Research Clusters Information

- Communications
- VLC
- LESA Support
- Cognition
- Healthcare
- Efficient Buildings
- Plant Science
Cognitive Environments

Information from several types of networked sensors can be used to characterize the patterns of activity and language of occupants in a space. LESA will create smart service systems utilizing advanced time-of-flight sensors, custom made beam-forming microphones, and natural-language-understanding algorithms for self-commissioning environments that are integrated with the smart building system. Future applications include intelligent room designs with automated meeting management capabilities for widespread use in education, finance, business, government and other meeting-rich areas.

Research Areas

- Multi-modal Sensing & Control
- Occupancy Tracking and Control
- Human - System Interface
- Group Dynamics
- Computational Linguistics
- Autonomous Operation

LESA’s Smart Conference Room testbed includes advanced concepts for research and education that has the potential for greater public engagement with science and technology. Advances in cognitive, immersive environments and supporting system infrastructure can optimize building energy and lighting system ergonomics.

Research Focus

LESA’s research efforts include the integration of multi-modal, sensor-enabled, immersive environments. The research goals include development of sensor and actuator rich environments that tightly integrate with cognitive computing systems. LESA’s smart conference room testbed is a key component of the research infrastructure for the application of lighting enabled systems.
Lighting Enabled Building Management

LESA is developing powerful lighting based occupancy and activity sensing technologies that combine multiple low cost light field sensing technologies with digitized illumination. The integration of these lighting sensor platforms with advanced control algorithms, enables autonomous lighting management for improved human comfort, productivity and maximum energy efficiency. Furthermore, these lighting field sensing systems are superior to other technologies for generating data about human activity while preserving occupant privacy, and can be made an integral part of improving building services including energy efficient HVAC, improved security, improved operational efficiency, and worker comfort and productivity.

Research Areas

- Distributed Light Field Control
- Occupancy Tracking and Control
- Human - System Interface
- Building Systems Integration
- Autonomous Operation

LESA’s research for the implementation, evaluation, demonstration, and prototyping of new sources, sensors, and control algorithms for lighting enabled building management systems is based in the Center’s Smart Conference Room testbed where integration with building systems such as HVAC and window coverings are being explored.

Research Focus

LESA is exploring privacy-preserving light field and occupancy/activity sensing methods, integrated robotic control algorithms and simulation tools to enable autonomous lighting control and self-commissioning lighting systems with an emphasis on integrating smart, lighting-enabled systems into the built environment. The research goals include demonstrating substantial energy savings through adoption of advanced sensing and controls coupled with mechanisms for integrating occupant feedback. LESA’s smart conference room testbed is a key component of the research infrastructure for lighting enabled building management systems that improve energy efficiency, human productivity and health.
Healthcare Integrated Systems

Lack of synchrony between the internal circadian clock and the external environment can create circadian misalignment causing decreased alertness, sleep disruption, obesity, cardiovascular disease and other health and safety issues. Light has long been known to be the stimulus and synchronizer for regulating many of our biological systems. Through the use of actigraphy, photometry and log data we are learning that light, both artificial and natural can be used to improve circadian entrainment and sleep, thereby enhancing health, well-being and productivity. The ERC is building intelligent controls for autonomous lighting systems that adapt to human needs and environmental changes, and is developing the utilization of advanced circadian-aware lighting systems for health and well-being applications.

Research Areas

Circadian Rhythm Control Modelling  
Dynamic Lighting Impact on Human Health  
Circadian-Aware Lighting  
Circadian Phase Estimation  
Patient-based Lighting & Health Studies  
Activity monitoring data collection

Smart Lighting can deliver additional health benefits through dynamic illumination optimized for circadian function, patient recovery rates, and greater safety through adaptive, circadian-aware lighting. LESA’s Hospital Room Testbed at UNM and Drosophila Testbed at RPI are pictured above.

Research Focus

The research efforts of this cluster include modelling the dynamics of circadian rhythms, human circadian rhythm management, circadian control research applied to the treatment of sleep disorders and circadian disruption for patients with traumatic brain injuries and other diseases. The drosophila testbed at RPI utilizes the drosophila species in the modeling and implementation of circadian rhythm control algorithms. LESA’s Inpatient Hospital Room Testbed installed at the University of New Mexico Hospital is equipped with an integrated network of tunable LED luminaires, sensors and controls to support a controlled experimental environment for human health applications of smart and circadian-aware lighting technologies. Analysis of circadian and sleep disruption in concussed and post-stroke patients is being investigated at the Thomas Jefferson University test labs.
Horticultural Lighting Systems

The advent of solid state lighting has resulted in new opportunities for optimizing and regulating plant growth and plant biochemistry in controlled environment agriculture applications. Light is a requirement for photosynthesis and provides information that plants sense and use to modulate their metabolism to maintain photostasis. A focus of LESA’s research is to remotely sense plant signals in order to automate the spatial, spectral and temporal characteristics of the light environment. This automated control is to purposely improve indoor plant production - plant yield, biomass, nutritional or pharmaceutical value – with relevance to food security, water and energy conservation.

Research Areas

- **Plant Pigment Studies**
- **Plant Fluorescence Signal Sensing**
- **Dynamic Plant Light Control**
- **Plant Growth Optimization**
- **Multi-wavelength Plant Lighting**
- **Photosynthesis Regulation**

Light-enabled systems applied to horticulture have significant impacts in the optimization of plant growth, the regulation of photosynthesis and beneficial biochemical pathways, and are instrumental components of developing an automation platform for biological feedback controlled systems.

Research Focus

LESA is actively engaged in the fusion of plant physiology with control systems engineering for the development of lighting enabled systems for horticulture applications. Hydroponics and controlled growth environments provide the foundation for spectrally controlled growth experiments to study biomass, pigmentation, photochemistry and other physiological effects under various lighting conditions. Fundamental research efforts include lighting automation for photosynthetic organisms, integration of advanced plant fluorescence sensing techniques, dynamic lighting, and advanced control algorithms.
Visible Light Communications

Visible light communication (VLC) continues to gain interest worldwide. High speed VLC research is paving the way for ubiquitous high bandwidth wireless communications by adding optical connectivity to address limited RF spectrum availability. The development of Heterogenous Networks (HetNet) capabilities that seamlessly integrate light and RF-based wireless communications is critical to the future IoT-connected world. LESA’s research aims to satisfy these unique challenges and explore opportunities in advanced lighting enabled systems and services.

Research Areas

- Hybrid WiFi / VLC Networks
- Heterogeneous Networking
- Multi-wavelength VLC
- VLC Sensor Architecture
- Object tracking for VLC Applications
- Building Energy Efficiency via VLC

Visible light communications is an enabling technology to satisfy bandwidth requirements for indoor optical communications, expand wireless access, and maintain download speeds in the connected environment.

Research Focus

Work in this area is focused on using visible lighting systems for high data-rate, visible light communications including VLC/RF HetNets and the associated challenges in mobility, networking and hardware implementation. Advanced driver and receiver design compatible with OFDM techniques are integrated into the Center’s VLC research platform. Research goals include improving productivity through high-performance data access in indoor spaces through the implementation of dual-use lighting systems that permit high data rate and high data rate density while simultaneously providing adaptive illumination.