Make Your Own HCI!

Annika Geurtsen
LIACS, Leiden University
Niels Bohrweg 1, Leiden
a.geurtsen@umail.leidenuniv.nl

Bobbie Smulders
LIACS, Leiden University
Niels Bohrweg 1, Leiden
b.smulders@umail.leidenuniv.nl

ABSTRACT

This paper describes and discusses an explorative research into the design and functionality of a game controller that can be built entirely from paper and without the use of electronic components.

Author Keywords

Analog controller; User satisfaction; AR interaction.

ACM Classification Keywords

H.5.2: Information Interfaces and Presentation (e.g., HCI): User Interfaces

INTRODUCTION

This project aims to provide a starting point for exploring the designing and building of hardware (in this case a game con- troller) without using electronic components. This paper dis- cusses a game controller free of electronic components and existing entirely out of paper, that can be placed on a plat- form in order for users to play games. The idea originated from a discussion on the seemingly high threshold building custom hardware (containing electronic components) poses on non-technical people interested (people that we were familiar with) in building and using custom hardware.

Even though platforms exist that encourage people to start working with hardware, like Arduino [1], Dwengo [3], and Phidgets [6], these platforms are still using electronic components, thus requiring the user to possess a certain amount of knowledge about electronics before being able to build their own custom hardware. The aim of the paper game controller is to enable non-technical users to quickly design and build a functioning piece of hardware (a controller) without the need of prior knowledge on electronics and thus lowering the threshold for non-technical people to start building their own hardware [5].

THE WORKINGS OF THE PAPER GAME CONTROLLER

The game controller described in this paper is made out of

paper and free of electronic components, enabled by the use of AR markers (Figure 1). The controller consists of a paper box the size of a shoebox (but it could have any size) that can be mounted with 3 different types of buttons: a turning knob, a toggle switch and a slider (Figure 2 & Figure 3).

Note that these buttons are just options for buttons. In theory any type of button can be created as long as the software is able to recognize a distinct motion.
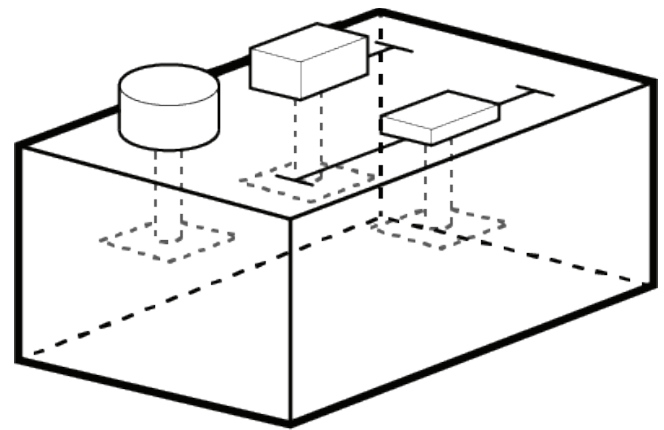
Figure 1. The paper game controller existing of a (shoe sized) box that is mounted with 3 types of buttons (turning knob, toggle switch and slider). Each button type can appear more often on the game controller or not at all depending on the wishes of the user.
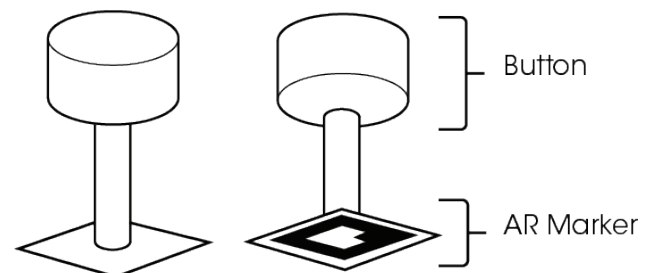
Figure 2. Anatomy of the button

Each button is provided with an AR marker that in turn is registered by a webcam connected to a computer that runs custom code in Processing (Figure 5). The button is recognized by the system through motion of the AR marker: the turning knob button has to turn, the toggle switch has to slide between a distance of 2 to 3 cm and the slider has to slide between a distance of 4 or larger.

The AR marker is placed facing downward so that a webcam can be placed below the controller. In doing so, the user can use and manipulate the buttons without obstructing the view of the AR markers for the webcam.

The webcam is installed inside a pedestal to create distance between the webcam and the AR markers. This is done in

order for the webcam to read the AR markers more precisely. Furthermore a light is installed next to the webcam to allow for more contrast between the black and white of the AR markers resulting in more precise vision of the webcam (Figure 5).
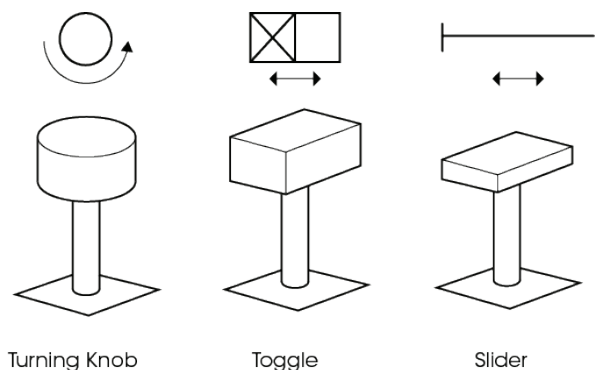

Turning Knob   Toggle   Slider
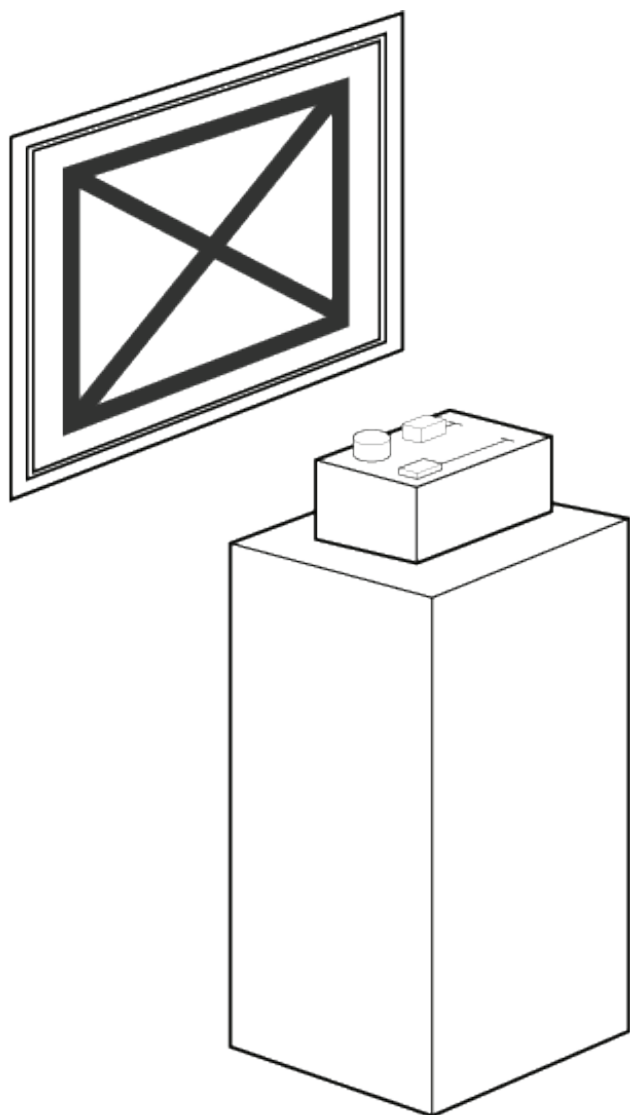
Figure 3. Types of buttons

Figure 4. Set up of the game controller for gaming. The paper game con- troller is placed upon a pedestal and the user will use the game controller to control a game on the screen

The game that can be played in this case is a game created specifically for the paper game controller. The game uses a two-dimensional physics engine that can be controlled by the three types of buttons. The game screen is filled with balls.
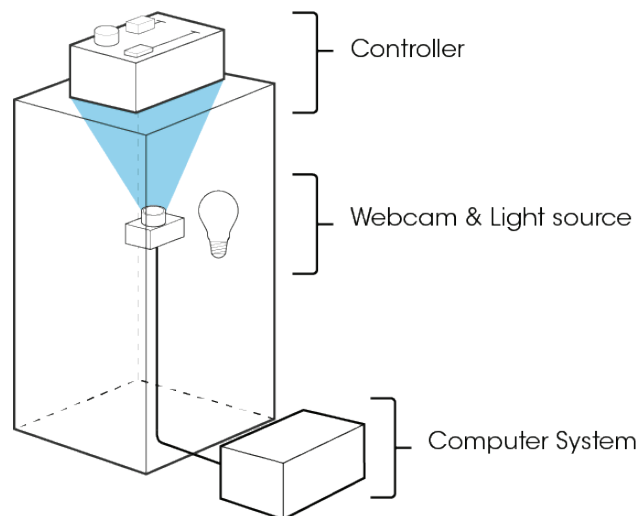

Figure 5. Set up of the paper game controller with the webcam (aided by a light source) that reads the AR markers, and a computer system that interprets the button types

A slider button can be used to control the overall gravity (be- tween non-existent and earth-like), a turning knob can create a local gravity field at the location of the knob and a toggle switch can switch all turning knobs from attracting the balls to repulsing the balls.

DISCUSSION — KEY CHALLENGES

The choice of material for the game controller is paper, due to its flexibility (it can be folded, cut and pasted) and the familiarity of users with the manipulation (e.g. cutting) of this medium. Unlike metal or plastics, paper is a medium that is easy to manipulate in a home environment without the need of special skills (e.g. metalworking). One of its disadvantages is that the possibility of the paper controller breaking down (e.g. due to rough handling) is larger than when the game controller would have been made out of wood or plastics. On the other hand building a controller using paper requires less time and skill in comparison to building a controller made out of wood. The scope of this project is to enable users to quickly and easily build their own game controller, not to create a lasting controller. Therefor paper as a medium to build the game controller suits this project better than wood, metal or plastics.

The main challenge presented by the paper game controller is the absence of electronic components in the game controller itself. This means that a standard, direct communication between the game controller and a computer system that controls the game is not possible and that an indirect means of communication between both systems must be set up.

Various platforms exist that enable communication between the analog game controller and the computer system on which the game is played. Kinect [4] states that nothing else but you should be the controller. A motion sensor registers the users movements and creates a digital skeleton based on

distance measurements. Even though this is a very nice method for creating a controller without any electronic parts (stating that the user is the controller and that the sensor, though part of the communication to the computer system, is not), it does not allow the user to build his own custom hardware.

An example of natural feature tracking as a way of creating an analog controller is SketchSynth [7] in which a user can draw figures on paper and by doing so creates functioning buttons that can be used to perform tasks. Once drawn, the controller sends Open Sound Control messages to a synthesizer running in Pure Data. Even though both projects emphasize the ease of interaction (through drawing in SketchSynth and using paper to build the analog game controller), the paper game controller differs from SketchSynth in the sense that rather then having buttons drawn on a 2 dimensional surface, it is a 3 dimensional controller that needs to be built. In our opinion the paper game controller approximates the concept of building hardware more than the SketchSynth, because in the Sketch-Synth project a controller is being drawn and not really being built.

The reason for using AR markers is that they can be printed or (if necessary) even drawn on paper, without the drawing itself becoming the button. A webcam detects the AR markers and feeds the information to the program. This makes the AR marker completely free of electrical or digital components and easy to make. Also AR markers are simple in use, since they just need to be cut and pasted on the bottom of a button.

Another project venturing into simplifying the use of hardware is d.tools.[2] It is a hardware and software system that was built to support design thinking rather than implementation tinkering. The set up of electronic components (physical controllers, sensors and output devices) is simplified. In this sense d.tools shares an identical aim as the paper game controller. However it does make use of (simplified) electronic components, whereas the paper game controller tries to eliminate electronic components in the game controller all together. Next to that d.tools aims to create a platform for rapid prototyping of devices, so that designers can experiment and monitor physical user interfaces, whereas the paper game controller is aimed at a broader audience, focussing on the building of a game controller.

A project closer to the paper game controller is VoodooIO [8]. It is a physical interface consisting of a flexible sheet that allows for buttons to be aggregated and organized into it. VoodooIO is similar to the paper controller in that the intention of the project is to overcome the obstacles that prevent hardware interfaces from being easily appropriable. Also it uses a modular system to distribute buttons (or

atomic units of control). However this project uses direct communication between the computer and the controller.

FUTURE WORK

Possible future work for the paper game controller include the design of different forms of boxes for the body of the paper game controller. This project focussed on using a box similar to a shoebox, but the body of the controller does not have to be limited to the shape of a shoebox. In fact a different shape of body might allow for different functionalities. The only restriction that is to be applied is that the webcam has clear vision on the AR markers.

A similar concept accounts for the design and functionality of buttons. In this paper three types of buttons are discussed: the turning knob, the toggle switch and the slider. This leaves room for investigation of other types of buttons, for instance pressing buttons.

Also the type of game could be investigated. Existing games could be implemented, so that users can play these games with their own custom build controller or games could be de- signed to specifically fit the paper game controller software system. Aside from games, other types of systems could be explored, such as rapid prototyping interfaces.

REFERENCES

1. Arduino – homepage. http://www.arduino.cc/

2. HCI at stanford university – d.tools: Enabling rapid prototyping for physical interaction design, 2006. http://hci.stanford.edu/research/dtools/

3. Dwengo: gets you started with micro controllers. http://www.dwengo.org

4. Xbox – kinect overzicht. http://www.xbox.com/nl-NL/kinect .

5. Korukonda, A. Personality, individual characteristics, and predisposition to technophobia: some answers, questions, and points to ponder about. Information Sciences 170 (2005), 309 – 328.

6. Phidgets inc. - unique and easy to use usb interfaces. http://phidgets.com .

7. SketchSynth drawable user interface by Billy Keyes. http://www.creativeapplications.net/openframeworks/ sketchsynth-drawable-user-interface-by-billy-keyes/

8. Lancaster university computing department – voodooIO: Pin & play interface architecture. http://hci.stanford.edu/research/dtools/