Improving Smart-device Interactions for Elderly Through Augmented Reality

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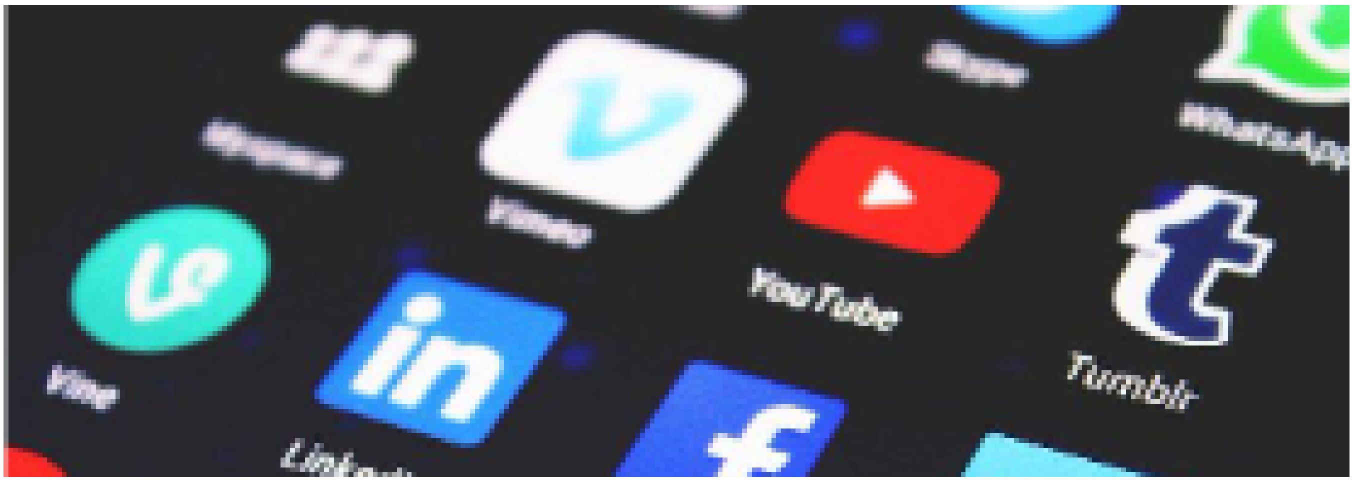

Figure 1: A modern touchscreen interface.

ABSTRACT

Nowadays, as smart touch screen devices become more and more ubiquitous in our everyday lives, many elderly users are being left behind. These users often struggle to use or learn these interactions due to decline in dexterity, reaction time, and cognitive abilities. For example, a user might want to press a small pause or exit button for a video playing on a phone, but miss it because their finger is not accurate enough to press the tiny area of the screen. Or, say there is a pop up or a story on social media that has a limited time to interact (it disappears after a few seconds), but the user can't react fast enough in order to use the interaction. As human computer interaction designers, it is paramount to consider the accessibility of new devices. Rather than focusing purely on creating more powerful devices with more functionalities, we must remember to ensure our technology is accessible to all users and not exclude a certain group like the elderly.

KEYWORDS

Human computer interaction, Augmented reality, Accessibility

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1 INTRODUCTION

1.1 Past Solutions

In a paper by Hoe et al. in 2017 [2], the authors utilize an augmented reality (AR) system to teach spatial visualization to elderly participants. They then measured the mean error rate and reaction time of participants before and after completing an AR lesson versus a 2D system. The results are shown in 2. Additionally, they found that participants participants understood 3D visualizations better and maintain focus more effectively. They tested users with a mental rotation task (MRT) in which they were asked to compare two 3D objects and describe if they are mirrored or identical in rotation.

In a paper by Tao et al. [1], the authors studied the effect of button size and shape on interaction performance. This study found that larger buttons had significantly lower error rates and faster completion time. Users were asked to type using a keypad system with various shapes and sizes of buttons, and the researchers compared the number of tokens completed as well as the speed of completion.

1.2 Challenges

The primary challenge for this problem is that we need to keep our solutions very simple. Elderly users often struggle with the general concept of touch screens, and in general struggle with

Group	Times test taken	Experimental		Control	
		(*n* = 11)		(*n* = 11)	
Mean error rate (%)		Pretest	Posttest	Pretest	Posttest
	1	53.33%	20.30%	47.88%	32.12%
	2	53.94%	20.61%	47.57%	32.42%
	3	51.51%	18.79%	48.79%	30.91%
	4	52.73%	18.49%	46.67%	30.61%
	5	54.24%	17.58%	46.67%	30.03%
	6	53.33%	17.88%	45.15%	32.12%
	7	50.61%	15.46%	43.64%	30.61%
	8	48.18%	13.03%	44.24%	30.00%
	Mean	52.23%	17.77%	46.33%	31.10%
Mean reaction time (s)		Pretest	Posttest	Pretest	Posttest
	1	16.56	10.68	16.93	11.21
	2	16.67	10.85	16.95	10.98
	3	16.21	11.00	17.67	11.50
	4	15.83	10.17	16.67	11.19
	5	16.45	11.01	16.56	10.96
	6	16.53	10.36	16.50	11.12
	7	16.07	10.51	17.12	11.23
	8	16.16	10.78	16.72	11.17
	Mean (SD)	16.31 (1.31)	10.67 (1.40)	16.89 (1.38)	11.17 (0.82)

Figure 2: Results from AR vs. 2D lesson.

complex fine motor tasks such as button presses. While the past methods showed great promise, the studies were not performed on elderly participants. Furthermore, each method on its own does not directly generalize to a touch screen application. The study on button size was done with actual physical buttons, and so it is uncertain whether the findings will apply to a touch screen. The smartphone has become an almost ubiquitous element of our modern society, and thus research on physical buttons might be out-dated (at least for small personal devices).

1.3 Approach and Rationale

My proposed solution is to combine the principles demonstrated by the aforementioned previous works. I aim to develop an AR wearable in the form of glasses or over-glasses attachments that sync with the users' phone screen to enlarge and "3D-ify" the 2D buttons on the screen. In doing so, we leverage the advantage of using AR techniques for learning spatial tasks from [2], and combine that with the benefit of larger buttons as shown in [1].

This will be implemented with traditional AR hardware such as glasses-like wearables, combined with a software solution to sync touchscreen buttons into the AR world. This could be done through actual communication between the phone and the glasses, or using computer vision (CV) techniques to identify buttons. These buttons will then be enlarged and turned into 3D objects within the AR system. However, some redirection techniques may have to be used to ensure users actually still touch the correct area in order to actuate the button on the phone. A rough sketch of the proposed device design is shown in **??**

1.4 Benefits

I hypothesize that we will be able to combine the advantages in interaction performance and ease of use offered by each approach into a single solution. The enlarged buttons are easier to press for elderly users with reduced dexterity and reaction time, while the 3D appearing buttons are easier to understand than a simple flat touchscreen.

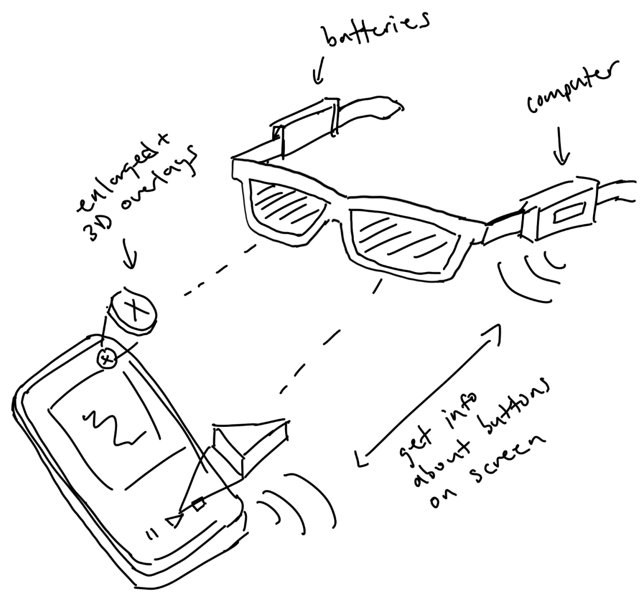

Figure 3: A sketch of the hardware and software details in the proposed solution.

2 POTENTIAL USER STUDY

2.1 Task

To test the effectiveness of our solution, we will ask users to complete a series of interaction tests using a modern smartphone. This will involve pressing various buttons (on the touch screen) that will appear at random times. This will involve creating a simple software that generates small interactive buttons at different locations on the screen.

2.2 Setup

To set up our experiment, we will ask the user to perform a baseline test. This will entail performing our test without any assistance or augmentation devices for a certain length of time. Next, we will ask them to perform the same duration of test (with randomized buttons) while wearing our AR glasses.

2.3 Measurement

To measure the performance of the user on our interaction test, we will measure their reaction time automatically using the software to calculate how long it takes for a button to be pressed once it appears on the screen. Furthermore, we will measure the accuracy of the user by counting the number of missed buttons. An important detail here is that to accurately measure precision we will only allow one screen press per button. i.e. the user cannot simply press the screen as fast as possible with multiple fingers in order to press as many buttons as possible.

2.4 Conditions

As mentioned before, we will compare the following conditions:

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Condition A: NO AR assistance
Condition B: WITH AR assistance
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3 CONCLUSION

By developing an AR tool to enhance elderly interactions with touch screen devices, we aim to ensure at-risk groups are not excluded by technological advancements. Especially in recent years, device design trends have overwhelmingly converged towards devices that are *smaller* while having *more functionalities*. This leads to smaller and smaller screens that require even *more complex interactions*...which is a nightmare for users who are suffering from decreasing dexterity and reaction times. Rather than designing an entirely new device geared towards elderly users, we feel that it is more desirable to instead make *existing* devices easier to use. This will improve accessibility without increasing costs or completely redesigning a device that already performs well. Users can make the most of devices they already own!

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