Angel-Echo: a Personalized Health Care Application

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***Abstract*—Technology is constantly pioneering new paths in health care by creating new outlets for medical professionals to care for their patients. With the development of wearable sensors and enhanced forms of wireless communication like Bluetooth low energy (BLE) communication, health data can now be collected wirelessly without compromising the independence of patients. Interactive voice interfaces such as the Amazon Echo provide an easy way for individuals to access a variety of data by using voice commands, making interacting with technology easier for those of limited technological experience. Wearable sensors, such as the Angel Sensor, combined with voice interactive devices, such as the Amazon Echo, have allowed for the development of applications that provide easy user interaction. Here, we propose a smart application that monitors health status by combining the data collection capabilities of the Angel sensor and the voice interfacing capabilities of the Amazon Echo. We also present test results of the Amazon Echo speech recognition on different populations.**

Keywords— Wearable sensors; Angel Sensor; Interactive voice interfaces; Amazon Echo; Health monitor

I. Introduction

With the elderly being the largest and fastest growing demographic in the world, health care is one of the largest components of the world in need today. When one reaches an elderly age, signs of illness tend to increase, which means their health status has to be monitored frequently. However, quality of life is impacted when a person is constantly getting tested for illness. Technology has created a way for medical professionals to receive in-depth health information of patients remotely without interfering with the daily activities of the patient. Wireless Sensor Networks [1] (WSN's), a network system with number of wireless sensor devices and a central server communicating through Bluetooth low energy technology [2], has created ways to collect and process data for analysis. The elderly population is not as fluent with technology as the younger population, which means interfacing methods between the elderly and technology is best when simplicity is involved. Preferred interfacing between the elderly and technology is speech [3]. Speech recognition makes it easy for an elderly person to communicate a task to an electronic device. However, current state-of-the-art speech recognition APIs are targeted to recognize younger populations and may have some limitations for recognizing speech patterns of the elderly population [3]. With the help of WSNs, BLE technology, and speech recognition interfacing, we implemented a smart application that monitors health status, combining the Angel Sensor [4] for data collection and the Amazon Echo [5] for voice access to health information and status. We also tested the limitations of the Amazon Echo speech recognition process on different populations.

II. Implementation

The Angel sensor [4] device is a wristband that monitors heart rate, blood oxygen, temperature, step count, sleep quality and so on. It also offers unrestricted, real-time APIs to its sensors and full control of the data. The Angel Sensor SDK, Bluetooth profiles, and apps are open source. Amazon Echo [5] is both a wireless speaker and a voice command device capable of voice interaction, music playback, making to-do lists, setting alarms, streaming podcasts, playing audiobooks, and providing weather, traffic and other real time information. It can also be used to control certain smart devices.

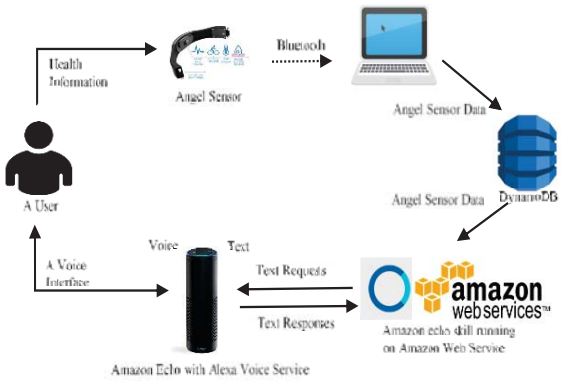

Fig. 1. System Diagram of the Smart Angel-Echo application

We proposed and implemented an Angel-Echo application to study how users might monitor their health information with a voice interface. See Fig.1. A computer receives health information (heart rate, steps and skin temperature) collected from the Angel Sensor via Bluetooth GATT Protocol, and then stores the data to the Amazon DynamoDB database [6]. In the implementation, an Amazon Echo is chosen to provide the voice interface with users. The Alexa Voice Service (AVS) [5] integrates Alexa's built-in voice capabilities into Amazon Echo, so users' health-related questions can be recognized and converted between voice and text. We wrote a new skill program for the Amazon Echo to handle users' health-related requests, fetch the corresponding data from the database, organize the

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data to responses, and forward them to AVS. Then AVS can convert the text responses to voice. Amazon Web Service is used to manage and execute our skill code.

III. Results

A. The Angel-Echo Application test

The Angel-Echo application comprises two main parts: (1) data collection from an Angel Sensor to the Amazon DynamoDB database and (2) data retrieval from the Amazon DynamoDB database to an Amazon Echo. We first tested the data collection part and then tested the data retrieval part.

In the data collection test, a user wore the Angel Sensor. A computer received the pulse, skin temperature and steps data from the sensor, and then stored them in the Amazon DynamoDB database. An example is shown in Fig. 2.

Fig. 2. Health data collected from the Angel Sensor is stored in Amazon DynamoDB database.

With the help of the Amazon Developer [7], we can test the designed Amazon Echo skill by entering test requests. After entering a request "What is my heart rate?", a response "Your heart rate is 58" was generated as shown in Fig. 3, which illustrates that the designed speech interactive application allows a user to easily communicate with the Echo to get his/her health information from the Angel Sensor.

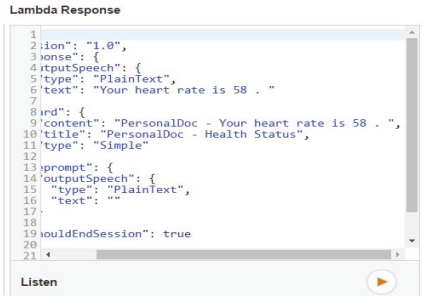

Fig. 3. Amazon Echo response to user's request "What is my heart rate?". "Your heart rate is 58" was spoken out by Amazon Echo.

B. Speech Recognition Accurcy

We conducted an IRB-approved experiment by recruiting a group of subjects older than 65 and another group between the ages of 18-30. There were 15 older adults and 10 younger adults. We then had each test subject read out a list of phrases to the Amazon Echo, and using the prebuilt "Simon says" skill [8] in the Echo, we tested how well the Echo repeated every sentence. We listened closely to the repeated phrase and marked off every word that had been picked up inaccurately, as well as the sentence structures that had been changed.

Our results found certain words should be avoided because of their high probability of being misinterpreted by the Echo. For example, the word pulse was often turned into pause. Also, the word health was often turned into house or hills (Table I). We also found that within the elderly subjects, female voices were more easily detected than male voices. These results provide invaluable information that allow us to see which phrases should be excluded for future Echo applications to achieve better usability. Table II shows the number and percentage of words not recognized for the different groups.

TABLE I. Frequently Mis-interpreted Words

words or phrases	*times*	*repeated incorrectly as*
health	18	hill; how; house; hail
pulse	13	pause
was	4	or;have;is
an hour	6	in our
vacation	3	location

TABLE II. Number and Percentage (%) of Words Missed

	Elder Adults		*Younger Adults*	
	Number	*Percentage*	*Number*	*Percentage*
Men	42	8.93	22	4.68
Women	59	6.27	21	4.46
All	101	7.16	43	4.57
Total Words	1410		940	

IV. Conclusion and Future Work

We have successfully created a personal health care application utilizing the Amazon Echo and Angel Sensor. From this preliminary work, there are a vast number of options that could improve the reliability and usability of this application. One immediate next step is identifying additional health information the application could provide. The results of our experiment were conclusive in the sense that they will allow us to further target our application to better suit the needs of the intended audience, e.g., avoiding words that are often misinterpreted. In the future, we intend to run more extensive speech analysis tests on the Amazon Echo with a larger sample size for more usability results.

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