

# Proposal of Spoken Interactive Home Doctor System for Elderly People

Naohiro Shoji  
Kanagawa Institute of Technology  
Atugi City, Kanagawa, Japan  
naohiro.shoji0326@gmail.com

Takayo Namba  
Teikyo Heisei University  
Ichihara City, Chiba, Japan  
maryannie0920@gmail.com

Keiichi Abe  
Kanagawa Institute of Technology  
Atugi City, Kanagawa, Japan  
abc@he.kanagawa-it.ac

**Abstract**— For the coming super-aged society, we proposed a voice-dialogue type home doctor system for elderly people who live alone, who can be a close partner on a daily basis and be a partner who can take care of health every day. The recent spread of COVID-19 infection has increased the necessity of daily health management. So, we have equipped the system with a function that can detect health deterioration due to pneumonia due to COVID-19 in real time.

**Keywords**— *Natural Interactive, Home doctor system, Health care, AI*

## I. INTRODUCTION

In recent years, along with the aging of the society, the number of elderly people living alone has been increasing rapidly [1]. If an elderly person living alone becomes physically handicapped, he / she will spend more of the day at home, which greatly reduces the chances of talking to people. In addition, even if an elderly person becomes sick, he / she may hesitate to go to a medical institution, which may impair his / her health. For this reason, it is necessary for the elderly living alone to have someone like a partner who can talk to them and manage their health. In order to solve these problems, we propose a home doctor system for elderly people using a voice interaction agent that enables them to have a natural conversation like a familiar partner and to provide daily health management and health advice. The spoken dialogue agent is a system that allows users to select their favorite character according to their preference. In order to make it easy to change the character according to the user's preference, we have adopted a system that uses CG (Computer Graphics) characters. In addition, the recent spread of COVID-19 infection requires daily health care. This time, we installed a function that can detect, in real time, the deterioration of health due to pneumonia caused by COVID-19.

## II. PROPOSED SYSTEM

Fig. 1 shows the voice interactive home doctor system for elderly people proposed in this study. It is a system that implements functions such as natural conversations, providing daily life information and operating home appliances by voice, and user health management. In this system, distributed processing is performed on Windows-PC and Raspberry PI3B + (hereafter called RPI) as shown in Fig.1. The RPI is in charge of natural conversation functions (voice input, natural conversation, and speech synthesis), human sensor detection, and remote control of various home appliances using ECHONET-Lite. On the Windows-PC side, the display of the 2D CG character that interacts with the user is switched. The character display on the PC side uses a GIF animation created with Live2D and FaceRig, and the processing program on the RPI side uses Python. In addition,

the RPI is equipped with a function to control the CG character to actively talk to a person detected within 300 mm by a human sensor connected to the RPI. Microphones and speakers are used to input and output voice for communication with the user. In order to realize natural conversation in this system, we used Google Speech API service for speech recognition, User-local Chat Bot API for natural conversation, and Open-J Talk for speech synthesis.

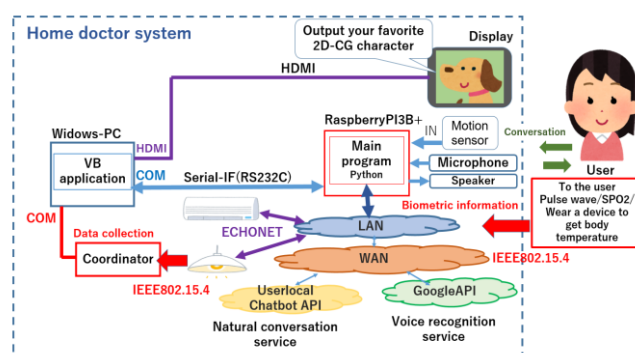


Fig. 1. Our Home Doctor System

TABLE I. HEALTH JUDGMENT BASED ON HEALTH MANAGEMENT DEVICE ACQUISITION INFORMATION

Acquisition information	Judgment result			
	No problem	Follow-up	Infection test recommendations (PCR test)	Recommended to go to a hospital
Pulse (Bradycardia)	50bpm ~	49bpm~	—	< 40bpm
Pulse[PS] (Tachycardia)	85bpm	86bpm~	≥ 130bpm	≥ 120bpm
SpO2	≥ 96%	—	96% > SpO2 ≥ 93%	< 93%
Body temperature	35.0°C~36.9°C	37.0°C ~38.4°C	≥ 37.5°C	< 35.0°C or ≥ 38.5°C
Judgment criteria	All values must be above	One of the above values applicable	Two or more of the above values applicable	One of the above values applicable
CG advice content	No particular	Please rest	There is a risk of pneumonia / infection Please take an inspection	Please go to the doctor and see

Data communication between Windows-PC and RPI is done by RS232C serial communication. The RPI is in charge of the main processing of this program, and the system switches the 2D CG character display by sending an arbitrary request from the RPI to the Windows-PC at the required timing. This process was developed with Visual Basic 2019. In addition, the system is equipped with a wearable health management device that acquires three types of biological information: pulse wave, percutaneous arterial blood oxygen saturation (hereinafter referred to as SpO2), and body temperature. After that, we made a system in which the health condition was judged based on the health judgment criteria [3]-[10] shown in Table 1, and the CG character gave the user voice advice. In this paper, this system is called the home doctor system. This system has a function to detect

pneumonia due to COVID-19 infection. It has been found that COVID-19 infection causes pneumonia and inflammation of the alveoli of the upper lobe and lower lobe of the left lung and the upper lobe, middle lobe, and lower lobe of the right lung, and SpO<sub>2</sub> falls below 96% [8][9]. In addition, COVID-19 infection can raise the body temperature to more than 37.5 °C [9][10]. So, we equipped the device with the function of determining the possibility of pneumonia based on the user's body temperature and SpO<sub>2</sub>, and providing advice through the CG character. This our system may output two pieces of advice depending on the judgment result. In this Table 1, for example, if the pulse wave is more than 130 beats per minute, our system will advise both "Please go to the doctor and see" and "There is a risk of pneumonia/infection Please take an inspection".

#### A. Development of health management device

As shown in Fig.2, we have developed two prototypes of the newly developed health care device: a pulse rate and SpO<sub>2</sub> acquisition type, and a body temperature acquisition type. Both were developed as bracelet types that can be attached to the arm. The MCU (Micro Controller Unit) was ATmega328P, and the data communication with Windows-PC was made using the XBee module of the power saving wireless communication standard IEEE802.15.4. The pulse wave and SpO<sub>2</sub> information are acquired from the fingertips using the GOHOU MAX30100 sensor module. Body temperature is acquired without contact from a person's axilla, forehead, ear hole, etc. using a module board equipped with an infrared temperature sensor MLX90614 manufactured by GOHOU.

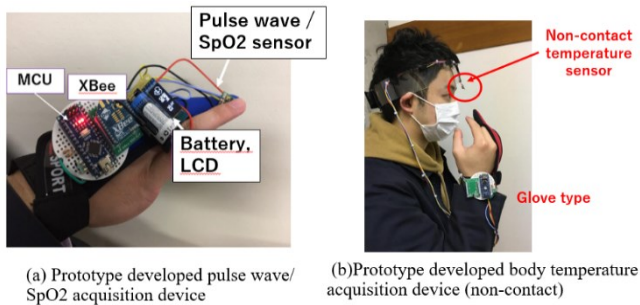


Fig. 2. Health management device

#### B. How to change CG character

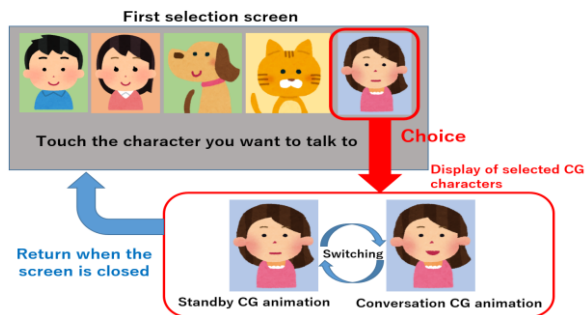


Fig. 3. CG character selection screen

Multiple CG characters were created using Live2D and FaceRig. Figure 3 shows an image of the CG character selection screen application developed this time. Characters such as animals (dogs and cats), men, women, children, etc. were prepared in advance so that the user could select their favorite CG character on the screen. As for the voice, we

implemented an original voice by adjusting the voice synthesis parameters with Open-JTalk according to the character. We also prepared two GIF animations for each CG character: conversational CG animation and standby CG animation. Conversational CG animation has lip movement, while standby CG animation is CG without lip movement. By switching between these two CG animations according to the utterance situation, the CG character's lip movement was performed.

### III. EVALUATION

#### A. Evaluation of measurement accuracy of health care devices

An evaluation experiment of measurement accuracy was performed by comparing the developed health care device with the measurement values of a commercially available pulse oximeter (CB-1 / custom) and thermometer (TO-401 / Doritech). The test subjects were males in their twenties, and the measurement method of SpO<sub>2</sub> and pulse was evaluated by wearing a commercially available pulse oximeter (CB-1) in the left hand and the developed device module in the right hand. Figure 4 shows a graph comparing the SpO<sub>2</sub> and pulse wave measured with the device we developed and the commercial product (CB-1). As shown in Fig. 4 (a), the SpO<sub>2</sub> value of the device we developed was 97% and that of the commercial product (CB-1) was 99%, and the difference was 2%, and the results were almost the same. As shown in Fig. 4 (b) for comparison of measurement of pulse wave, the result obtained with our device was almost the same as with the commercial product (CB-1). Furthermore, the measurement of body temperature showed the same result when compared with the commercially available TO-401 as shown in TABLE II. This confirmed that the same measurement results as with the commercial product were obtained.

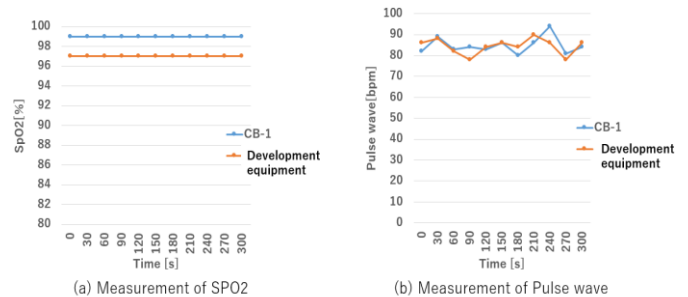


Fig. 4. Comparison Result of our developed device vs Commercial Product

TABLE II. MEASUREMENT RESULTS OF BODY TEMPERATURE

Number of measurements	Our development equipment	TO-401
1	36.5	36.4
2	36.2	36.2
3	36.1	36.2
<b>Average</b>	36.3	36.3

### IV. CONCLUSION

In this paper, we have proposed a voice-interactive home doctor system for elderly people who live alone, as a partner that they can talk to everyday and manage their health every day. We plan to carry out demonstration experiments in the

future. In the future, we would like to develop the system to cover more than one person.

#### ACKNOWLEDGMENTS

This study was approved by the Ethical Review Board for the use of human subjects of Kanagawa Institute of Technology (No. 2019-061).

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