Design of HACCP Communication Protocol

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***Abstract*—Hazard Analysis Critical Control Point (HACCP) is a systematic preventive regulation to prevent several hazards in food manufacture and treatment processes. We proposed an intelligent HACCP system to put several check points into digital data in order to improve management of food sanitation. In this paper, application level network protocol is introduced for the server to control devices in the working field and for a lightweight device to transfer its check point results to a server.**

Keywords-HACCP; intelligent HACCP system; application level network protocol; food sanitation.

I. INTRODUCTION

The intelligent Hazard Analysis Critical Control Point (i-HACCP) system is a wirelessly connected client-server system for food sanitation management to minimize food safety accident and track the cause of outbreak [1]. Basically, it provides two kinds of lightweight computing devices, which are locked-up type and portable type, to gather several hazards occurred in food processing course. It guides nutritionists in workplace to check Critical Control Point (CCP) every day and record its results online in their tracks. Consequently, the computer-assisted management, such as record, collection and documentation of data inspecting CCPs would make the HACCP help decreasing the food safety accidents effectively.

In this paper, an application level communication protocol is proposed to support efficient information exchange between devices and server in the i-HACCP system. Check items at each CCP step, which nutritionists should inspect and transfer to the server are defined. Encode tables for menus and gradients are maintained between server and devices to minimize network traffic. Some entries in the encode table could be changed by server when a new menu or gradient is introduced. Table management protocol is also designed to inform devices to keep tables updated. The contribution of this paper is that it is the first approach to apply information technology to HACCP in order to enhance its effect on the food sanitation.

Section 2 introduces the i-HACCP System. The HACCP protocol is described in Section 3 and conclusion is made in Section 4.

II. I-HACCP SYSTEM

The i-HACCP system targets a school cafeteria where spaces for pretreatment, cook and food distribution are separated. The overall organization of the i-HACCP system is shown in Figure 1. There are two kinds of terminal devices deployed in the work place. One is a lockup device, which is anchored to a specific place, to get inputs of the examination results for CCP4, CP5, CCP6 and CCP7 by workers on the spot. It can be powered by a permanent and stable electric supplier or operated by a battery. The other one is a portable device with various sensors, such as thermal sensor, chlorine level sensor, iodine level sensor. It is used for recording the examination results for CCP4, CP5, CCP6, and CCP7. This system allows the inspection results to be gathered promptly. It results in increasing the reliability of the HACCP archives, since it minimizes the time interval between the inspection and the record.

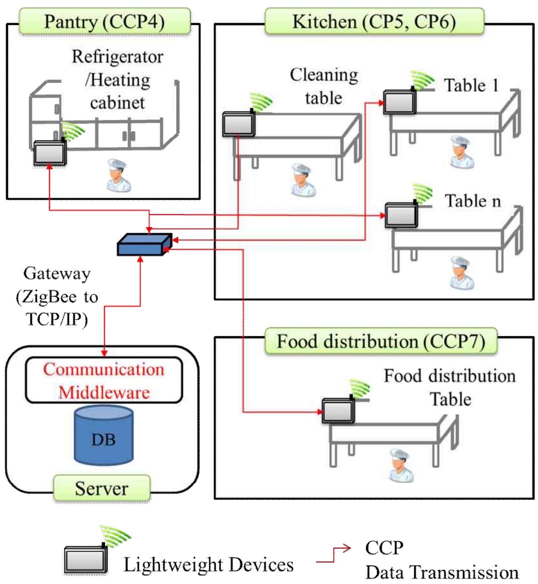

Figure 1. Organization of i-HACCP System.

The terminal device is constructed with a light weight processor, which requires low power and low to medium level processing power. In general, it will be 8 to 32 bit System On Chip (SOC) type microprocessors like ARM's Cortex-M3 or Atmel's ATmega series. The lockup device will use touch panel as an input device, while traditional input buttons will be carried with the portable device. They have 4.3" and 2.5" Liquid Crystal Display (LCD) panel respectively. The devices will use ZigBee Radio Frequency (RF) modem for low power and low data rate wireless communication.

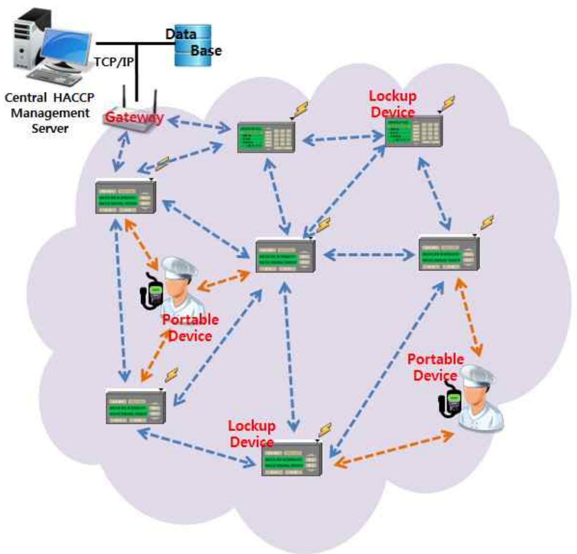

Figure 2. The Network Architecture for i-HACCP system.

Figure 2 shows the network architecture for i-HACCP system. The lockup device plays a role not only as an input terminal but also as a router to transmit data to the neighboring terminal. Basically, the network for i-HACCP system supports a multi-hop network routing protocol to find a path from a terminal device to the HACCP management server. It can be done statically with predefined routing table or dynamically with searching for a proper transmitter at every transfer. Ad-Hoc On-demand Distance Vector (AODV) protocol [12] is usually used for dynamic ad-hoc routing. Basically, the portable device selects one among neighboring lockup devices within its communication range for a transmitter based on signal strength.

III. HACCP PROTOCOL

Based on analysis of HACCP regulation, messages communicated between server and devices are classified into three types, such as request (REQ), response (RSP) and acknowledge (ACK) messages. REQ message are used when a device needs to ask server to register itself or send information, such as current time or today's menu. RSP message are sent only by server when a device sends REQ for current time or today's menu. ACK message indicates that receiver performs its duty to the corresponding REQ or RSP completely. Figure 3 shows flow of messages between client and server for various requests.

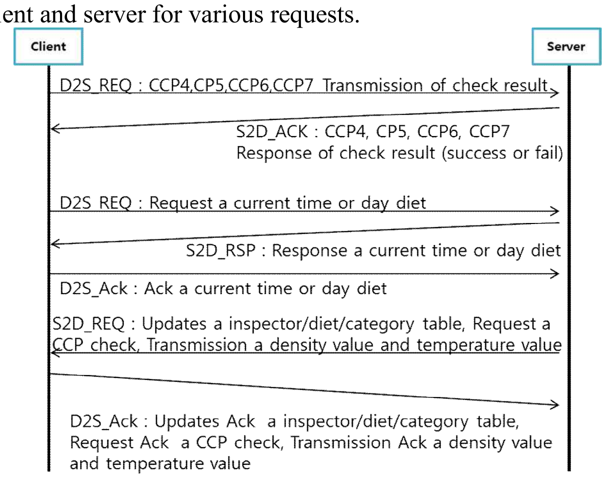

Figure 3. HACCP Communication Protocol.

TABLE I. MESSAGE FORMAT

Field	Description
STX	Start of message (0xAB1)
MSG Type	Message type (REQ, RSP, ACK)
IEEE Addr	IEEE address of device registered in Server
CCP/CP	Device's CCP/CP step and type
Payload Length	Length of payload transmitted
Payload	Data transmitted between client and server
SUM	Byte basis sum from IEEE field to Payload field
ETX	End of message (0xCD34)

The message format for the three types of messages is designed as shown in Table I. MSG type field contain message profile that identifies its meaning, as well as message type. Message types are subdivided into five types, such as D2S_REQ, S2D_REQ, D2S_ACK, S2D_RSP, S2D_ACK according to the transfer direction, i.e., D2S_REQ means a REQ message from device to server.

IV. CONCLUSION

The i-HACCP system collects data written in by nutritionists on the spot in a computerized way and builds HACCP archives automatically to enhance effectiveness of HACCP for a school cafeteria. The i-HACCP system is a multi-hop network architecture that connects several lockup devices and portable devices posted at a suitable place with a wireless modem. In this paper, we proposed a network protocol for i-HACCP system.

For future work, we will focus on the evaluation to measure the impacts of the encode tables, which are shared between server and client devices and used to reduce the load of network traffic.

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