

# Digital sponge art

Project report

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## Abstract

The idea of this project is to use the characteristics of an ordinary sponge to create drawings on touchscreen devices. The sponge can be squeezed to create thinner or thicker brushes. Additionally, different colored sides of the sponge for instance are used to map different tools (e.g. brush and eraser tool). With this technique, the general workflow should be fastened. The project itself was realized by implementing an Android app with Processing on a tablet with a capacitive touchscreen and developing a sponge recognition program written in Python. The actual recognition was done with a laptop webcam. The exchange of data between those two apps was done by implementing UDP sockets which require both devices to be connected to the internet.

## Motivation

Due to the clumsiness of the mouse, many people who sketch or draw digitally with 2D image manipulation programs such as Photoshop often use a drawing tablet to better control the brush tool. In this work, a new interaction technique is proposed where one can control brushes with a sponge. The material of a sponge is usually very lightweight and easily moldable. These characteristics can be used to create thick brush lines without needing to adjust the size every time. Some use cases of thick brush lines include painting landscapes. Additionally, due to the softness of the sponge the opacity can be easily adjusted as well. The aim of this work is to find out whether using a sponge for digital drawings can be a good alternative to the usual drawing tablet pen in terms of efficiency, fun factor and usefulness in some specific use cases (e.g. painting landscapes).

## Related work

The main inspiration of the idea are the drawing tablet devices. These tools improve the workflow of drawing digitally immensely as it simulates drawing traditionally with pen and paper. With sponges, a new tool next to the pen is introduced which should immerse the painting experience by extending the number of tools a digital painter has like a traditional painter with their arsenal of different pencils and brushes.

Researchers Blagojevic et al.<sup>1</sup> have developed an innovative system where tangibles such as a ruler can be used to aid the user in drawing geometric shapes. Evaluation shows that this tool is useful to easily create simple forms.

Our project also aims to help the user to ease their workflow. In contrast to the referenced work, the sponge is not restricted to specific forms (e.g. straight line when using a ruler) but its shape can be modified to meet the users' needs.

## Concept

The core components of this project are the usage of a sponge as a drawing tool and a touchscreen surface as canvas which will be explained later in greater detail.

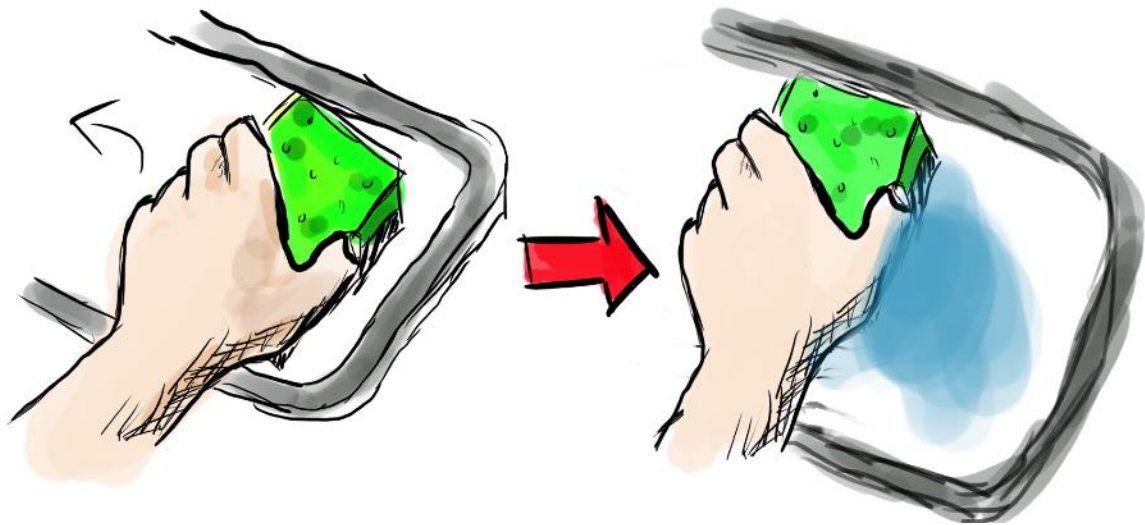
First, all interaction scenarios with the sponge are described in the following section.

## Interaction scenarios

All interactions are based on the shape and moldable material of the sponge. For example, the large area of the sponge can be used to create large brushes. The picture below illustrates the interaction.

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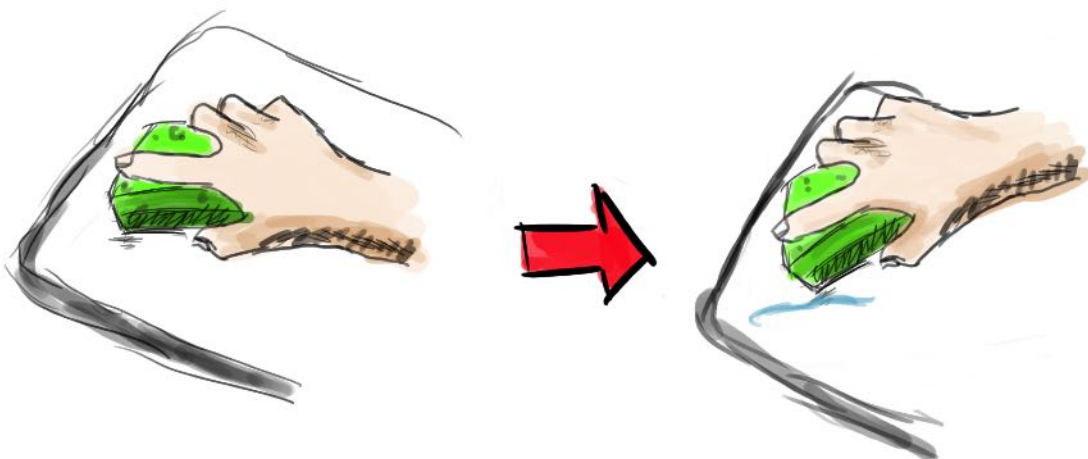
<sup>1</sup> Rachel Blagojevic, Xiliang Chen and Ryan Tan et al. Using Tangible Drawing Tools on a Capacitive Multi-touch Display. DOI: 10.14236/ewic/HCI2012.44



Concept: large brush tool

Besides the obvious interaction where one can just press the whole sponge on the touchscreen, it is also possible to squeeze the sponge in half which creates two touch points. With this technique, it can be possible to draw thick parallel lines at the same time.

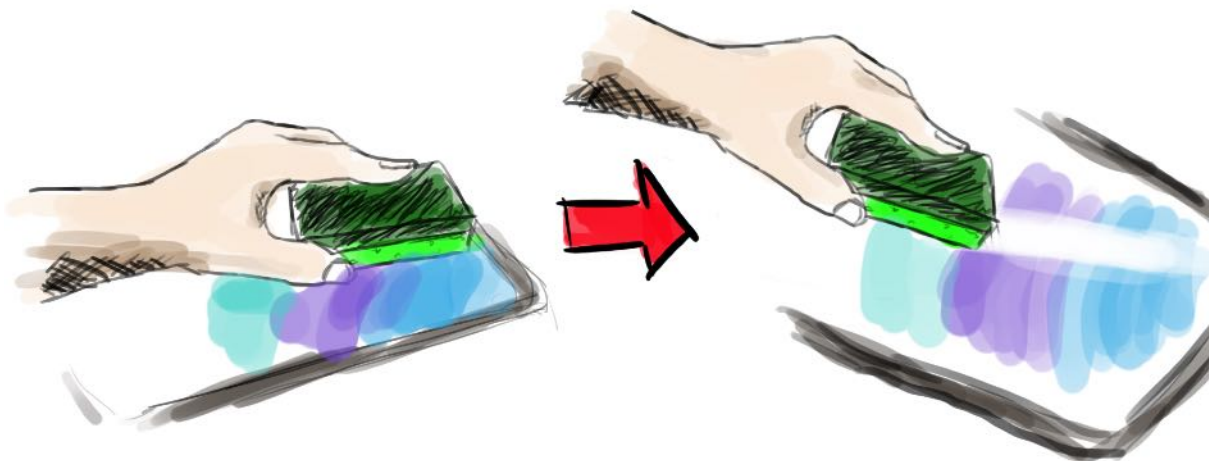
With the sponge, thinner lines can also be drawn. The edges of the sponge can be used to create fine lines. This is useful for sketching or painting smaller areas of the canvas. See the sketch below for a visual demonstration of this interaction.



Concept: thin lines tool

Not only can we use the shape of the sponge to create interactions, but also the color of it. A normal sponge for dishwashing usually has differently colored sides. With this characteristic, the different sides can be mapped to different interactions. For example, the brighter side can be mapped to the brush tool while the darker side may be mapped to the eraser tool.

The illustration below shows how the erasing interaction looks like. Here, the brighter side is mapped to the eraser tool.



Concept: erasing tool

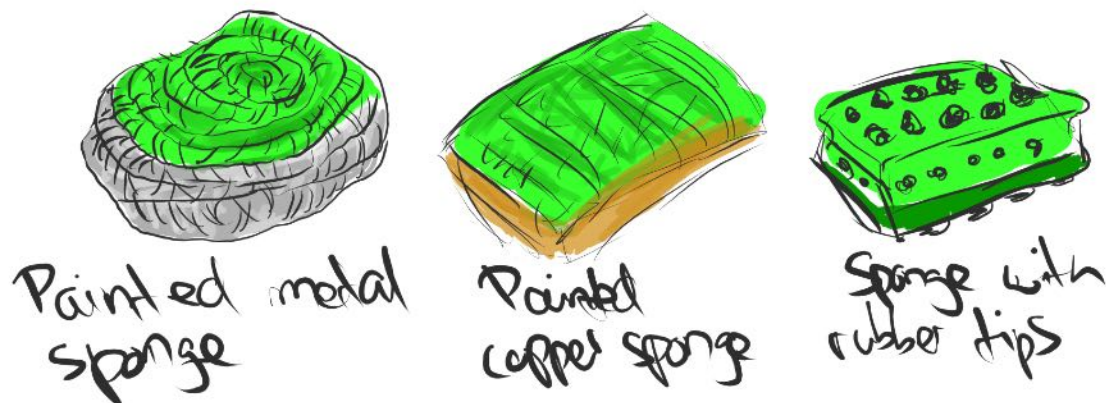
For all interactions, a sponge is needed which also needs to work on touchscreens. In the following section, the conceptual sponge design will be explained in greater detail.

## **Sponge design**

Usually, modern touch screens are capacitive. This means that in order to register touches, the material must be made of a conductive material. Some obvious objects are for example metal objects but also rubber.

In the early stage of this project, some experiments with different materials were made. Metal sponges and even ordinary sponges were tested carefully on touch screens. The first approach was to use a painted metal sponge. This idea however was scrapped due to the fact that it could damage the touch screen even if it would be wrapped in foil. After that, we tried to test the third approach where the rubber tips are glued on the sponge. The sketch below shows all conceptual sponge variants made for this project.

## Sponge Variants



Concept: sponge variants

During the extensive testing of different sponges on touch screens, we randomly found out that a particular sponge type was working on any capacitive touch screen. The material is not quite known because it is not stated on the sponge package, but we assume that it could be cellulose.

With these insights, a modified sponge was created where the upper and lower side is covered with smaller bits of a cut out sponge. This is necessary to ensure that multitouch interactions work.

See picture on the right for the modified sponge.

For the sponge interactions, we need two programs (drawing, object detection) that will be described further in the next section.

## **App design**

The sponge interaction requires a touch screen which registers the touches. For that, we developed an Android app with Processing/Java as the programming language. The actual program was running on an Android tablet.

The app includes some basic features such as drawing on the canvas with different colors. On top of that, the drawing can be cleared or parts of it can be erased with the eraser tool.



In order for the eraser tool to work, we implemented an additional program written in Python which recognizes the different sides of the sponge based on color. Every time when another side is recognized, the Android app needs to be informed of it. This exchange of information was implemented with sockets and the usage of the UDP network protocol. For further details, please refer to chapter “Implementation”.

## **Technical limitations**

The tablet used for this project had some technical limitations which forced us to restructure the implementation. For example, the touch pressure was not fine granular. Because of this, a workaround was implemented to differentiate the number of touches. A single touch creates a fine line with full



opacity, while multiple touches create large brushes with adjustable opacity.

The next chapter describes how all components work together.

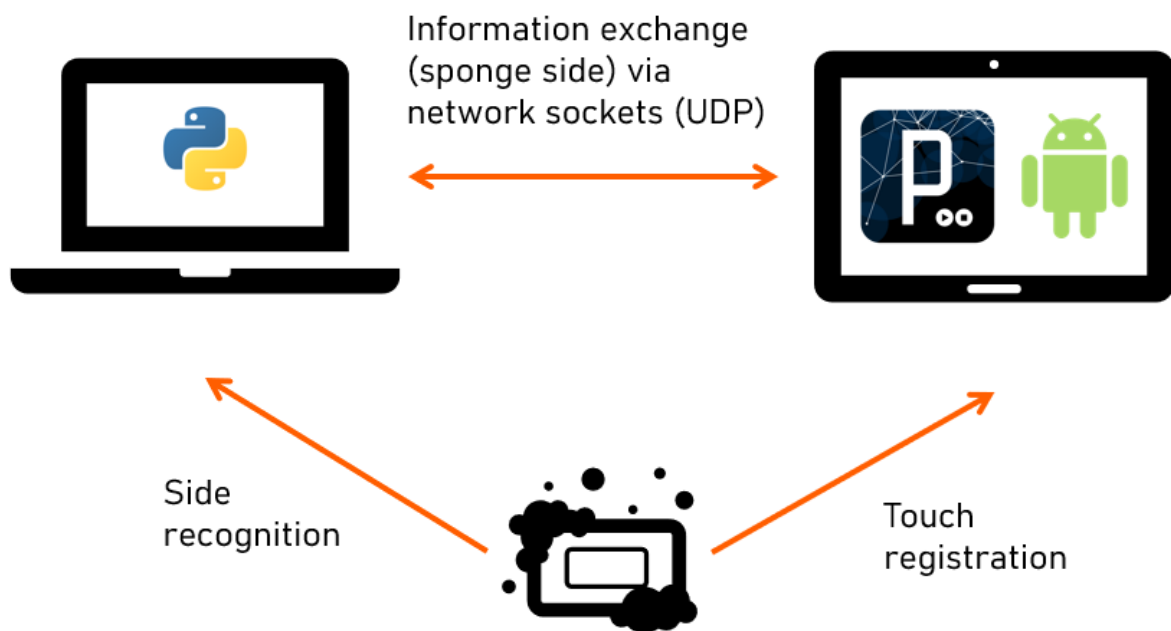
## Implementation

The Android app which runs on the tablet acts as the canvas for the user to draw with the sponge. As already mentioned in the previous chapter, the brush size depends on the number of touches on the tablet. In order to switch between the drawing modes (brush and eraser tool), the different sides of the sponge need to be recognized by the Python app.

This program is run on a different device (laptop with an integrated webcam), therefore it is necessary to implement a network connection between these components with the help of sockets.

Once the Python app registers a change of the recognized sponge side, it will send the information to the Android app so that the drawing mode is updated accordingly.

The illustration below shows how all components work together.



Interplay of all components

After the implementation, the next step was to test the usability of this project. This topic will be explained further in the following section.

## Evaluation

For evaluation purposes, a user study was conducted which will be explained in the next section.

### User study

In order to test the usability of the prototype, a small user study was conducted with 4 people (3 male, 1 female) aged between 20-30 years. All participants did not have any experience with drawing tablets prior to this evaluation.

In total, two conditions were tested (sponge as a drawing tool vs. hand as a drawing tool) with several tasks. The users were asked to do each task with both conditions. To maintain persistency, they were also asked to always do the sponge condition first and then the hands condition.

The main goal of the user study is to find out whether the sponge can be used reliably as a tool to draw.

### Setup and preparation

For the user study, a laptop with a webcam and a tablet (Samsung Galaxy Tab S3) was used. The actual drawing program was running on the tablet, while the tool recognition was done with the webcam of the laptop.



All tasks and questions were presented in Google Forms.

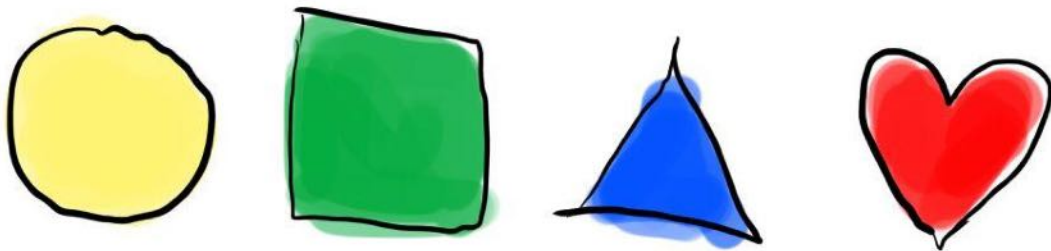
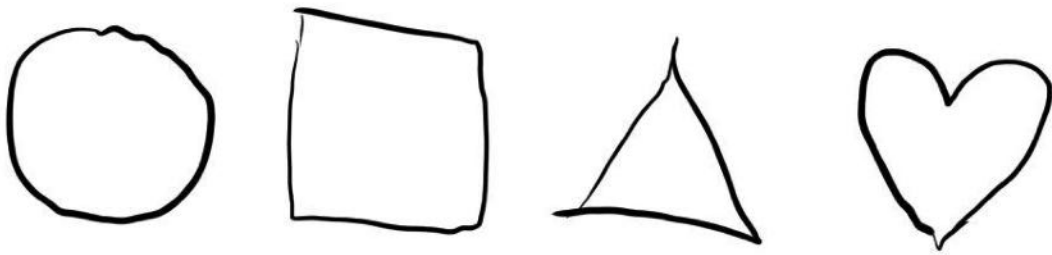
### Tasks

The tasks were designed in a way to test every aspect one could do with a drawing sponge.

1. Draw the outlines of four shapes (circle, square, triangle, heart) in black and fill them with different colors.
2. Draw two parallel lines. (thin and thick)
3. Fill the whole canvas with three different colors.

Below you can find a visual representation of task 1:

Task 1:



### Questionnaire

At the end of the study, the participants were asked several questions about their overall experience with the prototype. The questions were weighted on a scale of 1 (strongly disagree) -7. (strongly agree)

The questionnaire also included a set of questions where the user was asked whether the drawing sponge performed better (in some situations) than hands.

1. Generally, it was fun for me to draw with the sponge.
2. Drawing with the sponge was intuitive for me.
3. It was quite easy for me to color large areas in the canvas with the sponge.
4. It was easier for me to color large areas with the sponge than with my hands.
5. It was quite easy for me to draw thin lines with the sponge.
6. It was easier for me to draw thin lines with the sponge than with my hands.

7. The eraser tool of the sponge was easy to use.

Besides the specific questions, the users could also give open feedback to the prototype.

- Tell us what you liked most about the drawing sponge.
- Tell us what you disliked the most about the drawing sponge.
- Tell us what you think about how the drawing sponge could be improved.

## Results

	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6	Question 7
Person 1	6	5	6	5	4	4	7
Person 2	7	4	3	3	7	6	7
Person 3	6	4	4	5	3	2	6
Person 4	5	3	6	6	3	3	6
Mean	6	4	4.75	4.75	4.25	3.75	6.5

Table 1: Questionnaire Results

Table 1 shows all the answers to the compulsory questions, from which we can draw some conclusions. Participants indicated with a high score that drawing using a sponge was fun (mean rating: 6) but showed a neutral opinion on whether using the sponge was intuitive (mean rating: 4).

Using the sponge to draw large areas was approved by the participants (mean rating: 4.75), although one of them gave this question a 3, which was the discordant score. In addition, they indicated that they found it easier to draw such areas with the sponge than with their hand (mean rating: 4.75), although the participant mentioned above again rated this question with a 3, again being the lowest scorer on this question.

About whether the sponge was easy to use for drawing fine lines, participants were neutral (mean rating: 4.25), although the

response of the same user who was highlighted above is striking, in this case rating the ease of using the sponge for these cases with the highest score. In addition, they were also almost neutral (mean rating: 3.75) when asked if they found it easier to draw this type of lines with the sponge than with their hand, in this question was obtained the worst score, 2, by a different participant to the one highlighted above.

The participants indicated that they found it very easy to use the sponge as an eraser, obtaining the best average of all the questions (mean rating: 6.5).

In the feedback section we received several opinions. The ease of the eraser tool and the ease of drawing large areas were the most notable. In terms of what they liked least, they highlighted the sometimes poor performance of the touch detection and the need for dexterity to draw large areas. The participants recommended us to look for a better design for the sponge and to make it easier to draw large areas.

After analyzing these results, we can say that our prototype has potential, although it should be further developed to improve certain aspects. It also shows that the sponge could be used as a new drawing tool.

Below is a screenshot of all open feedback received from the participants during the user study.

## Open feedback

Tell us what you liked the most about the drawing sponge.

3 Antworten

Mostly intuitive

The ease of drawing large areas

- Creative idea
- Easy erasing

Tell us what you disliked the most about the drawing sponge.

3 Antworten

You need practice to color large areas

It's difficult to make drawings with a lot of detail

- "Touch detection" not working correctly sometimes

Tell us what you think about how the drawing sponge could be improved.

2 Antworten

easier use for coloring large areas

The size of the sponge to fit better in your hand

## Conclusion

Based on the feedback of the user study, drawing with the sponge is a fun and innovative way to draw. However, the prototype is still expandable in terms of the overall touch detection as the controls are still clunky. To address these issues, more tablet models should be tested as some of them have more or less a better touch recognition. The tablet used for the prototype came with technical limitations as described in the

section “Concept - Technical limitations”. Additionally, there is still room to improve the sponge design in terms of placement/amount/material of the smaller bits glued to the sponge.

In the future, the prototype could be extended by adding more interactions. This may be done by making more use of the object recognition program. For example, the program would not only detect the different sides of the sponge but also the shape. With this technique, it could be possible to create stamp-like brushes with the sponge.

Furthermore, more tools like a color picker or paint bucket can be added. These tools can be recognized similarly to the current eraser mode tool.