Smart Lighting research at VTT

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Abstract
In this document we are presenting our expertise and related research projects in the field of smart lighting.

Author Keywords
Smart lighting; Integrated lighting control; People tracking; Printed electronics

Introduction
"For high quality lighting we need high quality light sources, luminaires and lighting design. For smart lighting we need the same things with intelligence: connectivity, smart control, sensors, and the ability to adjust to the user's needs." says Janne Aikio, Principal Scientist at VTT.

VTT has had a common goal in developing the components needed for the next generation of smart lighting. Research has extended to optimization of high-efficiency LED-lighting, development of luminaires with color changing, dimming, and beam-steering properties as well as smart sensors and control solutions. The applications range from energy-saving street lamps to comfortable, self-adjusting interior lighting for offices, shopping centers and residential buildings.

"Thanks to the development initiated in Finland, modern smartphones are now much more than

Figure 1 Flexible LED luminaire concept

telephones. I can see a similar development for lighting. As a part of smart buildings and cities, the result will be much more than lighting. We want to be a part of that development."

Our Offering

Responsible lighting control systems

- Dynamic control of lighting intensity, distribution and colour based on people's activity
- New sensors can be easily attached for sensor fusion and advanced context recognition
- Support for multiple lighting control standards: DALI, DMX, Zigbee Light Link, enOcean

People tracker

- Depth sensor based people tracking solution
- Reliable (>95%) and accurate (<10 cm)
- Anonymous detection
- Tracking area up to hundreds of square meters

Consultancy and engineering

- Hardware and software engineering of connected IoT devices
- Integration of technologies and mechanical design of luminaires
- LED module thermal design, simulations and measurements
- Optical design, light quality measurements and prototypes for challenging applications
- Energy efficiency estimations and measurements
- Future proof lighting concepts, vision
- Technology surveys, pilots

Lighting+

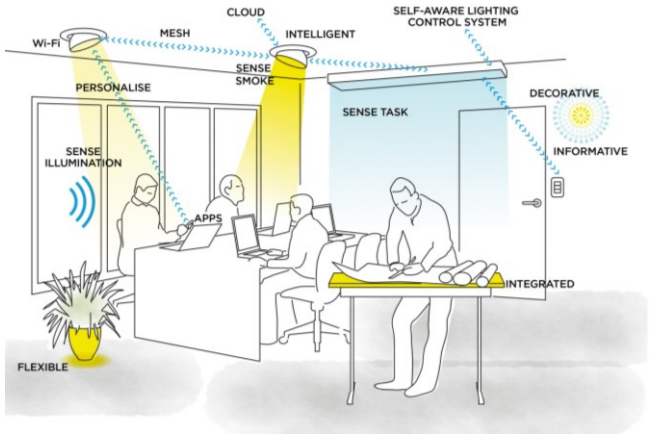

Figure 2 Overview of a Lighting+ enabled office

- Integration of sensors, connectivity and LED drivers to light products
- MEMS sensors (spectroscopic, acoustic, acceleration)
- Wireless and internet connectivity
- Wireless power based on NFC standard (1-20 mm) and proprietary technology (1m)

Smart flexible luminaires

- Flexible luminaires
- Printed sensors
- System integration
- Pilot manufacturing

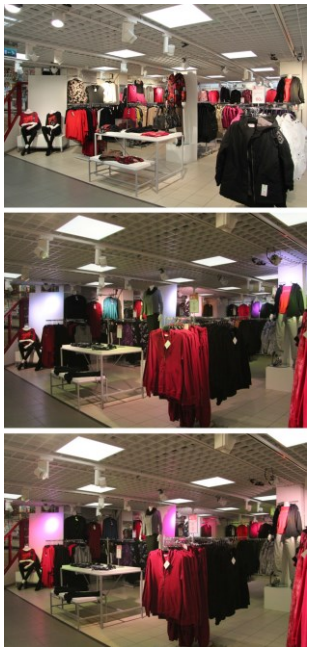

Figure 3 SparkSpace project Lighting schemes

Relevant Projects

AthLEDics

STREET LIGHT

Remotely controllable and monitorable street lighting was studied in the AthLEDics project. Four prototypes capable of sensing external and internal luminosity, and people moving near the lamp posts was installed on a pedestrian road in Helsinki. The lamps can be operated in three modes: regular "on at nights" –mode, adaptive intensity based on natural light - mode and a mode where the intensity increases from dim to regular only when pedestrian has been detected.

INDOORS LUMINAIRE

An indoors luminaire. with adjustable lighting beam without using any mechanical parts was developed during the project. The beam and brightness of the luminaire can be controlled over Bluetooth LE radio using an Android application. The luminaire is also equipped with an accelerometer, which can be monitored with the application.

SparkSpace

The goal of the SparkSpace project has been to search for new possibilities to control lighting interactively by using intelligent real-time lighting control methods, multi-sensory measurements and user feedback. The project was fruitful collaboration with researchers from University of Oulu, Department of Architecture.

The major technical pilot of the project was carried out in a retail store. Lighting of the ladies' clothes section was controlled in order to highlight selected hotspots in the area. By displaying products under dynamic lighting, the changes in light intensity attract customer's attention.

People at the target area were followed with a depth camera array based people tracker. The tracking data was used in classifying the customers' behavior and triggering different control modes.

SeeThrough

In the SeeThrough project we have been developing concepts to allow creating natural lighting environments from real scenes and enabling ambient communication by using dynamic controllable light sources.

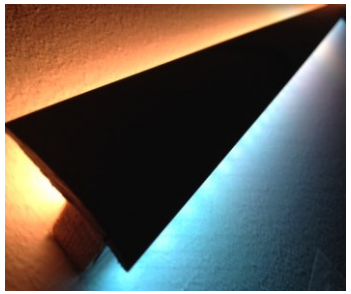

Figure 4 SeeThrough artificial LED strip horizon