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Intelligent Lighting Control

Introduction

Widespread adoption of autonomous systems gave rise to more intelligent automobiles, appliances, aircrafts and many other systems. Many of these systems can make intelligent decision without human intervention. Current lighting system control lacks intelligence to allow local customization of illuminance level and autonomous operation. However, current lighting systems have achieved significant reduction of energy through use of occupancy sensor, timer, day-light sensor, etc. Notwithstanding energy saving achieved, serious limitations exist: inability to respond when lighting sensors are added or partitions are added in open office; and inability to provide appropriate illuminance at an arbitrary location. New lighting control systems must incorporate intelligence to allow not only reduction of energy but also autonomous operation.

Overview of Intelligent Lighting System

Intelligent lighting system comprises multiple lighting fixtures connected in a network to provide automatic control of lighting level to meet user's need. Current lighting control systems often incorporate some automatic control but they can only create limited number of illuminance pattern due to limitations imposed by field wiring of lighting fixtures. On the other hand, field wiring of lighting fixtures has no limitations on intelligent lighting system operation. Once the user's preference is set, intelligent lighting systems can automatically provide appropriate illuminance without making the user aware of the location of the lighting fixtures.

Multiple movable illumination sensors, lighting fixture controllers and a power meter connected together forms a small independent network where information is shared locally and with other networks. Controllers in intelligent lighting systems are capable of acquiring new intelligence and can operate autonomously to control the lighting fixture. Figure 1 below shows the configuration of an intelligent lighting system.

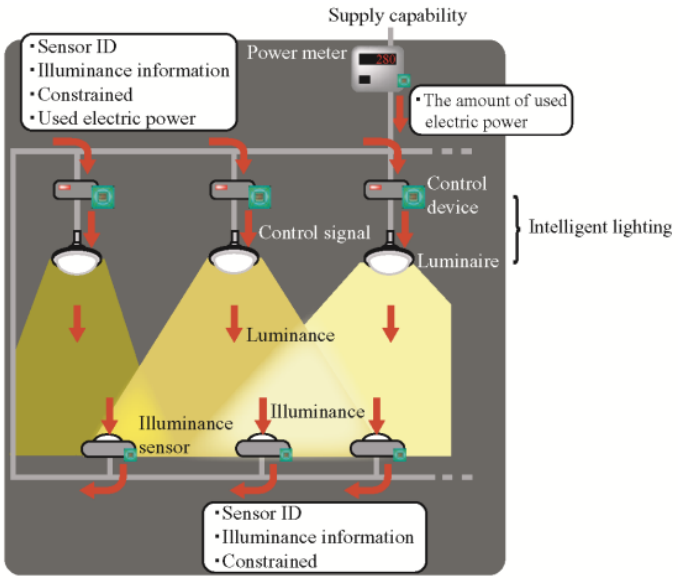

Figure 1: Configuration of intelligent lighting system

Intelligent Lighting System Control

Intelligent lighting system has no central controller and operates in a distributed manner to provide autonomous control. Each individual controller adjusts luminance of the fixture to meet the illuminance goal. The intelligent lighting control sequence is as follows:

1) Initialize the intelligent lighting system and provide minimum illuminance at each sensor locations.
2) Each illuminance sensor detects the current illuminance level.
3) Each illuminance sensor communicates its target illuminance level and current illuminance level to the network.
4) Controller of each intelligent lighting fixture controls luminance based on the current and target illuminance of each sensor with the goal of minimizing power consumption while achieving target illuminance.
5) Repeating steps 2 thru 4, the system constantly senses environmental information, and adjusts control parameters so that goals are achieved.

Using the above process, each intelligent controller can autonomously perform lighting control to satisfy both energy saving and illuminance goals. Constant sensing of environmental information allows intelligent lighting control system to respond quickly to changes such as addition or movement of illuminance sensors and addition or malfunction of lighting fixtures. In addition, intelligent lighting control system can balance conflicting preferences of adjacent illuminance sensors and implement demand response control through load shedding during times of peak electricity pricing.

Conclusion

Artificial lighting consumes 20-30% of total electricity in a commercial building. Use of occupancy sensor, timer, day-light sensor in existing lighting control systems can significantly reduce energy footprint of the lighting systems. Likewise, intelligent lighting system also strives to reduce energy consumption. In addition to energy savings, intelligent lighting system provides individual lighting comfort level autonomously without human intervention. Barrier to widespread adoption of intelligent lighting control is high initial cost. However, cost of deployment will decrease in coming years as costs of processors and wireless sensors are falling rapidly. This will allow future lighting system to operate autonomously and intelligently.

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