Evaluation of Textual Feedback for Incorrect Usage of an Augmented Reality Application

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March 7, 2020

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Abstract

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Introduction

In recent years the number of available Augmented Reality (AR) applications has increased. Although AR technology is no novelty, it was not widely available for society until a wide variety of smartphones were capable of running AR applications. Since most users are newly discovering AR technology, they don't know how to use its features yet, thus using unsupported gestures as input, which leads to frustration. Our main motivation for conducting this research is the lack of good feedback in case of incorrect usage, which could help a lot of users to avoid repeating common mistakes. Providing good feedback could also help teach users to control AR applications without the need of a separate introduction.

Our research goal is to provide appropriate feedback to unsupported gestures and decide what type of textual feedback is better in comparison to other types. For validation of our approach we conducted a usability case study.

The organization of the paper is as follows. The section Foundations gives information about usability in general and the AR environment we provide the feedback for. In the section Related Work we discuss similar work on AR and feedback done in the past. The Approach section gives a detailed illustration of the feedback we present to users. In the section Case Study, we talk about the setup case study we conducted in order to validate our approach, followed by our results and the discussion thereof. Lastly we present the Summary and Outlook.

Foundations

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Related Work

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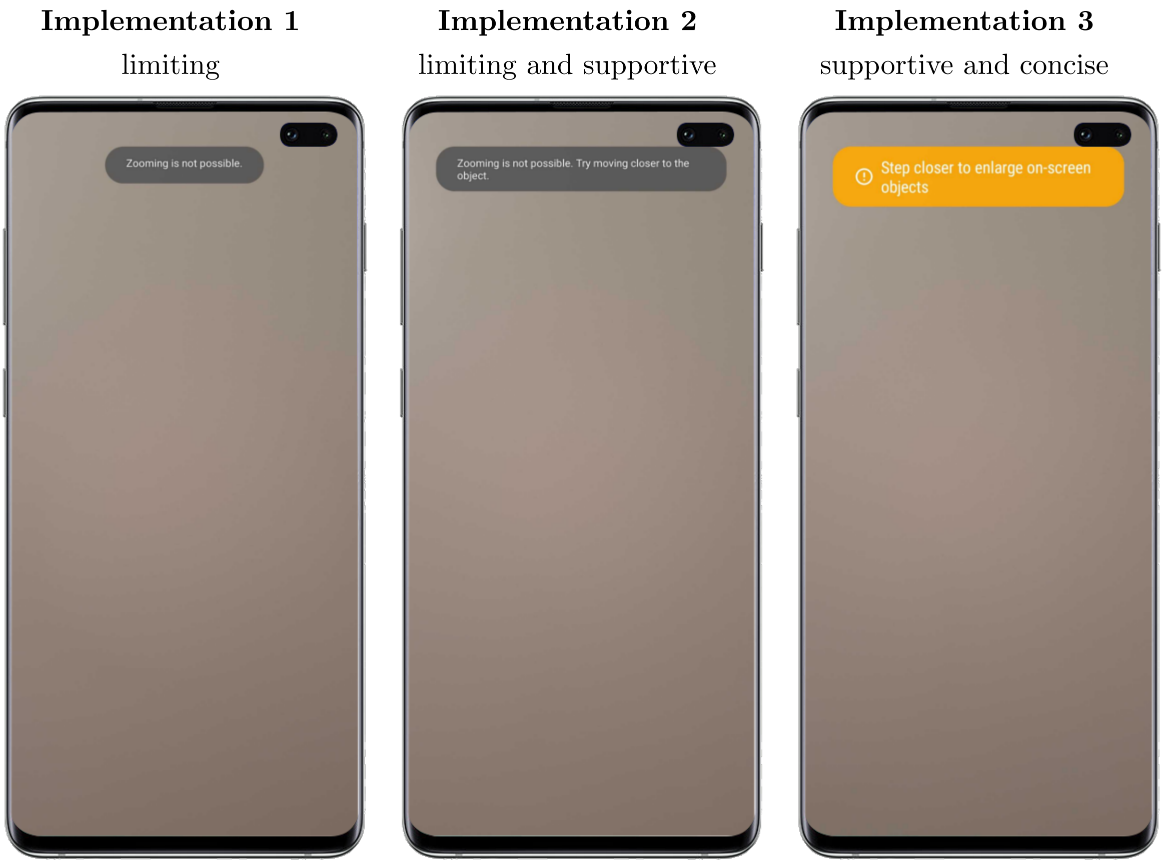
Approach

In order to find feedback in response to incorrect usage of an AR application, we have to define what kinds of gestures we consider incorrect in the first place. The user interface provided by the Vivian framework is based on one finger inputs (see Foundations), therefore we should take into consideration each input that is not done with a single finger. Prominent examples for multiple finger gestures are the *pinch zoom* and the *two finger rotation*. To move an object in Vivian-based apps, the user has to put his finger on the object, drag it, and let go of it in the desired spot. To cover greater distances, the user can move the device. Similarly, to rotate an object in Vivian, the user has to hold their finger on the object and rotate the device until they find the desired orientation. Common misconceptions by inexperienced AR users might include using said pinch zoom to either zoom in on objects or to bring them closer, or using two finger rotation to rotate objects.



Implementation 1
limiting

Zooming is not possible.

Implementation 2
limiting and supportive

Zooming is not possible. Try moving closer to the object.

Implementation 3
supportive and concise

Step closer to enlarge on-screen objects

Figure 1: The three different feedback messages in response to the example of pinch zooming.

To make users quickly and easily understand the controls of Vivian-based apps, we provide three sets of feedback message implementations that differ in content, colors, size and duration. The content of the first feedback implementation is *limiting*. If the user inputs a gesture that we consider incorrect, we provide him with a message that said input is not possible. For example, if a user tried pinch zooming, they would receive a message saying: "Pinch zooming is not possible”. The content of the second feedback implementation is *limiting* and *supporting.* The user is provided with a message stating that above mentioned input is not possible and hinting them towards what they should try instead. In the scope of the previous example, such a message would say: ”Pinch zooming is not possible. Try moving around the object.” In the first two implementations, the messages have the same size, color scheme and a duration of x seconds. The third implementation is *supporting* and more concise. For our previous example the exact message is saying: ”Step closer to enlarge on-screen objects.” It also differs in color scheme and size (see Figure 1). It is displayed for [X] seconds.

Imp.	Description	Gesture	Response
#1	limiting	two finger rotation	A
		pinch zoom	B
#2	supportive, limiting	two finger rotation	C
		pinch zoom	D
#3	supportive, concise	two finger rotation (rotatable object)	E
		two finger rotation (static object)	F
		pinch zoom	G

Table 1: The responses for each input in each implementation.

The contents of each message can be found in Table 1. Note that the third implementation recognizes two different kinds of two finger rotations.

Case Study

Setup of the Case Study

To evaluate the quality of our feedback implementations we conducted a case study in the domain of usability engineering. We used two different prototypes supported by the Vivian Framework (see Foundations). Both of them are quite simple kitchen devices: a toaster prototype and a microwave prototype (as seen in Figure 2).

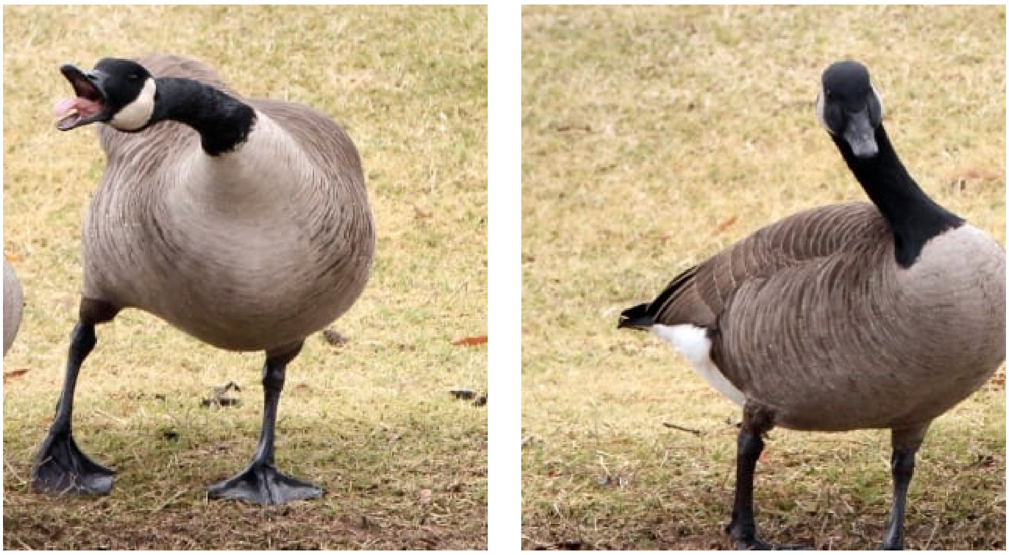


Figure 2: Augmented models of the microwave (left) and the toaster (right).

The microwave's functionality is limited to heating an object inside it with constant power. It has one button to add 10 seconds to the heating duration and one to open the door. The door can be closed by moving it. The status of the microwave is visually indicated by a small display showing the remaining heating time and a light inside the device, which turns on when it is open or heating. The toaster can toast one or two pieces of bread at a time. The toasting can be started by pulling down a handle and stopped by pushing it up again or by pressing the stop button, which is on the backside. Otherwise, the toasting stops automatically after a time which is defined by the position of a rotatable knob. The time mode is divided into 'low', 'medium' and 'high'. Further functionality is provided by the unfreezing mode, which can be activated by the snowflake button on the backside. The activation of the unfreezing mode results in a longer toasting duration and is indicated by a light above the button. The toasting process itself is displayed by the glowing of the heating elements. Both prototypes have a serial number on the backside. Both scenes contain different additional objects, which the user can interact with. These are pieces of bread for the toaster and for the microwave a cup which is already inside the microwave in the beginning and a piece of cake next to it.

#	Microwave	Toaster
1	Read serial number off the microwave	Read serial number off the toaster
2	Heat up the cup	Toast the toast
3	Remove the cup, put the pie in, set the timer to 20 seconds and remove the plate at 5 seconds	Toast the toast on high heat and put the toaster in unfreezing mode

Table 2: The tasks for the different prototypes.

Based on these functionalities we designed 3 tasks per prototype. As you can see on the concrete tasks in Table 2, they are increasing in complexity. An example of this increase is that task 2 of the microwave asks to heat the cup, which is already in the microwave, for any time. Therefore just the start button has to be pressed once to fulfill the task. Afterwards, task 3 is to replace the cup by the pie and heat for a specific time. This contains a lot more necessary steps: open the door, move the cup out, move the pie in, close the door, press the start button multiple times and finally also press the stop button after the desired time is over.

For the case study, we divided the participants into 4 groups. Each of these groups tested another version of the feedback implementation. Participants in group 0 got no feedback at all, in group 1 they got implementation 1, in group 2 implementation 2 and finally in group 3 implementation 3 (see Approach). We acquired 10 participants per group, so in total 40 people took part in the case study. Each participant was asked to fulfill the tasks for each prototype in the order provided in Table 2. One half of the participants were asked to do the tasks of the toaster prototype first, while the other half did the tasks for the microwave prototype first. We were able to evaluate subgroups with a certain implementation level and a certain order of prototypes they tested. Each of those subgroups contained 5 participants. In the following, the subgroups are named *TM*, which translates to "first toaster, then microwave" and *MT*, which translates to "first microwave then toaster", followed by the number of their feedback group. For example, a participant who was assigned the toaster first and then the microwave without any feedback was in the subgroup TM0.

Before the actual start of the test, we gave every participant a short introduction. This introduction contains information about the AR technology and reasons behind usability testing to prepare the participants and create a similar level of expectation. It deliberately does not contain any information about how to use the application or the scope of the case study. This is important so the participants are not biased about wrong usage and the feedback they would get. During the test, we used screen recordings to measure each participants use of the application. These enabled us to acquire completion times for the different tasks and count the number of wrong usages. We used a notepad to register further observations.

Following the test of the application the participants were asked to fill in a questionnaire. This questionnaire consists of 3 parts. First we asked participants if they have used AR applications before. The second part is an System Usability Scale (SUS) (see Foundations) about the usability of the AR application. The third part is an open question directly aimed to the feedback provided by the application, namely: "If you have any suggestions on what kind of feedback from the app you would find better, please let us know".

Summary and Outlook

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[3] AR AR

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