Can smartwatch help users save time by making processes efficient and easier?

Midterm report – INF 5261 Autumn 2014

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06.10.2014

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1 Introduction

1.1 Background

Though smartwatch has been commercially available since early 80's, it has not gained much publicity or interest from public consumer. However in the past one year, smartwatch has gained significant momentum and 2013 was even said by analysts "could have been year-of-the-smartwatch". That momentum was signified by the release of several smartwatch products such as Pebble by Pebble Technology Corp, Galaxi Gear S by Samsung, SmartWatch by Sony and Toq by Qualcomm. Later in 2014 Consumer Electronic Shows a large number of new smartwatches were released by various companies such as Razer Inc, Archos, LG, Motorola and even Google Android Wear platform was then introduced. That is on top of what other firms have confirmed that they are in process of developing their smartwatch products due for release in near future, such as Apple with Apple Watch and Swatch with Swatch Touch to virtually concludes 2014 as start of "wrist revolution" where many high-tech companies have started their competition in this market.

With that recent situation development, the big question is whether smartwatch will really get its own positioning within public consumer product lines, considering there are many other existing personal computing devices with various form factors and computing power such as laptop, netbook, tablet, smartphone, etc. What is the advantage of smartwatch compared to others? Where should smartwatch fit within people daily activities? Will smartwatch be a real killer-device with true tangible benefit rather than just a sci-fi hype?

This report is trying to explore what smartwatch can or should do in order to save people time, by making some daily tasks processing easier and more efficient. One focus area is how the "human-smartwatch" interaction should be designed in order to achieve that time-saving objective. The design is based on what technology is available today as well as what has been patented.

1.2 Motivation

We have several motivations as to why we think smartwatch as people time-saver is an interesting and relevant topic these days:

1. Ever increasing activities a person can have with limited time. People have considerable more activities today than before. People tends to get more meetings, more appointments, more information to digest, etc. Can it be helped or facilitated by smartwatch?

2. Emerging smartwatch products on the market from various vendors with various capabilities. Smartwatch is no longer a sci-fi thing which we could only watch in sci-fi movies, rather it has become a reality and it offers a lot more capabilities than what it did when it was first commercially released in early 80's. There are more choices available, and it could become a commodity in near future like what smartphone has been today.

3. More demanding interactions driven by social/professional needs which are typically performed using smartphone today. Smartphone has been human's main 'digital companion' in the past two decades that has helped people to be always connected in mobile way and allows more interaction. But, will picking up phone form pocket be still practical with more demanding people interaction e.g. if we get either one mail or one SMS or one important news feed or one phone call every ten minutes, will picking up from pocket still be fine or becoming cumbersome? Not to mention how many touch, tap or slide we need to do to access that information resource from smartphone.

4. Promising various technologies and inventions/patents to overcome today's smartwatch shortcomings (e.g. battery charging over WiFi, GSM/3G mobile enabled smartwatch, etc). Smartwatch's technological shortcomings have been one of barrier-to-use that prevents smartwatch acceptance from public consumer –aside from its comparative cost. But the recent technology advancements start closing the shortcomings as well as making lower production cost.

5. Users do not use smartphones or tablet PCs constantly during everyday life for example while eating, sleeping, shower, or just being at home, and they are not built for an outdoor usage or rough environment. Furthermore, normal gloves cannot be used to operate capacitive touch displays [1]. However, smartwatches have a battery life span a couple of days to years, water resistant and the sensors to enable a possible gesture interaction. [2]

Thus, smartwatch can be worn constantly in all different context when other devices may not be viable.

1.3 Research questions

RQ 1: What activities take relatively long time to execute with smartphone today? e.g. measured by how many manual steps including the number of touch/tap needed.

The purpose of this research question is to assess the current activities with the aims to understand the domain, understand the case study and identify the problem to be solved

RQ 2: Can smartwatch make the process more efficient (shorten the steps) and easier? What kind of "human-to-smartwatch" interaction design could be done to exploit the advantage of smartwatch compared to smartphone, with the caveat of smartwatch's shortcomings (e.g. shortcomings on screen size, computing power etc)?

This question helps us to understand if the problem identified by research question 1 can be solved or minimized with smartwatch. Furthermore, this question help us to suggest the changes required to exploit the advantages of smartwatches in regards to their shortcomings.

RQ 3: Is smartwatch worth the cost for the benefit? Is there any cheaper alternative technology with similar benefit?

With this question, we want to identify if the users are willing to buy smartwatches for their benefits.

RQ 4: What can smartwatch do in the future to further help people save time which is not supported/available today? What are people's expectations for future smartwatch?

We want to look at available patents and suggest what can be done to further increase the efficiencies of smartwatch.

2 Method and audience

2.1 Method

We are going to do literature review (academic and theoretical point of view) on wearables in general and smartwatch in particular. In addition to that, we are going to review articles and market capabilities around existing smartwatch products on market today e.g. its capabilities and consumer's opinion/reception around its pros and cons. Furthermore, we will look at new patent/innovation reviews which may/have not be used in current smartwatch today but potentially usable in future smartwatch to open up further possibilities. Finally, we will deep-dive on several potential scenarios/case-studies and do technical analysis/design how it can be done. Below are the scenarios:

- Notification management
- Appointment making/reminding by voice command
- Sending SMS/email by "saying" (audio-to-text processing) , getting SMS/email by "hearing" (text-to-audio processor)
- Turn-by-turn navigation
- Generic future purposes by audio-command/audio-response.

2.2 Target audience

The target audience for our product are busy people who need to plan their task correctly and save as much time as possible. We are also focusing on the visually impaired people who have difficulties in operating smartphones.

Job workers (mid –senior level)

These are the people who are busy. They want to reduce the number of steps in any tasks so they have more free time which they can use for themselves or do other tasks. Example could be to schedule appointments. They have appointment both at work and private. They want to be able to quickly schedule the meeting without any clashes and be reminded of them.

Furthermore, they want to schedule the appointment in as less steps as possible. Another example could be navigation and so on.

Students

These user groups of people want to use affordable state of the art technology and look fashionable at the same time. They might want to use technology wherever they go and hence a better choice of smartwatches which unlike smartphones and tablet can be carried anywhere around. They also have busy schedule due to long school hours as well assignments and personal lives. The young people between the ages of 18-34 also seem to be the majority of wearables owners [3].

Visually impaired people

For people who cannot see, devices with voice commands seem the optimal solution. Smartwatches with their long battery lives and their possibility to be worn anywhere provide the best solution. Thus, this will enable them to save time.

3 Preliminary research and analysis

3.1 Situational analysis: smartphone today

Today smartphone has been the main device that is attached the a person and making it the most personal mobile device. Therefore the situational analysis is more focused to smartphone as the baseline comparison, rather than desktop PC, laptop or tablet.

1. Notification management: how many times do we need to pick our phones?

   In a single day someone can get many notifications electronically. It can be in many forms depending on the phone's capability including SMS, email, messaging service (e.g. Facebook message, Whatsapp message, Blackberry message) and traditional incoming phone call. A US phone user aged 18 - 24 receives 1831 SMS monthly or 61 SMS daily [4]. A business user receives in average 75 legitimate emails daily [5]. A Whatsapp user typically gets 2267 messages monthly or 75 messages daily [6]. Excluding number of phone call, based on the numbers above, someone could get over 200 notifications daily. Another analysis by Ahonen based on Nokia's study mentions in average people checks the smartphone 150 times daily [7]. As we don't carry phone by hands most of the time, that implies a person may need to pick up the phone as many as 150 times, and also put it back to at the same number of times after usage, be it out from pocket, bag, desk or from anywhere else. It could have been easier if we get notification on something that is wearable so we can have a quick look to decide whether we should respond by picking up the phone or not.

2. Smartphone: how many step is required to do things?

   Given the phone has been picked out from pocket and now is on hands, a person still needs to do some steps. Typically the steps are:

   - Unlocking the phone. While in pocket, a phone is typically screen-locked to avoid unwanted use. Unlocking requires several taps or slides.

   - Finding app. A person typically has number of apps that is more than one phone screen can hold and therefore apps icons are placed in multiple home-screens. Hence finding the apps required another one or two taps or slides.

- Running the app itself. This may vary based on how easy the app's user interface is, but it definitely needs more than just two taps.

With the number of steps above, in a mobile situation such as while driving, cycling, walking or running, the use of phone is not a convenient thing, time taking and could be even unsafe.

3. There is other time-taking aspects that people may see as disadvantage of smartphone.

   Smartphone is mobile but we need to carry, which implies while we are not carrying it, there could be a chance that we forget where we place the phone. Hence finding or searching for the misplaced phone is another time-taking exercise, compared to wearing thing.

4. There are some other non time-saving disadvantage aspects of smartphone compared to wearable such as potential of getting pick-pocketed (from bag, pocket, purse), relatively heavier and bigger dimension so not everyone pocket may fits, etc. However we do not discuss non time-saving aspect in this report.

3.2 Situational analysis: smartwatch today

There are various smartwatch products in the market offering various capabilities and prices.[1] Following are the smartwatch's barrier-to-use factors perceived by consumer:

1. Price. It typically costs more than smartphone, though today we can find smartwatch at less than $99 price tag such as Sony LiveView.

2. Feature. This may vary from one product to another but in general it can be classified into the following:

   - Battery life. Today it ranges from 1 to 7 days (could be a year for special purpose smartwatch), which is actually fairly comparable to smartphone, but would not be comparable to traditional watch.

[1] http://www.bestsmartwatchescompared.com/

- Computing power. It is definitely behind smartphone but actually smartwatch today has been equivalent to earlier smartwatch, such as Samsung Gear-2 with 1GHz dual-core processor.
- Screen size. It is inherited limitation of watch form factor which cannot be much improved but could be helped with better user interface design.
- Connectivity. In general it is more limited compared to smartphone and may position smartwatch as peripheral/accessories to smartphone.
- Apps. Due to its form factor, the number of apps is more limited.
- Size/style. It is sometimes too bulky or not stylish enough i.e. makes the user looks geeky/neerdy.

There are new inventions which could be applicable to smartwatch:

1. Battery charging over wireless

   This technology enables smartwatch's battery to be charged while user is still wearing it and still mobile. Today there has been three consortiums competing to become the standard protocol:

   - Power Matter Alliance (AT&T, Duracell Powermat, HTC, Huawei, Kyocera, LG, NEC, Power Kiss, Samsung, Sharp, Starbucks, ZTE etc)
   - Wireless Power Consortium (Belkin, Energizer, HTC, Huawei, LG, Motorola, NEC, Nokia, Panasonic, Philips, Samsung, Sony, Verizon etc)
   - Alliance for Wireless Power (Deutsche Telekom, HTC, Intel, LG, Qualcomm, Samsung, SanDisk etc)

2. Bluetooth LE or Bluetooth Smart

   It is a wireless personal area network technology to provide considerably reduced power consumption and cost while maintaining a similar communication range to conventional bluetooth, therefore it is perfect for smartwatch connectivity solution.

3. 3G GSM connectivity

In the early days, smartwatch was seen more as peripheral to smartphone as it did not have its own GSM connectivity. But today we have seen Samsung Gear-S has 3G GSM connectivity and likely will be followed by others. That allows smartwatch to completely replace smartphone for calling.

4 Literature review

We will look at various literatures to better understand the solution to the problem, and find the best solution. We plan to use the suggested ideas by various scholars in our design.

Smartwatch barrier-to-use

The paper by Song studies the reason why consumers do not buy wearable devices and what is the ideal product they are willing to buy and wear. It uses different researches example ABI research, Forrester research, Nielsen and so on, and also looks at the problem from the customer viewpoint. It states that for majority of consumers to buy smart devices they look for three parts: function expectation (a good smartwatch which might replace smartphone); design expectation; and product system. [3] Therefore, the smartwatch need to have good functionality, look stylish and a good product line for the customers to relate to.

Smartwatch context awareness

Tamminen et al. 2004 studies mobile contexts as they differ from fixed indoor contexts. Both internal factors such as tasks and goals along are different along with external factors such as social resources are dynamic and unpredictable. [8] Studies have already shown that smartwatch application can perform common actions in an office environment without losing too much time. [9] Therefore, the users can use their smartwatch to replace different physical application with their smartwatch. Perhaps this feature can be extended.

Smartwatch input modality

There are several types of input modality. Physical touch or tap to the smartwatch button or screen menu has been widely used today, similar to how we operate smartphone. The physical touch is a response from visual output shown on screen. However due to smartwatch small screen size, it is important to consider other input modality which is “eyes-free”. Such “eyes-free” interaction is also aimed at reducing visual focus attention requirement from user, allowing more usage while in mobile/moving condition.

Perrault et al., 2013 looks at how wristband can be used for solving the visual occlusion and the fat finger problem in the wristwatch due to their screen size. It also investigates the usage of wristband for eyes-free contexts and presents techniques where the bracelet can be used together with the screen to provide precise continuous control over list scrolling. Gesture based interaction seemed to be faster than using a touch screen in few conditions by the result of their experiment. [10]

Kyu Yeol Paik [11] highlights that gesture can be other considerable input modality. However it was argued that gesture is quite limited in numbers, can be unnatural, may consume user's focus, and has quite margin of gesture detection inaccuracy. Audio/sound is another possible input modality, with some challenges around recognition of personal accent difference and surrounding noise. The computing power of smartwatch was also seen as limited to do complex speech recognition.

Smartwatch output modality

Screen/visual output has been the default modality for many mobile devices. Kyu [13] mentions there are several other possible output modal namely audio and haptic/tactile/vibration. [11] Audio output modality includes auditory icon (symbolic methaphore of event), earcon (pre-defined tone output) a natural audio speech.

Smartwatch interactions with other mobile devices

Rhodes et al. 1999 looks at the advantages and disadvantages of ubiquitous computing and wearable computing. Then the author proposes the complementary problems for the two perspectives. And finally, the author attempts to demonstrate that the failing of both ubiquitous and wearable computing can be alleviated by the development of systems that mix the two. The author proposes the use of peer-to-peer network of wearable and ubiquitous computing components, with proper information flow to solve the disadvantages of wearables. [12] Therefore, we could have the smartwatch react with the environment for example with the smart room where a room with multiple sensors work together with smartwatch settings of multiple individuals.

Chen et al. 2014 explores input modality that combines smartwatch gesture with smartphone spatial context to create new multi-device input interaction. Such new gesture-based interactions are claimed to be useful & increases easiness compared to conventional way of doing it in following aspects: reduces cumbersome steps if they were done using smart phone alone, provides extended display on screen (ie the new interaction removes the necessity to have extra icon/button so freeing more screen space on smart phone), allow extra interaction capabilities beyond their individuals. [13]

Kevin et al. 2008 looks at how users can do other activities like checking calendar while in a phone call without interrupting the call. The author replaces the visual interface of mobile phone with one based on auditory feedback where the users interact using the phone keypad without looking at the screen. Then it is presented for the users to test it where the majority of them preferred this method.[14] Therefore, it is worthy taking note that other input methods might be better.

5 Design principles

The generic principle is that the smartwatch interaction should be natural, simple and easy-to-use, which translates to the following design principles:

1. Minimize number of menu on screen. Due to its small screen-size, people with fat fingers will have difficulty in selecting menu precisely if there are too many menu on screen. The menu on screen should be limited to what's important.
2. Minimize number of screen-touch as input method and allow other input method to open/run app
3. Menu selection should allow other input method than screen-touch (e.g. physical programmable button, watch bezel, watch bracelet, gesture or even audio command). Wristband functionalities could be added to the wristband to solve fat finger and scrolling problem.
4. Minimize eyes-interaction demand. Focusing eyes on small screen could be tiring, especially on too dark or too light environment or while on mobile situation (e.g. driving, walking). Other output interaction should be explored (e.g. audio).
5. Intuitive/natural. The interaction should be natural and does not require additional accessories than the watch itself in order to execute the app's function.
6. Total number of steps required to execute the app's function should be less than steps required on smartphone. Though we do not need to pick it out from pocket, it will not save time if the total number of steps is more than smartphone's steps today.
7. Visual appealing. The user interface should be simple to use and visually appealing. Since they are part of wearables and also serve as a part of fashion statement for the younger and older generation alike.

6 Time-saving scenario using smartwatch

This section briefly highlights the scenarios where smartwatch could possibly help saving users' time. This midterm report illustrates the high level idea, such as what the input and output of the interaction. The processing to convert from input to output will be covered further in the final report.

1. Notification management

Smartwatch to classify which incoming information is important vs not-so-important and output different type of notification to user. When used in pair with smartphone, user can decide whether or not to pick up the phone from pocket based on notification tone, hence saving time.

High level interaction design:

- input:
  - incoming phone call, SMS, messaging service (e.g. Whatsapp message, BBM, Facebook message etc)
  - configurable notification setting based on sender information, message subject, message content etc.
- output : different type of notification based on the importance

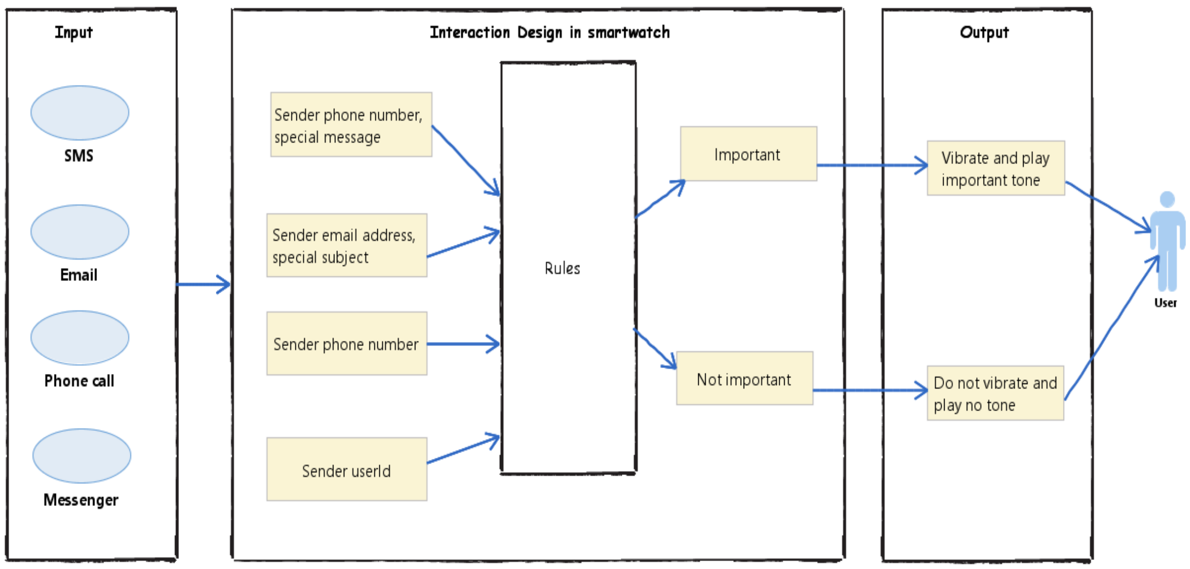

Figure 1. How smartwatch can help users save time by notification based on importance

The input can be anything as seen in the figure above. We will have a set of rules in the smartwatch that will help filter the important input from the unimportant inputs. The rules could be anything for example like user defined rules at Microsoft Outlook to filter out the emails or algorithm to prioritize the inputs.

2. Appointment making/reminding

Smartwatch to allow appointment making by voice command and synchronizing it with calendar with audio and/or haptic output reminder. It save times than making appointment in smartphone by touch interaction.

High level interaction design:

- input: predefined set of voice commands and user's calendar
- output :
  - Appointment set up and synchronized with user's calendar if there is no conflict. Whenever appointment is almost due, smartwatch will provide audio/haptic reminder.
  - Audio response to warn user if there is conflict with existing appointment in the calendar. The new appointment can still be set up upon user confirmation to override the conflict.

The following diagram shows how the user can book an appointment with his/her smartwatch.

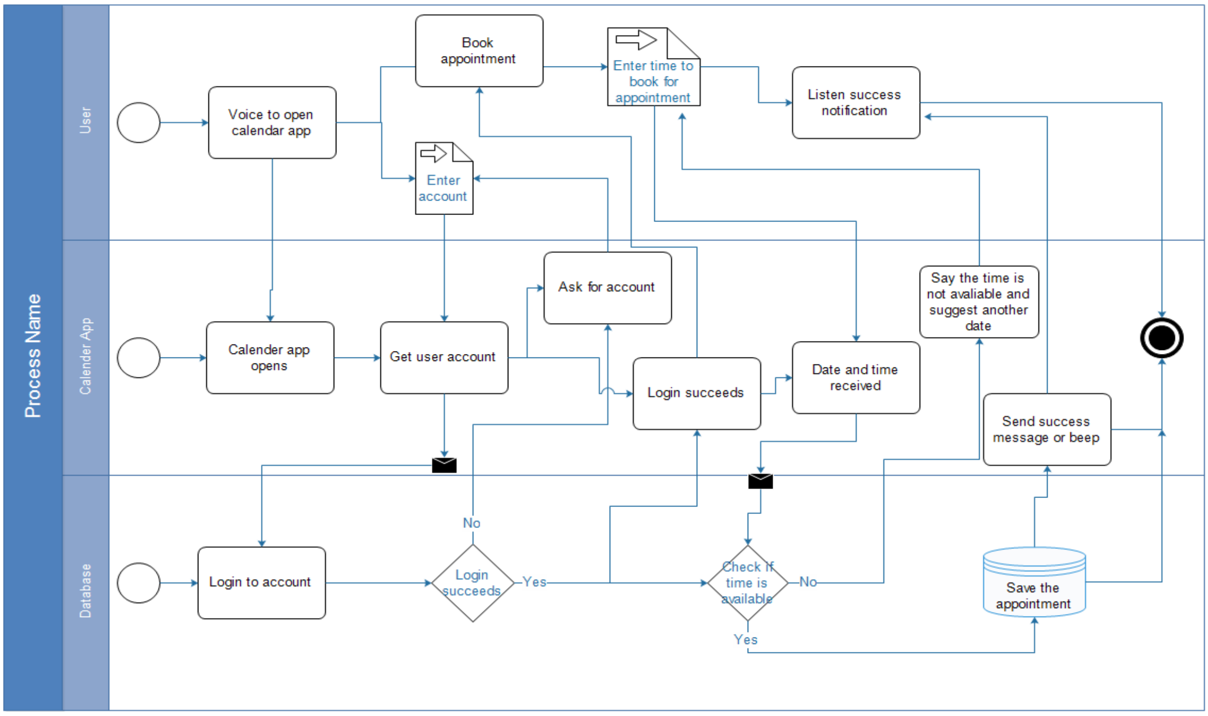

Figure 2. Diagram showing how appointment can be easily booked with voice

3. Sending and getting SMS/email

Smartwatch to allow voice-to-text/transcriber to send SMS/email ie. sending SMS/email by "saying". Also allow text-to-voice to read the SMS/email for the user, allowing touch-free and eyes-free interaction ie. receiving SMS/email by "hearing".

High level interaction design:

- input :
  - predefined set of voice commands to send/get the SMS/email
  - user's speech that will be transcribed into SMS text or email message.
- output :
  - SMS/email sent without touching smartwatch
  - SMS/email message heard by user without touching smartwatch

Input	Interaction Design /How		Output
	Step-1	Step-2	Step-3
Need to SMS/email	Activate "audio-interaction" function	Say "Read SMS"	Hear SMS audio
		Say "Write SMS"	Dictate the SMS content
		Say "Read Email"	Hear email audio
		Say "Write Email"	Dictate the Email content

Figure 3. How interactions for reading and sending sms/email can be performed by using voice

For the same second scenario, smartphones would need the following steps:

1. Unlock the phone
2. Find email/SMS app
3. Open the app
4. Read or write the message
5. Send it

As seen above, the same process can be done much faster with the voice command through the smart watch, and thus, it helps the user save time.

4. Turn-by-turn navigation

We will look at how simple navigation action can be performed effectively through smart watch to save time.
Note: There have been various smartwatch's navigation application on the market for example Garmin on Sony Smartwatch-2.

5. Generic future purposes by audio-command/audio-response.

Various purposes for example:

a) Pre-programmable/scriptable task (e.g. making call to favorite pizza store) which is tagged to certain audio-command. It saves time than finding contact number and placing normal call.

b) Making personal foreign language translator which takes audio input and provide audio output and vice-versa. This can save time when we are in foreign country and needs to understand some conversations.

High level interaction design:

- input :
    - predefined set of voice commands
    - configurable script that the smartwatch will execute to respond the voice commands
- output :
    - automatic call to pizza shop
    - automatic audio translation based on foreign language audio received by the smartwatch

7 Future Work

1. We have prepared a survey with multi choice to help sharpening the answers to our research question. At the moment we are still in the process of collecting survey result. This is to add on top of some answers we have got from literature review and third party survey result.

2. We also need to get more scholar’s view from technical literature in order to define what kind of detail interaction techniques suitable to each scenario.

3. Another main work that should be covered in the final report would be the detail technical design on how each scenario technically can be implemented. This includes what kind of hardware, software and connectivity would be needed to implement each scenario.

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