# Annoted Bibliography for Smart Campus Proposal

Fields of View

8 July, 2012

## References


[1] C.J. Andrews, D. Yi, U. Krogmann, J.A. Senick, and R.E. Wener. Designing buildings for real occupants: An agent-based approach. *Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on*, (99):1–15, 2011.

> This paper presents a framework for prospectively measuring the usability of designs before buildings are constructed, while there is still time to improve the design. The framework, which was implemented as an agent-based computer simulation model, tests how well buildings are likely to perform, given realistic occupants. An illustrative model for lighting design shows that this modeling approach has practical efficacy, demonstrating that, to the extent that users exhibit heterogeneous behaviors and preferences, designs that allow greater local control and ease of operation perform better. This is the closest work to our proposed approach however, in this work the authors are in the building planning stage for new buildings. The architects are the target audience. The problem at hand is one of retrofitting.

[2] S. Arlekar, K. Harsha, B. Palavalli, and R. Jayanth. Platform for large-scale disasters. Technical report, CSTEP, 2011.

> An example of our previous experience with agents and socio-technical systems.

[3] V Callaghan, J Woods, S Fitz, T Dennis, H Hagras, M Colley, and I Henning. The essex idorm: A testbed for exploring intelligent energy usage technologies in the home. In *3rd International Conference on Intelligent Green and Energy Efficient Building & New Technologies*, 2007.

The paper is motivated by the belief that by empowering the domestic consumer, to be better able to visualize and control their energy consumption, a significant impact on the problems of energy consumption and climate change will follow. The platform also facilitates technological intervention at the power system level if the user has no regard for a conservation policy. To these ends we describe a test-bed, the iDorm, which explores future possibilities for innovative intelligent energy technologies and usage strategies within the home environment, together with some of the key technologies involved. We note that this has been the most successful implementation of smart environment system so far and hence a significant piece of work to study and cite. Conclusion: In this paper we have described an innovative test-bed for exploring intelligent energy usage technologies for the home, the Essex iDorm. We have explained how the test-bed is a combination of a digital home, intelligent power and micro-generators whose operation is orchestrated by intelligent agents. Essex has a successful track record in the development of agents to control digital homes and we are now embarking on are search program whereby we will integrate this work with the emerging power generation and control technologies. The goal of this work is to address the climate change issue at its roots, by enabling ordinary people to have a more direct say over their carbon usage by making the power they consume more visible and giving them the technological tools to be able to exercise their will in the most efficient ways possible. The role of the agents is to remove the cognitive load associated with the underlying technical complexities from people, freeing them to think about energy management at a much higher level. A factor we do not consider in detail in this paper is the need to change personal consumption habits in a way that is not seen as excessively coercive: such would be doomed to failure. The need to do so has to be recognized at the personal level, and from an early age, so input to the primary and secondary education systems is vital. To this end we expect to collaborate with other disciplines specifically Psychology, Sociology, Government and Biological Sciences. This work too considers the problem as a socio-technical system.

[4] Han Chen, Paul Chou, Sastry Duri, Hui Lei, and Johnathan Reason. The design and implementation of a smart building control system. In *IEEE International Conference on e-Business Engineering*, pages 255–262. IBM Thomas J. Watson Research Center, 2009. DOI

10.1109/ICEBE.2009.42.

A proof-of-concept implementation of the architecture is used to demonstrate the support for building-wide energy conservation policies using real-time energy pricing and individual occupants locations and preferences. It shows that the proposed architecture enables fine-grained building control and reduces energy consumption while maximizing its occupants comfort. This work is one of the examples where there are attempts made to combine the energy policy of the institution with the control mechanisms. In this case it is again an agent based approach to control.

[5] S. Cherian and R. Ambrosio. Towards realizing the gridwise trade; vision: integrating the operations and behavior of dispersed energy devices, consumers, and markets. In *Power Systems Conference and Exposition, 2004. IEEE PES*, pages 1–6, 2004.

This paper presents an approach that addresses one of the major technology hurdlesdeveloping an affordable and highly scale-able platform that enables energy service providers to model and implement business processes that integrates dispersed physical assets, energy consumers, and energy markets to create and capture new value.

[6] M.H. Coen et al. Design principles for intelligent environments. In *Proceedings of the National Conference on Artificial Intelligence*, pages 547–554. John Wiley & Sons Ltd, 1998.

One of the earlier works on intelligent spaces and approaches to building it. This paper is used to talk about the basic principles of this work

[7] Diane J. Cook, Michael Youngblood, and Sajal K. Das. *Lecture Notes in Computer Science*, volume 4008, chapter A Multi-agent Approach to Controlling a Smart Environment, pages 165–182. Springer, 2006.

Because of the size of the problem, controlling a smart environment can be effectively approached as a multi-agent task. Individual agents can address a portion of the problem but must coordinate their actions to accomplish the overall goals of the system. In this chapter, we discuss the application of multi-agent systems to the challenge of controlling a smart environment and describe its implementation in the MavHome project.

[8] Paul Davidsson and Magnus Boman. Distributed monitoring and control of office buildings by embeddedagents. *[Information Sciences*, 171:293–307, 2005. DOI: 10.1016/j.ins.2004.09.007.

Describes a decentralized system consisting of a collection of software agents that monitor and control an office building. It uses the existing power lines for communication between the agents and the electrical devices of the building, such as sensors and actuators for lights and heating. The objectives are both energy saving and increasing customer satisfaction through value added services. Results of qualitative simulations and quantitative analysis based on thermodynamic modeling of an office building and its staff using four different approaches for controlling the building indicate that significant energy savings can result from using the agent-based approach. Conclusions: The use of the agent approach was initially motivated by the close mapping that it offered between the entities of the application domain and the entities of the software. The concurrent non-deterministic nature of the activities inside the building was another factor that led to the development of concurrent autonomous entities. In fact, the intelligent office building domain matches all the characteristics of the domains for which agent-based systems has been found useful. Finally, we evaluated the approach by means of qualitative computer simulations and quantitative analyses based on thermodynamic models. Our results indicate that the approach is viable and that considerable energy savings are possible while at the same time providing added value for the customer. In addition, the approach enables a much more fine-grained control of the trade-off between energy saving and customer satisfaction than is possible with current approaches. It is also worth mentioning that an agent-based approach permits even more advanced control mechanisms than previously mentioned in this paper. For instance, it is possible to let the agents take into account that the price of energy is not constant. This work has demonstrated significant results and is field testing the solution in retirement homes. This a another demonstration of a agent-based approach to implementing smart environments.

[9] Cuong P. Flueck, Alexander J.and Nguyen. Integrating renewable and distributed resources -iit perfect power smart grid prototype. In *IEEE PES General Meeting*, pages 1–5. IEEE, 2010.

The goal of this paper is to provide a brief overview of the Perfect Power Smart Grid Prototype at Illinois Institute of Technology, while highlighting some of the multi-agent system applications. Conclusions: In addition, the four research thrusts in advanced distribution automation, cable fault diagnostics, intelligent power system controls and direct load controls will establish new strategies for integrating renewable and distributed resources, while improving reliability and reducing peak demand. All four of the research thrusts can benefit from a multi-agent system framework. In particular, the advanced distribution automation area was highlighted in this paper. The co-simulation environment enables engineers to test new ideas with realistic models, before committing additional resources to hardware implementations.

[10] Geoff James, Dave Cohen, Robert Dodier, Glenn Platt, and Doug Palmer. A deployed multi-agent framework for distributed energy applications. In *AAMAS 06*, pages 676–678. ACM, 2006.

In this paper, we describe the adaptation of an open-source multi-agent platform for distributed energy applications and the trial deployment of resource-controller agents. Such a decentralized architecture improves grid reliability, allows consumers to play a more active role in their energy usage, benefits the network by alleviating the effects of peak wholesale prices and network constraints, and creates new business opportunities in a deregulated market. Agents have been deployed to control hardware at trial locations in Australia, providing a realistic test environment for the platform, and medium-scale trials are anticipated in the near future. This work again is used as example of multi-agent technology on the supply side. However, the researchers also offer insight into the changing nature of the demand side with the adaptation of micro-grid technologies. Given the energy demands of India and current trends in demand side, it will be evident that we will too have to account for micro-grid connectivity or consider multiple sources of energy. Thus, this work offers an abstract overview of such a system.

[11] J.K. Kok, C. J. Warmer, and I.G. Kamphuis. Powermatcher: Multiagent control in the electricity infrastructure. In *AAMAS 05*, pages 75–82. ACM, 2005.

Present the PowerMatcher, a market-based control concept for supply and demand matching (SDM) in electricity net-

works. In a presented simulation study is shown that the simultaneous process of electricity production and consumption can be raised substantially using this concept. Further, a field test with medium-sized electricity producing and consuming installations controlled via this concept, currently in preparation. This paper is used as an example with field-tests of an Multi-agent based control system on the supply side with implications on the electricity markets.

[12] S.S. Krishnan, N. Narang, S.K. Dolly, R. King, and E. Subrahmanian. Global mechanisms to create energy efcient and low-carbon infrastructures: An indian perspective. IEEE conference on Infrastructure Systems and Services: Next Generation Infrastructure Systems for Eco-Cities, November 2010.

An example of our previous experience with agents and socio-technical systems.

[13] M. LeMay, R. Nelli, G. Gross, and C.A. Gunter. An integrated architecture for demand response communications and control. In *Hawaii International Conference on System Sciences, Proceedings of the 41st Annual*, pages 174–174. IEEE, 2008.

An example of using agent-based technology and intelligent environment for demand side market modeling. A demonstration of both energy policy modeling and the extent to which information collected in this effort can be used.

[14] K Manickavasagam, Nithya M., Priya K., Sruthi J., Sruthi Krishnan, Smriti Misra, and Manikandan S. Control of distributed generator and smart grid using multi-agent system. In *Electrical Energy Systems (ICEES) 1st International Conference*, pages 212–217, 2011.

The objective of this paper is to design and model a multi-agent system which consists of Distributed Energy Resource (DER) agent, Data Base agent, Control agent and User agent. This is a paper that is presented as an example where maintenance on the supply side is moving towards agent based control technology.

[15] S.D.J. McArthur, E.M. Davidson, V.M. Catterson, A.L. Dimeas, N.D. Hatziargyriou, F. Ponci, and T. Funabashi. Multi-agent systems for power engineering applications-part i: concepts, approaches, and technical challenges. *Power Systems, IEEE Transactions on*, 22(4):1743–1752, 2007.

Part I of this paper examines the potential value of MAS technology to the power industry. In terms of contribution, it describes fundamental concepts and approaches within the field of multi- agent systems that are appropriate to power engineering applications. As well as presenting a comprehensive review of the mean-ingful power engineering applications for which MAS are being investigated, it also defines the technical issues which must be ad- dressed in order to accelerate and facilitate the uptake of the technology within the power and energy sector.

[16] S.D.J. McArthur, E.M. Davidson, V.M. Catterson, A.L. Dimeas, N.D. Hatziargyriou, F. Ponci, and T. Funabashi. Multi-agent systems for power engineering applications-part ii: technologies, standards, and tools for building multi-agent systems. *Power Systems, IEEE Transactions on*, 22(4):1753–1759, 2007.

Part II of this paper explores the decisions inherent in engineering multi-agent systems for applications in the power and energy sector and offers guidance and recommendations on how MAS can be designed and implemented.

[17] M.C. Mozer. The neural network house: An environment hat adapts to its inhabitants. In *Proc. AAAI Spring Symp. Intelligent Environments*, 1998.

One significant cost of an automated home is that someone has to program it to behave appropriately. Typical inhabitants do not want to program simple devices such as VCRs, let alone a much broader range of electronic devices, appliances, and comfort systems that have even greater functionality. We describe an alternative approach t in which the goal is for the home to essentially program itself by observing the lifestyle and desires of the inhabitants, and learning to anticipate and accommodate their needs. The system we have developed controls basic residential comfort systems air heating, lighting, ventilation, and water heating. We have constructed a prototype system in an actual residence, and describe initial results and the current state of the project. Conclusion: The research program hinges on a careful evaluation phase. In the long term, the primary empirical question we must answer is whether there are sufficiently robust regularities in the inhabitants behavior that ACHE can benefit from them. The research that does involve control of actual equipment makes simplifying assumptions about operating conditions and the

environment. We intend to show that adaptive control will yield benefits in natural environments under realistic operating conditions. Though the approach used in this work is that of neural-networks and not agent based approaches, the paper gives important insights into design of intelligent environment and the significance of using a natural environment and operating conditions.

[18] S. Rahman, M. Pipattanasomporn, and Y. Teklu. Intelligent distributed autonomous power systems (idaps). In *Power Engineering Society General Meeting, 2007. IEEE*, pages 1 –8, june 2007.

This paper presents the concept of a specialized microgrid called an Intelligent Distributed Autonomous Power System (IDAPS). The IDAPS microgrid aims at intelligently managing customer-owned distributed energy resources such that these assets can be shared in an autonomous grid both during normal and outage operations. The proposed concept is expected to make significant contributions during emergency conditions, as well as creating a new market for electricity transaction among customers. Another example demonstrating the use of agent-based systems for privately owned microgrids. The demonstration of the approach to have the capability to handle such a scenario, given that a campus may exist for a long term operation.

[19] D.M. Staszesky, D. Craig, and C. Befus. Advanced feeder automation is here. *Power and Energy Magazine, IEEE*, 3(5):56 – 63, sept.-oct. 2005.

Distributed intelligence, as applied to distribution feeder circuits, makes it possible to consider application of automation to solve tactical problems, such as the large retailer that requires better-than-available power reliability. The utility planner can use this new technology to not only address such tactical problems but to eliminate or reduce the need for costly system upgrades, thus providing optimal asset management. This report is used as a demonstration of how multi-agent technology will be used up-stream in the system even before the distribution networks.

[20] Michel J. Wooldridge. *An Introduction to MultiAgent Systems*. John Wiley and Sons, 2001.

This is a textbook on Multi-Agent system. On page 225-226 of Chapter 10, the author explains when is an agent based approach appropriate.