttle. The cargo is held substantially rigid during launching and landing of the space shuttle, thereby avoiding structural damage to the cargo or the shuttle by resonance. The technology also allows mounted cargo (e.g. a communications satellite) to be released from the attachment without excessive force once the space shuttle is in orbit around the Earth. The cargo mounting accommodates thermal expansions and contractions due to temperature differentials by using rotatable ball heads secured in a manner that allows the side member of the cargo to distort.

Commercial Potential

Commercial applications for this technology include transportation of cargo by land, sea or air. Additional storage-related applications for cargo on land or in space represent further commercial applications of the subject technology.

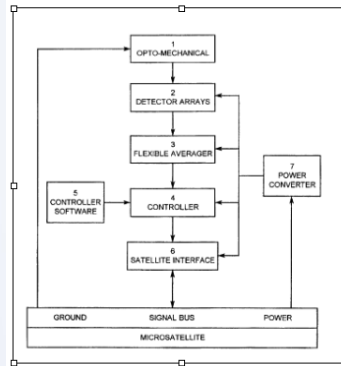
Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50390

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



The Business Opportunity

The attitude control subsystem on a satellite is considered one of the most critical systems necessary for mission success. Unlike current sensors, which are limited to specific altitude levels, this technology allows operation over a wide range of orbital altitudes. In addition, the sensor has no moving parts, which provides for a greater reliability than that provided by current sensors, which typically rely on scanning mirrors or spinning assemblies. Only one sensor is required to provide the same or more information normally provided by two or more sensors, thereby saving launch mass and overall cost.

Satellite Attitude Sensor Using Thermal Imaging

The Technology

The invention provides a method and sensor for the orientation and attitude control of satellites using the overlay or superposition of thermal images. The invention utilizes a segmented mirror to provide multiple fields-of-view. The images are superimposed onto a common detector, which provides the resolution requirements for a wide range of operational orbital altitudes. The sensor may potentially be operated from low earth orbit (LEO) to geosynchronous earth orbit (GEO), an altitude range of 200 to 36,000 km.

Commercial Potential

The subject invention utilizes the principle of overlaid images to differentiate objects. Application of this technique requires a target to be distinct from its background. Therefore, it is applicable if the background is relatively identifiable, uniform, or well known. Possible applications of the subject invention include the following:

- Astronomy applications (e.g. tracking star movements);
- Surveillance and tracking of ships at sea;
- A thermal infrared sensor for detection and tracking of spacecraft and/or human workers in the vicinity of a space station; and
- Sensing wildfires on earth from satellites.

Technology Transfer Details

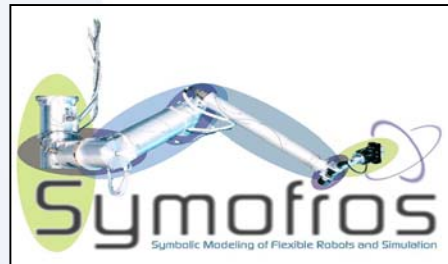
This patent is jointly owned by the CSA, Centre for Research in Earth and Space Technology, and Thompson-CSF Optronics Canada Inc.

The business opportunity may be referred to by its CSA case ID: 50392

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



The Business Opportunity

Different tools are often used in dynamics modeling/simulation and model development. As such, hand coding or the use of advanced tools that generate code for real-time applications is often required. In many cases, the final code implemented on the real system differs from the code used in the development, making upgrades, maintenance, and validation of coding both challenging and costly.

To address this challenge, the subject technology integrates the modeling, simulation, and real-time control in a single seamless environment. It is able to use the same architecture for non-real time simulation, real-time simulation, or the control in real-time of a mechanical system. This eliminates the need for hand coding modifications.

Symofros Software

The Technology

Symofros is a user-friendly tool that integrates the modeling, simulation and control aspects of robotic development in a seamless, real-time or non real-time environment. It also allows an unlimited number of users to develop, design, test and validate in simulation. Users can then replace the model of the hardware with input/output functions to actually drive the hardware itself, performing real-time control without recoding. Symofros is flexible and open, allowing it to be portable on many different hardware and operating systems. It provides a large library of functions to facilitate the development of a controller.

Commercial Potential

The software can be applied to the development of advanced robots that use model-based control to achieve better performance. In addition, the software can be used with application involving robotic control, as well as those applications involving control/simulation and modeling of multibody systems.

Examples include the development of complex electro-mechanical systems, including robotic applications (e.g. demining, nuclear plants, bomb disposal, etc.), motion platforms, rovers, vehicles, solar panel models, flexible structures, training simulators with hardware-in-the-loop, transmission systems, and satellite dynamic modeling and attitude control systems.

Technology Transfer Details

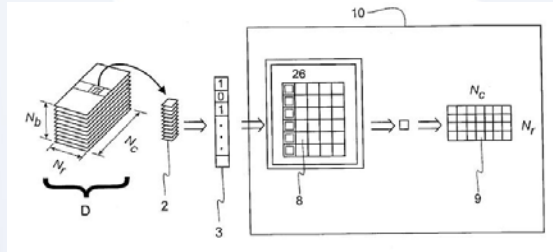
This software is available as open source.

The business opportunity may be referred to by its CSA case ID: 50487

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



The Business Opportunity

The subject invention can be used to encode, browse, store, and transmit any type of imaging spectrometry data (also known as hyperspectral imagery), whether ground-based, airborne, or spaceborne. Because data is stored and processed in compressed form, the system provides for an abundance of imaging spectrometry datasets in combination with fast information and products retrieval capabilities. Alternative systems do not provide equivalent features and on-line access to large imaging spectrometry datasets across wide-area networks.

This invention is the only known system to combine encoding, processing in compressed form for effective product retrievals, index mapping, compressed data storage, high-speed transfer, and rapid decompression, while empowering the user to determine the usefulness of an imaging spectrometry dataset via wide-area networks before investing in it.

System for Interactive Visualization and Analysis of Imaging Spectrometry Datasets over a Wide-area Network

The Technology

The invention has been patented in the United States (US Patent no. 6,546,146). The technology allows users to interactively visualize and analyze large imaging spectrometry datasets using a personal computer a connectivity package for a wide-area network (i.e. internet).

Using a new "on-the-fly" compression process, the technology reduces the volume of the data by about 100 times. Users can select, view and analyze imaging spectrometry datasets via a wide-area network with almost no lag time thanks to the operation being on the data in compressed form.

Commercial Potential

Potential commercial application areas include earth observation, military surveillance, astronomy, microscopy, medicine (i.e. medical imaging systems), and characterization of materials (i.e. material science). There may also exist applications in forensic and general medicine. The techniques of the invention may be applied to imaging spectrometers that are used in absorption or reflection spectroscopy, fluorimetry, and energy transfer diffractometry. Further applications of these techniques include process control and energy-dispersive tomography.

Technology Transfer Details

A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50344

Commercialization Contact

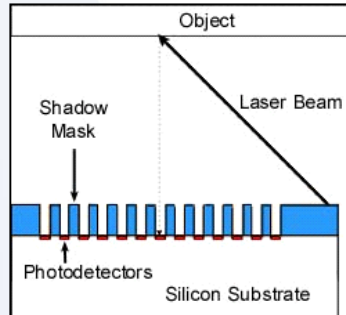
Commercialization
Office
Intellectual property and
technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
 Fax: (450) 926-4449
 E-mail:
iptt@space.gc.ca

The Business Opportunity

In addition to simple proximity detection, this technology can triangulate for orientation, motion and even surface features of the object. The system has no lens and thus works in any medium and is wavelength independent. In addition, the technology contains no moving parts and can be made inexpensively with conventional mass production microchip manufacturing processes.

The vision system works at centimeter distances and improves as the sensor gets closer to the target object, a very useful feature for robot graspers. Ordinary cameras are inadequate in such close quarters.



Vision Skin Technology

The Technology

The subject invention is a patented optical proximity sensor for robot manipulators. The invention consists of a small laser light source, a special optical structure called a shadow mask, and a charge coupled device (CCD) array. It uses an electronic circuit to compare the intensity of light received by individual photodetectors in the flat CCD array. Signal intensity is determined and the distance of the object can be inferred by triangulation.

The shadow mask combines slightly angled holes with vertical holes. Light entering the angled set of holes yields a parallax view resulting in a stereo image. 3D surface features can be resolved on objects—features like fingerprints for identification. Since the system has no lens, there is no need to focus.

Commercial Potential

The invention has commercial potential in police and security applications as a human fingerprint biometric sensor (a fingerprint reader). Additional applications as a replacement to hacker-prone passwords exist in the computer industry. Other market applications and potential business opportunities include inspection of pap smears, bar code identification, industrial proximity sensing for collision avoidance, hazardous environmental applications (e.g. radioactive waste, radioactive material, bomb disposal, etc.), and applications in quality control inspection (e.g. inspection of product defects, control of assembly lines, infrared ultraviolet and natural inspection, and location of defects in raw materials).

Technology Transfer Details

A commercialization license for this technology is available.

The business opportunity may be referred to by its CSA case ID: 50661

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



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.

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

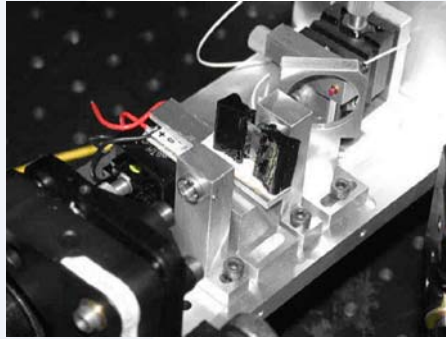
A commercialization license for this technology is available.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



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.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



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.

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

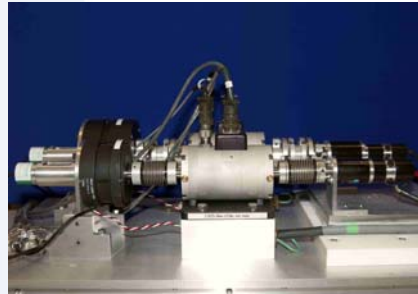
A commercialization license for this technology is available.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



Dynamometer with Active Load for Testing Manipulator's Joint Prototypes

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, as such robots 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.

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

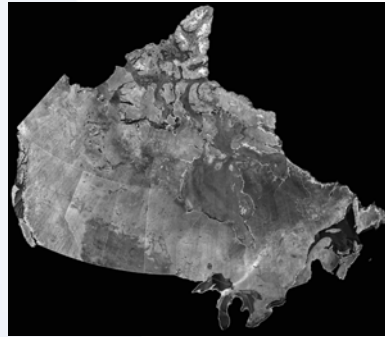
A commercialization license for this technology is available.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



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

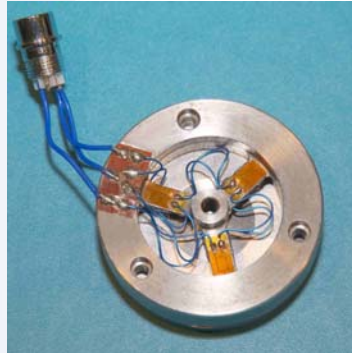
A commercialization license for this technology is available.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



Design of a Load Cell with Large Overload Capacity

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.

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

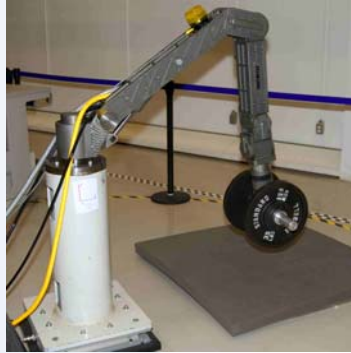
A commercialization license for this technology is available.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



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.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



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.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



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

The innovation significantly improves the control performance of harmonic drives by using a proprietary control algorithm (i.e., 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 to 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.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



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 posed 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

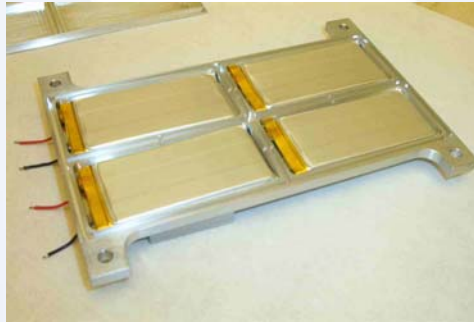
A commercialization license for this technology is available.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



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 interconnect 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

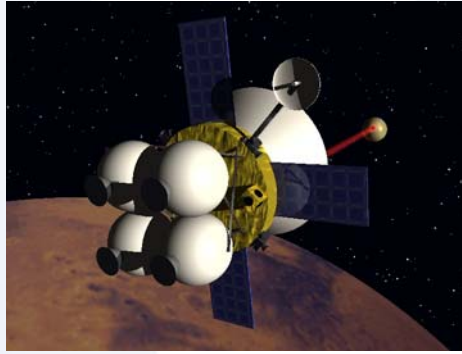
A commercialization license for this technology is available.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



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.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



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 Systems

The Technology

This invention is an algorithm (i.e., 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 technology is available.

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

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency

Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



Advanced Ship Autopilot System (ASAS)

The Technology

The Advanced Ship Autopilot System (ASAS) is an innovative track-keeping autopilot for ships navigating in open and confined waters. This technology consists of two major components: a vessel trajectory predictor and a controller. The use of an intelligent system accurately predicts not only the ship's heading but also its actual track through the water. The controller makes the necessary adjustments to the vessel's steering controls in order to maintain a predetermined trajectory or "track" through the water. Existing systems are designed to maintain only the ship's heading and not its actual track. ASAS therefore represents a significant improvement over existing automated systems.

Commercial Potential

In addition to its direct application in the marine industry, research has indicated that the ASAS technology can be extended to a wide assortment of industries including robotics, industrial control and artificial intelligence. Commercial applications include, but are not limited to, the following: conventional and flexible robotics applications; autopilots for other vehicles such as aircraft, unmanned aerial vehicles, and ground vehicles; and industrial process control systems.

The Business Opportunity

The Advanced Ship Autopilot System (ASAS) is a sophisticated ship manoeuvring and control system capable of maintaining a ship's track in confined waterways and harbours. Unlike existing autopilots, the ASAS utilizes advanced predictive artificial intelligence (PAI) technology which assists in minimizing rudder movements and course changes in open water.

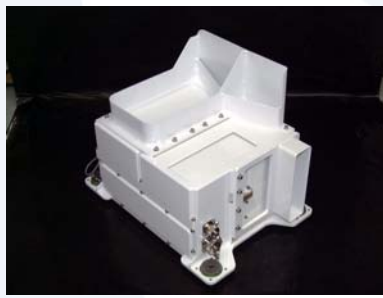
ASAS enables improved fuel consumption, sailing time, efficiency, and navigational track-keeping (resulting in fewer marine accidents).

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50414

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



Laser Camera System (LCS) and Advanced Space Vision System

The Business Opportunity

The Laser Camera System (LCS) is a laser scanning instrument that is currently available for providing high precision 3D surface, orientation, and positional information with millimeter accuracy from distances of up to 10m.

The LCS offers significant advantage over traditional video cameras because it is immune to the effects of changing lighting conditions.

The Technology

Neptec's Laser Camera System (LCS) is a wide angle, high-speed, laser scanner that is currently installed on the Space Shuttle. In imaging mode, the LCS scans objects and captures reflections from their surface features by employing a patented synchronized scanning technique to generate high precision 3D data measurements. This can be used to detect fine damage to the thermal protection system (TPS), which protects the space shuttle during re-entry from orbit. In centroid acquisition mode, the LCS determines the position and orientation of discrete target points on an object, which allows the LCS to guide space robots or act as a sensor to guide spacecraft as they manoeuvre to dock with one another in space. The LCS offers significant advantage over traditional video cameras because it not only provides full 3D surface information, but it is also immune to the effects of changing lighting conditions. This technology has increased the efficiency of the Space Vision System, which processes signals from conventional video cameras to accurately determine the position and attitude of objects such as satellites.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50629

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca

Commercial Potential

The LCS can be used to improve automated measurements in sectors such as mining, manufacturing and agriculture. Applications include imaging rock faces in mines to delineate joints to design adequate tunnel support, and acquiring detailed images of sandstone masonry walls. High-fidelity spatial information and intensity data captured by the LCS concurrently make it a valuable tool for the classification of geomaterials based on reflectivity and texture.



The Business Opportunity

The High Speed Proximity Tracking Control System (PTCS) has commercial applications as a self-contained laser beam auto-focus head in dedicated laser cutting systems to improve cutting efficiency.

Compared to conventional methods used in the textile industry, the High Speed Proximity Tracking Control System offers improved power consumption, lower costs, and higher cutting quality.

High Speed Proximity Tracking Control System

The Technology

The Proximity Tracking Control System (PTCS), developed by RD Corporation, in collaboration with the Alberta Research Council, tracks the proximity between a robotic head and an object while the robotic head is moving along the surface of an unknown shape, color and texture with a very high speed. PTCS comprises three main sub-systems, namely a proximity sensor, an actuator and a control sub-system. In terms of a mechanical arrangement, such a robotic head may be mounted directly on the beams of gantry positioners, or any other type of robotic arm.

Commercial Potential

This technology may have applications in space robotics, manufacturing, and the military. In the textile industry, PTCS has application in precision measurement and laser beam fabric cutting of garment parts. Additional commercial applications include profiling surfaces and objects for pattern matching and inspection of defects and different thicknesses.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50476

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



Hollow Bore Optical Rotary Joint Technology

The Technology

The Fibre Optic Rotary Joint (FORJ) technology was developed by Focal Technologies as a means to pass signals and large volumes of data across rotating interfaces while operating in extreme environments with low electrical noise, high and low current transmission capabilities and low out gassing. FORJ technology provides a range of video/data multiplexers, which allow the combination of multiple electrical and/or fibre optic signals into a single high-speed optical fibre. FORJ are designed to work under all sorts of extreme environments, from continuous rotation at 60 RPM, from vacuums with no outgassing and low particle generation to adverse weather conditions.

Commercial Potential

Commercial applications for FORJ include, but are not limited to, the following:

- Robotics
- Material Handling Systems
- Cranes and Vehicle Turrets
- Remotely Operated Vehicles
- Advanced Radar Antennas
- Cable Reels (bomb disposal robots)
- Medical Systems
- Video Surveillance Systems
- Marine Propulsion System
- Sensor Platforms
- Wind Energy Turbines
- Naval and Geophysical Towed Arrays

The Business Opportunity

Fiber Optic Rotary Joints (FORJs) represent a means to pass signals across continuously rotating interfaces.

FORJ technology relies on the intrinsic advantages of fiber optics (i.e. small size, small weight, high bandwidth, Electro Magnetic Interference (EMI) immunity, etc.) to work under extreme environment conditions.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50582

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

Culture preparation for microbiology is a labour intensive, tedious process done, for the most part, manually. Specimen streaking lacks precision and repeatability and varies considerably between lab personnel. Moreover, lab personnel are exposed to biohazards while being at the same time potential sources of contamination for specimens.

In response to these needs, an autonomous robotic technology called InocuLAB was developed, to simplify the process of culture preparation and make it both more reliable and efficient.

Method and Apparatus for Automatically Inoculating Culture Media With Bacterial Specimens (InocuLAB)

The Technology

InocuLAB is an automated workcell developed by Dynacon Inc. that performs culture preparation in microbiology labs by leveraging robotic control and vision system technology to automate the preparation procedure. InocuLAB performs the following functions: specimen containers are identified via bar codes, uncapped and recapped; medium plates are dispensed, uncapped, recapped, bar-coded and stacked; exposed agar media are inoculated and streaked in preprogrammed user-specified patterns.

InocuLAB processes large numbers of specimens in a time and cost-effective manner with little human intervention, which improves precision, repeatability and security of lab personnel during specimen preparation.

Commercial Potential

The technology has application in the laboratory automation market, where it provides a competitive advantage by reducing labor cost, increasing quality, replacing scarce labour and eliminating exposure to repetitive strain injury. Models are available to handle urine or swab specimens or both simultaneously, with the slowest model up to three times faster than its human counterparts.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50386

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

Structures exposed to harsh environments may endure undesirable shape deformation, vibration, oscillation, and rotation that can compromise their functionality and life expectancy.

Smart Structures, based on a network of sensors, actuators and intelligent control mechanisms, respond to stimuli in a predetermined manner in order to control vibrations, as well as rigid-body and elastic deformations. As such, performance versatility, structural stability, and life-expectancy of structures are maintained.

Smart Structures

The Technology

Smart Structures are piezoelectric-based structures, a technology that allows lightweight structures to meet the challenge of maintaining their shape and resisting vibration. In particular, three smart structure components, the Active Strut Member (ASM), the Active Structural Panel (ASP) and the Smart Control System (SCS) were developed by SensorTech. This technology has been successfully demonstrated in the laboratory to maintain the shape of a large parabolic reflector in spite of distorting influences.

Commercial Potential

Smart Structures will make it possible to have, in the future, extremely large structures in space for applications in the areas of high speed communications, solar power and solar sails. Smart Structures also have applications in active shape control (weapons systems, fibre optic and laser systems, etc.), active vibration sensing and damping (to limit fatigue and premature failure), and noise cancellation systems. Examples of possible terrestrial applications of Smart Structures are active vibration suppression in automobile suspensions, intelligent bridges, buildings and smart skis.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50634

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

Environmental and economic concerns are forcing agricultural procedures to modify traditional practices to remain viable. Traditionally, chemical weed control procedures for land in fallow require the applicator to spray the entire field with herbicide, which is both damaging to the environment and an expensive means of control.

This technology allows to selectively spray weeds in stubble or fallow, thereby achieving a cost-effective solution and protecting the environment from unnecessary damage.

Selective Application of Weed Control Chemicals

The Technology

SprayVision System is an automated agricultural sprayer system developed by APRO Applied Robotics that will detect the presence of a weed in a fallow field and activate a sprayer to spray only the area around the weed with herbicide, thus eliminating the need to spray the entire field. The technology rely on the fact that the earth absorbs infrared radiation and plants reflect it, the SprayVision System can therefore sense when a weed comes within its field of view. As this happens, the SprayVision System activates the nozzle and the weed is sprayed with herbicide.

Commercial Potential

The selective spray technology provided by SprayVision could be used in pre-plant, chem-fallow, and post harvest applications. It is possible, within certain limitations, to make the SprayVision System selective to plant heights and colour, and hence it can distinguish between a weed and a crop plant. This technology offers a cost effective solution and a significant contribution to protecting the environment via reduced spray usage.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50389

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

In the harsh space environment, conventional cameras and vision systems must be handled with great care in order not to aim them at the sun. This novel very short range radar vision system allows sophisticated controls to deal with the very broad range of lighting conditions.

While radars are normally used for long range detection (10 to 100s of kilometres), the present vision system is based on very short range radar (from a few meters to 25 meters) which can resolve decimetre scale features and provide images of the scene in real-time.

Very Short Range Radar Vision System based on Phased-Array Antenna Technology

The Technology

A Phased Array Antenna (PAA) is a COMLAB Inc.-developed technology with no moving parts that offers greater reliability and improved operational speed over mechanically-rotated antennae. Based on this technology, a novel radar-based vision system was developed and a prototype hardware was tested on-board underground mining vehicles. The very short range radar vision system is able to do work at close distances with great positional accuracy via adjustments in the radar operating frequency and pulse. Short-range radar (from a few meters to 25 meters) resolves decimetre-scale features and provides real-time images.

Commercial Potential

This technology could have an important impact on the security of workers in underground mines. Among the many dangers that come with working in mines, fire is one of the most feared. Due to the very thick smoke and dust cloud, visibility is nearly zero and no conventional camera or laser-based vision systems can be used to assist rescue teams. To get to trapped miners, rescuers must slowly drive their rescue vehicle while probing a pole through the side windows to “feel” their way through the mine galleries, with the constant danger of running over somebody unconscious. Tests performed at Noranda Mining provided initial justification of the technology in mining applications, and showed that radar was clearly superior to other technologies.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50415

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



photo: TECSULT (Groundwater Drilling-Mali)

The Business Opportunity

The assessment of groundwater resources is an issue of great importance in Canada and around the world. Current methods for pinpointing groundwater sources in many countries rely on aerial photographs and outdated maps. As such, pinpointing groundwater sources is difficult and significant unnecessary expenses are incurred due to the large number of unsuccessful well drillings.

The method encompassed by this technology for the assessment and drilling of groundwater resources has proven to be better and more cost-effective than conventional methods.

Optimized Methodology for Groundwater Mapping using RADARSAT-1 Imagery

The Technology

Tecsult International Ltd., in collaboration with the CSA and the Canada Centre for Remote Sensing (CCRS), developed an optimized methodology for groundwater mapping using RADARSAT-1 imagery. This method loads enhanced RADARSAT-1 imagery into a geomatics technology (GIS) to facilitate the identification of topographic variations and the analysis of natural linear features, which can then be used to map and identify deeper geological structures that identify promising sites for water drilling.

Commercial Potential

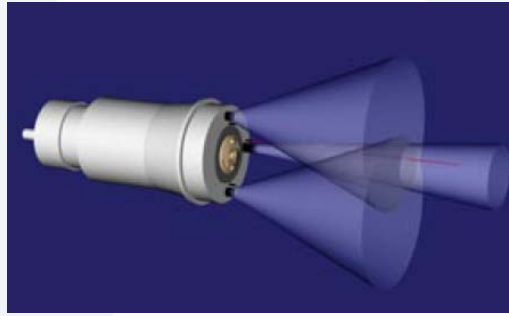
Potential applications of the proposed methodology include its use to locate springs, update regional bedrock structure, and refine Quaternary deposit maps.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50698

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



The Business Opportunity

The Object Recognition and Pose Estimation (ORPE) software toolkit is available under a license and represents a technology capable of acquiring and processing 3D target data under extremely severe conditions of illumination and contrast. Such conditions often result in poor distance judgment and depth perception and inhibit common maintenance, assembly, and inspection tasks on objects.

The ORPE software toolkit overcomes these difficulties and has applications in various robotic systems that are subject to poor lighting conditions but require the performance of ongoing maintenance, assembly, and inspection tasks (e.g. satellite docking operations).

Object Recognition and Pose Estimation Software Toolkit

The Technology

The Object Recognition and Pose Estimation (ORPE) software toolkit, developed by MacDonald Dettwiler Robotics (MDR) in collaboration with the CSA, permits identification of an object, its position and its orientation, using 3D natural features and geometrical models. The ORPE Toolkit processes stereo camera images to compute 3D data and includes stereo vision systems, contains no moving parts, is of low power and survives well in the space environment. The toolkit can estimate in near real-time the position and orientation of an object (POSE). The ORPE software toolkit can also integrate data from other 3D imaging systems such as range finders.

Commercial Potential

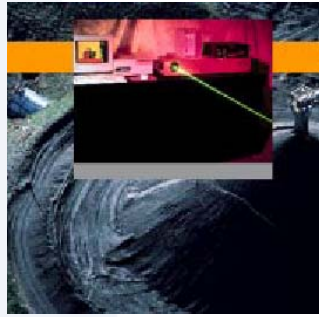
The ORPE software system will be used in satellite docking operations and is ideal for autonomous robotic tasks, such as satellite servicing. It enables the performance of tasks such as assembly, inspection, and maintenance by facilitating real-time vision, as a result of its capability to acquire and process 3D target data under severely contrasted illumination. Spin-offs of this technology could be used for various robotic systems operating under difficult lighting conditions.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50602

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



Scanning Laser Ranging / Imaging System

The Business Opportunity

The Scanning Laser Ranging technology is a very cost effective method for generalized digital terrain mapping.

The Scanning Laser Ranging technology can provide high resolution mapping (1 cm) and can be conducted during day and night.

The Technology

Scanning Laser Ranging technology, along with an inertial reference system and GPS receiver, have been combined to form an integral part of a terrain high-resolution mapping system. The system developed by Optech Inc. consists of a compact laser instrument that is mounted onto an airborne platform, and flown over the survey area. Since the active sensor is a laser, data collection can be conducted during the day or at night.

Commercial Potential

Scanning Laser Ranging technology has applicability in a wide range of topography and non-topography applications where it can be used instead of classical photogrammetrical and geodetic methods.

This technology is particularly useful in mining/excavation applications where the surveying task proves hazardous due to the possibility of cave ins or falling rocks. Surveying from an airborne platform or from a remote distance avoids these hazards.

Applications of the product include: topographic surveys; erosion surveys; shoreline control; forestry applications; disaster prevention/assessment; urban mapping; urban infrastructure and development; and road construction.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50585

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



Small Cell Lithium Ion (Li-Ion) Batteries

The Business Opportunity

COM DEV is a pioneer in the development of a line of space qualified, small-cell Li-Ion batteries.

Li-Ion batteries for satellites and spacecraft significantly reduce the mass and increase power storage capacity and reliability relative to other systems currently in use.

The Technology

Large battery modules are required to provide electrical power to satellites during periods when the demand for power onboard the satellite exceeds the ability of the solar arrays to generate sufficient electrical power. To meet this demand, COM DEV has developed a Li-Ion battery for satellites. The Li-Ion battery system provides large mass savings per satellite, resulting in substantial cost benefits. The battery uses uniform, reliable cells that require no cell-level power management electronics, thus providing mass savings over competing systems.

Commercial Potential

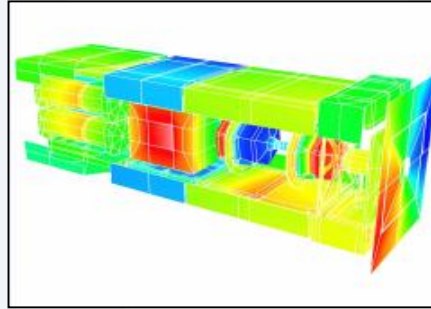
Li-Ion batteries are smaller, lighter and can provide more power than the batteries currently in use, giving satellite operators the option of building smaller less costly satellites, or increasing the satellite payload. On a large satellite, savings can be in excess of 100 kg. The technology has been successfully flown on the Canadian SCISAT satellite. The product features a scalable modular design that makes it a flexible solution, easily tailored to a wide range of uses.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50641

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



TMG Thermal Analysis Tool

The Business Opportunity

The TMG thermal analysis tool is a software that enables one to perform accurate thermal analysis quickly and effectively, thereby delivering the engineering insight and turnaround speed needed to ensure success within today's rapid development cycles.

The software delivers exceptional modeling capabilities and leading-edge numerical technology for variety of nonlinear and transient heat transfer processes.

The Technology

The CSA supported MAYA Inc. for the development of some special features of a thermal analysis software package called TMG. This is a comprehensive thermal analysis package, which makes it easy to accurately model and simulate non-linear and transient heat transfer processes within complex assemblies (e.g. conduction, radiation, free and forced convection, fluid flow, and phase change).

The efficiency and accuracy offered by the TMG thermal analysis and design software has contributed to it becoming a standard tool for thermal analysis within the Canadian space industry. It has also been adopted by industry leaders: Boeing, Lockheed Martin, Matra-Marconi, and Aerospatiale, and is used on a wide range of programs (including RADARSAT, MSAT, GPS, SOHO, Space Station, NGST).

Commercial Potential

TMG software finds application in the space industry and has potential applicability in other fields including automotive, electronics, and medical fields. With extensive post-processing and visualization options, interfaces to other thermal analysis programs (such as Sinda, Esatan, TSS, Esarad, Thermica), and a wide variety of customization capabilities and execution options, TMG is an ideal solution for any engineering environment.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50650

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



The Business Opportunity

Spacecraft orbiting around the earth are constantly subjected to disturbance from various sources such as earth gravity, solar radiation pressure, magnetic fields, and aerodynamic drag. These disturbances affect the attitude of the spacecraft, which, in turn, influences spacecraft performance. Hence, attitude determination and control is critical on most spacecraft. Spacecraft Attitude

Using Dyad Method provides an improved method resulting in greater accuracy and improved robustness for spacecraft attitude determination.

Spacecraft Attitude Determination Using Dyad Method

The Technology

The technology provides an improved method to determine a spacecraft attitude. It involves the use of measured and referenced vectors, where one of the vectors can be used independently of the other. In particular, the Dyad Method uses a certain reference frame and certain order of rotation to generate a universal form of a set of trigonometry formulas for spacecraft attitude determination. By applying this method, it is possible to achieve redundant information about the same attitude determined twice with different vector contributions. This ultimately improves the robustness and accuracy of the attitude determination.

Commercial Potential

Possible commercial applications of the technology include its use in the majority of spacecraft, which use TRIAD as either their principal or secondary attitude determination method. In addition, other government agencies or personnel that plan to design or procure spacecraft would benefit from incorporating the proposed technique in the attitude determination method.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50727

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca



Tactile and Proximity Sensors

The Technology

Proximity sensors are required for collision avoidance and close proximity operation of robot manipulators. Tactile sensors expand the manipulative capability of robot arms and end effectors. These novel sensors may be manufactured in various sizes and shapes, and can conform to various surfaces. The ranges for these sensors may be made to vary from several feet down to virtual contact. Variations to the same technology can produce a hybrid proximity and tactile sensor.

Commercial Potential

The technology has robotic applications in collision detection and avoidance, as well as close proximity operation of robot manipulators. Potential biomedical applications involve the integration of the technology with prosthetic limbs. Experiments have already been conducted towards the integration of space tactile sensor technology in prosthetic hands. Lastly, there exists a number of possible safety-related applications that could benefit from this effective sensing technology.

The Business Opportunity

Tactile and Proximity Sensor technology offers sensor technology with very low profile (i.e. flat) and relatively inexpensive manufacturing requirements,

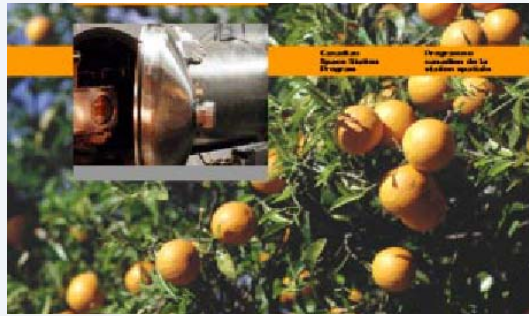
Tactile and Proximity Sensors have also the ability to conform to various and curved surfaces.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50606

Commercialization Contact

Commercialization
Office
Intellectual property
and
technology transfer
Canadian Space
Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



Integrated Miniature Optical Spectrometer

The Technology

MPB Technologies has introduced a miniature optical spectrometer, called IOSPEC, which is based on integrated optics and allows the measurement of the optical signatures of elements in the infrared spectrum. The technology can be configured for different spectral ranges and resolution requirements. It is optimized for the near infrared (1.2 to 3.2 μm) and the mid infrared (2.0 to 5.5 μm) but can operate in the far infrared as well.

Commercial Potential

The technology has many applications in various fields. For example, in the agricultural field, IOSPEC can be used to measure the ripeness of fruit by measuring its spectral reflectance characteristics. Additional applications include gas detection, water or blood analysis, geological services, and pollution or process monitoring.

The Business Opportunity

Spectrometers provide information about the chemical composition of materials through the measurement of their spectral characteristics.

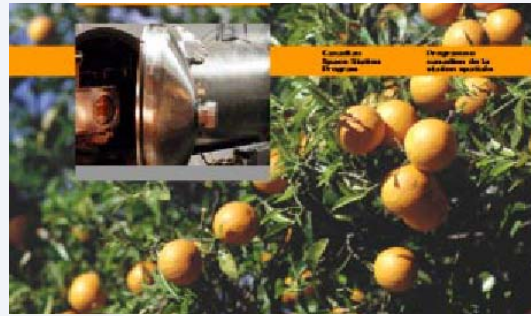
MPBT's integrated miniature optical spectrometer, IOSPEC, can be employed in environments not suitable for traditional spectrometers which require stable, vibration-free operation conditions.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50671

Commercialization Contact

Commercialization
Office
Intellectual property and
technology transfer
Canadian Space
Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail:
iptt@space.gc.ca



Plasma Processing Facility for Large Substrates

The Technology

Etchings and coatings are useful to protect materials and improve their properties. MPB Technologies designed a plasma processing facility which causes suitable gases to react with substrates to provide either etchings or coatings. This facility is unique in that it can process relatively large substrates, up to five feet in width, and relatively large roles of flexible substrates such as Kapton®. Another unique characteristic of this facility is that it can treat plastics due to the low substrate temperatures and the low energies of the ions in the plasma.

Commercial Potential

Plasma processing is useful for the fabrication of various integrated thin film electronics or optical circuits. For example, the etching and coating plasmas can be employed for the fabrication of a miniature integrated optical spectrometer.

The Business Opportunity

The harsh conditions of the space environment require that effective means be developed for protecting structural materials and finishes for hardware, so that they can maintain their physical and functional integrity in the Low Earth Orbit space environment for 10 to 30 years.

This Plasma Processing facility can process relatively large substrates and plastics that can meet this requirement, but also several other applications.

Technology Transfer Details

The business opportunity may be referred to by its CSA case ID: 50671

Commercialization Contact

Commercialization Office
Intellectual property and technology transfer
Canadian Space Agency
Tel.: (450) 926-5800
Fax: (450) 926-4449
E-mail: iptt@space.gc.ca

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
Method and system for compressing a continuous data flow in real-time using recursive hierarchical self-organizing cluster vector quantization (HSOCVQ)	28/09/2004	6,798,360
Method for Evaluating Vestibular Response	28/09/2004	6,796,947
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

Protection title	Issue date	U.S. patent number
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 datasets over a wide-area network	08/04/2003	6,546,146
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*T	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.