

## Research Article

# Wireless Lighting Control in Food Enterprise under Internet of Things Environment

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**Abstract:** This paper studies the food enterprise mode, information management approaches under Internet of Things environment and proposed an intelligent lighting control system in the food enterprise. Using CC2530 of the TI Company, the system researches and designs a sending module and a receiving module of intelligent wireless lighting control system. The ZigBee terminal node sends control signal to the coordinator node. The coordinator node CC2530 output of PWM wave signal according to the control instruction signal the output of the PWM wave signal controlled the LED brightness through PT4115 chip LED driver circuit. Through tests, the results show that it can meet the demand of daily light regulation.

**Keywords:** Food enterprise, internet of things, lighting control system

## INTRODUCTION

The Internet of things refers to the networking between any things, also called M2M and its specific definition is: 'it connects the things and the internet with Radio Frequency Identification (RFID) and other information sensing device, so as to realize the interconnection between human and human, between human and thing and between thing and thing and to realize the intelligent identification management (Gao *et al.*, 2013). The main features of the internet of things is to obtain various information of physical world with information sensing device, conduct information transmission and interaction with internet, net and other network and adopt intelligent computation technology for analysis and processing of various information obtained, so as to improve the sensing ability of material world and realize the intelligent decision-making and control. The internet of things mainly consists of sensing layer, network layer and application layer.

At present, the internet of things is in the starting stage in terms of relevant technical standard, application service and industry. In sensor network, ubiquitous network, internet of things, near field communication, application of IPv6 internet protocol, 3GPP and M2M, the research on relevant standard is started and the competition is increasingly fierce. The internet of things is mainly used in urban intelligent transportation, logistics field, industrial production control, environmental protection and monitoring, intelligent security protection, protected agriculture, intelligent household and other fields. This paper studies the food enterprise information management approaches under Internet of Things environment and

proposed an intelligent lighting control system in the food enterprise.

## MATERIALS AND METHODS

**The communication operator approaches:** The communication operator successively develops M2M business and application and the public-oriented applications just start, most of which are in the pilot stage. The relevant technical research on the internet of things in China has deployed the key scientific and technological project in the key national project research field. Extensive researches are conducted in chip development, communication protocol setting, network and safety management and cloud computation and certain research result has been obtained; preliminary results have been obtained in near field communication, telecommunication, 3G network, construction of the internet of things and application standard; meanwhile, extensive researches in network interface between sensors, mark and identification, application security and integrative development of net and researches on the internet of things architecture and other relevant technical standard are conducted. The relevant technology of the things of internet has been applied in domestic urban intelligent transportation, modern logistics, disaster monitoring, environmental protection, medical service, electronic toll collection, medicine circulation, agricultural production, intelligent government official business and other fields and is being implemented in intelligent grid and intelligent security protection.

The communication operator conducts all-around researches in M2M business application by using its own advantages and conducts researches on the

comprehensive integration between sensor network and communication network. Although the internet of things has been of extensive researches and application in China and certain achievement has been made, there are still some problems in core technology, proprietary intellectual property right, industrial chain and industrial scale. Meanwhile, as the internet of things is new, its application level is low, its application field is narrow, the demand of its final user is low and there is no standard in terms of its application and security.

#### **Food enterprise information management approaches:**

**Informatization construction in food enterprise:** The infrastructure construction, application of system software and cultivation of informatization talents are the external, direct and formal informatization construction, also called hardware informatization construction (Lee and Park, 2011). The food enterprise informatization construction is the primary specification of food enterprise informatization construction and the material basis for informatization construction. Without the hardware informatization construction as the support, the food enterprise information construction is like a castle in the air.

**Infrastructure construction in food enterprise:** The infrastructure is a set of technology, personnel and process, including technology and technical services that be shared in the scope of organization and its core is the computer technology, communication technology, shared technical platform and database. The infrastructure, which is convenient for the large-scale connection of enterprises and the effective operation of applications, is the material basis for food enterprise informatization and key problems of information system management as well as the bridge of international communication and media of external communication. Therefore, an informatization infrastructure platform with advanced technology and stable performance must be built.

**Cultivation of informatization talents:** The informatization talents refer to technicians engaging in software development, system integration and system maintenance and management devoted to plan compilation and resource integration. Bharadwa thinks it is hard to obtain the information technology human resources because they are complex and difficult to be stimulated (Fei and Frank, 2009). Only the high-quality informatization talents can bring competitive advantages to enterprises. The informatization infrastructure almost imposes no direct influences on the improvement of enterprise performance and its value can be realized only by being correctly used. However, the correct use needs cultivating high-quality informatization talents.

**Application of system software in food enterprise:** The system software includes CAD, CAM, MES and

other software for auxiliary design, auxiliary food and production control as well as CRM, SCM, ERP, DSS, BI and other software for auxiliary management and decision making. These software are powerful means of realizing production automation, management networking and decision intelligence.

**Software informatization construction:** What corresponds to the hardware informatization construction is the software informatization construction, including construction of enterprise culture, reform of organizational structure, reengineering of business process, transformation of management philosophy and optimization of decision-making mechanism. As it is an internal, indirect, potential and intangible informatization construction, it is also called software informatization construction. The software informatization construction is the advanced form of food enterprise informatization construction and the internalization and sublimation of hardware informatization construction. The pure hard informatization construction only has the form the informatization construction, without the spirit of informatization construction and the food enterprise informatization construction can have both form and spirit only by combining the hardware informatization construction with the soft informatization construction.

**Construction of food enterprise culture:** The development of any management system must involve the cultural reform (Huang and Tseng, 2005). If the culture of an organization does not change to form the culture applicable for informatization, the informatization will fail. The successful informatization integrates into the food enterprise culture, rather than stays on the technical form. According to the survey of the informatization of food industry in China by e food in January 2007, it is found among the obstructive factors of informatization, the low application initiative of employees accounts for 12.6% and the insufficient leadership support accounts for 8.7%. The nonsupport of senior leadership, resistance of middle management and low initiative of grass-root employees will affect the informatization progress. The key to solve such problems is the construction of enterprise culture, which is the informatization going deeply into the enterprise soul and the informatization of enterprise leadership and employee concept (Yu *et al.*, 2006). By adopting information education, creating good environment, building corresponding mechanism and other methods, the enterprise can cultivate and build a humanistic and harmonious, development and communication, understanding and participation information culture, strengthen the information consciousness, build information concept and eliminate information noise, so as to make its employees willing to communicate and share the private information with advanced information technology and benefit a lot from it. The role of enterprise culture is to maintain the

information ability, so as to keep the competitive advantages.

**Reform of organizational structure:** There is a mutual-construction mechanism between information technology and organizational structure, in which the information technology directly acts on the food enterprise organization system by the contextual dimension and structural dimension of organizational structure. With the development of information technology, the organizational structure also changes. The reform of organizational structure means in the dynamic environment and by combining with the information technology, the food enterprise correspondingly adjusts the traditional positions and functions, sets up information center and information intelligence department as well as CIO post and adopts business division, matrix, dynamic network and other organizational form to make the organizational structure flat and organic, to reduce the management level and intermediate links, to alleviate the disadvantages of multi-level management agency, such as unsmooth information flow and opportunity loss and to shorten the information transmission time.

**Reengineering of business process:** In the food enterprise informatization, the use of information technology and the reengineering of process are not separable. In certain sense, the reengineering depth of business process determines the improvement degree of organizational performance. Without fundamental thinking about the disadvantages of the low performance of original process, the automated processing simply with information technology cannot create new high-performance business process, but will make the various activities without any performance originally locked in the process, thus deteriorating the old business process. Therefore, the food enterprise should conduct reengineering and transformation of business process by combining with CAD, CAM, MES and other information technology and adopting lean production, agile food, concurrent engineering and other advanced production mode, so as to improve the automation level from product design to production and food.

**Transformation of management philosophy:** The food enterprise informatization is a process of information technology application and management reform aggregation. The problem of informatization is not only a technical problem, but also a management problem. The informatization should not only use various information systems in the enterprise management, but also combine with HR, CRM and other information technology, so as to integrate the process management, virtual enterprise, learning organization and other advanced management philosophy into the enterprise management and improve the management level of food enterprise.

**Optimization of decision-making mechanism:** The decision relates to the prospect of food enterprise. One cannot make bricks without straw, the decision needs the support of a large amount of information; however, the decision is often made without complete information. The decision quality often depends on the quality of information obtained. Therefore, it is required to combine DSS, BI, EIS, ES, SIS and other modern information technology and adopt advanced decision-making mechanism to strengthen the information processing ability and scheme evaluation and selection ability of decision maker, expand the thinking space of decision maker, extend the intelligence of decision maker and improve the decision-making benefit and efficiency.

## RESULTS AND DISCUSSION

**Design of ZigBee wireless controlling in food enterprise:** Intelligent wireless dimming control's core module is CC2530. The hardware including sending module, receiving module and driver module. The schematic of this system is show in Fig. 1.

Terminal node CC2530B sends key's information to coordinator node CC2530A. The coordinator node CC2530A will adjust the duty ratio of PWM (Pulse-Width Modulation) according to the information come from CC2530B. The duty ratio will adjust the lamplight through LED driver.

**Hardware circuit design:** The hardware circuit of this system including key module, terminal node, coordinator node, LED driver and LED light. We will introduce the ZigBee module CC2530 and LED driver module in briefly.

**ZigBee module:** ZigBee is a new wireless technology treaty which meets IEEE802.15.4 specification. It has low power consumption of wireless physical layer. ZigBee has the characteristic of low power consumption. The distance of communication is far. ZigBee will work at the 2.4 GHz public transmission bands. The transmission distance of the border node will reach 100 m. If we add the power amplifier, the distance will improve to 1.5 km. And the data will be realized multi-hop transmission. The distance depends on the multi-hop. This solved the transmission distance of serial port effectively. Meanwhile, ZigBee will meet the demand of people for it maximum transfer rate is 250 kb/sec in network.

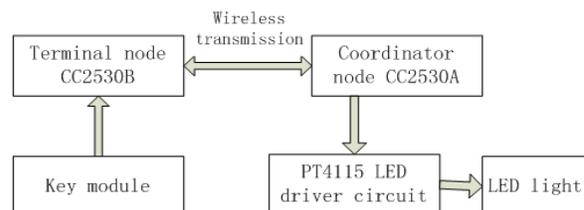


Fig. 1: The schematic of this system

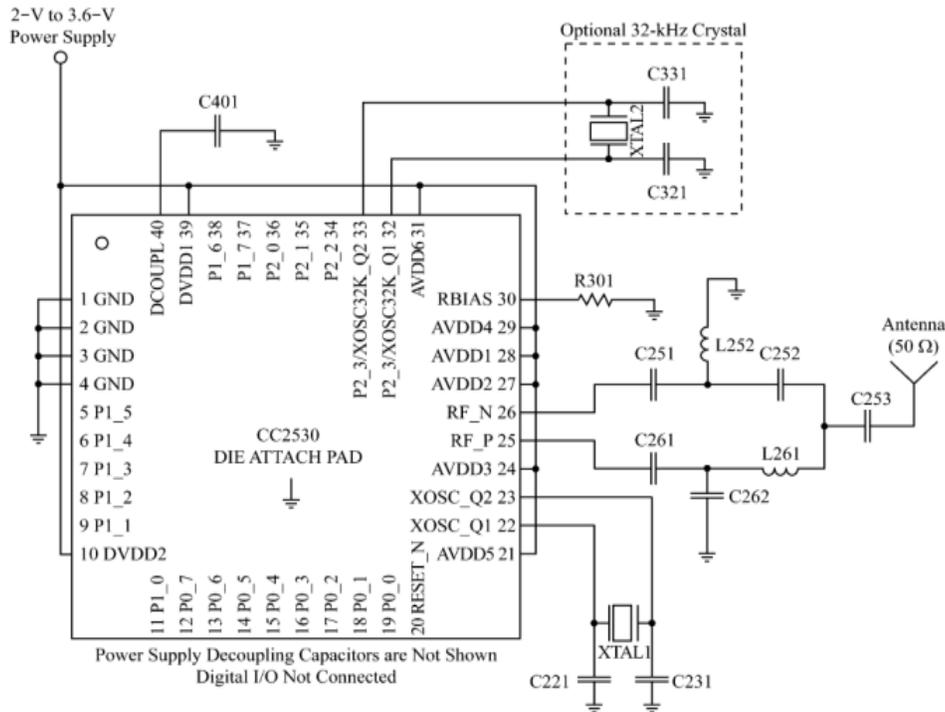


Fig. 2: CC2530's schematic circuit

CC2530's solution improves the performance and meet demand of low cost and low power consumption of 2.4 GHz ISM band based on ZigBee. CC2530 includes a high-performance RF transceiver of 2.4 GHz DSSS and an enhancement mode 8051 microcontroller. CC2530 chip integrates an enhancement mode 8051 microcontroller, RAM and a front RF of ZigBee. It has an eight-bit MCU (8051), 32/64/128 KB programmable internal memory and 8 KB RAM. In addition to that, it includes an ADC, a few timer, 32 KHz crystal oscillator sleep mode timer, watch dog timer, power on reset circuit, power failure detection and 21 programmable I/O ports. CC2530's schematic circuit is shown in Fig. 2.

**LED drive module:** LED drive circuit uses PT4115 chip. PT4115 is reduction voltage constant current power which has an inductance current break-over model. PT4115 can drive one or several LED which was in serial. PT4115 has power switch, which is received analog and PWM signal to adjust light through DIM pin. PT4115 drive LED directly and the usages are very simple. LED's maximum average current is determined by the resistance which is connected in VIN and CSN pin. The light is adjusted by output current which is determined by the adjustable duty ratio PWM signal in DIM pin. The output current will changed from 0 to 100% through PWM. In order to avoid seeing the twinkle light we control the frequency of PWM at 100 Hz. The superiority of PWM adjusting lie in that the chromaticity of LED is not changed. Main characteristic of the PT4115 is:

- Few external component
- Wide input voltage: from 6 to 30 Volts
- The maximum output current is 1.2 Ampere
- Multiplex DIM pin to on-off the LED, simulate dimming and PWM dimming
- Five percent output current accuracy
- LED open circuit safeguard
- Efficiency reaches 97%
- The output constant-current control
- Enhance heat-dissipation potential ESOP8 packaging in favor of driving high-power. PT4115 schematic circuit is shown in Fig. 3

**Software design:**

**Overall software design of ZigBee protocol stack:** There are three logical devices in ZigBee network, coordinator, router and terminal device.

Flow chart of networking for Coordinator node is shown in Fig. 4. After power on, system initialization includes stack initialization, every hardware module initialization, MAC initialization, application layer initialization, operating system initialization and so on. If the initialization finish, coordinator will set up the network. If the network is set up successful, the indicator light in the circuit will be illumed.

**Terminal device applies for joining:** If the application is allowed by the coordinator device, the indicator light will be lightened homologous. If we power on the terminal device, the fist work is system initialization and detecting whether some network is existed around or not. If there has a network, the terminal device

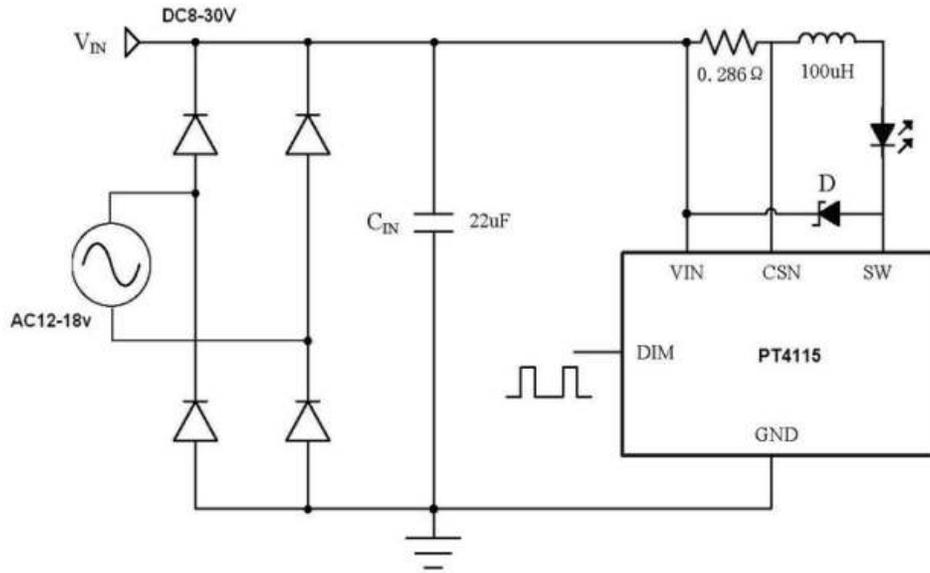


Fig. 3: PT4115 schematic circuit

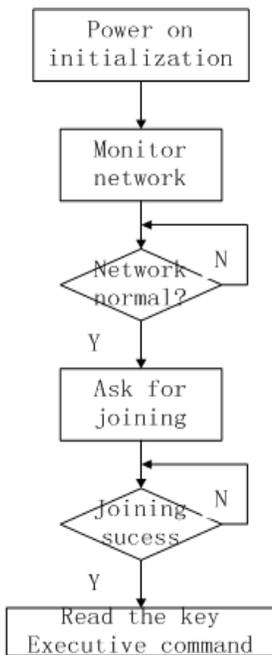


Fig. 4: Flow chart for coordinator node

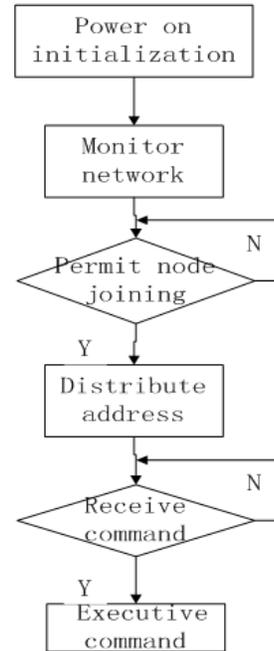


Fig. 5: Terminal device applies for joining

will applies for joining. The terminal device execute command when the networking is successful. This is shown in Fig. 5.

Here defines two keys, one is adding luminance of the LED (UP), the other is reduction (DOWN). Different keys defined different event. KEY\_UP is the interrupter 1 and KEY\_DOWN is the interrupt According to the key's information, the terminal device send data through invoking function from ZigBee protocol stack. An AF\_INCOMING\_MSG\_CMD OSAL handles the data received in coordinator device.

## CONCLUSION

As the construction of the internet of things is a large and complex system project, involving wide knowledge and technology and the technicians of food enterprise are lacking, the construction of food enterprise informatization based on the internet of things should be gradually implemented according to the planning of enterprise. The food enterprise can cooperate with colleges for test and use the test experiences in the actual construction based on

experiment. This study has already made some progress in wireless dimming light based on ZigBee. With the development of the technology, ZigBee technology will enter into thousands of household in someday and will bring great convenience for our life.

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