Implementing a ZigBee-Based Smart Lighting System

This article is a summary of (Hatziantoniou & Asgharian, 2014)

We are living in a fast growing world, with a population rate higher than ever and demands on resources such as food and consumer products are sky high. To be able to meet these demands new factories and warehouses are built every year. As the industrial sector is growing so is the energy consumption.

What is smart-lighting?

Well, the main principle is to control lighting where it is needed. Meaning there is no reason having the lights fully turned on if no one is there; and it is vital to have the correct light where it is needed. It is a combination of daylight sensing and occupancy sensing to provide a centralized control of all lighting within a home or commercial building. The components used for smart-lighting is often a motion sensor and a light sensor. The motion sensor will detect moving objects that emits heat. If for example a person walks by the sensor, it will turn the lights on, since the person emits heat. The light sensor will sense the light in the area and if the area is bright enough through sunlight, the lights can be reduced to a lower setting to save energy and if it is dark increase the light to a higher setting.

Figure 1. The lamp

What did we investigate in our report?

It is common that a warehouse with an operation of 24 hours a day, 7 days a week, does not have a smart lighting system. This means that the lights are turned on all the time and drains a lot of energy that could have been saved by implementing a smart system. An issue that can occur with light fixtures only controlled by a motion detector is for example when forklifts are used. A vehicle moving at various speeds in a facility with a lot of obstacles and narrow aisles can be hard to detect in time. This can result in accidents and be a safety hazard. The forklift will need proper lighting prior to entering an area for optimal maneuvering. One solution is to try to detect the forklift before it approaches and light up the area in advance for a proper lightning condition. To do so another sensor has to be implemented. A ZigBee module at every light source and a ZigBee tag attached to every vehicle was a solution that met the criteria. The goal of this master thesis was to implement this system to allow all LEDs to communicate with each other and with the vehicles.

ZigBee radio protocol in brief.
The IEEE 802.15.4 standard is the basis for the ZigBee. The standard mainly focuses on very low complexity, low speed communication and low cost by consuming very low power. The range of communication is around ten meters, and it has a bit rate of 250 kbits/s, 40 kbits/s or 20 kbits/s. It operates on the unlicensed 2.4 GHz frequency band. It uses CSMA/CA as a method for avoiding collisions and also has support for secure communications. A great advantage of the Zigbee protocol is the ability to support mesh networking. With the mesh topology any node can communicate with any other node. This can be done by being in the range of a specific node or via multiple nodes. The benefit is that the network can be spread out over large areas.

What was the result?
A fluorescent light tube usually consumes around 60 Wh. Since every lamp contains at least four tubes the consumption of the lamp is 240Wh. In a warehouse with a 24/7 operation the fluorescent light will consume 5760 Watts. The LED used in this project consumes 88 Watts in average (LP5/LS5 Specifications). With the smart lighting system the LED will be emitting light for an average of 12 hours a day. This leads up to an average of 1056 Watts per day. One fluorescent lamp will in this case consume 5.45 times more energy than a smart LED lighting system.

We are convinced that this system has the potential to save energy if used in its intended environment, as compared to what many companies are using as their main lighting source today.

Bibliography

(Hatziantoniou & Asgharian, 2014)
Hatziantoniou, P. & Asgharian, A., 2014. *Implementing a ZigBee-Based Smart Lighting System,* Lund: Department of Automatic Control, LTH.