



Research Opportunities In Advanced Automation

UWM and the UWM Research Foundation are exploring research opportunities in advanced automation along with area corporations such as Rockwell Automation. In the fall of 2007, the UWM Research Foundation will issue a call for proposals in the area of advanced automation under the Catalyst Grant Program, made possible by support from Rockwell Automation.

Evolution of Advanced Automation. Forward looking companies such as Rockwell are expanding from delivering hardware products to delivering solutions, which may be any combination of products, systems and services to meet their customer's business needs. To be successful, Innovation must 1) reflect the voice of the customer, 2) be built on a solid business case and 3) be based on technologies that integrate well with the existing architectures and 4) take into account societal interests in the issues of health, safety, security, and environment including energy conservation as they impact both employees in the workplace, and the surrounding communities. A portion of the internal research and development efforts are geared towards commercialization within 24-36 months, and universities such as UWM could help in research that will impact products and solutions in 3 to 5 years and beyond.

Research Areas. UWM industry partners, including Rockwell Automation, are interested in building research capabilities at UWM in three areas viewed as critical to technology evolution in advanced automation. The areas of interest are:

- ***Software and Manufacturing Informatics***
- ***Sensors and Devices***
- ***Advanced Materials***

Software and Manufacturing Informatics

Bridging the Gap Between the Shop Floor and the Top Floor. The evolution and acceptance of global standards coupled with customer needs are driving the need to link the factory automation systems found on the factory floor with Enterprise Resource Planning (ERP) systems such as SAP used at the highest levels of management. Challenges and opportunities in this area include:

- Adoption of standards-based Manufacturing Execution Services (MES) layer of software that links shop floor automation, which has relied heavily on proprietary integration standards with higher level systems
- Reconciling the data produced by factory automation systems, often in the form of many small messages, with the needs of higher level monitoring and control systems
- Creating strategies to manage the mismatch in timing and data latencies between factory automation systems that demand millisecond responses with high level systems that may have latencies of minutes to hours
- Creating more flexible architectures that do not depend on specific devices or need to be manually reconfigured when a particular component is changed
- Overcoming the challenges of Services Oriented Architectures (SOA) standards that don't necessarily meet the speed of execution demanded by shop floor automation
- Development of efficient communication strategies and standards which optimize communication between equipment at the lower level application layer versus higher level network layer

Legacy Software Challenges. Automation software has evolved over a long period of time leading to some systems that could have a monolithic architecture spanning several million lines of code.

Some systems may be written in C or C++ programming language and could be several years old. This creates challenges in managing legacy software systems and in evolving new systems, including:

- Developing tools that analyze structures in legacy software systems
- Developing tools that can self document legacy software
- Developing Application Programmer Interfaces (API's) for software components that will encourage the development of software from small software vendors
- Creating tools and strategies to recover designs and architectures from existing software
- Modularization and componentization of systems so that modules such as “valve controller” or “temp controller” can be standardized and extensively reused
- Refactoring or rearchitecting and modularizing legacy software systems in ways that do not compromise performance
- Finding strategies for leveraging the strengths of Business Process Execution Language (BPEL) such as graphic representation and services defined by contracts while overcoming the shortcomings in an advanced automation setting such as timing, latency, efficiency and reliability

Prognostics and Dynamic Control. Advanced automation systems will increasingly be called upon manage faults in an intelligent manner, allowing the system to continue to operate, helping guide maintenance teams to degraded or failed components and to prevent catastrophic failures all while ensuring that the fault management doesn't worsen the situation. This will rely upon accurate diagnosis of the problem and strategies to dynamically manage the process. Opportunities in this area include:

- Developing strategies and architectures to ensure control stability
- Developing systems to discern the health of a the system from disparate information and maintain accurate status of degraded components
- Creating autonomous agents that can monitor the operation of the core system and respond when changes are detected
- Implementing systems that can dynamically adjust gains, pressures and other control parameters to maximize Remaining Useful Life (RUL) of components including state space algorithms and other control strategies
- Implementing automation systems that are both safe, secure and energy efficient in their own operation and capable of managing energy utilization within the complete enterprise.

Sensors and Devices

Fluid and Vapor Property Measurements. Advanced automation is used extensively in food and chemical processing industries where fluid properties are key control parameters. Customer needs in this area include:

- Measurement of fluid properties beyond the standard measure such as Ph and viscosity such as measurement of contamination in grease used in food processing
- Development of sensors that can operate in-line or at-line rather than off-line to improve process control
- Vapor sensing and identification of specific materials in vapors

Sensors for demanding Environments. Sensors used in factory automations are often required to operate in difficult environments, including highly corrosive environments or environments subject to significant EMI/EMC. Research in this area could support:

- Development of sensors that can operate in corrosive environments (such as the highly acidic environment of orange juice)
- Development of sensors that can operate reliably in the presence with significant Electromagnetic Interference (EMI)

Biometrics. Issues of security and access control create opportunities for biometric sensing coupled with advanced automation systems, including:

- Biometric sensing for personnel identification
- Location-based identification of personnel and matching with required credentials for access and performance of maintenance operations

Advanced Materials

Nanomaterials Coupled with Sensing. Opportunities exist to address sensing challenges with advanced nano-materials, such as:

- Development of sensors based on nanomaterials
- Use of nano coatings to address corrosion
- Application of EMI/EMC absorbent nano coatings to sensors

Miniaturization. Miniaturization of controllers, switches and other factory automation components creates opportunities to apply advanced materials, including:

- Carbon nano-tube composites that direct arcs for electrical contacts
- Application of high thermal conductivity materials around electrical contacts
- Application of nano-materials to minimize reliance on precious metals in contacts
- Miniaturization of springs and other components of electrical contacts

Environmental Standards. Increasingly stringent environmental standards also present opportunities that can potentially be addressed by advanced materials, including:

- Elimination of Cadmium Oxide and hexavalent chrome in components
- Use of sustainable materials
- Cytotoxicology research to determine long term impacts of nanomaterials
- Addressing future problems with lead free soldering as the technology matures

Other Advanced Material Opportunities. Other potential applications for advanced materials include:

- Addressing challenges in lubrication, wear, ESD damage and fretting
- Application of nanoscale constituent additions to polymeric and other films – including conductive films, films used for corrosion control and self healing coatings
- Use of nano ceramics and composites in thermal barriers
- Bulk polymer enhancements
- Applications for heat sinks, thermal conductivity and directional thermal management
- Energy conservation and recycling through the use and application of nano engineered materials and systems