Framework of Ubiquitous Healthcare System Based on Cloud Computing for Elderly Living

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***Abstract*— This work discusses a integrating framework on health care, home safety, convenience and entertainment for elderly living. Since the increasing number of elderly people will live alone, yet requires more smart and automation home services, the proposed framework attempts to develop a smart living helper to improve their later life. Two systems are proposed in the Ubiquitous Healthcare System (UHS) framework including, the Web-based User Remote Management Service (WURMS) and the Multimodal Interactive Computation Services (MICS). The proposed systems are coordinating couple existing audio-visual and communication techniques, including the speech/sound recognition, the speaker identification, the face identification, the sound source estimation, the text to speech (TTS) and the event recognition. For elders' friendly interfaces, the proposed services include, 1)Home care services, 2)Emergency assistance, 3)Family interaction, 4)Remote medical services, 5)Security monitoring, and 6)Information services, to improve the elders' life in more convenience.**

Keywords: Ubiquitous Healthcare System, Home Care System, Elders Living, Smart living, Smart Home, Elderly care.

I. INTRODUCTION

A recent research reports that the average age of the population in developing countries is arising. An investigation reported by Ministry of the Interior in Taiwan indicates that the people aged over 65 has been occupied 11.2% of population in 2012, and will rise to 20.1 % in 2025, the tendency implies that one in every five citizens will be the elderly person[1].

With the ever-changing family structure (e.g. the nuclear family) existed in the modern society and the ratio of senior citizens who live alone is also proportionally increasing. The problems are caused not only by failed keeping abreast with the home living environment, but also in a lack of caring system, and the phenomenon leads to a heavy burden in society. Since elderly people usually live alone, to create a helpful homecare and healthcare infrastructure for elderly people becomes an important issue.

Furthermore, both diets and habits in modern society are different from before, the health of elderly people caused by some modern diseases, such as, diabetes, chronic obstructive pulmonary disease, arthritis, and cardiovascular disease are getting more and more, and the numbers of elderly people suffered from such chronic diseases are also increasing. Elderly people suffered from the diseases would face a lot of living problems in their daily life, for example in Fig 1. Therefore, to construct the ubiquitous healthcare environment to provide the living-alone elderly person in safety and convenience is needed. With rapid development of technology, the computer technologies involved in cloud computing, telecommunications, and sensors[2], have been delivered the home care functionalities to elderly people successfully[3], [4], and such a system attempts to reach the aging elderly people who can live in a security and a health environments.

The development of service-oriented system at smart home has drawn much attention to researcher recently. The developing research expects to design a system with the automation interactions as well as the friendly interfaces[5], [6], further to improve the mental health and the life quality to decrease the loneliness. Several research groups have explored the idea of smart living based on cloud-computing, by processing the vast amounts of data through the powerful computing capability[7], [8], and further processing the computational-intensive tasks of the audio-visual recognition applications.

Fig. 1. A scenario describes the met difficulties from the elderly people.

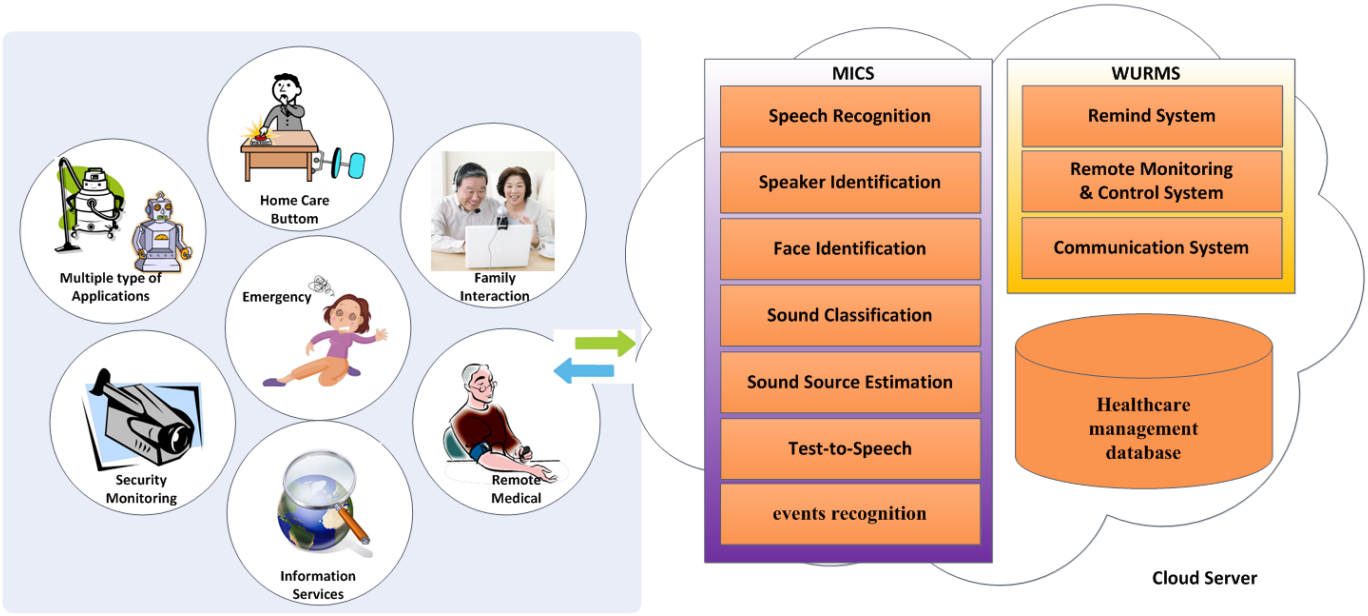

Figure 2. The proposed system of smart living for early people, with WURMS and MICS based on cloud computing.

In this study, the ubiquitous healthcare system is proposed to improve the healthcare environment for elderly people. Two cloud services are proposed, that is, Web-based User Remote Management Service (WURMS) and Multimodal Interactive Computation Services (MICS). The proposed framework is not only to improve their health and living quality, but also to promote their life confidence. The major services include the health care, the home security, the home safety, convenience and entertainment, and the details will be discussed in the following sections.

This paper is organized as follows. Section II describes the system framework. The services of our proposed system are predated in Section III. Section IV introduces the system overview of scenario for elderly living, as shown in Fig 2 and conclusion and summary are presented in section V.

II. Framework of Ubiquitous Healthcare System

Figure 2 shows the framework of proposed ubiquitous healthcare system based on cloud computing infrastructure. The system includes remote-interaction services called Web-based User Remote Management Service (WURMS) and smart-interaction services called Multimodal Interactive Computation Service (MICS). WURMS allows user to manage the instant message service remotely and establish the connection to healthcare service center for emergency assistance. MICS provides the interactive multimodal services from multiple sensors in the house and replies the processed results for interactive request. The following descriptions discuss the details of WURMS and MICS.

A. Web-based User Remote Management Service

The proposed system provides user with three types of web-based services, the first is manageable reminder service, the second is remote monitoring service and the last one is communication system.

For the reminder service user-interface, users can update the reminding events, and be prompted to collect the psychological/physiological signals for personal health information. Multiple types of appliances can be remotely monitored and be controlled through the services. Furthermore, the communication system is able to transmit and feedback the personal health state to the healthcare center, and provides the chatting functionality to family member or medical staff through the VoIP application.

B. Multimodal Interactive Computation Service

By using cloud information network, MICS is capable of providing multiple interactive and multimodal services, including the audio-visual signal reception, analysis, and response with corresponding modes determination. The detailed descriptions of the audio-visual applications are illustrated as follows:

- Speech Recognition: Since speech recognition plays an important interactive service for users, particularly for elderly people, accordingly, in MICS, the sentence-based ASR system is embedded in the home appliances by using simple commands, to allow elderly to easily control the appliances in the smart living room.
- Speaker Identification: To authenticate the personal identity of the target speaker, and then to provide the right information and feedback to the right and specific user (e.g., personal preference, medical information).
- Face Identification: Facial expert is similar to speaker identification for user identification; however, facial expert provides the capability to recognize the multiple faces in a scene rather than one target identity recognized in speaker expert. In additional, the face recognizer can be fused with speaker expert to improve the identity recognition accuracy.
- Sound Source Estimation: To detect the location of the sound source in a space, and lock the position of the sound source, thereafter, to record the scenario events by using camera and then analyzes the events through the collected audio-visual signals.
- Sound Classification: To recognize multiple types of the unusual sounds frequently happened at home,

several types of sounds are defined and implemented in the sound classification system (e.g., wailing, glass broken sound, screaming and phone ringing). The application is particularly useful for detecting the emergency cases happened if elderly lives alone at home.

. Text-to-Speech: Test-to-Speech system performs the functionality to respond the synthesized speech to the user, by using speech synthesis technique that the synthesized text can be defined in the system-initial or user-defined mode.

. Events Recognition: By using following recognition systems, including, the multiple sounds source estimation, the sound classification and the image recognition, those are used to detect the emergency cases at home (e.g. fall, faint) through the audio-visual signals analysis.

III. SERVICES OF CLOUD COMPUTING

In this proposed framework, three types of services, that is, the emergency services, the medical services and the family caring services, are functional and incorporated based on multiple audio-visual of biometric recognition applications and communication systems. Fig 3 indicates the proposed framework. Three blocks are composited in the framework, including, Interactive block, Healthcare block and Remote control block. The interactive block consolidates multiple existing audio-visual applications; include the speech recognition, the sound recognition, the speaker identification, the face identification, laughter detection, the sound source estimation, the text to speech (TTS) and the event recognition. Interactive Block describes two types of user interfaces, including the speech control interface and the touch-panel control interface. In this block, interactive capability is controlled by the MICS and the device is capable of transferring the data from sensors and displays the feedback for users.

In the beginning, client user establishes a connection to MICS, thereafter, the corresponding system parameters in the multimedia database (e.g. music, book, etc.) are updating between cloud server and clients. Next, the training data in MICS including, the corpus in speech recognition, the users' model in speaker recognition system, the user facial database in face recognition and the environmental sound for sound classification are retransmitted and retrained.

In the voice control, a scheme is proposed to initiate the system by using a key word, (i.e. wake-up) to active the speech recognition system. When the user announces the key word "wake-up" at first, the device will respond a alert "beep" and turn into the "standby" mode for user. This sound indicates that the user can use the voice command to interact with system within 3 seconds. Otherwise, the system back to "sleep" mode and waiting for user to wake it up. This wake-up scheme can be prevented the noise sound interruption, and keep the system in usability. On the other hand, for the manual control, user can interact with the system by panel touching, pushing button, typing keyboard and moving mouse to send the interactive message. Besides, the remote control block is functional to manage the events between the distant customer care staff and elders' family via the internet or 3G communications. In this case, both them could control the service and receive the instant service between family and the care center.

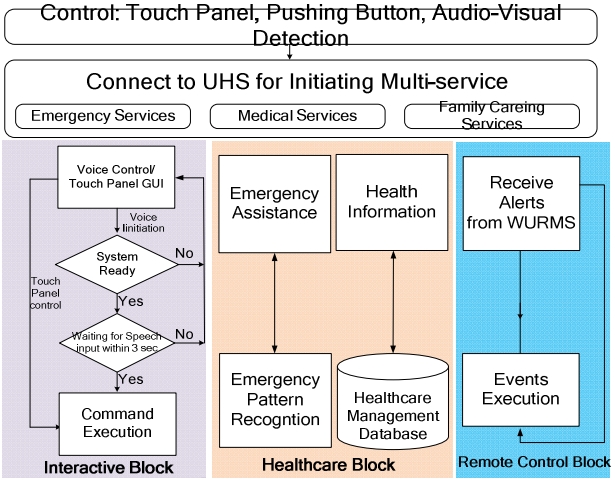

Fig 3. Overview of the proposed services based on ubiquitous healthcare system

IV. SCENARIOS

The goal of the proposed framework is to design a useful ubiquitous healthcare system for home elderly, and principally followed by the notion of WHO constitution's definition of "Health", that elucidates the health is a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity[9]. In order to fit these three states as aforementioned, six scenarios of regarding services are described below:

A. Home Care Services

Home care services provide the right time and required services for customer. When living alone elderly encounters the general requirement at home and need the help, the elderly is able to push the buttons designed and located surrounding at home, that can be easily reached by the elderly. When the assistance message is received by the staff in customer care center, the staffs will arrive to the venue at right time, and provide the useful support and care to the elderly.

B. Emergency Assistance

The difference between the home care services and the emergency assistances is that, the latter one provides an emergency assistance to elderly people who encounter the emergent conditions. Emergent situations indicate that elderly people is risky in their health, life, property or environment. Whenever the cases are happened, they can push this emergency button to ask for help. Nevertheless, in some cases, such as choking on food, falling down, getting into a coma due to certain diseases, etc., and the elderly fails to push the button. In this case, the sound detection and falling detection will function to notify the customer care staff to help immediately.

C. Family Interaction

The elderly people, in general, occasionally experiences the events of mental health and depression, and need to care for by family and home support. Of those people, they may require a mental health service. In this case, family interactive service substantially provides a mental care for elderly people. In most cases, elderly people usually live alone and need the

encouragement from their family. Therefore, the VoIP service provides the convenient connection and calling between family member and elderly people. In additional, another remote control service that can be remotely controlled by family member to help the elderly people to search and play the favorite video and music on PC or smart TV through the internet.

D. *Remote Medical Service*

When elderly people are aging and healths become worse, the remote medical service that can provide distantly clinical health care becomes an important consideration, due to disability movement of the aging people is hardly moved to hospital. As a result, the remote medical services that can be immediately monitored and diagnosed by the nursing staff to give the instant consultation. Furthermore, the elderly physiological signals including, blood pressure, heart rate, weight, blood glucose, and hemoglobin, that can be collected through the remote service to measure the elderly health status. Also, the laughter detection system is applied to record laughter time period to help the doctor understanding their daily mood.

E. *Security Monitor Service*

Security monitoring service provides the home security for elderly people. The camera sensors monitor the living room and the kitchen areas that can be in a remote surveillance by the family member as well as customer caring staff on smart device or computer. Hence, many threats or intrusive events such as, break-ins, burglary, health hazards and natural hazard can be detected and dealt with immediately. However, due to the personal privacy factor in bath room, the feasible sensor work should be functional in the blurring image. Besides, the incorrect control of home appliance may lead the elderly in the risky situation, to decrease the risk in such a case, the smart home appliances have to provide the distant controlling capability through the internet or telecommunication networks to remotely keep the appliances in a security condition.

F. *Information Services*

To consider the elderly people who can retrieval the internet information, yet troubled in typing the keyboard, consequently, the automation speech recognition embedded in information retrieval interface is convenient for elderly to survey the useful information, such as, weather report, knowledge searching and order the commence product. Elderly people can utter the keywords such as “What's the weather like?” and "What’s the time?" to the device. Then the requested information will be feedback via the cloud information network and respond in TTS with corresponding information.

V. Conclusion and Future Works

In this work, a novel Ubiquitous Healthcare System (UHS) architecture is proposed to realize two types of cloud services that is, the MICS and the WURMS services. To realize the UHS, six main services and related scenarios are proposed and described in the paper, the proposed services as well as the framework are to improve the home healthcare for lonely elders. In the future work, this system is going to integrate more web-based services to promote the functionalities and the capabilities to service more elderly people. For example, the MICS can be extended to provide more functionality, not only support elderly people but also the disabled one. In additional, the WURMS can be extended to improve the living environment by using more sensors to keep elders in a security and safety living environment at home.

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