CS5760: HCI & Usability Test

Topic Assignment-2

Mobile Touchscreen User Interface

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Abstract:

The recent evolution of touchscreens mobile devices has opened many doors of user interfaces. Users are getting more dependent on mobile touchscreen UIs than other available touchscreen devices due to its readily accessibility. Its fast, appealing and handy features make touchscreen UIs very demanding. With the increasing interest of different touch applications, efficient and user friendly UI design is becoming a field of research interest. To provide users with optimum user interface experience it is necessary to study user's interaction patterns. The paper provides a study of User's touchscreen interactions and suggestions for useful UI design patterns relating to previous works. It also discusses the different advantages and disadvantages of mobile touchscreen UIs.

Introduction:

Touchscreen mobile usage has become extremely popular over the last decade. A mobile touchscreen is an input device that is elegantly layered with a special type of glass on top of a mobile device. The touchscreen enables a user to interact directly on that glass through single or multi-touch gestures by touching the screen with fingers (skin) or a special stylus/pen [1]. A mobile touch user interface (TUI) is a mobile display-pointing technology that combines sense of touch (haptics) to react to user's input as a confirmation. Mobile touch user interface has become so popular that we cannot think of a single day without using any of the touchscreen mobile UIs. Starting from setting alarms to grading student's exam scripts or navigating location through GPS, all are performed using the mobile touchscreen applications. With the growing demand of unimaginable variety of applications, it is necessary to enhance the UIs. Though touch UIs are already popular for their advantageous features and their user experience significantly studied, there is still sectors of UI design that need to be improved.

The biggest challenge of designing UIs on touchscreen mobile devices is its small display size. It becomes really difficult to accommodate all the elements in the proper 'Thumb Zone'. Due to small touchscreen the navigation elements and target sizes should be customized according to the mobile's platform guidelines to provide visual clarity and proper usability of the touch elements. Designers also need to identify the user's natural positions and selection of hand/s to hold the phone. The paper discusses some of the most important factors, some surveys and popular touch application's design pattern to give an idea of the conventions and standards of designing a touch UI. Haptic feedback is one of the most important features of a touchscreen UI. With the feedback technology being integrated to the touch mobile devices, mobile usage has become noticeably efficient in terms of tapping the correct key almost every time. To get the best UI design pattern some UI practices to follow is suggested.

User's device Interaction:

As the usage of touchscreen devise are rising, so is the necessity of its UIs to be user friendly. Most people using a phone are using a smart phone with a touchscreen display. Some people use mobiles more than opening their desktops or laptops to access their desired information. The mobile websites and apps are becoming popular due to their readily accessibility on the palm of

hands. For example, a tourist travelling in NY subways would find the desired track through tapping on his/her phone's app or website rather than opening a laptop or a big subway paper map in the middle of the platform. With the popularity of smart phone usage, various types of apps, games, websites etc. are being developed based on the need of these users. It is necessary to stick to some of the conventional design of touchscreen UIs and also enhance those UIs in accordance to the UI domain. And in such a competitive app market worldwide, it is also necessary to design the best UI to keep the user's attention in terms of usability. A poorly designed UI can make a simple app complicated for the user and switch to some other app with a better touchscreen UI design.

Over the last decade, designers are learning more about user's interaction with mobile interfaces and refining the mobile user experience. They are consistently creating usability conventions and standards that designers follow to provide a better usability experience to the user. To understand what it takes to make a successful touchscreen UI design, it is necessary to understand how the users physically interact with their mobile devices. Their interaction experience depend on some factors like, with which hand they are using or in which position they are using their mobile. Using mobile has become so common that naturally people mostly hold their mobile device on one hand and keep the other hand free. Otherwise, they also might use both hands to navigate the touchscreen contents. If users are using their devices single handed then comes the question of which hand it is. These natural behavior of using mobiles has helped in defining the fundamental mobile design patterns that we rely on today.

An educative guess can be to say, that most users interact their mobile with their right hand while using mobile device. But it is also true that there are many users who use their left hand or both hands to hold the phone and navigate on the touchscreen display. Cornelia, a User experience researcher and designer, makes a survey [3] showing the statistical report of which thumb is used mostly to interact mobile devices in correspondence to some specific common position of users, like- sitting, standing and walking. Table-1 shows the percentage of users interacting the device with right hand, left hand and both hands while sitting, standing, and walking and an overall total observation. It can be seen that, for every case users interact with their mobile device with their right hand rather than their left. This is particularly true when users are sitting. Again, while walking, the percentage is very close to the one observed for standing and holding the phone. The survey performed is only applicable for mobile phones and not Tablets or similar devices.

	Sitting	Standing	Walking	Total
Left hand	13.49%	25.98%	32.09%	22.89%
Right hand	66.05%	57.48%	57.46%	60.53%
Both hands	20.47%	16.54%	10.45%	16.58%

Table-1: Percentage of Left, right and both handed users holding the mobile against their various positions of using the mobile [3]

From this table UI designers can decide whether they should design for both hands or stick to right handed design. Depending on the position in which the users will be mostly holding their phones, they can decide their design pattern. Instead of telling the designers about what they should do, it is preferable to consider the context or site of the app that will be used and approach the project accordingly.

The best interfaces for a phone focus on designing for one-handed grip. The one-handed grip is common for mobile because users hold their phone with one hand while freeing the other to do things like writing, eating/drinking coffee, holding bags or baby etc. And when it comes to designing for touchscreens it actually means designing for thumbs. So, while designing a touchscreen UI, Thumb Zone is one of the most important factor to consider. Steven Hoober's book *Designing for Mobile Interfaces* [4] introduces the "Thumb Zone" theory that refers as the most comfortable area for touch navigation with one-handed use. While designing a mobile interface a designer should keep in mind that mobiles have limited small size of screen and users are mostly using their thumb to touch navigate. That being said, it becomes necessary to place the most of the important navigation elements within the reach of the thumb to allow for a comfortable and natural user experience.

Figure-1(a) shows the different level of Thumb Zone for right handed users. The green area is the most naturally accessible zone for the right-thumb navigation, while yellow and red gradually being the lesser accessible zone. The Thumb Zone pattern for left-handed users will be just the opposite of the right-handed Thumb Zone. To provide users the comfort and ease of navigation, the most important elements (very frequently used elements for the app) are suggested to be placed within the green zone. And the less important elements (less likely to be used very often) may fall on the yellow and red zone. But what about the design patter for the left-handed users? Though the percentage of left-handed mobile users is significantly smaller than the right-handed users, the design should still be made in a way that it not only serves the usability for the right-handers but also accommodates for the left-handers. Again the area of Thumb Zone can change for different dimensions of the touch display of the device and the hand size of the user. One way to overcome these challenges is to find an average range that fits most of the requirements as prioritized with an aim to make the design as user friendly as possible for all the cases. The neutral zone shown in Figure-1 (b) can be considered as an average area for both the left and right handed users and also the thumb zones for users who use both their hands.

(a) Right-handed Thumb Zone

(b) Neutral Thumb Zone

Figure-1: Thumb Zone areas [2]

Overlaying the Thumb Zone to one of the most popular web application, Facebook android application is shown in figure-2. From the figure, we can see that the most important navigational tools like, message, profile, menu and notification icon, messenger head, the main body of posts, 'Like' buttons etc. are located within close proximity to the green zone. Even the newest additions like the emoticons for Likes have been placed within the green zone. Elements that are used less frequently are positioned in the yellow and red zone in order of importance next to the green area.

Figure-2: Overlaying Thumb Zone over the Facebook Android application

Touch feedback:

Over the last decade, various researches have been performed to provide the user with an effective feedback on touching an element. Some of the very common feedback types are visual feedback, audio feedback, haptic feedback and most recently a combination of both visual and haptic feedback. Upon touching a key, the Visual feedback will display information as a reassurance of the touch being taken place. Visual information can be glowing the key edges or increasing the size of the key tapped to make it visible. Visual and audio feedback are good ways of confirming touch action and hence reducing errors risks. But it is less effective when the user is not concentrating at the display due to other activities or is at a quiet environment. Again, for mobile touchscreens, the use of fingers can occlude the icon/key tapped beneath the finger and result to tapping the wrong key due to lack of view. These scenarios are very common for a mobile user.

One of the key features that a touchscreen UI lacking over the physical keyboards is the ability to get the physical feeling of pressing the buttons to naturally know that the action has been performed and need not to be explicitly checked. This feeling can be achieved by introducing haptic feedback to touchscreen mobile devices. By adding tactile feedback to key controls, users can get the 'Mechanical feel' of how the keys moves inside devices. Hoggan et. al. [9] showed that tactile feedback can reduce errors and increase speed when typing on a mobile touchscreen. Hundreds of millions of touchscreen mobile devices are installed with haptics by the manufacturers and has become an ever growing technology. The vibration sensation for a mobile device can be achieved

by attaching an actuator or motor that is controlled by embedded software and integrated into a device's user interface via control software APIs [10].

Now a days, the tactile feedback is created with the combination of audio and/or visual feedback to give even stronger touch reconfirmation to the user. Users expect the sight, sound and feel of their experience to be consistent, rational and integrated. Though the combination of all the three haptics can be really wonderful but if any of the haptics is not synchronized properly then it can turn into a poor feedback system creating confusions for the user. Haptics add confirmation and tactile feeling in touch user interactions, like- tapping or holding an icon, button pressing, keyboard typing, click of a camera, turning of a page and many more.

There are many companies who are providing state-of-the-art haptic technology to the mobile manufacturers. Among them, Foxconn is for iphone's haptic technology provider, Immersion's for LG, Huawei etc. Immersion's technology has been integrated in 3 billion digital devices, and provides haptics in mobile phone, automotive, gaming, medical, and consumer electronics products from world-class companies [10].

Touch UI design practices:

This section discusses some of the best UI practices while designing touch UIs for mobile devices. Other touchscreen devices like a Tablet, touch monitors have the advantage of a bigger screen size over a mobile device. Creating UIs for mobile devices in a small display area is always challenging for the UI designers. In order to provide users with optimum UI experience the designers need to follow some user interface practices for touch screen.

Follow the Thumb Zone: As mentioned above, the thumb zone is an important factor to be considered while designing touch UIs for mobile devices. First, it is required to identify the majority user's thumb zone through studying the users of the particular application. Then efficiently accommodating the important navigation UIs in order of the green, yellow and red zone.

Larger touch target: Mobiles with small touch targets are harder for users to hit than larger ones. When designing mobile interfaces, it's best to make targets big enough so they're easy for users to tap. The platform developers sometimes provide a user interface guideline where they mention their standard dimensions. Apple's iPhone Human Interface Guidelines [5] recommend a hit target of about 44 x 44 pixels for tappable controls. Nokia's developer guidelines suggest that the target size should be no smaller than 1cm x 1cm square or 28 x 28 pixels. Setting a large target size makes it easy for users to interact with content and controls with enough spacing between interactive elements. According to Fitt's Law [6], the time to reach a target is longer if the target is smaller. Small touch target make users adjust their figure orientation cautiously in different ways to hit the targeted area accurately. This consumes a lot of time and effort, and also leads to errors like tapping on to the wrong element while adjusting fingers. The width of an adult thumb is almost an inch which can be converted to 72 pixels. Author Anthony T in his "Finger-Friendly Design: Ideal Mobile Touchscreen Target Sizes" article published in the 'Smashing magazine' [8] shows that the thumb finger's tip perfectly fits comfortably inside the target area. User errors declined [7] as the target size increased and were able to tap the target faster without having to reorient their thumb.

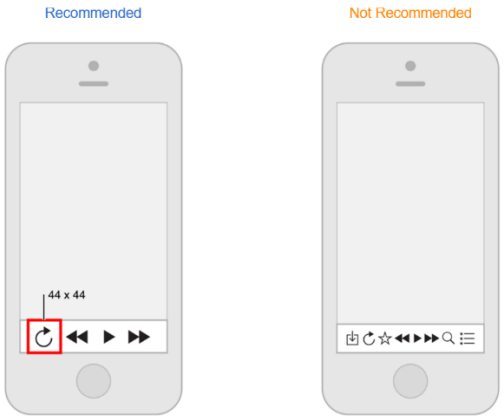

Figure-3: iPhone's recommended target size [5]

Larger touch elements: Making large touch keys can be very useful for users to tap on the element easily and effortlessly. Large touch keys reduces touch errors with a very high success rate and tapping convenience. Again, large items catch the eye very easily and tend to appear more important than smaller ones to the user. Larger items are also easier for users to tap, which makes them especially useful in apps—such as Phone and Clock—that users often use in distracting surroundings [5].

Use touch feedback:

Now a days mobile phones without haptic feedback cannot be imagined! The realistic feeling in the hand of touching a key serves as a reconfirmation of a successful action that reduces the error rate significantly. The haptic can be designed on various touch gestures like tap, double tap, press and hold, drag, swipe, pinch and spread etc. The vibrations for each of the gestures should be unique, so that the user can distinguish between the appropriate feedbacks. The time and intensity of the vibrations should be mild, short or rhythmic. Tactile feedback for each of the gestures should customizable for the users. This provides the freedom to choose the type and duration of vibrations by the user. Giving options of integrating other feedbacks like audio and visual can be very efficient. Some mobiles may have all the feedbacks for an application, but some particular user may find it disturbing and distracting, so they should have to option to switch off some or all the feedbacks. The most recent actuators that are recently used in mobile devices are Piezo Modules, Eccentric Rotating Mass (ERM) Actuators, Linear Resonant Actuators (LRAs) and many more. It is also necessary to choose the best fit actuator for your mobile that consumes less power.

Avoid touch key elimination and congestion: As we learnt that, larger target area and touch keys are convenient for a faster and accurate key hits. But this practice is critical to mobile device's small display size. Making the touch keys large requires more space and so it becomes challenging to accommodate all the required UI elements within the small screen size. This is less critical with traditional desktop or tablet touchscreens, since they have a much bigger screen size. To accommodate the keys, a designer might think of sacrificing some keys or decrease the size of the keys to cramp everything on the desired interface. In both cases either some desired key will be missing from the page or due to too many small keys placed side by side will increase the risk of touching the next wrong key. Designers should be careful in avoiding both as much as possible.

More to that, UIs should also have enough swipe space (free of navigational keys) so that user has the room for swiping up-down, left-right. The good news is, at present the mobile companies are increasing their screen size for every new model they release. This is allowing designers to get more and more real estate to fit the desired size and number of keys easily and efficiently and hence enhancing the user's UI experience.

Clear and consistent design elements: While adjusting the pixels of the touch keys, care should be taken to make the key's resolution clear enough so that the user does not have hard time understanding what it actually means and in the process delay in making the action. Any unnecessary information or element should be removed from the small space of the display to avoid user's confusion and distraction from selecting the appropriate button. Generally, elements that have similar functions should also look similar. Users have this psychology of assuming that there must be a reason for the inconsistencies they notice and as a result they tend to spend more time trying to figure it out.

Advantages:

The touchscreen UIs are inherently designed simple and easily accessible. The touch element's placement depending on the sweet spots make the interaction real fast and handy. It makes everyone an expert through its readily accessibility during any moment of time. Some people might be hesitant in using a laptop or Tab's mouse or trackpad when hands are occupied or during a busy walk, but will always reach out to the phone's touchscreen UI knowing that nothing can go wrong. The touch feedback, especially haptic feedback, ensures an error free mobile usage experience to the user. To make the touchscreen UI experience short, it provides clearly defined menus with small step-by-step less error prone sequences for a complicated task. Touchscreens on mobile devices are advantageous because of the application's customizable inputs, and flexible use of screen space. A good touchscreen UI will have every single of its available pixel utilized with an efficient design. Furthermore, the mobile's touchscreen is much bigger since there is no existence of a physical keyboard. Touchscreen UI's tactile and audio interface allows visually impaired users an added level of interact with their phone.

Conclusion:

The disadvantages of a touchscreen UI is the amount of power consumption for running the UIs. Some of them like the haptic feedback consumes a significant amount of power and also RAM which can be studied to find ways of reducing it. In spite of the limitation of a small touchscreen display and the power and RAM consumption, the popularity of using touchscreen UIs is not stopping for a bit. The elegance of the touchscreen UI is its handiness and efficiency. The wonderful features of a touchscreen UI should explored more to provide users with even more enhanced user experience.

References:

1. Walker, Geoff. "A review of technologies for sensing contact location on the surface of a display." *Journal of the Society for Information Display* 20.8 (2012): 413-440.
2. https://parachutedesign.ca/blog/design-trends/mobile-design-patterns-a-look-at-the-thumb-zone/
3. http://realites-paralleles.com/2014/02/do-users-interact-with-their-mobile-devices-with-their-dominant-hand/
4. http://www.uxmatters.com/mt/archives/2013/02/how-do-users-really-hold-mobile-devices.php
5. https://developer.apple.com/library/ios/documentation/UserExperience/Conceptual/MobileHIG/LayoutandAppearance.html
6. Fitts, Paul M. "The information capacity of the human motor system in controlling the amplitude of movement." *Journal of experimental psychology*47.6 (1954): 381.
7. Parhi, Pekka, Amy K. Karlson, and Benjamin B. Bederson. "Target size study for one-handed thumb use on small touchscreen devices."*Proceedings of the 8th conference on Human-computer interaction with mobile devices and services*. ACM, 2006.
8. https://www.smashingmagazine.com/2012/02/finger-friendly-design-ideal-mobile-touchscreen-target-sizes/
9. Hoggan, Eve, Stephen A. Brewster, and Jody Johnston. "Investigating the effectiveness of tactile feedback for mobile touchscreens." *Proceedings of the SIGCHI conference on Human factors in computing systems*. ACM, 2008.
10. http://www.immersion.com/wp-content/uploads/2015/09/Haptics-in-Touchscreen-Hand-Held-Devices_April2012.pdf