ABB Research Grant Program

2013 Call for Proposals

1 OVERVIEW

ABB already collaborates with a number of academic research groups world-wide. The ABB Research Grant Program is intended to enlarge and complement the circle of our university partners.

1.1 Research grants

We plan to award research grants for the 2014 calendar year, typically in the range of $50,000 to $80,000, for research in the power and automation area. While we expect to fund projects over multiple years to support graduate students, we will approve funding decisions for one year at a time. Applications should combine academic research with industrial application.

The applications must be submitted by a main applicant who is a professor associated with a university, university college, or research institute. The main applicant will be ABB's sole point of contact.

Applicants are invited to submit proposals according to the requirements outlined in Section 3. ABB will review the proposals and select which proposals will be awarded a grant. All applicants will be informed about the outcome of the review.

1.2 Evaluation process

Applications will be assessed by an ABB-internal evaluation committee. The applications will be evaluated with respect to how well they correspond to the topics described in section 2 and with respect to the expected outcome of the project. In addition, the following aspects will be taken into account:

- Objective, choice of problems and working methods on the basis of novelty and match with the topics in this call
- Scientific quality of the project and track record of the applicant(s)
- Balance between content and requested amount of funding
- Prior track record in collaborative work, especially with industry

1.3 Terms and conditions

The ABB evaluation committee will determine the successful grant recipients. ABB expressly reserves the right not to grant any award if no submission is deemed sufficient and suitable.

Each applicant shall bear its own costs prior to the announcement of the grant recipients.

Granting of the award shall be conditional upon the proposed grant recipient's signing of a Research and Development Agreement with ABB before the start of the project. The ABB General Terms and Conditions can be found here.

1.4 Proprietary and Confidential Information

ABB will treat all information submitted in proposals as non-confidential and non-proprietary. Applicants must ensure that no confidential or proprietary information is included in submitted proposals.

1.5 Important dates

2013-07-18

Announcement of program on ABB website

2013-09-02

System opens to accept applications

2013-09-30

Deadline for submitting application.

2013-10-31

Start communication award decisions.

2014-01-01 to 2014-12-31

Funding period

All dates are subject to change by ABB.

2 RESEARCH TOPICS

ABB, a world leading company in automation and power, is calling for unique and innovative research proposals. The topics for the 2013 call are listed below.

CONTROL & OPTIMIZATION

Topic 1: Advanced alarming

ABB is looking for an academic partner to contribute with novel ideas towards the development of next generation alarm management systems. Alarms are an important layer of protection in process plants. Current industrial practice in alarm configuration often leads to low quality alarm systems as it lacks of systematic and efficient procedures. Investigations on the use of long term historical process data for the optimization of alarm configuration parameters (thresholds, hysteresis and filters) could be conducted in order to limit the engineering effort while maintaining an acceptable level of quality. In addition, online methods using shorter term process data in combination with current alarms helping operators to better diagnose a plant abnormal situation should be developed. Another interesting area is tools supporting the analysis of alarm logs to create a better understanding of the alarm system as basis for future improvements.

GRID AUTOMATION

Topic 2: Faster than real time simulation of power systems

We are interested in exploring a future simulation paradigm for power system dynamics where the execution speed is high (ten to hundred times faster); the accuracy is within an acceptable tolerance; the approach is scalable for large systems (one- to ten thousand buses); and the associated cost to materialize and operate the paradigm is low. The proposal should address the complete chain of simulation: input, analysis, and processing and presenting of the output.

Topic 3: Electricity market operation with high levels of renewable generation

With increasing levels of variable output renewable energy sources (e.g. wind and solar) existing engines running power markets might need to be modified to account for higher levels of uncertainty. We are interested in investigating: 1) the quality of stochastic model of renewable generation; 2) the temporal and spatial granularity of stochastic model needed for market scheduling; 3) compatibility of market settlement and stochastic scheduling; 4) metric, justification and process to quantify the benefits of stochastic scheduling over existing approaches.

INDUSTRIAL COMMUNICATIONS AND ELECTRONICS

Topic 4: Reliability Improvement of Electronics

Embedded devices in distributed automation systems continuously grow in functionality. Their power consumption is decreasing due to reduced geometrical dimensions and voltage levels, but this is often absorbed by the increasing number of requirements for additional functionality needed. The aggressive scaling of process technology increases the vulnerability of embedded systems and therefore, ensuring their reliable operation becomes a major challenge. Existing system management solely aims at reducing power consumption while optimizing performance and disregard reliability issues. Moreover, there is a steady increase of devices needed for safety critical applications and in particular these products need to be developed so that they operate with a defined “Mean time to failure”. Furthermore, safety critical systems need to detect and prevent dangerous errors to reduce the risk of accidents. This requires thorough diagnostic functions and measures in order to detect and prevent random and systematic errors to propagate through the system and create dangerous situations that can harm environment, property, or human. It can be concluded that there is a lack of a global long-term runtime system management that collects and evaluates all parameters of the miscellaneous components of an embedded system. Consequently, a more sophisticated system control, especially for predictive maintenance and safety critical operation, is required.

Novel ideas addressing these challenges (but not limited to) are encouraged to send an application.

INDUSTRIAL SOFTWARE SYSTEMS

Topic 5: Trusting compiled code loaded at runtime in real-time

More and more often code of industrial automation systems, e.g. controllers, has been designed by various internal and external parties. Such code runs mission-critical tasks in real-time and is typically compiled. How can we trust these software components and ensure that they work properly in real-time? What are the limitations of the real-time security that a software platform can provide and ensure? How can we upgrade these systems in a safe and secure way?

Topic 6: Bug Reproduction Productivity Techniques and Tools

Bugs and security vulnerabilities in industrial software systems are notoriously difficult to reproduce, at least partially due to the complex software and hardware systems within which individual products operate. Critical memory leak bugs, library version mismatches, and even straightforward bugs can take hours if not days to reproduce. ABB seeks solutions to reduce the time necessary to reproduce software bugs, including (but not limited to) automatic provisioning of test configurations from a bug report, remote debugging tools, remote data collection tools or strategies, or even well-defined studies around incentivizing/training end-users to provide high-quality bug reports.

Topic 7: The future of control rooms in times of pervasive mobile devices

How does the concept of a plant control room develop if all workers have a mobile device in use? What types of mobile solutions support the workers' communication and interaction in different settings in an optimal way? How can a mobile device be used by field workers to collect contextual information? How can information be shared between workers? How can information be used for maintenance?

Topic 8: Software architecture knowledge management

Software architecture knowledge manifests in documented rationale for architectural design decisions. In a large cooperation such as ABB there are several similar software products in different domains. There is potential to utilize architectural knowledge from existing products to drive the design and evolution of other products. However, the architecture knowledge detail and quality may differ across individual products. Furthermore, rationale for technology decisions may quickly become obsolete or not be transferable to another context. How can we make use of architecture knowledge across software products and organizational units?

Topic 9: Testing Tools and Techniques for IEC 61131-3 Languages

The IEC 61131-3 languages are the standard for industrial automation, used by domain experts for a variety of large automation projects, such as controlling the lighting in commercial complexes or precisely coordinating large-scale chemical processes. Because IEC 61131-3 sub-languages are both graphical (e.g., function block diagrams) and textual (e.g., structured text) there exists no clear unifying strategy or tooling for testing. ABB seeks the creation of a testing framework and appropriate tooling for IEC 61131-3 languages targeting both graphical and textual sub-languages. While innovative additions, such as the inclusion of live programming environments for creating test cases (e.g., http://arxiv.org/pdf/1212.1796.pdf) are encouraged, proposals will be evaluated primarily on their ability to seamlessly test all sub-languages.

Topic 10: Software Performance Engineering

Large-scale, distributed software systems often suffer from performance problems, such as slow response times or over-utilized servers. The reason for such performance problems is often poorly designed software architecture rather than misused data structures or inefficient coding. Architectural performance models can help to avoid certain architectural performance problems by simulating designed software systems in advance. However, today it is costly to create such model, since they require significant manual efforts as well as skilled and experienced performance engineers. How can we automatically create useful, architectural performance models from system trace logs?

Topic 11: Fine-Grained Developer Productivity Metrics Suite

While it is unlikely that a single metric can be produced to fairly assess a developer's individual productivity, certain types of behavior can be measured (e.g., the amount of structured versus unstructured navigation, as was studied in "How effective developers investigate source code: An exploratory study"). ABB seeks the definition of key developer behaviors and an accompanying suite of metrics as well as ultra-low impact

approaches to automatically collecting that data, preferably in the IDE but possibly by analyzing relevant artifacts.

MECHATRONICS

Topic 12: Next Generation Manufacturing

The ever increasing demand of product personalization, immediate availability and lower cost from consumers has pushed the current manufacturing systems out of limits. On demand, just in time, zero inventory, reconfigurable and burst manufacturing are some of the key words describing the next generation manufacturing systems. Key enabling technologies are picking up the steam: mobile and human assistive robots are entering the manufacturing floors; additive and 3D printing methods enable rapid production of custom low volume productions without the need for tooling and pre-production process; the miniature of computer hardware allows software to be embedded into more products; internet of things enables every aspect of the manufacturing process and products to be monitored and analyzed. ABB believes that we are in the drawn of this fascinating technology breakthrough. As an automation company, we are looking for proposals that can make ABB successful in the future in areas including but not limited to: (1) robots for future manufacturing floors, (2) resource scheduling and process optimization, (3) additive manufacturing.

Topic 13: Mechanisms & manipulators

ABB has a large number of different types of motion systems in our product portfolio, ranging from circuit breaker drives to robot manipulators. The trends for the systems are towards:

- Decreasing cost
- Lower weight & smaller footprint
- Higher speed
- Higher energy efficiency

To meet the challenges introduced by the above trends we are calling for unique and innovative research proposals on topics related but not limited to:

- Actuation principles.
- Gearbox concepts.
- New structural materials & manufacturing methods.
- Lightweight designs.
- Mechanical energy storage solutions, allowing driving highly dynamic movements.
- Modeling techniques providing insight on the transient multi-domain system behavior under normal and oblique impacts with shockwave phenomena. Additional topics of interest which may elucidate the system behavior include nonlinear damping and nonlinear friction phenomena.

Topic 14: Multi-disciplinary optimization of servo motors

Design of servo motors for industrial robots is typically done in a separate process from the design of an industrial robot. This makes it difficult to achieve truly optimal design of the servo motors. Objectives of this project are 1) to develop a Mechatronic system simulation and design approach such that the design of a servo motor may be co-optimized with the drive system that conducts the control of the motor and with an industrial robot, on which the servo motor is used and 2) To understand the trade-off relationship between the motor performance and the robot performance in the aspects of accuracy and energy consumption. Goal of the proposed project is to achieve a drastically more optimized design of servo motors for industrial robot applications. ABB is seeking for proposals to develop sophisticated methodologies and tools in multi-disciplinary modeling, simulation and design optimization of servo motors to accomplish the defined project objectives and goal.

MATERIALS AND TRANSFORMATIONS

Topic 15: Compressible dielectric liquid

Finding additives for dielectric liquid to be able to contract in volume when put under isotropic compression. Wave propagation in fluids depends on the speed of sound which proportionally is related to bulk modulus. When decreasing bulk modulus of liquid the speed of sound propagation is reduced and in consequence acoustic impedance of the fluid decreases. With lower acoustic impedance of the medium not only the attenuation increases but also less energy is transmitted to the container. The objective is to investigate possibilities to increase significantly compressibility of a liquid maintaining the high dielectric strength.

Topic 16: Electrically self-healing insulation

Is it possible to develop an "electrically driven self-healing" process within an electrically insulating material? In the last decade self-repairing solid materials have been successfully developed, engineered and partially market introduced for structural applications. However, significant achievements for self-healing polymers and polymer composites for dielectric applications (damaged by electrical discharge activities) are still missing. ABB is working on creating novel dielectric materials for the next generation of high voltage power products. We seek for proposed material concepts, solutions for the design and synthesis/formulation of novel materials that show the capabilities (inherent or integrated) of self-repairing dielectric properties.

Topic 17: High Thermal conductivity in polymers (matrix modifications)

Polymers are good electrically insulating materials but present generally low thermal conductivity (typically 0.2-0.3 W/m.K). This is a major drawback in various applications, where the heat generated through the conductor needs to be dissipated.

We seek for innovative polymers having an inherently high thermal conductivity (> 1 W/m.K) and easy processable (low processing viscosity).

Topic 18: Detection of conducting inclusions in electrical equipment

In electrical insulation materials, the presence of defects like tiny voids or metallic contaminations can critically affect the life time of components under high electrical stresses. For voids, the detection of field induced partial discharges is a well proven and established non-destructive detection method for such defects. For metallic inclusions, however, corresponding NDT-methods are less obvious or too time consuming on a production scale (e.g. CT-imaging). We encourage research proposals addressing the non-destructive detection of conducting inclusions in dielectric insulation materials. Successful proposals should show the feasibility to detect the presence of conducting defects on a length scale down to well below 0.5-1 mm and have the potential for scaling up to the industrial level (object size cm - m, inspection times in the minutes range). Defect imaging is nice to have but not mandatory (however discrimination from metallic inserts is a must). Advanced THz-technology is a promising approach, but other novel approaches are equally interesting.

SENSORS AND SIGNAL PROCESSING

Topic 19: Sensors for water analysis

In the field of analytical measurements for the water industry there is a strong need to replace reagent-based or electrochemical sensors with analyzers that require low maintenance and do not need consumables.

ABB, as a leading supplier of equipment, instrumentation and analyzers for the water and waste-water industry, is interested in research on robust technologies for in-situ, multi-parameter water analysis based on optical chip or fiber optic technologies.

Of particular interest in this field is the combination of these technologies with selective coatings or membranes for the detection of specific parameters or components in water, such as e.g. pH, dissolved oxygen, phosphate, nitrate, and ammonium ion concentration.

Topic 20: Industrial microwave and millimeter-wave sensing applications

In the last decades microwave and millimeter wave technologies have been continuously expanding from the original high-end niches (e.g. military systems, aviation, and radio-astronomy) to a wide range of communication and remote sensing applications, as well as to consumer electronics. Off-the-shelf components, development tools and manufacturing capabilities are more and more commonly accessible; in conjunction with microwave and millimeter-wave integrated circuits (MMICs), they offer the possibility to implement complex systems in small volumes (e.g. as in the case of 77 GHz collision-avoidance radars for automotive applications).

We are interested in exploring the potential of microwave and millimeter-wave technologies for industrial applications, in particular in the area of industrial sensing. The activity could range from the next generation of existing technologies (e.g. for industrial radar level measurements), to novel non-destructive testing and evaluation applications (e.g. by tomographic techniques) as well as to microwave active and passive imaging. The activities might address hardware aspects (e.g. multi-channel RF circuits, array

antennas), signal processing (e.g. beam-forming, super-resolution techniques), as well as system aspects (e.g. feasibility under particular requirements).

Topic 21: Energy harvesting devices and systems

Autonomous power supply plays a crucial role for wireless devices. Harvesting energy from ambient sources has proven to deliver enough energy to drive power-efficient devices. Available sources are manifold: thermal energy, vibrational energy, kinetic energy, electromagnetic energy etc. For each of these sources there exists a variety of technologies to convert the harvested energy into useful electric energy to drive an electrical device. We are not only interested in the energy converter itself but also in associated aspects like low power electronics, power management, energy storage and wireless network aspects. The technologies and concepts we are looking for need to have a perspective of being able to deliver useful electric power in the range of milliwatts. The whole system must use the available energy as efficient as possible. The design should take aspects of lifetime, robustness and reliability into account which are mandatory for a fully autonomous system which is intended to be installed in an industrial environment. Scope is applications in automation as well as in power business.

SWITCHING TECHNOLOGIES

Topic 22: New computational methods for vacuum arc simulations

ABB is a leading supplier of low, medium and high-voltage interrupters and relies strongly on arc simulations in order to improve its products in an efficient way. Vacuum interrupters are one typical example, where a metal vapor arc is produced by the evaporation of contact material in a vacuum bottle. The prevailing high current densities and temperatures, the strong gradients of the plasma density and electrical conductivity, the high velocities of the plasma jets produced by strong evaporation of the contact material, and the arc motion driven by a self-generated magnetic field have to be predicted accurately. This poses a challenge to standard simulation tools.

For the future we seek to explore the use of advanced simulation techniques that are able to give robust, reliable and accurate solutions, with a focus on:

- new methods beyond finite volume / finite element approach for solving arc simulation problems, e.g. mesh-free, Lagrangian, particle based methods.
- inclusion of both fluid- (gas-) and electrodynamics models with a possible addition of radiation transport.
- the possibility to treat non-ideal gases and possibly also multispecies.
- the ability to deal with a complex 3D geometries including realistic, nonstandard boundary conditions.
- stability and robustness in the solution of problems with strong gradients and extremely high contrasts in pressure, temperature, electrical conductivity and flow velocities.
- the possibility to include in the future new models beyond fluid dynamics, for example, multi-fluid MHD, rarefied gases, particle simulations.

We are looking forward to receiving proposals on the application of the above computational methodologies to a benchmark problem resembling a vacuum circuit breaker.

Topic 23: Advanced Fuse Technologies

Power fuses used today in MV circuits are cost-effective overcurrent protection devices with unique time-current characteristics (TCC) curves that allow coordination with other protection devices. While power fuses have matured over many years and remain very popular, there has not been a fundamental technology leap in terms of functionality and performance.

The need for a technology leap arises from new and emerging requirements in the context of future distribution systems with bi-directional power flows and increased generation and load variability. In this context, proposals of interest include:

- New materials that can reset itself, especially for temporary faults. In particular, evaluation of design and system limitations of using advanced materials and/or research on new materials which could be used in fuse applications, as self-resetting fuses and fused cutouts.
- New, low-cost sensors and electronics for fast and reliable detection of faults and disturbances and communication options that allow integration into automation schemes. We aim to innovative components, cost-competitive and powerful enough to handle requirements for fault management, data capture and communications.
- New and creative mechanical design options and methodologies to incorporate new and advanced functionalities into the same fuse cutout assemblies. We are interested in novel manufacturing concepts that allow retrofitting of new fuses assembly into existing fittings in the field.

3 GUIDE TO SUBMITTING PROPOSALS

The applications should be entered online in the ABB Research Grant database. A link to the database will also be provided on the ABB homepage. Note that the database opens up for applications on September 2.

Questions regarding the ABB Research Grant Program should be sent to ResearchGrantProgram@se.abb.com

The application is limited to eight pages (A4, 12pt, PDF) and must include the following sections:

- Project title and requested amount of funding
- Relevant Topic Number(s) on RFP
- Abstract
- Context and motivation
- Aims and objectives
- Related Work
- Proposed method
- How will success/progress be measured?
- Execution plan
- Resources
- Time plan
- What is the impact if successful?

The following attachment (as one separate pdf file) should also be included in the application:

- CVs of applicants and Bibliography of Related Work (not part of 8 pages)