User Manual

Tim Visée & Nathan Bakhuijzen

October 2018

1 Goal

The purpose of this manual is twofold:

- To inform research how to use the platform to execute experiments and conduct research
- To inform future developers how to continue developing the platform

1.1 Problem Definition

What physical motions are natural, effortless and easy, in order to control a computer or other digital device?

Questions of this nature can be answered using the *Can't Touch This* platform. *Can't Touch This* aims to be a platform for researchers that would like to conduct research in the field of touchless computer systems. We believe that our platform allows researchers to build a strong foundation for the future of touchless control. Giving researchers the opportunity to conduct research improves the chance for touchless control of computers only seen in futuristic movies and tv shows.

1.2 Motivation

At the start of the KB-80 minor, students were given a choice in the subject of the research. Mister Hani introduced us to a series of subjects, of which the LeapMotion project was the most interesting to us. The idea of the LeapMotion was to create or extend existing software to enable people to control a computer without touching any peripherals, like keyboards and mice.

1.3 Background information

Research in the field of touchless computer systems is motivated by the desire for these systems in sterile environments. For example, surgeons often make use of computer systems to aid them during their surgeries by providing crucial information such as CT, MRI and X-ray scans. This is where touchless computer systems come in. These systems allows surgeons on control a computer without the need for physical peripherals.

2 Installation Guide

2.1 Requirements

- A computer with the Windows (7+), OSX (10.7+, Lion+) or Linux (kernel 2.6.18+) operating system
- An installation of the LeapMotion SDK
- An installation of the Rust programming language
- The physical LeapMotion device itself

2.2 Software Dependencies

The *Can't Touch This* platform is written using the Rust programming language. This means that the operating system that the platform will run on must support the Rust language. Fortunately, Rust runs on all popular operating systems today, shown above in the list of requirements. An up-to-date list of all supported versions can be found on the Rust website. Additonally, the *Can't Touch This* platform requires the LeapMotion SDK to provide all necessary sensor data. Just like the Rust programming language, the LeapMotion SDK can be installed on all platforms.

2.3 External resources

Can't Touch This requires no addional resources to run the platform, other than the items listed above.

2.4 External development tools

Continuing development of the *Can't Touch This* platform requires basic tools like a text editor or IDE, and a terminal. It is highly recommended to use git, as this was used during development of the platform. Additionally, setting up an CI server may prove useful. Setting up an CI server is beyond the scope of this manual.

3 User Instructions

This chapter gives users instructions on how to use the *Can't Touch This* platform. It assumes that the user has followed the instructions found in the *Installation* chapter. The following instructions will detail how to setup the platform so that you can conduct the *experiments* found later in this manual.

3.1 Usage

- Attach the LeapMotion device using it's provided USB cable
- Start the LeapMotion tracking program provided by the LeapMotion SDK
- Start the *Can't Touch This* platform by running the provided executable program, or run it manually in a terminal (`cargo run`)
- Start up an web browser (Chrome, Firefox, Safari, etc) and navigate to `http://localhost:8000`
- Click on '*Start Recording*'
- Move your physical hand above the LeapMotion device to make a desired gesture
- Once you are done making the gesture, click on '*Stop Recording*'
- The recorded gesture you've just made should be visibly represented on the canvas
- Save the gesture by clicking on '*Save Recording*' and bind the gesture to a predefined action
- Click on '*Recognition Mode*' and make one of the gestures you've made beforehand
- The computer will give positive feedback if the gesture is recognized

4 Requirements

This chapter details the list of open and finished requirements of the *Can't Touch This* platform. The prioritization of this list is not according to the MoSCoW method. This is because this exclusive project required us to figure out what to do on the fly, rather than planning everything out beforehand.

Requirements that are satisfied:

- An Operating System independant platform
- A web interface for users
- A list of predefined gestures
- The ability to record and store new gestures
- The ability to use fingers of both hands in a gesture

By using the Rust programming language we inherently met the Operating System requirement. This saved us a lot of work and allowed us to focus on the platform's functionality. Similarly, we chose to use a web interface for the interaction between user and system. This also saved us a substantial workload.

Requirements that are still open:

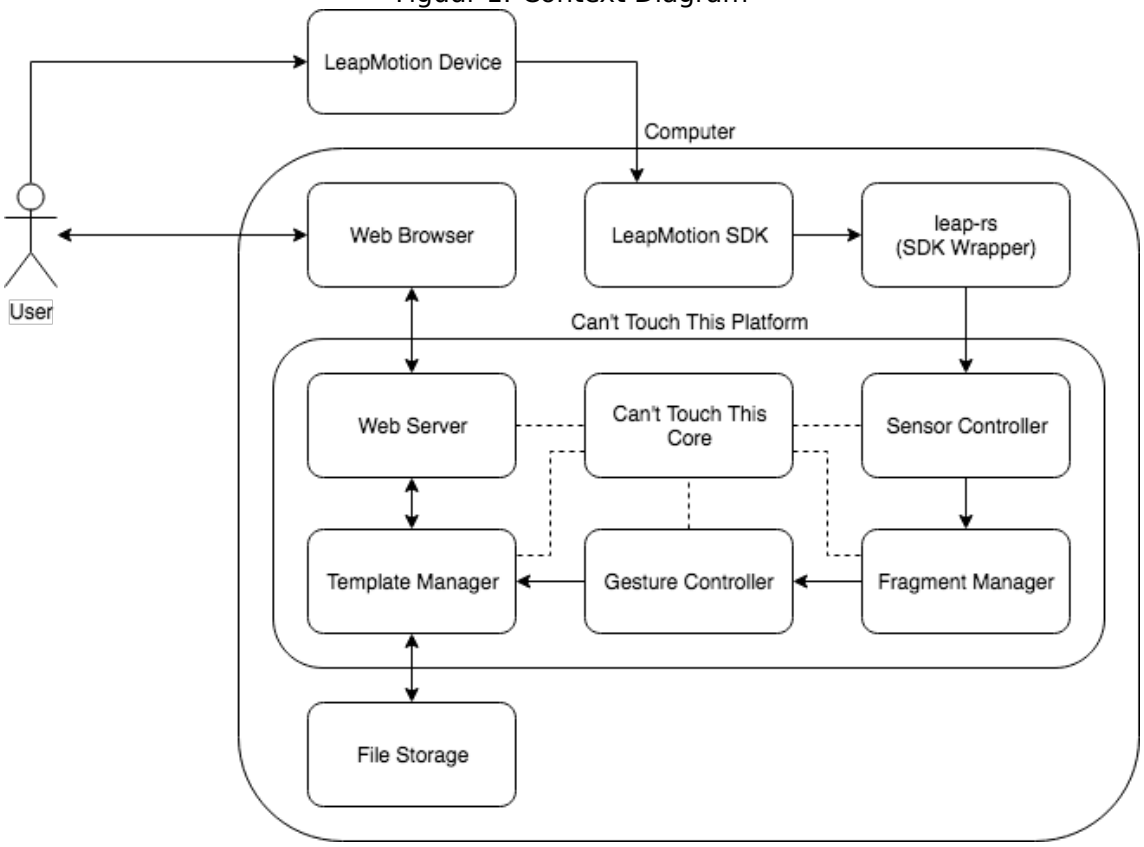
- The ability to bind actions to predefined or recorded gestures
- The ability to combine multiple sensors

The ability to bind actions to gestures is unfinished because of two reasons. The first reason is a lack of time. Writing *Can't Touch This* from scratch is a large task, and it consumed most of our development time. Second, executing actions based on gestures was not the main goal of the platform. The goal of the platform is to allow researchers to conduct experiments in the field of touchless computer systems. This research is not aided by the ability to execute actions based on gestures, but rather on if a gesture is recognized at all. It is because of this that we decided to give visual feedback in the web interface instead.

At the start of the project we wanted to combine multiple LeapMotion sensors in order to achieve increased accuracy. We looked into this, but we found out that this was impossible, due to the proprietary nature of the LeapMotion sensor. Several websites pointed out something like this would be better suited for the developers of the LeapMotion.

5 Architecture Diagrams

Figuur 1: Context Diagram



In this diagram, the *Can't Touch This* platform displayed globally. It Shows three main objects:

- The user
- The LeapMotion device
- The Can't Touch This platform

The user attaches the LeapMotion device to the computer, installs the platform and moves it's hand above the sensor to conduct an experiment. The LeapMotion device captures the data of the hand, and passes it on through the LeapMotion SDK, to the leap-rs wrapper. This leap-rs wrapper maps all functions made available through the LeapMotion SDK to the Rust programming language. Normally, a platform like *Can't Touch This* would have to be programmed using the C programming language, as this is the language the SDK is written in.

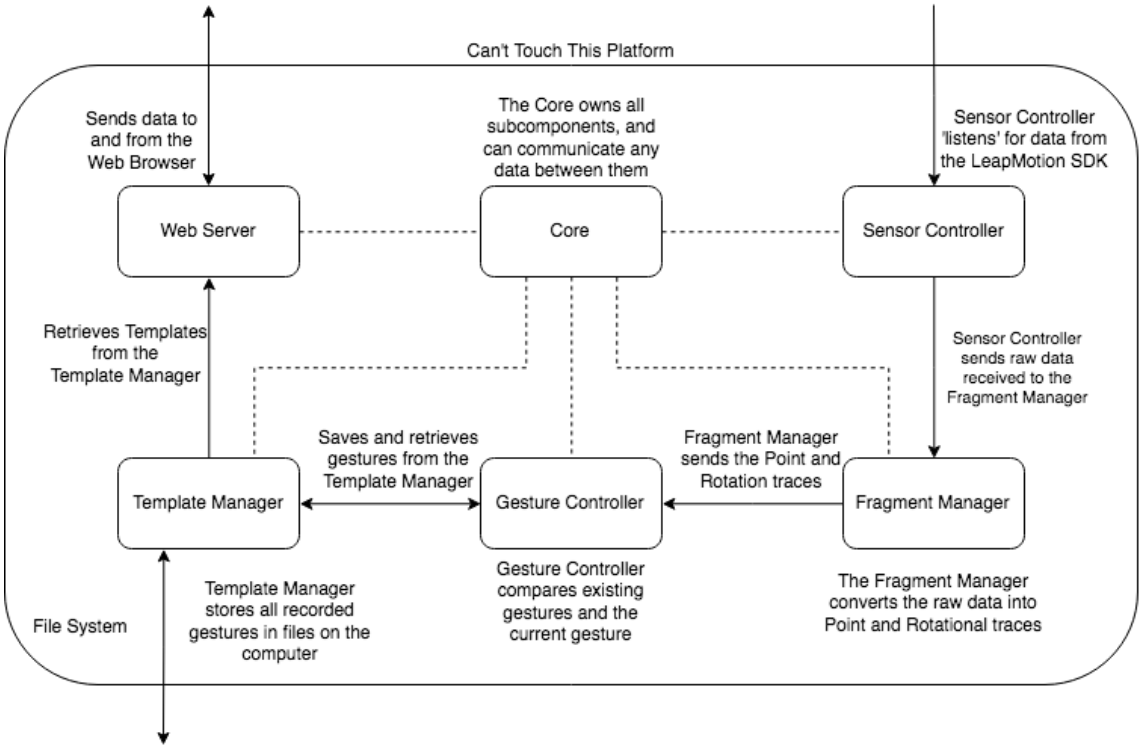
The leap-rs wrapper enables the SDK functionality in our platform, which we use in the Sensor Controller. The Sensor controller is our gateway of information, of our bits and bytes. The Sensor controller passes this data on to the Fragment Manager, which records all data and converts it into Points, Rotational Points (*RotPoints*) and Traces of both kind. It even improves the recorded points in the trace by sampling them. Sampling is ...

After the conversion and sampling, the Gesture Controller receives the data and compares this to existing gestures, stored in the Template Manager. The Template Manager compares the received gesture to the existing ones stores on the system. The gestures are saved in text files, as the data is not that complex. If the system matches the current gestures with an existing one, it will give positive feedback through the

web interface. The user will see the positive feedback and know that that gesture is working well.

The web interface also retrieves all the stored gestures for the user to review. It can add and delete gestures as the user wants, except the pre-defined gestures.

Figuur 2: Context Diagram



6 Domain Model

7 Test Report

7.1 Code Quality

7.2 Existing Tests

The platform currently has a few unit tests that cover basic operations such as the conversion of a *Point* to a *PointTrace* and more. We we also have set up a few tests where we cover the comparison of traces, such as straight lines and curves. Below you can see the test code:

```
#[test]
fn straight() {
    let points = PointTrace::new(vec![
        Point3::new(0.0, 0.0, 0.0),
        Point3::new(1.0, 1.0, 0.0),
        Point3::new(5.0, 5.0, 0.0),
    ]);

    let expected = RotTrace::new(vec![RotPoint::new(0f64, 2f64.
       sqrt())]);

    assert_eq!(points.to_rot_trace(false), expected);
}
```

This unit test creates `points`, a trace of `Point3`'s, and compares it to `expected`, a `RotTrace`.

The `PointTrace` on line 3 contains three points that travel the same distance at every step. The platform recognizes this as a straight line, as there is no change in the trajectory. the variable `expected` then gets assigned a `RotTrace` that contains only one `RotPoint` of 0 degrees. This is correct, as the line drawn on line 3 is straight.

```
#[test]
fn corner() {
    let points = PointTrace::new(vec![
        Point3::new(0.0, 0.0, 0.0),
        Point3::new(0.0, 5.0, 0.0),
        Point3::new(5.0, 5.0, 0.0),
        Point3::new(5.0, 0.0, 0.0),
        Point3::new(0.0, 0.0, 0.0),
    ]);

    let expected = RotTrace::new(vec![RotPoint::from_degrees
       (-90.0, 5.0); 3]);

    assert_eq!(points.to_rot_trace(false), expected);
    assert_eq!(
        points.to_last_rot_point(),
        Some(RotPoint::from_degrees(-90.0, 5.0))
    );
}
```

The `corner` test is a little more complicated than the `straight` unit test. It creates a `PointTrace` with points that represent a 2D square. The expected RotTrace then contains three `RotPoint`'s of -90 degrees.

7.3 Known Bugs

- *Can't Touch This* may crash upon running the release version of the exectable

- On macOS, the LeapMotion device may never give data to begin with
- On macOS, the LeapMotion device may stop recording data randomly
- On macOS, the application may not run well when minimalizing the backend application