

Appendix E. User test

This report contains the guidelines to evaluate the haptic and visual feedback incorporated in the portable ECG keychain.

Background

Three out of five users interviewed to evaluate the usability of the products of the Box (Appendix D) reported that they do not use the Kardia Mobile (KM) portable ECG monitor outside home. The reasons for not using it are unclear, some point out to convenience, unwillingness to clip it to the back of the phone, or simply, lack of experience using such a device on the go. At the same time 3 members of the clinical staff reported that:

- KM is difficult to understand by patients.
- KM does not allow the storage of data on the phone of the patient after the first month without paying the premium package.
- The data provided by the device can not be integrated within the system as KM does not provide an application program interface (API).

Moreover the device is not very reliable. In the largest study of its kind in a real setting, 233 patients with 5.982 reading of the KM were monitored for one year¹. The results of the device were compared with the assessment of a cardiologist. The device failed in the following categories:

- Kardia Mobile assessed 17% of the readings as unclassified. From this 8% (72) were atrial fibrillation.
- Kardia Mobile assessed 22% of the readings as AF. From this, 20% were not AF, which can lead to confusion and alarm in the patients.
- Kardia Mobile assessed 59% as normal sinus rhythm with very accurate results (99%+).

Method

The test is separated in two parts. Firstly, the patient will be asked the following questions to understand their current experience with KM:

1. Are you familiar with the Kardia Mobile device?
2. Have you been using it for the last months?
3. Did you have any problem during the usage? Why?
4. Did you use the device outside your home?
 - a. Why?
 - b. How was the experience?
 - c. Did you have any problem during the usage? Why?

Secondly, the Prototype 1 (Figure 1) will be given to the user with a brief explanation of the usage. The explanation is intended to guide the user towards the desired test.



Figure 1. Keychain prototype.

Hello, this is a test for a graduation project at the TU Delft in order to evaluate the usability of a future portable ECG. You will be required to use it for two minutes. You will be asked a few questions about it, which you may answer or not answer.

The prototype is a small portable ECG. It can be carried on your pocket in the keychain. It is capable of recording your ECG even if you do not have the mobile phone at the moment, any time you feel palpitations or that your heartbeat is irregular.

The prototype consist of three parts:

1. The electrodes: This is where you make contact with the device to proceed with the recording.
2. The light indicators, which can be seen in the holes. The light indicates how much time is left to finish the recording.
3. The vibrator motor. It is not seen, but vibrates gently when the recording starts and when it finishes.

To start recording you can place it in your arm, holding it as indicated in the image (Figure XX).

The user will be asked to use the device, without a phone for 30 seconds. It will be recorded with a digital camera, pointing to the users hands. The user will be required to fill the Table 1.

	Strongly Disagree	Disagree	Agree	Strongly Agree
I noticed when the reading started due to the vibration.				
I noticed when the reading finished due to the vibration.				
I noticed when the reading started due to the lights.				
I noticed when the reading finished due to the lights.				

Table 1. Visual and Haptic Feedback

Finally, the device will be used again with the application. The application is used in a Motorola G5 android phone, it is interactive and the user can see the main screens and a record of their signal. The signal shown is a 30 seconds first lead ECG from PhysioNet/CinC Challenge 2017². This is because there is some noise with the recording setup and which improvement. The screens that user interact with are the main screen, record-ecg and doctor messages. The user is asked to:

- Please, do an ECG record, this time using the application.
- Once it is finished, the user is asked to continue and suggested to review the doctor messages.

Once finished, the user is asked:

- Did you find easy to use the application?
- Do you find convenient to have direct contact with the doctor and receive an answer afterwards?

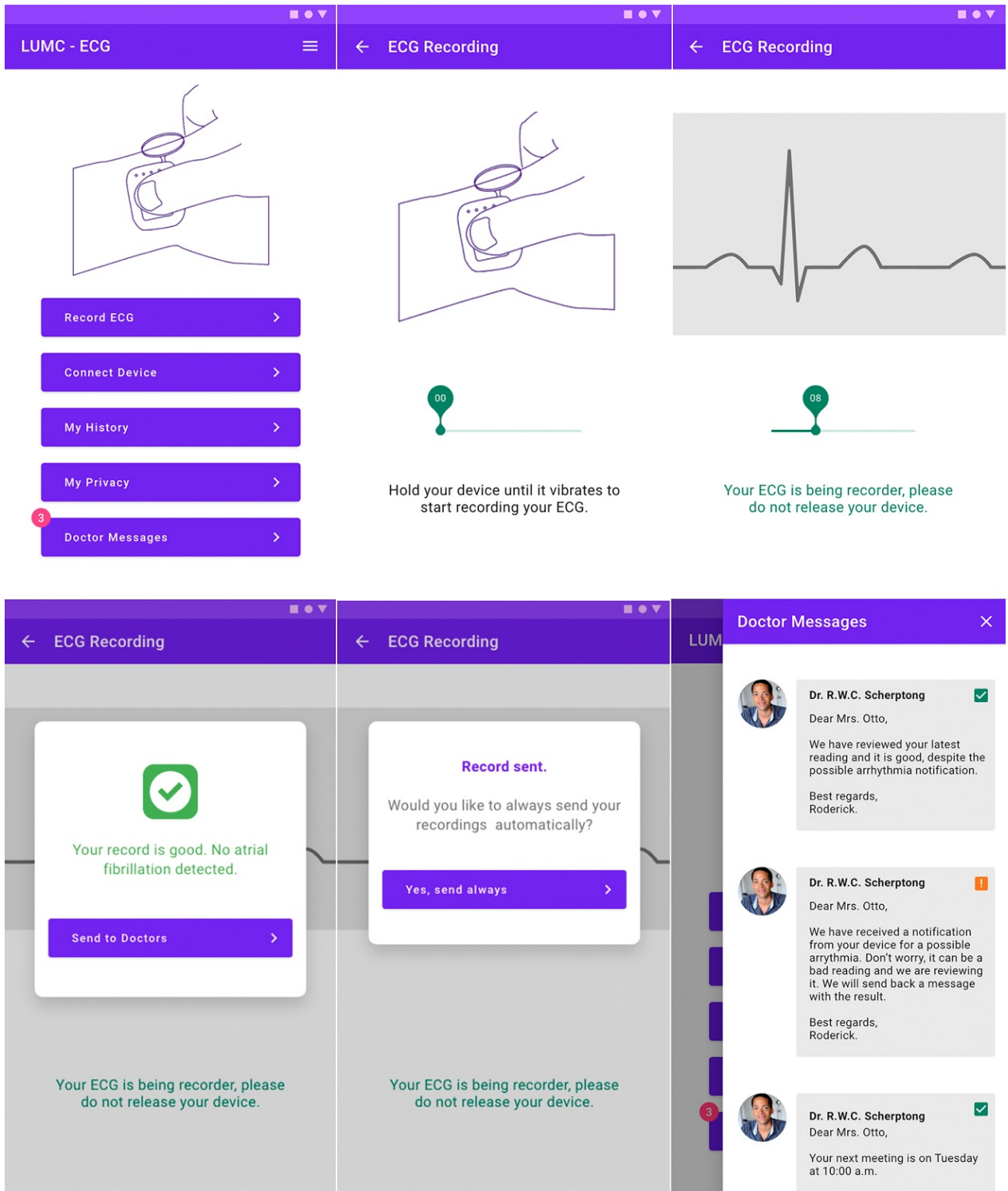


Figure 2. Application screens in order. Left to right, top to bottom. Top left: initial screen. Top middle: initiation of the recording. Top right: recording. Bottom left: result with option to send to the doctors. Bottom middle: reminder to send or not the record. Bottom right: message system with the doctor.

Test setup

The test takes place at the LUMC hospital in a small hall near the outpatient clinic.

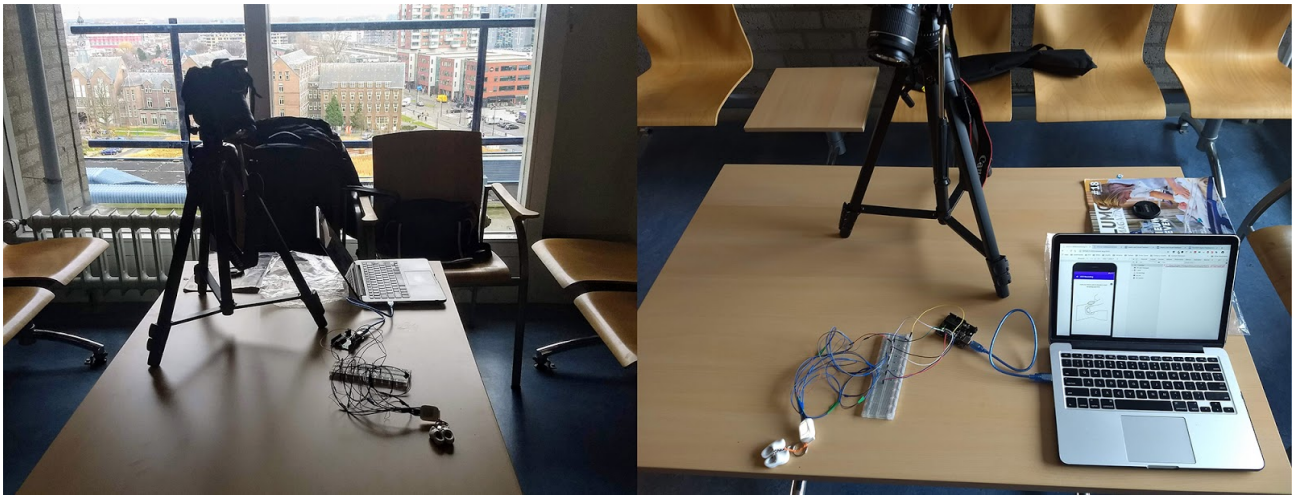


Figure 3. Prototype setup at the LUMC.

Results

User 1

Gender: Male

Age: 67

1. Are you familiar with the Kardia Mobile device? **Yes.**
2. Have you been using it for the last months? **Yes.**
3. Did you have any problem during the usage? Why? **No.**
4. Did you use the device outside your home? **No.**
 - a. Why? **I use it once a day and then I leave it**
 - b. How was the experience? **Good, no problems.**
 - c. Did you have any problem during the usage? Why? **No.**

	Strongly Disagree	Disagree	Agree	Strongly Agree
I noticed when the reading started due to the vibration.				
I noticed when the reading finished due to the vibration.				
I noticed when the reading started due to the lights.				
I noticed when the reading finished due to the lights.				

- Do you think this size is more convenient? **Agree**
- Would you place a device like such in your keychain? **Yes, the smaller the better.**
- Did you find easy to use the application? **Yes.**
- Do you find convenient to have direct contact with the doctor and receive an answer afterwards? **Yes, it I like it.**

Observation:

- The patient completely ignores the light feedback.
- The patient understands the application and the instructions without a problem.
- The patient comes with his partner.

User 2

Gender: Male

Age: 57

5. Are you familiar with the Kardia Mobile device? **Yes.**
6. Have you been using it for the last months? **Yes.**
7. Did you have any problem during the usage? Why? **No.**
8. Did you use the device outside your home? **No.**
 - a. Why? **Generally I use it only at home.**
 - b. How was the experience? **Sometimes doesn't work well near the computer, but it is easy.**
 - c. Did you have any problem during the usage? Why? **No. The data is sent to the hospital without any problem.**

	Strongly Disagree	Disagree	Agree	Strongly Agree
I noticed when the reading started due to the vibration.				
I noticed when the reading finished due to the vibration.				
I noticed when the reading started due to the lights.				
I noticed when the reading finished due to the lights.				

- Do you think this size is more convenient? **Yes**
- Would you place a device like such in your keychain? **Yes, why not**
- Did you find easy to use the application? **Yes.**
- Do you find convenient to have direct contact with the doctor and receive an answer afterwards? **Yes, it is nice to see the doctor here.**

Observation:

- The patient is not aware that the application does not send information to the hospital automatically.
- The patient completely ignores the light feedback.
- The patient understands the application and the instructions without a problem.
- The patient comes with his partner.

User 3

Gender: Male

Age: 54

1. Are you familiar with the Kardia Mobile device? **Yes.**
2. Have you been using it for the last months? **Yes.**
3. Did you have any problem during the usage? Why? **No.**
4. Did you use the device outside your home? **No.**
 - a. Why? **I only want to use once a day. Why should I use it more?**
 - b. How was the experience? **It works well.**
 - c. Did you have any problem during the usage? Why? **No.**

	Strongly Disagree	Disagree	Agree	Strongly Agree
I noticed when the reading started due to the vibration.				
I noticed when the reading finished due to the vibration.				
I noticed when the reading started due to the lights.				
I noticed when the reading finished due to the lights.				

- Do you think this size is more convenient? **It is ok**
- Would you place a device like such in your keychain? **No, I don't have a keychain, I have the keys on my wallet. I don't see any advantage in having a product smaller that I can not carry with me. KM works well, I do not see why I should change.**
- Did you find easy to use the application? **Yes, no problem.**
- Do you find convenient to have direct contact with the doctor and receive an answer afterwards? **It is ok.**

Observation:

- The patient completely ignores the light feedback.
- The patient does not use a keychain, therefore considers it not compatible.
- The patient understands the application and the instructions without a problem.
- The patient comes with his partner.

User 4

Gender: Male

Age: 68

5. Are you familiar with the Kardia Mobile device? **Yes.**
6. Have you been using it for the last months? **Yes.**
7. Did you have any problem during the usage? Why? **Yes, with the application.**
8. Did you use the device outside your home? **Yes, in a travel to Spain I took it with me.**
 - a. Why? **For travel**
 - b. How was the experience? **It works well, but had some problems when I changed my phone due to the application.**
 - c. Did you have any problem during the usage? Why? **The application.**

	Strongly Disagree	Disagree	Agree	Strongly Agree
I noticed when the reading started due to the vibration.				
I noticed when the reading finished due to the vibration.				
I noticed when the reading started due to the lights.				
I noticed when the reading finished due to the lights.				

- Do you think this size is more convenient? **It is ok**
- Would you place a device like such in your keychain? **Yes.**
- Did you find easy to use the application? **Yes.**
- Do you find convenient to have direct contact with the doctor and receive an answer afterwards? **Yes, it is nice to see the doctor here.**

Observation:

- The patient completely ignores the light feedback.
- The patient is not aware that the hospital does not receives automatic information from the KM.
- The patient understands the application and the instructions without a problem.
- The patient comes with his partner.
- The patient puts emphasis on the mobile phone, he mentions that for him is difficult to use applications, despite being a highly educated person.

Expected behaviour on the evaluation of the Application

Rating (5 Positive, 1 Negative)	Visual Feedback	Haptic Feedback	Record Signal with Interface	Send Message to Doctors	Communication System
5					
4					
3					
2					
1					

Table 2. Expected behaviour

Table 2 illustrates the expected behaviour from the users divided in the main categories that define the interaction. The expected behaviour is:

1. Patient understands the visual feedback without problem.
2. Patient understands the haptic feedback without problem.
3. Patient may have problems in recording the signal using the application, such as waiting time to start, button click and follow-up actions.
4. Patient send the record to the doctor.
5. Patient values positively the on-app messages.

Rating (5 Positive, 1 Negative)	Visual Feedback	Haptic Feedback	Record Signal with Interface	Send Message to Doctors	Communication System
5					
4					
3					
2					
1					

Table 3. Final behaviour

Table 3 illustrates the final behaviour from patients. Visual feedback does not add any value and it is completely ignored. The application is easy to use and the communication system is well accepted.

References

- [1] Selder, J. L., Breukel, L., Blok, S., Rossum, A. C., Tulevski, I. I., & Allaart, C. P. (2018, 12). A mobile one-lead ECG device incorporated in a symptom-driven remote arrhythmia monitoring program. The first 5,982 Hartwacht ECGs. *Netherlands Heart Journal*, 27(1), 38-45. doi:10.1007/s12471-018-1203-4
- [2] Gari Clifford, Chengyu Liu, Benjamin Moody, Li-wei H. Lehman, Ikaro Silva, Qiao Li, Alistair Johnson, Roger G. Mark. AF Classification from a Short Single Lead ECG Recording: the PhysioNet Computing in Cardiology Challenge 2017. *Computing in Cardiology (Rennes: IEEE)*, Vol 44, 2017 (In Press).