A Do-It-Yourself Device For And By Augmented Reality

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Abstract
Augmented Reality started to be widely mainstreamed among children, due to some interactive successes mainly in video games and social networks on mobile phones. Based on this interest, we present Carton, an open and complete solution suitable for children dedicated to the construction of an augmented reality headset device. The solution, inspired by the Do-It-Yourself and maker movement includes different components such as blueprints, tutorials, videos, mobile apps, a software development kit and a dedicated website. Among the mobile apps, we implemented one to guide the children in the construction process with augmented reality features to handheld devices. To validate our solution (in particular the blueprints, the construction process and the guiding app) and understand its effect on children in regard to their relation to technologies we conducted four construction sessions. We report in this paper the results of an evaluation among 57 children and teenagers (ages 8-16), showing a positive outcome about their own constructed device (all functional), their feelings and wishes regarding the augmented reality.

Author Keywords
Augmented Reality; AR; Construction; Children; Wearable; Technology; Do-It-Yourself; DIY.

Figure 1. An augmented reality viewer prototype made from a cereal box.

ACM Classification Keywords

H.5.2. User Interfaces – Prototyping; K.3. Computers and Education.

Introduction

Nowadays mobile phones are the main medium to experience augmented reality, mobile application such as video games and social media helped to make augmented reality widely available among the population. The main social networks added augmented reality face morphing features that are particularly used by the youth, allowing them to transform themselves into cats, unicorns or whatever offered by the platform. The potential of the augmented reality is not limited to those previous domains, for instance a lot of work has been done in education [8, 16], allowing students to interact and train their skill with an augmented reality book. Augmented reality for helping procedural tasks [4, 17] has also been subject to intensive research, consisting of adding contextual information during a specific process such as assembling. On the other hand, there is a proliferation of new hardware such as head-mounted display (HMD) [11] dedicated to augmented reality, allowing the user to have different kinds of experiences. Due to the expensiveness and form factors of these kinds of devices, they are less available. However some solutions offer an accessory to transform a mobile phone into an HMD.

Inspired by the newly wide interest of augmented reality, the reachability of new devices, the efficiency of augmented reality assembly and construction instructions and the potential of augmented reality to education, we created a complete and open solution to make an augmented reality headset (called "viewer" in the present paper).The solution resulted from one and a half year of incremental, iterative and participatory design process, including previous experiments, and discussions with users, professional educators and specialists of educational technology. The aim is to create a groundwork enjoyable and rewarding that have the potential to be expended and applied to other domains in science and technology.

A Constructing Augmented Reality Solution

The idea is to allow anyone and in particular children and teenagers to create an augmented reality headset device, called the viewer. To build the viewer, the solution includes a guided construction app on a handheld device that also implement augmented reality features. Thus, the solution intertwines the construction process and its result from an augmented reality perspective, allowing users to understand more deeply the impact and benefit of this kind of technology.

Components

The solution has many components, both hardware and software. The viewer is the tangible element of the solution, it is an augmented reality eyewear device (Figure 1) following a Do-It-Yourself approach currently in its second version. The viewer is made of simple materials with standard tools (Figure 2). The shapes from the blueprint presented in Figure 3 must be printed and paste to pieces of cardboard before being cut, folded and assembled all together to form the viewer. We use two kinds of cardboard, a few small parts are from regular one used to solidify the viewer, the rest and majority are made from thin cardboard such as cereal box. A couple of other materials complete the viewer, a sponge is placed between the viewer and the user’s forehead to make it more comfortable, a utility stretch straps through the viewer

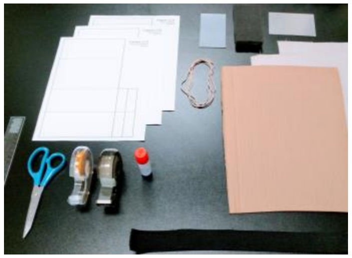

Figure 2. Materials and tools needed.

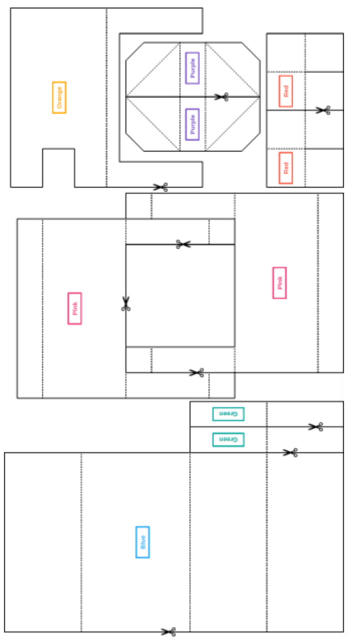

Figure 3. Blueprint of the viewer printable on regular paper format (US Letter/A4).

and around the head to hold it and allow hand-free interaction. Finally, a piece of mirror (not glass but thin plastic) is positioned at 45° to reflect the light of the mobile phone screen to the transparent plastic sheet (see Figure 4), this visual configuration is an illusion technique called Pepper's ghost effect.

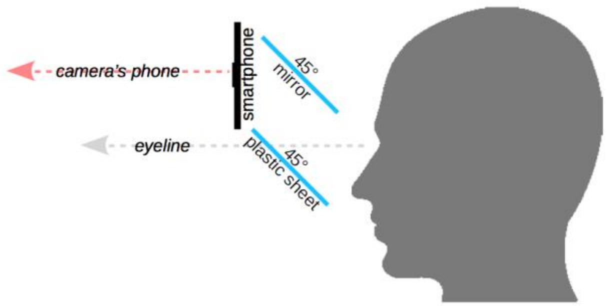

Figure 4. Pepper's ghost effect configuration for the viewer.

The guiding app (shown in Figure 5) is a mobile application dedicated to the construction of the viewer. The aim of this app is to provide instruction step by step supported by visual cues, an animation of a 3D model. As the user goes further into the different steps, the 3D model becomes more and more a complete virtual viewer. The animation at each step helps the user to understand how to fold each part and how to assemble them. The visual cue can be appreciated in two different ways: as simple and regular 3D models presented on the handheld device (phone/tablet) and could be rotated with a finger gesture (swipe left or right), or with an augmented reality experience by aiming at a specific image (QR Code). The augmented reality feature respect the real size of the material and thus allow the user to easily compare their own construction with a virtual one. Along with the visual cue, each step is composed of a number, a short instruction and sometimes another. Two buttons allow the user to navigate through the different steps.

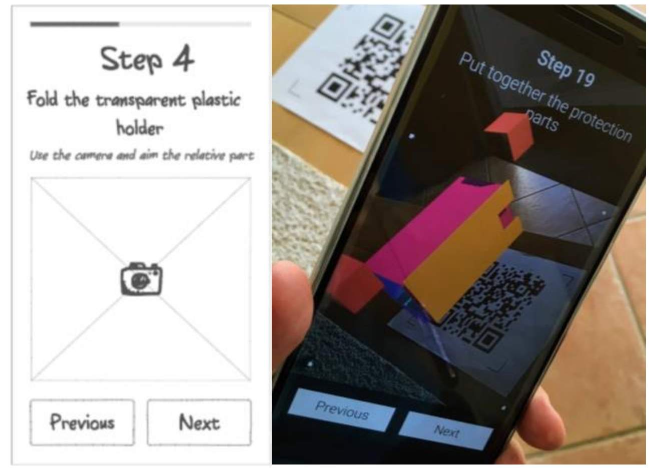

Figure 5. A mock-up and a picture of the guiding app step including augmented reality features.

Evaluation

We evaluate the solution and in particular the viewer and the guiding app first to assure the constructability, and second to understand the motivation and appreciation of the augmented reality technology with this solution among children. Hence we also compare their affinity between the different visual cue of the guiding app (augmented reality features or regular 3D models present on the screen of the handheld device). The study took place in a summer camp (2017) at a local school. We ran four different construction sessions and recruited a total of 57 children aged between 8 and 16 (M=11.7; SD=1.7). For each session, the

Figure 6. Construction of the viewer by children forming subgroups around tables (sharing tools).

participants were divided (by themselves) in subgroups of 3 to 4 individuals around tables (Figure 6). Each subgroup had to share some tools and a provided mobile phone with the guiding app already installed. However all the materials were individually provided for each participant allowing them to create their own viewer. Beside some tracking from the guiding app, they were told to answer a post-experiment questionnaire.

Results

Results come from the questionnaire, our observations and also from the logs of the guiding app. Most of the participant, 94.8% had a pleasure to use the construction guided app. However, 5.2% did not have enough pleasure (explicit reasons unknown). The design, interaction and contents of the guiding app were all individually scored at 4.0/5 on average (*SD*=1.1). The satisfaction of their own construction scored on average at 3.8/5 (*SD*=1.0) and 91.2% were proud to use a device they constructed themselves. Half of the participants had no preferences between the augmented reality over the non-augmented reality visual cue presented in the guiding app. Then, a quarter preferred the augmented reality visual cue and the last quarter the non-augmented reality visual cue. A majority of the participant, 75.4% answered that they would appreciate using this kind of guiding app also to other construction projects. Even, 63.2% would also like to have an augmented reality course with academic oriented content such as history, geography, physics, chemistry, mathematics and literature. More of them, 84.2% would appreciate having a similar simple guiding app with instruction about a specific course as a support to be used at home or in the classroom.

Conclusion

In this work we presented a solution for constructing an augmented reality device with the help of the augmented reality itself. We reported on the design, development and evaluation of the solution among 57 children, aged 8 to 16 years. We found that children greatly appreciated construct their own device and liked to follow the construction guiding app allowing them to enjoy and actively be engaged with the augmented reality technology. In addition to providing the solution available and open to anyone, we believe our results to be interesting for the teachers, educators, designers and researchers that want to integrate this kind of solution into the classroom or at home to introduce augmented reality or even go further into new domains through the construction of an augmented reality device for children.

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