A haptic handheld phone-camera for eyes-free interactions

Nigere Epps, Rachel Gagnon, Angela Liu
Prof. Pedro Lopes
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I. Final Prototype Implementation

Our final prototype is a slim fitting phone case (fit to iPhone 8+) that features a back dial to switch between 4 camera modes, a zoom slider, and toggle switches for turning on flash and video mode. Additionally, photos are taken with a spring-like button on the underside of the phone when it is held in landscape (like a typical camera).

Fig. 1. Participant holding final prototype with individual parts labeled.

A. Capture Photo Button

We created a push-down button to implement the capture photo action. This consisted of three separate parts: the lower outer ring which secures the spring, the upper ring to provide pressure on the spring, and the outer ring to hold both pieces together. The rings have been designed to fit a typical ballpoint pen's spring. When the parts are combined, the button moves with bounce feedback, emulating the action of pressing down on a camera shutter. It bounces back to its original position after being the finger pressure is released.

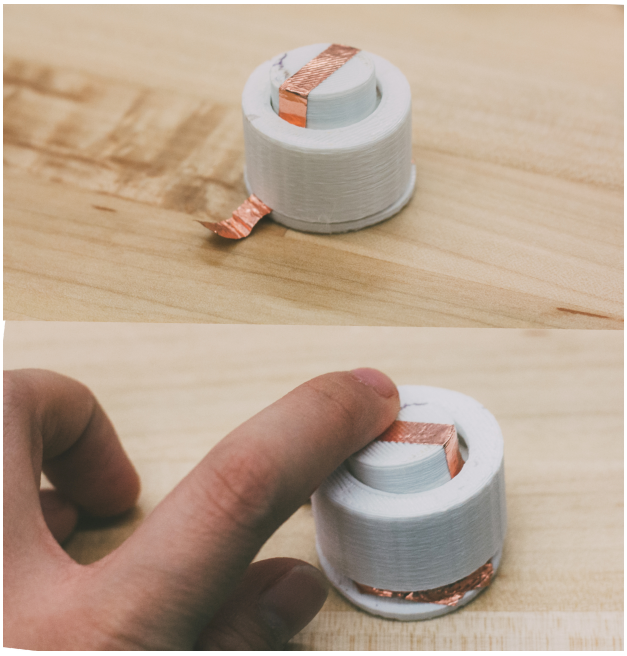

Fig. 2. Participant testing bounce feedback on final iteration's photo capture button with spring mechanism

B. Four Mode Dial Mechanism

Each of the four camera modes are represented on a dial on the back of the phone. A raised arrow indicates which mode the user is currently on as they spin. The modes are indicated with raised icons which can be easily recognized when users are aware of the shapes beforehand (Sun for Day Mode, moon for Night Mode, clock for Timer Mode, and gradient knobs for Custom Mode). As the user rotates the dial, the divots along the circumference tap the raised arrow, imitating a clicking feeling. This lets the user know ergonomically how much they have rotated the dial. The user can rotate the dial either clockwise or counterclockwise until their desired mode is chosen.

Above the dial is a selective We cover that blocks all but one of the modes so it is easier for the user to tell which setting they're on in without the arrow or clicking. The cover is opened in a way that enables the user to still turn and grip the dial.

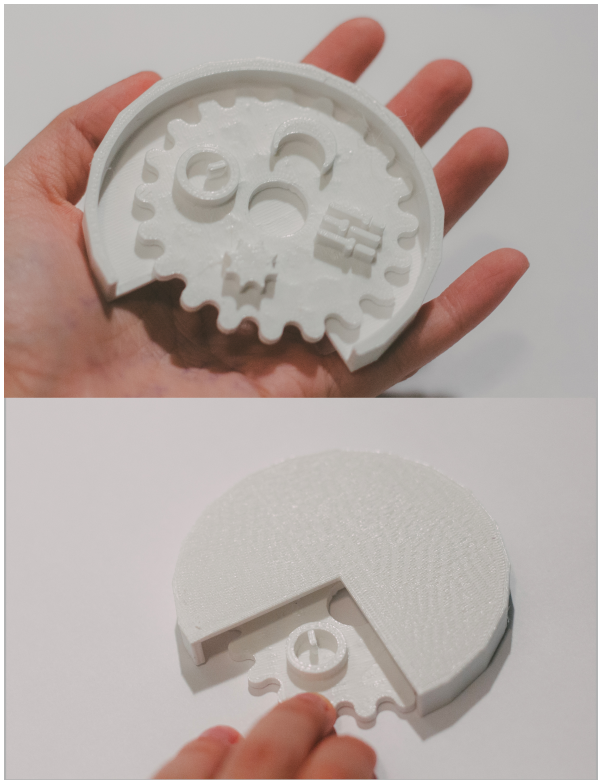

Fig. 3. Participant testing out final iteration's four modes dial with selective cover

C. Zoom Slider

To zoom in and out on the camera, the participant slides a small knob across the side of the phone case. One end of the slider is marked with a + symbol to indicate a closer zoom, and the other with a - symbol, where the end point is a normal photo with no zoom. The slider features tick marks at the 25, 50, and 75 percent marks to communicate to the user how zoomed-in their current view is.

D. Toggle Switch

To represent camera settings that have binary states - either on or off, we used a toggle-like mechanism. We used this mechanism to represent the flash and video modes on our final implementation. The toggle switch consists of two parts

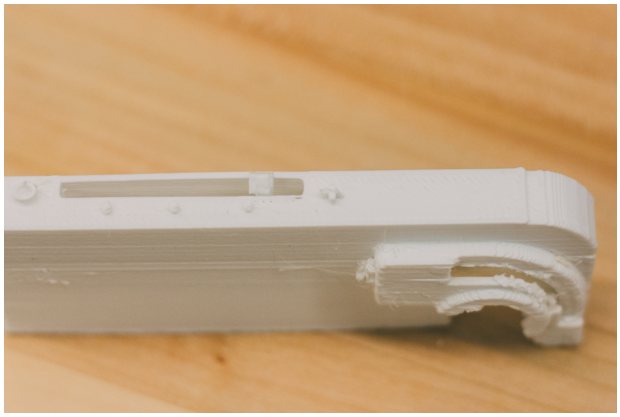

Fig. 4. Slider to adjust camera zoom, incremented every 25 percent zoom

– the outer frame and the sliding module. After assembling the toggle by inserting the slider in the frame, friction holds the piece together and enables the sliding motion. Sliding the toggle completely to the left (default) turns the function off, and sliding it completely to the right turns the function on.

Fig. 5. Final iteration toggle switch for flash and video modes

E. Photo Filter Holder

To allow for adding on separate lenses or colored filters, we appended a holder with a slit in

which photo filters can be inserted easily. With the camera comes three different filters, which we created using translucent, colored plastic - you can see an example of one of them below. Inserting a filter adds a colorful effect to the photo and is completely accessible hands-free.

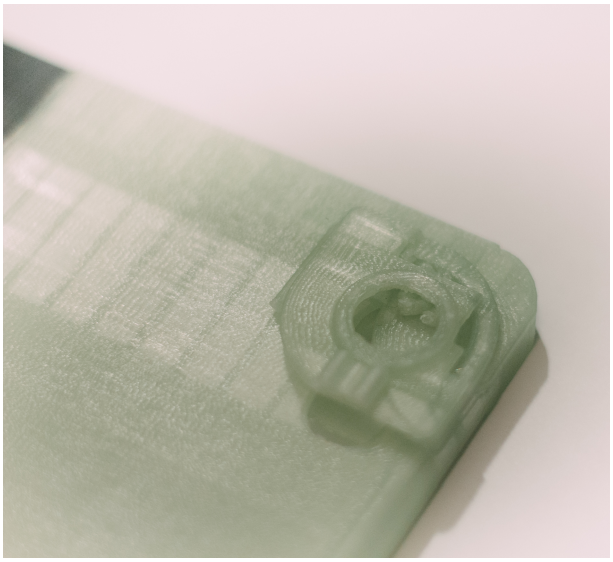

Fig. 6. Photo filters are inserted through the front of the back camera

II. Early Iterations

Before arriving at our final iteration, we made 3 attempts, along with several separate attempts for each phone feature as well.

A. Capture Photo Mechanism

Our first idea for the photo button was to utilize the built-in shutter (volume) button on the iPhone 8+, which is also capable of capturing photos, and just added an opening in the case where the volume button is, and appending a piece of plastic on top. This iteration, however, lacked haptic feedback, and led us to brainstorm new ideas for a press-able button. We then created a press-able button which had two components: the inside printed ”button” and outer container which produced friction as the button slid. Since this button lacked a spring mechanism, however, when we ran user studies, we found that participants missed the ”bounce-back” feeling they were accustomed to on other shutter buttons. In our next iteration, we integrated a spring to address this issue.

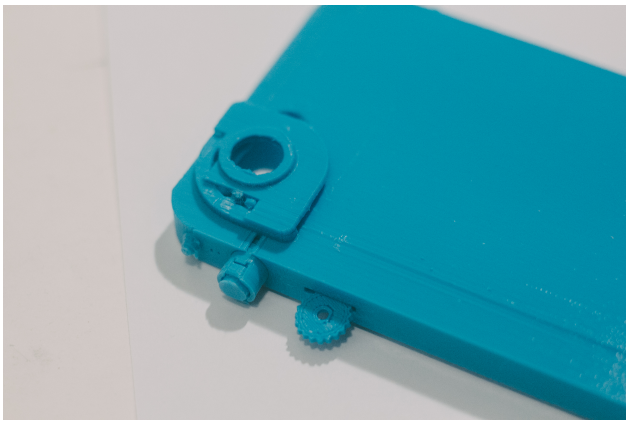

Fig. 7. First Iteration with Photo Capture Button and Zoom Mechanism

B. Four Mode Dial Mechanism

Our initial dial was quite similar to the current dial but was much smaller in comparison (about two centimeters in diameter). The dial was positioned on top of the camera, emulating the mode dial on a typical point-and-shoot camera. The icons were also different, both in symbol and in size. For example, the ”custom” mode was represented by a ’C’ symbol in the second dial (fig. 7), but we found that this could be easily confused for the ’C’ in the countdown mode or the copyright symbol. In order to make these icons more apparent to the touch and make the four modes mechanism a larger focus on the case, we opted to increase the dial size and move it from the side of the camera case to the back. This second dial (fig. 7), featured much larger icons (a sun, moon, letter C’, and timer) and was shifted to back of the case, in comparison to the first dial (fig 8). For our final iteration, we also added divots in the gear to emulate the clicking feeling of a typical settings dial when clicking into place for each setting.

C. Zoom Mechanism

The first zoom mechanism we designed was a dial embedded in the top of the phone near the photo button. However, this mechanism was difficult to control, as you couldn’t stop the dial at a specific point to indicate a specific zoom setting, and it fell out of the phone easily. To combat this, we changed our zoom dial to a slider along the side of the phone case. We appended a 0 and 1 symbol at either end to indicate how

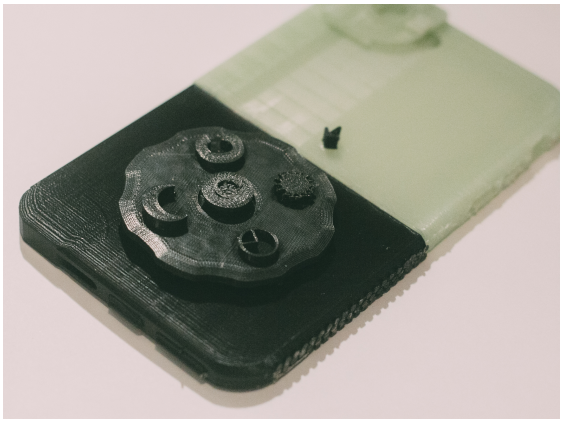

Fig. 8. Third Iteration Mode Dial

much zoom the user was applying, but in our final iteration, we modified the symbols to + and -, and added tick marks in increments of 25 percent, since percentages are more intuitive to use for sliders than probabilities.

Fig. 9. Second Iteration with Zoom Mechanism Slider, Capture Button, and Dial

D. Toggle Mechanism

To model the flash and video modes, we first tried using miniature press-able buttons, that would stay down when the setting is turned on and rise when turned off. However, without a spring mechanism in place (similar to one we eventually used for the capture-photo button), the rise motion would not occur naturally. Instead of implementing miniature spring buttons, we opted for a sliding toggle to combat this.

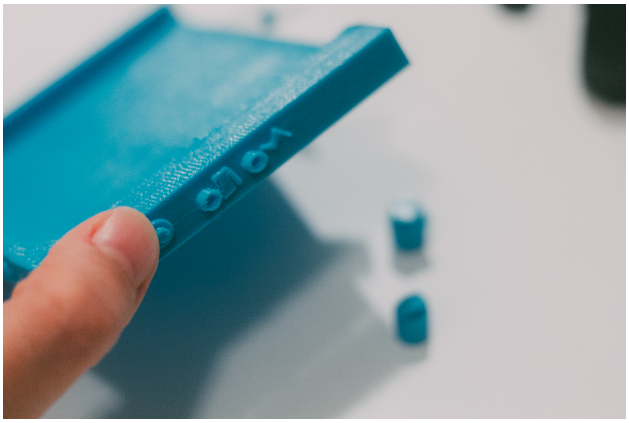

Fig. 10. First Iteration Flash and Video Buttons

III. Ergonomics

In order to make the camera versatile for many use cases, we positioned all key features on one side of the case, so as to be used with one hand if desired. This allows the user to comfortably use the camera in selfie-mode, as well as switch easily between portrait and landscape mode.

We also moved the camera shutter button to be closer to the mode dial, based on Fitts' law for positional placement.

IV. User Testing

Our process of user testing for each feature consisted of blindfolding the participant and asking them to complete the following tasks, explaining their thought process throughout.

- Take a photo with flash on Night Mode.
- Take a selfie-style video with timer enabled.
- Take a photo zoomed in 50 percent and on Custom Mode.

We did not conduct a formal user-testing procedure for our first two iterations, but rather tested them ourselves to make sure the mechanisms worked mechanically. For our third and fourth iterations, we ran the user study with four different volunteers, 2 males and 2 females, all aged in the range 19-21, and used their feedback to optimize our next iteration.

The most important factor to us was how intuitive to use our product was for participants. Participants in the study voiced that the dial in the third iteration was confusing because there was no

Fig. 11. User Test Involving Blindfolded Task Completion

haptic feedback as to how far the user had spun the dial. To fix this, we added the divots along the dial. They also voiced that the photo button was difficult to use while in video mode. We moved the location of the photo button in order to make this easier.

V. References

- iPhone 8+ base phone case: *https://www.thingiverse.com/thing:3187046*
- All other gears, buttons, etc. were created using Tinkercad templates (tinkercad.com)