iAdhere: A Voice Interactive Assistant to Improve Adherence to Medical Treatments: Demo Abstract

Sirat Samyoun, Md Abu Sayeed Mondol, Ifat A. Emi and John A. Stankovic
{ss8hf,mondol,iae4qb,stankovic}@virginia.edu
Department of Computer Science
University of Virginia
Charlottesville, VA

ABSTRACT

Adherence to prescribed medical treatments is crucial for health outcomes in chronic diseases. Recent advancements in smartwatch technologies have opened opportunities to use these wearables in improving adherence through reminders and tracking. This paper presents iAdhere, an Apple Watch based system for reminders and tracking adherence to the prescribed activities for stroke patients.

1 MOTIVATION

Non-adherence to medical treatments causes increased morbidity and mortality, as well as brings huge annual cost to the healthcare industry. Clinicians also find it challenging to monitor if the daily treatments are properly adhered by the patients. A recent study [2] shows that up to 26% of hospital re-admissions are medication-based, and thus preventable. Several medication reminder systems, mostly smartphone or smartwatch applications, have been developed to improve adherence. However, a limitation of the smartphone based system is they lack effectiveness in different contexts. For example, a user can be away from the phone and can miss reminders. Though the smartwatches are more effective in

these scenarios, they are difficult to interact with visual inputs and outputs due to small form factor. To overcome these challenges, Mondol et al. proposed MedRem [1], a smartwatch based reminder system that verbally interacts with the user. However, such systems are only medication based and are not best suited to any chronic disease management, such as, the rehabilitation for the stroke patients. In particular, for the stroke patients, the important aspects of the other prescribed activities needs to be considered, such as, guidance for doing an exercise or monitoring the heart-rate. In this paper, we present iAdhere, a smartwatch based voice interactive assistant for stroke patients for monitoring and improving adherence to these prescribed activities. iAdhere tries to make sure that the user is adhering to the prescribed medical treatments. It also uploads the outcomes of the interaction with the user to the cloud. The physician is able to remotely view the data and can change the prescribed treatments dynamically. We developed a working prototype of the system on the Apple Watch, and used an Amazon EC2 server as a cloud platform. This system will be useful for remotely monitoring stroke patients, particularly the patients living in the undeserved areas.

2 SYSTEM OVERVIEW

iAdhere is a lightweight, standalone app consisting of an Apple Watch and a Cloud server. It does not require a smartphone to operate and can work in both Wi-Fi and Cellular networks. It uses the speech to text and text to speech technologies provided by Apple for verbal interaction. iAdhere operates according to the prescriptions provided by the physician. All the prescriptions are initially stored in the cloud database. When the app is opened, it downloads the updated prescriptions from the cloud server and loads the reminders into the watch. At the time of a prescribed treatment, iAdhere provides the user with a haptic vibration and a notification to alert the user. Once the user clicks the notification, the display shows up with the necessary information about the prescribed treatment. After finishing each reminder session, the app goes to idle mode to preserve battery.

Since the display size of the smartwatches is small, iAdhere uses different symbols and texts on the screen for effective
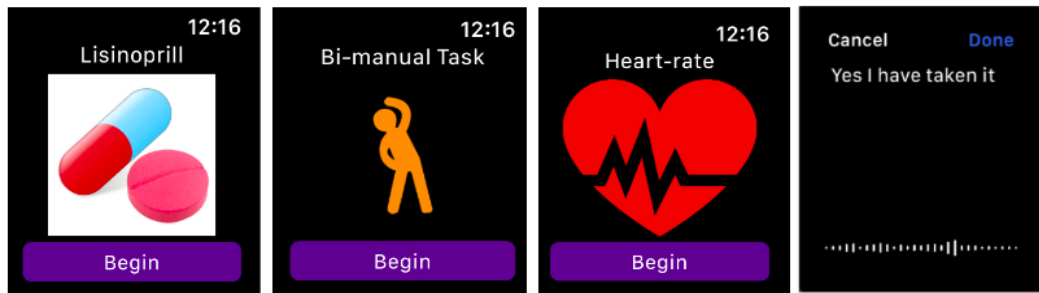
Figure 1: User Interfaces of the reminders to and the response from the users

understanding of the user. The name of the pill/exercise/the text heart-rate along with the symbol of a pill/person doing an exercise/a heart is shown when the user is reminded to follow these treatments. The symbols and the texts, as shown in the Figure 1, help the user to better understand the purpose a reminder has been provided, what kind of reminder it is, and what particular treatment needs to be done.

Besides providing reminders, iAdhere also tracks whether the treatments are adhered by the user. This is done from the verbal interaction with the user while providing the reminder. By default, iAdhere takes the input from the user in the form of voice command, as shown in figure 1. It maintains a dictionary of actions for the voice commands, which is updated over the time from the user input. However, it offers the user to interact through the touch screen whenever the internet connection is unavailable, causing the speech to text conversion not working, or whenever the voice command does not match with any entry from the dictionary. Overall, the interaction between iAdhere and the user has three stages: **(1)** User has received the notification. **(2)** User has viewed the reminder on notification click. **(3)** User has verbally interacted with iAdhere. When an interaction is finished at the stage 3, iAdhere makes a decision about the ground truth, whether the prescribed treatment has been done by the user. If an interaction has ended at stage 1 or 2, iAdhere tries to interact again with the user. This attempt is done up to 3 times. These information about an interaction are uploaded to the Cloud. During the conversation, iAdhere takes different actions according to user feedback, such as:

(1) When the user confirms the pill is taken/the exercise is done/heart-rate is checked, iAdhere thanks the user. The interaction is continued, until the user stops.
(2) When the user asks iAdhere to stop talking or stop the reminder, it stops the interaction immediately.
(3) When the user asks iAdhere the details or the ways to follow the treatment, such as, how to do an exercise or check the heart-rate, it explains accordingly.
(4) If the user asks iAdhere to postpone the reminder, it repeats the reminder at the time user mentioned

explicitly or after a default time of 10 minutes. The interaction session is closed immediately.
(5) If the user does not view the reminder or does not talk to the watch, iAdhere repeats the reminder after 10 minutes. The repeating is done up to three times.

3 DEMONSTRATION

iAdhere, installed on the Apple Watch, will be presented as a demo. Prior to the demonstration, a sequence of prescribed daily treatments, such as, pills, exercise, heart-rate checking with detailed information will be uploaded into the cloud. On opening the app, iAdhere will automatically download the reminder schedule from the cloud. One of the conference participants or the presenter will wear the watch. Though the app will provide daily reminders at the prescribed times, a button named 'Next Reminder 'will be provided to go through all the reminders. During the demo, the participant will go through the reminders. iAdhere will interact with the participant, and upload data to the Cloud.

4 CONCLUSION

iAdhere is designed and developed for the stroke patients, but it can be used for other chronic diseases without/with little modifications. We have tested it among several healthy subjects for initial assessment. It will be soon deployed among the real stroke patients with the help of the Center of Telehealth, University of Virginia. Future improvements will be done by measuring the quality of an exercise done and by detecting abnormal heart conditions using ECG sensors data from the Apple Watch.

REFERENCES

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