“*AnyTap*”: New Age Mobile Camera Interface

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ABSTRACT
During the current social media era, smartphone photography is becoming an integral part of human life. While smartphone camera features have evolved, their user interface has remained constant over the last decade. This study investigates the usability of *AnyTap*, an alternative interface for the default camera application. Through a comparative study with 12 university students, we examined comfort, satisfaction and touch behaviour across various photography tasks. Tapping patterns demonstrated that users do not naturally tap within the default shutter button zone, revealing a disconnect between the current most common UI design and natural ergonomic use. Our findings underscore the need for a more adaptive, user-centred design in mobile camera interfaces, especially to improve comfort and accessibility for a broad range of users.

Keywords
Mobile User Interface, Mobile Camera Application

INTRODUCTION

Beginning with the *daguerreotype* camera, commercial cameras have expanded significantly to encompass a multitude of formats, including Polaroid, film, and digital [2]. The evolution of photography as both a medium and an art form has been profoundly shaped by smartphones, allowing amateurs to capture high-quality photos and videos that parallel those of professionals.

The exact introduction of the smartphone has been long debated. Some sources state it was IBM’s Simon Personal Communicator in 1994 that sparked the smartphone boom, others say it was Japan's NTT DoCoMo in 1999 [6]. Regardless, it is widely acknowledged that smartphones have been a part of the sociotechnical ecosystem for a significant period of time. In the current day and age, smartphones have become the norm – an essential appendage to the human form. According to a study conducted by Emanuel et al. [4] in 2015, nearly 67% of young adults admit they need their phones at all times. This statistic has only increased in recent years due to the COVID-19 pandemic, during which individuals found comfort and community in their mobile devices [14].

Notably, an integral part of smartphone usage revolves around social media platforms like X/Twitter, Instagram, WhatsApp, and more [1]. Individuals have grown accustomed to the convenience and simplicity with which they can share details of their lives with the masses. Photos used to be seen as a way to communicate with others about past experiences. The introduction of social media in combination with smartphone cameras has turned the act of taking a photo/video into a method of communicating real-time experiences with a large audience [8, 11]. The smartphone camera has been the subject of many additions to the English language, such as terms like “selfie” when referring to a self-taken photograph and phrases like “phone eats first” to describe the act of taking pictures of one’s meal before eating it. From these aforementioned examples, it is easy to see that the smartphone camera has become an essential part of humanity.

In recent years, many improvements and upgrades have been made to cameras embedded in mobile phones. For instance, the Motorola A920[1] released in 2003, was the first phone to introduce the front camera. From there, Samsung[2] has begun to create under-display cameras with their flexible screen phones. These advancements to the smartphone’s built-in camera are primarily hardware improvements. Since its introduction, the software/interface for the camera application on smartphones has remained consistent, with the placement of menus and buttons, especially the shutter button, remaining in the same position (as seen in Figure 1).

This presents several challenges, as it can restrict the user's mobility while taking photos and result in limited accessibility for differently abled users. Consequently, this research focuses on understanding, developing, and testing an alternative to the shutter/capture button in smartphone camera apps. Specifically, this paper will explore the optimal placement of the shutter button to enable differently-abled users to capture higher-quality photos more efficiently. This objective is framed through the following research questions:

- **RQ1**: When users are allowed to tap anywhere on the screen to take a photo, do they naturally tap within the traditional shutter button area?

[1]www.mobilephonemuseum.com/phone-detail/a920
[2]www.samsung.com/a-look-at-the-under-display-camera-udc-on-the-galaxy-z-fold4-and-fold5/

- **RQ2**: Which area of the phone screen do users most frequently tap when no visible shutter button is provided?
- **RQ3**: What do user tap patterns suggest for the optimal button placement for improved comfort and accessibility?

Figure 1.
Left: Camera App interface on Samsung Galaxy S2 (TechInsider). Right: Camera App interface on Samsung Galaxy S22 (PCMag).

RELATED WORK

A study conducted by McAdam et al. [9] in 2010 explored the common usability issues of the camera phone and claimed that most camera phones do not take full advantage of the available features to create an informative interface. In response to their findings, the authors developed a novel camera interface for the Nokia N95, one which efficiently and effectively utilises the space and platform features available. This improvement aimed to make the operation of camera phones more intuitive and accessible, especially in situations where visual attention could be limited. The findings of this study suggest that the integration of multimodal feedback can significantly enhance the usability of the camera application. Since the time the study was conducted, there has been little to no research addressing the usability of the camera phone application, and minimal advancements have been made in the interface design. Despite significant technological leaps in mobile devices and their almost universal spread, camera interfaces have, for the most part, retained their original layout with few innovations aimed at improving the user experience besides improvements in image quality.

Punchoojit & Hongwarittorrn [12] provide a comprehensive overview of studies in mobile design and identify areas lacking sufficient information. The review highlights that, despite the widespread use of mobile devices, there are no established standards for mobile UI design patterns. The authors emphasise the need for additional research that targets the development of comprehensive guidelines that address unique challenges posed by mobile platforms. The lack of standardisations and guidelines suggests that developers of the camera applications have to rely on easy, familiar practices rather than human-oriented design specifications. Our research aims to address this need by evaluating the existing camera app interfaces and proposing improved standards.

One of the frameworks that developers utilise when developing applications is the 'Natural Thumb Zone,' which describes the ways in which an individual's thumb interacts with mobile phones [5]. However, this framework was built upon a specific average thumb size and rarely accounts for differently abled individuals. Kim and Ji [7] critiqued the Natural Thumb Zone by examining the effects of thumb length and screen size on

the comfort of one-handed smartphone interactions. The study identifies the Natural Thumb Zone where users can comfortably interact with interfaces without any strain or discomfort, concluding that the lowermost and the upper-left regions of the touchscreen are generally uncomfortable to use, regardless of the thumb length or screen size. This research underscores the importance of the correct positioning of interactive elements, such as a shutter button, within ergonomic zones to enhance usability and improve the overall user experience. However, the study focuses on the thumb zone in the context of standard one-handed phone use, such as typing and scrolling, without considering the diverse ways in which people hold their phones for different tasks. With regards to camera application interfaces specifically, it does not account for the distinct grip people use when taking photos, particularly the common hand position for vertical selfies and the different thumb zones that these actions would entail.

It is worth noting that smartphones and their interfaces are designed based on certain assumptions about user abilities. In a 2023 study, researchers found that smartphones often fail to meet the usability requirements of individuals with mild-to-moderate dexterity differences [3]. Specifically, the study found that there exist large gaps in available and usable accessibility tools; thus, users create their own adaptations and modifications to enhance the usability of mobile phones and applications.

Correspondingly, Mott et al [10] evaluated the accessibility of smartphone photography from the lens of people with motor impairments. They conducted surveys and interviews to learn about people's experience with smartphone photography and found that people with motor impairments experience many challenges, such as steadying the phone to take a picture, using common gestures to control the camera, overcoming the social pressure of taking pictures, and even posting them online. Researchers learned about different tricks or "hacks" people have used to overcome these challenges and proposed two new interface options which aim to assist individuals with motor impairments in navigating the mobile photography process. Based on their findings, the authors suggest design recommendations that could be implemented for improved accessibility, such as an adjustable shutter button that can be moved around, one-finger zoom, and expanded voice commands.

Similarly, Qiu et al [13] present an evaluation of photo-capture software applications available at the time, highlighting the lack of standardised criteria for evaluating smartphone camera software usability. In response to this gap, they propose a new framework for usability testing that classifies usability based on how humans process information. After defining the criteria specific to the camera application, tests were conducted on three different phone models that aided researchers in identifying the usability issues and suggesting points for improvement. Even though times have changed and progress is unstoppable, the fundamental usability principles remain the same, highlighting the need for more human-centred design.

METHOD

Since the primary focus of this study is determining whether users, when unprompted by a traditional UI, would continue to tap within the area of a traditional shutter button placement, we conducted a comparative study with the help of a custom camera application in which users can tap anywhere on the screen to capture an image. The details of the study are explained below.

Participants

The study recruited a total of 12 participants aged between 18 and 25. Participants were randomly selected from a pool of individuals from York University, and the group consisted of an even mix of genders. All participants had an average experience of 4.33 years (self-reported) of taking pictures with a smartphone. Participants were not compensated for their participation.

Hypothesis Statement

The goal of this study is to evaluate how the location of the shutter button (and its general existence or lack thereof) affects usability (comfort and satisfaction) and efficiency (speed of taking good-quality images) with smartphones. Unlike the common smartphone camera application, which has a fixed shutter button, this study allows participants to tap anywhere on the screen with the intention of identifying which areas of the screen are more comfortable and efficient for users to interact with.

H_0: *In the absence of a visible shutter button in mobile camera interface, users will naturally tap within the region where the traditional shutter button is typically located.*

H_a: *In the absence of a visible shutter button in mobile camera interface, users will not naturally tap within the region where the traditional shutter button is typically located.*

Part of our analysis includes scatter plots within the constraints of the screen to mimic a heat map to illustrate where users press to take photographs most comfortably. By tracking the touch points of the users over multiple tasks, the "heat maps" provide a visual representation of tap frequency across different areas of the screen.

The qualitative results relating to comfort and willingness to use this type of application are evaluated in comparison to the standard camera application with a fixed location of the shutter button and the heat map data. Our analysis assists in determining whether the areas with the highest frequency of taps are different from the traditional shutter button position. Thus, we can determine if the tap location influences the user experience, either improving or hindering usability and efficiency.

We used ANOVA and Scheffe post hoc tests to determine whether or not there was a statistical correlation between the distance of where the participants tapped and the position of the shutter button when examined through the lens of task type, cell-phone orientation and overall participant performance.

Furthermore, our questionnaires include some open-ended questions. The answers for these questions are thematically coded to identify any common themes and/or issues that users may experience.

Apparatus

To develop our application, we used Android Studio (Ladybug 2024 2.1) with Kotlin. The source code for *AnyTap* is viewable on the research team's GitHub[3]. As seen in Figure 2, the front-end design of our application is meant to mirror that of the standard camera application, so users would only need to get comfortable with the method of taking pictures.

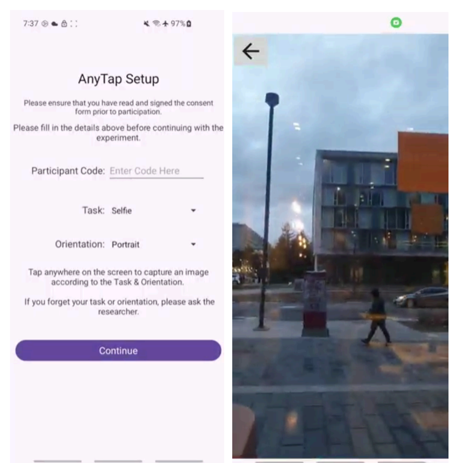

Figure 2. Screenshots of *AnyTap*.

For consistency across results and minimisation of confounding variables, we loaded the application onto a Google Pixel 6 Pro (Android 15, API level 35) and gave it to our participants for testing. Future studies could potentially include testing additional devices for broader performance evaluation.

Procedure

Once we had completed developing our application on Android Studio, we downloaded the application onto the aforementioned device. First, the potential participants were briefed on the study we were conducting and what their participation would require. Afterwards, they were invited to read through and sign an informed consent form (Appendix A).

[3] https://github.com/prach19/anytap-4443

Participants were invited into a quiet environment where they were provided with a pre-study questionnaire, asking for their opinions regarding the current/standard camera interface on their phones. Participants were then given the phone, and the facilitator would instruct them to take a picture in a specific orientation (see the Design section below for further details). The order of tasks was counterbalanced through randomisation to ensure that no order effects influenced the results. The facilitator was present throughout the trials to clarify any concerns or questions.

After completing the tasks, participants were asked to complete a brief questionnaire within the application, which asked them to rate their satisfaction and comfort with the new interface. Participants were later asked a series of open-ended questions through a Google Form to better understand their perceptions of *AnyTap*.

The study took approximately 10-15 minutes per participant, and an additional 5-10 minutes to answer the open-ended questions.

Design

The study employed a 3 × 2 within-subjects design. There were two independent variables:

1. **Task Type:**
   - Taking a selfie
   - Taking a "group" selfie
   - Taking a photo of the room/landscape
2. **Image Orientation:**
   - Portrait
   - Landscape

These tasks were chosen to simulate a real-world environment and experience, thus improving the generalizability of our results. The order in which these tasks were completed was randomised to counterbalance any order or learning effects.

Our results are based on the following dependent variables that are collected through the application itself by a questionnaire given after a successful photo is taken:

1. **Comfort**: Self-reported comfort rating on a Likert scale (1-5)
2. **Satisfaction:** Self-reported Yes or No rating
3. **Location**: Coordinates of each tap recorded by the application.

The total number of trials for this study was 12 participants × 3 tasks × 2 orientations = 72 trials.

RESULTS AND DISCUSSION

Overall Results

Across the 72 trials, participants reported consistently high comfort ratings, with the vast majority of them ranking 4 or 5, the average comfort rating was approximately 4.53 out of 5. The satisfaction rate of the picture taken was also generally high, with 94% of trial pictures taken being rated as "Satisfying".

Tap Location

The default shutter button location on our test device (Google Pixel 6 Pro) is located at coordinates 720x2850 pixels. The average tap distance from the default shutter location was approximately 617 pixels, with the biggest tap clusters forming slightly higher and much more widespread on the screen. An outlier was present as one of the users used the phone upside down when they were handed it for a landscape test, but this did not affect the data in a major way. Each of the taps registered by the app is represented by a dot on the scatterplot in Figure 3.

To formally test this behaviour, we used ANOVA and Scheffe Post Hoc tests to confirm statistical correlation and significance. The within-subjects variable tested was the distance from the shutter button on the Google Pixel 6 Pro, specifically the x-axis distance, the y-axis distance and the combined distance. This was compared against three between-subjects factors: the participants, task type, that being which picture the participant was directed to take, and the orientation, whether the photo was taken in landscape or portrait.

The effect the participants had on the distance from the shutter button was statistically significant ($F_{11,60} = 2.265$, $p < .05$), which demonstrates that between each participant, the locations they tapped were far enough from the shutter button's location to be notable. The same can be said for the orientation of the phone when the participant was taking the photograph ($F_{1,70} = 5.868$, $p < .05$).

However, there is no statistical correlation between the type of photograph the participant was directed to take and the distance from the shutter button ($F_{2,69} = 0.853$, ns).

These results demonstrate that users do not change their tapping location in a significant matter based on the pictures they take when looked at individually, but in the scope of the bigger picture, or when the orientation of the phone is the focus, the distance between the place on the screen that was tapped and the shutter buttons location is significant enough of which to take note.

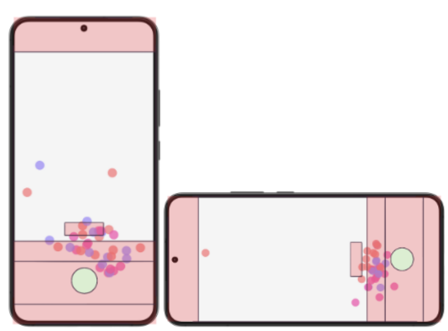

Figure 3. Scatterplots of taps registered in *AnyTap*.

Touch Target Implication

According to Android's Accessibility Design Guidelines[4], the minimum recommended target size is 48x48 dp, which translates to approximately 154x154 pixels on a Google Pixel 6 Pro's screen. That gives about 77 pixels away from the centre of the button. Given that the average tap was approximately 617 pixels away from the centre of the normal shutter button placement, which is about 8 times farther than this tolerance, it is evident that the users were actively engaging with the different parts of the screen rather than tapping within the normal shutter button placement.

CONCLUSION

Smartphones and their built-in cameras have advanced over the years. Specifically, we have seen significant development in the quality of images such that smartphone photography can rival digital photography typically done with cameras. However, in at least the last decade, the interface of the smartphone camera with which the user interacts has remained constant. With the growing dependency on smartphones and visual forms of social media, it is imperative that camera interfaces are usable and accessible. Our study has investigated the key issue with the camera interface, the fixed on-screen capture button. Through a user study with a custom application called *AnyTap*, we have found that users were generally satisfied and more comfortable taking pictures by tapping anywhere on their screen rather than a fixed shutter button. Additionally, we have discovered through scatterplots that, when the capture button is not visible, users typically tap around the general area of the shutter button but not on it exactly.

Future work should expand to test across multiple devices, include a more diverse demographic sample and consider the long-term usability through prolonged trials. Longer tests could also help evaluate the effect of flexible interfaces on accessibility, muscle fatigue, strain on the user and the learning curve of the application. Moreover additional features such as dynamic UI elements for different functions could be investigated. It is also essential to investigate how a dynamic interface will fare in comparison to a standard interface in terms of its efficiency, power consumption and system performance.

We believe that our findings can be applied to future research and development of the camera interface so that it is more accessible to the population. Our work highlights the need for innovation in mobile interface design, particularly for human-centred interfaces that adapt to real human behaviours rather than follow outdated legacy patterns.

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[4]https://developer.android.com/guide/topics/ui/accessibility/apps

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