

Wireless Voice-controlled Movable Electrical Heating Radiator

YuXin Li^{*}, JinPeng Chen^{**}, Bing-Yuh Lu^{**}, Xin Li^{***},
CanJie Yao^{**}, LinShu Zheng^{**}, Xin Bai^{*}, WanQin Jiang^{**}

^{*}Faculty of Electronic Information Engineering, Guangdong University of Petrochemical Technology, MaoMing City, Guangdong, China

^{**}Faculty of Automation, Guangdong University of Petrochemical Technology, MaoMing City, Guangdong, China

^{***}Faculty of Computer Science, Guangdong University of Petrochemical Technology, MaoMing City, Guangdong, China

franklinlu888@outlook.com

Abstract— This study presents a voice-controlled movable electrical heating radiator. The functions are (1) button or voice controlled the radiator by smartphone APP; (2) heat radiation power control, moving control and timing control; and (3) feedback artificial synthesis voice for instruction, temperature feedback, and ultrasonic sensing for anti-collision. The results show the successful rates are over 90% for most of the cases. A better performance and lower cost voice-controlled movable electrical heating radiator has been implemented. The convenience of the radiator elevates the quality of human living life.

Keywords—voice controlled, heating radiator, movable devices, cloud, bluetooth.

I. INTRODUCTION

Nowadays, the product with artificial intelligence (AI) is very popular in daily life, because the AI technology brings the convenience to human. For example, the application of face recognition can replace the keys of the doors, so some persons feel easier and comfortable in the pockets or bags. Some smart robots are designed for the smart live in houses, therefore, some persons reduce the trivial housings to make live easy which is one of the purposes of many studies relative AI. Shehab [1] emphasized the importance of home automation. Diones [2] designed an AndroidDuino-Fan which can be controlled by voice. He indicated that voice instruction is faster than writing or typing. Therefore, voice recognition is a better switch to control the fan. Moriyama and Saito [3] proposed a voice-controlled air conditioner. Browne et al. [4] explored voice control for lighting. Drennan [5] designed a voice-activated thermostat to adjust the temperature in the house. Funk et al. proposed a home automation system controlled by voice through phones [6]. These studies revealed the convenience and advantages of voice commands to control the electric appliances.

Xu et al. [7] developed a system named “little sun” is a combination of Arduino UNO and LD3321 modules. The four-channel relay switch module was connected with pins of Arduino UNO and embedded under the cover of a base set of the heater. Three commands, namely “Higher temperature,” “Lower temperature,” and “Stop,” were programmed. The voice commands were arranged to sound randomly to ensure comprehensive testing. The SNR of the command voice in a peaceful home is typically more than 10 dB. In 82 tests, the proposed device successfully recognized 80 voice commands at the first command. Thus, the success rate (SR) was 98%.

This study based on the prototype of “little sun” improved the functions which include (1) button or voice controlled the radiator by smartphone APP; (2) heat radiation power control, moving control and timing control; and (3) feedback artificial synthesis voice for instruction, temperature feedback, and ultrasonic sensing for anti-collision. The improve system is named as “sun magician”.

This study included five sections. Introduction section presented the motivation and literature study of this article. Method section introduced components and their connections. Results section presented function of APP and all of the system. Discussion section showed the comparison of previous studies. Finally, we have a conclusion in the last section.

II. METHODS

The functional block diagram of “sun magician” is presented in Fig. 1. The devices are introduced as follows,

A. Micro controller

The main micro controller is STM32 which has the specification of high-speed embedded memories (128 Kbytes of Flash program memory with read protection, write protection, and 36 Kbytes of SRAM), DMA and an extensive

range of system functions, enhanced I/Os and peripherals. The devices offer standard communication interfaces (two I2Cs, two SPIs / one I2S, and four USARTs), one 12-bit ADC (2.5 MSps) with up to 19 channels, a low-power RTC, an advanced control PWM timer, five general-purpose 16-bit timers, two basic timers [8].

B. HC-06 Bluetooth module

The serial port 1 serves as a data channel and connect the HC-06 Bluetooth module through the serial port pins. The baud rate is 9600 in the slave mode.

C. Motor drive module for the movable carrier

2 tank-type tracked wheels with the motor drive module were employed for the movable carrier of the electric heating radiator. The carrier was controlled by the IO port of STM32 G0. The key chip of motor drive module was L298N which was functioned by dual H-bridge. The range of power supply is 5 to 35V (dc). The maximum output current is 2A (the instantaneous peak current is 3A), and the maximum output power is 25W. The speeds of the wheels were tuned by pulse width modulation (PWM) technology where the duty cycles of the driving pulses were modulated by timers.

D. Timer for radiating

The function of the timer for radiating has implemented. For example, the users can set the timer when they go out in advance. When they back home, the pre-warm function will make them comfortable. The function was implemented by embedded basic Timer 7 of STM32 G0. STM32 timers are divided into 3 categories, including advanced timers, general timers and basic timers.

E. Active buzzer and HC-SR04 ultrasonic module

HC-SR04 ultrasonic ranging module can measure 2cm-400cm distance sensing function with 3mm accuracy. The function of anti-collision keeps 30 cm distance named safety range between carrier and obstruct. If the sensing distance is less than the safety range, buzzer sounds for warning and carrier stops for avoiding to collision.

F. DS18B20 temperature sensor module

DS18B20 temperature sensor module is a wide temperature measuring range with high accuracy. The sensing range of DS18B20 is -55 °C to +125 °C. The accuracy is ± 0.5 °C in the temperature range of -10 to +85 °C. The temperature sensor detects the temperature in front of the electric heating radiator to keep the temperature of the air and avoid the incidents of overheating. The temperature data can be called by the query command from the smartphone.

G. APP and Baidu voice recognition cloud system

Voice function are connected with the multiple api interfaces such as Baidu voice recognition cloud. The cloud was waked up and synthesized the voice signals. Therefore, a stable and accurate function of voice recognition is realized. The voice instruction was sent to the cloud for recognition by

WIFI transmission of the smart phone, then, the response from the cloud activates the response sentences in APP through the speaker of the smartphone. The App manages all of the sensors and the function of sending the instruction codes corresponding to the voice recognition to the microcontroller through the wireless communication technology of Bluetooth. . There are two modes to control the microcontroller in the APP. One is manual, the other is voice controlled.

H. System integration

The electrical power of all the system is input into 220 V (ac) then the transformer and voltage converters supply +12 V (dc) and 5V(dc). +12 V (dc) is the power source of the carrier. +5 V (dc) is the power supply of the digital system which includes the microcontroller. The microcontroller connects with motor drive module for the movable carrier, timer for radiating, active buzzer, HC-SR04 ultrasonic ranger, and DS18B20 temperature sensor module to sense the environment and control the electric heating radiator. Furthermore, through Bluetooth communication module, the information transmits and receives to the smart phone for further recognition and responses of voice commands.

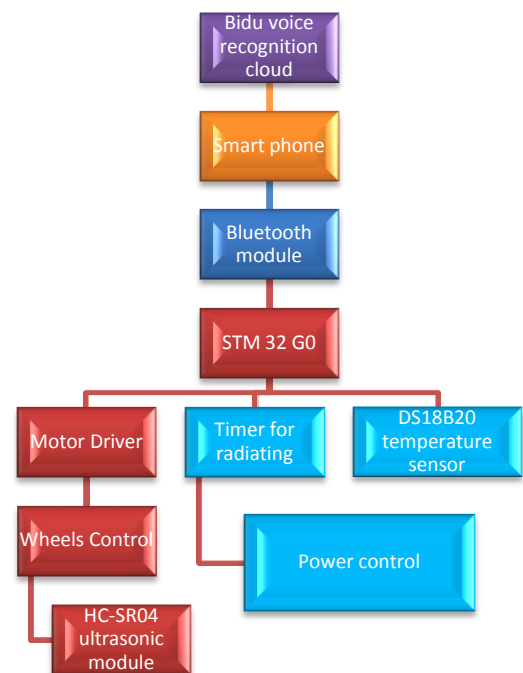


Fig. 1 Functional block diagram

III. RESULTS

A. APP

The display of APP is shown in Fig. 2. These buttons are for the manual mode operation. The voice mode operation accepts the voice commands to control the “sun magician”. Firstly, the Bluetooth modules should be paired between smart phone and carrier. Finished the pairing, the voice mode can be done by clicking the voice button. Otherwise, the users can

click “Lower temperature”, “Higher temperature” and “Constant temperature” for the temperature settings as well as “Forward”, “Backward”, “Turn right” and “Turn left” for the carrier moving in the operation of the manual mode. In addition, clicking the button of “help” will display the APP user guide. “Close” button is for turning off the heating power, and “Stop” button is for stopping the carrier.

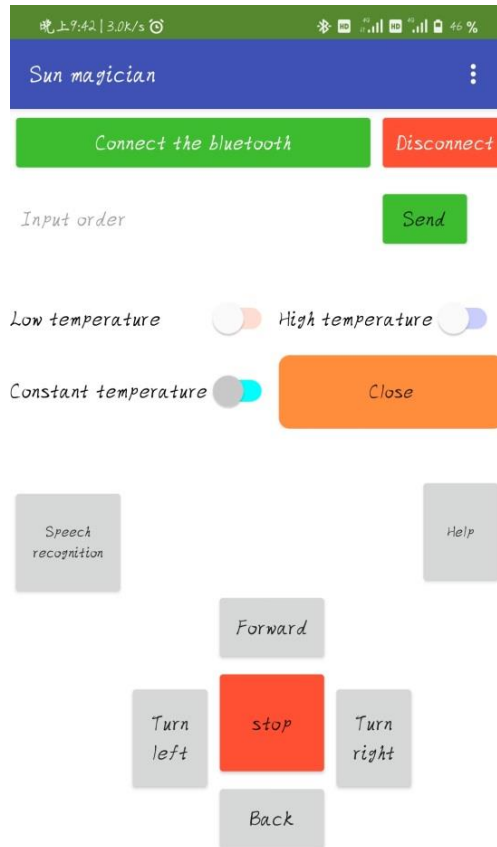


Fig. 2 The APP

B. System integration

The picture of the “sun magician” is displayed in Fig. 3. Under the cover of the electric heating radiator, the microcontroller connected with motor drive module for the movable carrier, timer for radiating, and active buzzer. In Fig. 3, HC-SR04 ultrasonic ranger was appended on the cover for anti-collision and DS18B20 temperature sensor module was in front of the radiator to sense the air temperature near the radiator and control the power of electric heating radiator.

C. Tests

For the manual mode operation, the corrective rates were almost 100%. Whereas, the voice controlled mode operation, all the commands (“Lower temperature”, “Higher temperature” and “Constant temperature”, “Forward”, “Backward”, “Turn right”, “Turn left”, “Close” and “Stop”) have been test for 100 times. The corrective rates were near 90%.

IV. DISCUSSION

The previous study [7] implemented the basic function of the voice controlled electrical heating radiator. However, some of the voice recognition in a noisy environment using LD3320 module is not good enough. This study improves the method of recognition to achieve a better performance.

In addition, the radiator was loaded by a movable carrier. It can adjust the position of the radiator by voice commands. While someone is taking a rest, this is an attentive function in the living room. The anti-collision devices ensure the safety of the moving radiator.

The voice commands which included “Lower temperature”, “Higher temperature”, “Constant temperature”, “Forward”, “Backward”, “Turn right” and “Turn left” can be fine tuned, such as “go ahead 30 cm” for further study.



Fig. 3 The “sun musician”

V. CONCLUSION

Based on the previous study, we improved the function of the electrical heating radiator. We believe that “sun magician” can function as a server for health care. Further study will enhance interactive function of the radiator.

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YuXin Li is currently a student with Faculty of Electronic information engineering, Guangdong University of Petrochemical Technology, Guangdong, China.

JinPeng Chen is the vice Dean of Faculty of Automation, Guangdong University of Petrochemical Technology, Guangdong, China.

Bing-Yuh Lu is currently a professor with Faculty of Automation, Guangdong University of Petrochemical Technology, Guangdong, China.

Xin Li is currently a professor with Faculty of Computer Science, Guangdong University of Petrochemical Technology, Guangdong, China.

CanJie Yao is a student with Faculty of Automation, Guangdong University of Petrochemical Technology, Guangdong, China.

LinShu Zheng is a student with Faculty of Automation, Guangdong University of Petrochemical Technology, Guangdong, China.

Xin Bai is a student with Faculty of Electronic information engineering, Guangdong University of Petrochemical Technology, Guangdong, China.

WanQin Jiang is a student with Faculty of Automation, Guangdong University of Petrochemical Technology, Guangdong, China.