Innovative Health-Care Helpers

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Abstract
Worldwide tendency of aging population requires huge amount of helth-care services in future. To relieve the work load and to enhance the efficiency of helth-care, an innovative helth-care helpers system was proposed in this paper. The system had been designed and implemented by the smart electronic and wireless technologies. It had also been verified according to the pre-defined requirements. The result proved that the helpers obviously reduce the helth-care load and promote the trustful relationship between a being-cared person and a caregiver.

Keywords
Health-Care; Helper; ZigBee; Microcontroller

Introduction
The aging society is a global trend. Under the trend, more and more health-care workers are anecessary to meet the being-cared demands of elderly and children.

This paper presented an innovative system which provided two friendly helpers to relieve the work load of a caregiver and to assist the requests from a being-cared person. The helpers improved the efficiency and quality of health-care work by the affirmative message transmission, the friendly human pronunciation, and the intuitively users' operation.

The helpers had been designed, implemented, integrated, and verified successfully. The following sections would illustrate and explain the helpers system in detailed.

System Design
The helth-care scenario and the architecture of the helpers system were illustrated in Figure 1. The system is composed of two helpers. One helper is placed near the being-cared person. The other one is placed near the caregiver. These two helpers will be connected through a wireless communication for convienent deployment. The communication is automatically relayed via intermediary nodes in order to cover all area of the application domain. The user of helper will operate the device by a joystick and will hear the request or response messages via the voice speaking.

The two helpers will have similar hardware structure as shown in Figure 2, yet they have different recorded contents for speaking services. The helpers are mainly composed of a microcontroller for the device control, a wireless module for communication, a joystick for user operation, a voice IC and a speaker for pronouncing, and a power supply module. Moreover, the joystick has multiple-sensing positions. Therefore, multiple pre-defined and pre-recorded messages could be pointed and sensed at each positions on the helper.

Application Scenario
The application scenario was explained as follows. At first, a being-cared person pushes the joystick on the nearby helper to a certain position to issue a pre-defined requesting message to a caregiver. Then, the being-cared person hears an "ACK" message replied automatically from the helper nearby the caregiver. Next, the caregiver pushes the joystick on the nearby helper a certain position to response a service message to the being-cared person. Later, the being-cared person would hear the responded "service message". Meanwhile, the caregiver also hears an "ACK"
message replied automatically from the helper nearby the being-cared side. With this affirmative manner, both sides obtain "ACK" after their issues, then receive the replied message from the other side. Furthermore, all messages are pronounced by pre-recorded human voices. This way eliminates mind distance and enhances the efficiency and quality of the caring work.

FIGURE 1. APPLICATION SCENARIO AND SYSTEM ARCHITECTURE

FIGURE 2. BLOCK DIAGRAM OF HELPER

FIGURE 3. CIRCUIT OF VOICE COMPONENTS

System Implementation and Verification
To implement the system design depicted in the above section, several electronic components were selected to compose the health-care helpers. The key components of the helpers include a joystick, an ATmega-328P microcontroller, an ISD-1720S voice IC, a microphone, a speaker, a XBee pro series 2 chip, an AC110V/DC10V power adapter, and a 7805/5V and a 1117/3.3V voltage regulating IC, etc. All components are laid and soldered on the printed circuit boards according the circuits shown in Figure 3 and Figure 4.

The relay router of the wireless communication illustrated in Figure 1 adopted the ZigBee technology. ZigBee is a well-known standard and was specified as the IEEE 802.15.4. It is a network protocol of wireless communication for sensing and control applications. Auto-configuration, multi-hops routing, and power saving functions are the native features of ZigBee. Therefore, ZigBee is one of the best candidates for this system.

Figure 5 is the photo of the helper near the being-cared person. This type of joystick on the helper has 8 touching positions. Each touching position could be defined a particular message according to particular application. For instance, there are 7 messages been defined for a long-term care, including “I feel uncomfortable”, “I need the toilet”, .., “HELP! (S.O.S.)” etc. Therefore the being-cared person could push the joystick to one of the positions to issue her or his request. General application scenario was explained in the previous section.

The photo of the helper near the caregiver was shown in Figure 6. In the caregiving application, there are only 2 messages been defined for the long-term care, containing “I’m coming soon” and “wait a moment”.

In order to verify the system, these two helpers were deployed in a four-room apartment. A person acted as a being-cared person and stayed in one bedroom, and the other person acted as a caregiver and stayed in the kitchen. When the being-cared person pushed the nearby joystick to the “I need water” position for one second,
firstly the person heard the voice of “Message was transferred” as the ACK message and the green LED on the helper was ON for indicating the request was normal and was waiting for service response. Then, the helper in the kitchen issues the voice message of “I need water” and flashes the red LED on the helper to indicate that the request was still waiting for service. If the caregiver was busy for other important business at that moment, the caregiver could push the joystick to the position of “Wait a moment”. Otherwise, the caregiver might push to “I’m coming soon” and quickly prepare a cup of water for the being-cared person. After the step, the red LED on the helper in the kitchen was OFF and the green LED on the helper in the bedroom was also OFF, respectively. The result showed that the operations and functions of the helpers were fully conformed to the pre-defined requirements.

Furthermore, the being-cared person expressed that the ACK voice could smooth his/her mood after the request been issued because the person understood that the request was successfully received by the helper in the kitchen. On the other hand, the caregiver also expressed that the intuitive voice request message could tell him/her how to prepare the material for the being-cared person. Hence, redundant round-trip physical movement was eliminated. It helped to save a lot of time and energy, thus the caregiver could provide more precise and better service to the being-cared person. Both persons positively conformed that the trustful relationship could be created between both sides.

**Conclusions**

This paper presented a helpers system for long-term care applications. The proposed system was composed of two helpers which were connected through the ZigBee wireless communication. The hardware and software of the system were designed, implemented, integrated, and verified successfully. The result conformed to the pre-defined requirement and expectation. Further enhancements were expected in future, for instance, to add WiFi to the caregiver helper so that a smart phone could be combined with the system for more convenient operation, to design and implement ZigBee based control modules to enable the being-cared person to control particular electrical equipment, such as turning ON or OFF an electrical sun-blind curtain, etc.

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**REFERENCES**

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Chien-Yuan Liu was born in 1960, Kaohsiung, Taiwan, R.O.C. He received the B.S. degree in 1983 from the Department of Electrical Engineering in National Taiwan Institute of Technology, Taipei, Taiwan, the M.S. degree in 1992 from the Department of Electrical Engineering in National Sun Yat-Sen University, Kaohsiung, Taiwan, and the Ph.D. degree from the Department of Computer Science and Engineering in National Sun Yat-Sen University, Kaohsiung, Taiwan.

From October 1983 to August 1985, he had been served as a lieutenant in Taiwan Army. Next, he worked as an engineer with the process control computer division in China Steel Corporation, Kaohsiung, Taiwan, from 1985 to 2000. Since August 2000, he has been in the Department of Electronic Engineering and the Department of Computer Science and information Engineering, Cheng Shiu University, Kaohsiung, Taiwan. His research interests include the integration and design of the systems and applications of software programming, web programming, database, networking, mobile APP, and smart electronics.

Dr. Liu is currently an associate professor of the Department of Computer Science and information Engineering, Cheng Shiu University, Kaohsiung, Taiwan. The work of the helpers presented in this paper had awarded the silver medals of the 2014 Kaohsiung International Invention, Kaohsiung, Taiwan, and the 2014 International Salon of Inventions and New Technologies, Savastopol, Russian Federation, respectively.