



Laser Projection Keyboard Kit Calibration and Usage Manual For kit version I and II

RoboPeak Team

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1. Introduction

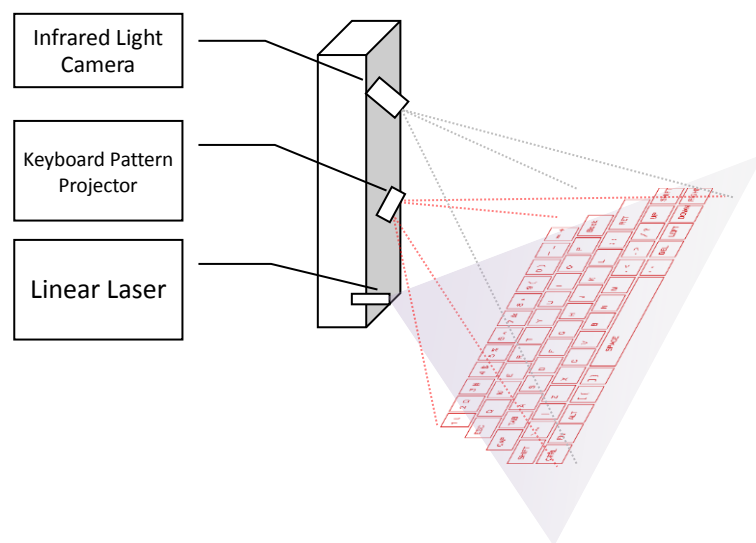
The Laser Projection Keyboard Kit is based on the open-source laser keyboard project designed by RoboPeak Team. After a few quick and simple assembly and calibration process, your laser projection keyboard is ready to work!

The laser keyboard works just like a standard keyboard on your PC/MAC with the help of the related signal processing software designed by RoboPeak. The signal processing software also supports turning your laser keyboard kit into a multi-touch pad.

As an open-source project, you can freely make any changes/improvement to the current design and go through the implementation detail of the kit.

1.1. Working Mechanism

The Laser Projection Keyboard kit contains the following 3 major key parts: an infrared light camera, a keyboard pattern projector and a linear laser.



The keyboard pattern projector displays a virtual keyboard pattern on a flat surface, such as a desktop surface. When a user touches virtual keys using his/her fingers, the top of fingers will be illuminated by the lighting plane created by the linear laser. Since the infrared light is used, the user won't notice his/her fingers are illuminated.

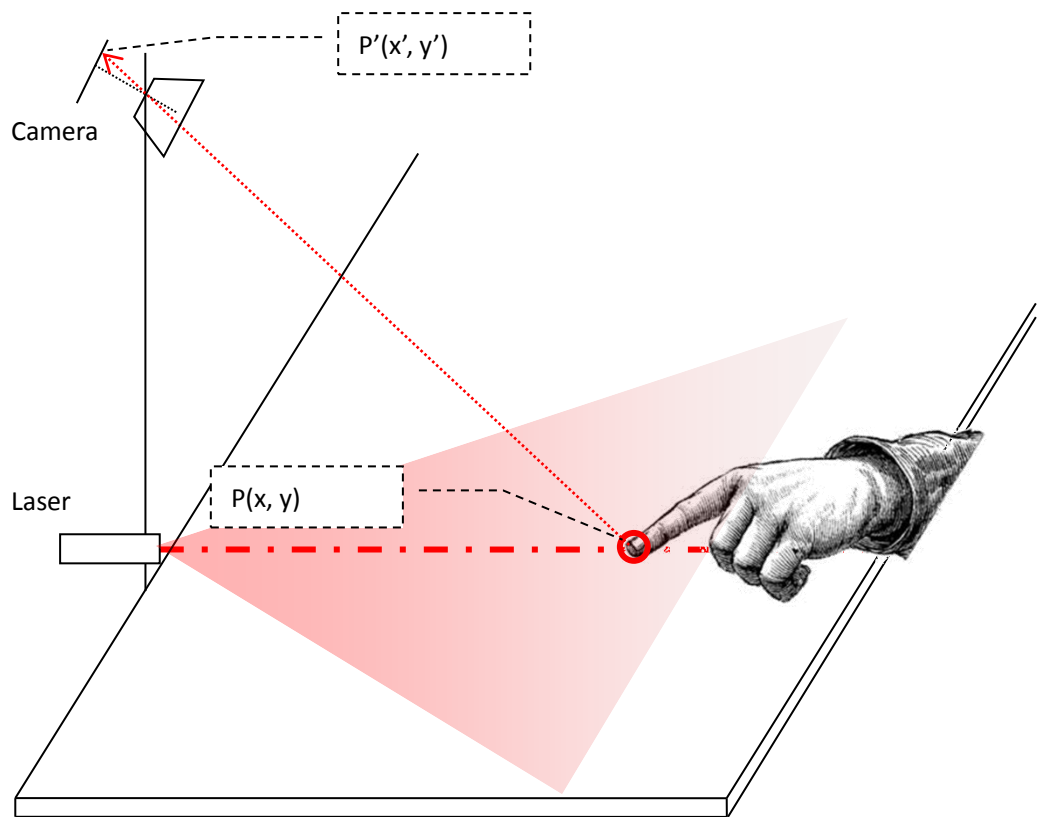


Figure: Detect the position of the fingers using triangulation

The infrared light camera captures the images of the illuminated fingers, and sends the images to the signal processing software. The position of the illuminated fingers is detected and localized by the software, and it will be transformed to the related key input events.

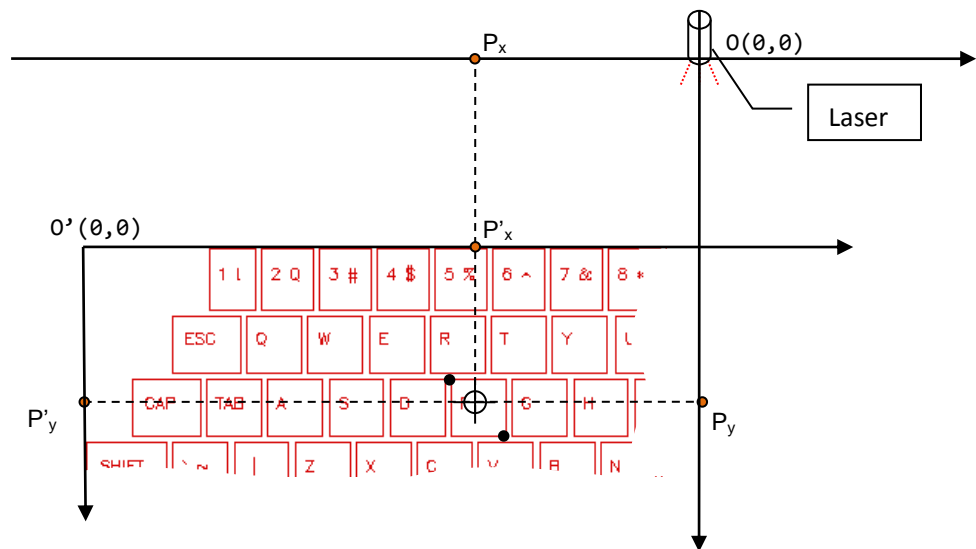


Figure: Mapping the desktop based finger position $P(x,y)$ to the keyboard layout based coordination and generating key events

2. Calibration and Tuning

You need to calibrate and tune your laser projection keyboard in the first use after assembly. A good calibration and tuning will make your laser projection keyboard perform well.

This chapter will guide you through these processes.

2.1. Basic Power-On Check

After finishing assembling the laser projection keyboard kit, please use a micro-usb cable to connect the kit with a PC/Mac. If everything works fine, you will see the projected keyboard pattern on the desk surface and the PC/Mac will prompt you a new camera device has been connected.

If you have noticed these, it means the assembly should be succeeded and you can continue to do the calibration job. Otherwise, please review the assembly manual to have further check.



Figure: Windows prompts a camera device is connected when connect the kit with the PC

2.2. Connecting with the Signal Processing Software

The signal processing software designed by RoboPeak team has been included in this kit. The software processes the input video signal and transforms it to the related keyboard input events. Also, the software will guide you during the calibration and tuning processes.

You can download the software via the DFRobot official website or from the official website of RoboPeak team. The software supports both Windows and MacOS(Intel x64 only) platforms and no pre-installation is required.

To run the software, simply double click the file named laser_kbd.exe (or laser_kbd.app on MacOS) as shown in the following figure. If it doesn't work, please contact RoboPeak.












	config	2013/4/4 22:02	File folder	
	res	2013/4/4 22:02	File folder	
<input checked="" type="checkbox"/> 	laser_kbd.exe	2013/4/2 21:57	Application	572 KB
	opencv_calib3d231.dll	2012/7/4 22:04	Application extension	717 KB
	opencv_core231.dll	2012/7/4 22:04	Application extension	1,678 KB
	opencv_features2d231.dll	2012/7/4 22:04	Application extension	848 KB
	opencv_flann231.dll	2012/7/4 22:04	Application extension	387 KB
	opencv_highgui231.dll	2012/7/4 22:04	Application extension	872 KB
	opencv_imgproc231.dll	2012/7/4 22:04	Application extension	1,595 KB
	opencv_legacy231.dll	2012/7/4 22:04	Application extension	745 KB
	opencv_video231.dll	2012/7/4 22:04	Application extension	279 KB

Figure: Running the software (Windows)

Before running the software, please make sure the laser keyboard kit has been connected to your PC/Mac via the USB cable. You should see the following window when the software is started. Please select the camera named: **Vimicro USB Camera(Altair)** using the left/right arrow buttons. (If there have been similar cameras connected to your machine before, the name may be altered.)

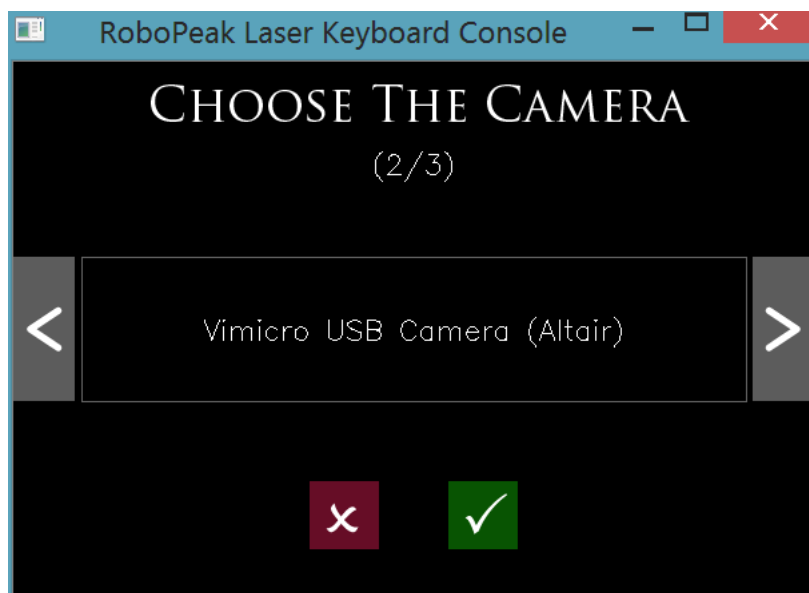



Figure: the Camera Selection Window

Press the button  to proceed. If everything works well, you will see the following window:

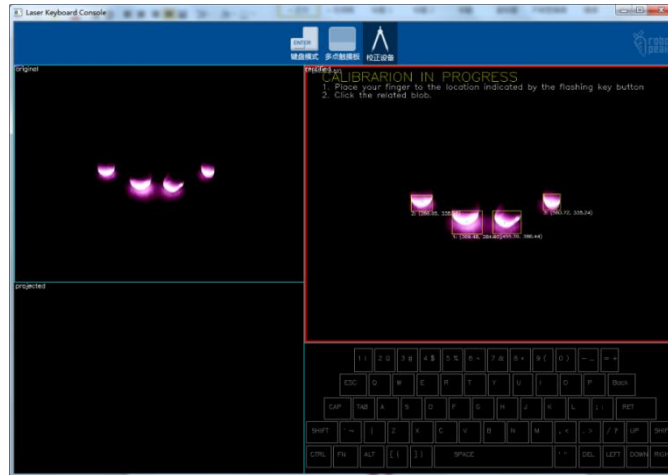
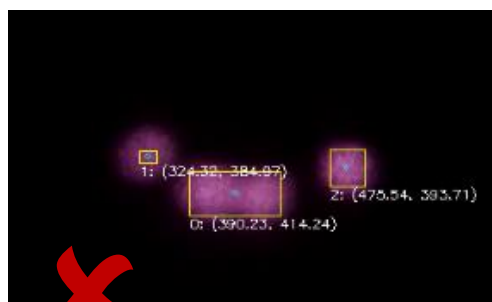


Figure: The working UI of the signal processing software

The upper-left corner of the window displays the image captured from the infrared light camera. The upper-right corner shows the detected finger position. The software will enter the calibration mode automatically during the first use.

2.3. Camera Focus Adjustment

You may need to adjust the infrared light camera's focus in order to make it capture clear images of the finger input events. Please watch the camera image displayed on the signal processing software's window. If you find the image is like the left side of the following figure, you need to re-focus the camera.

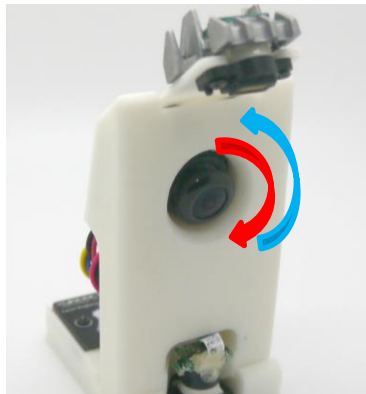


Not focused, the image is blurred

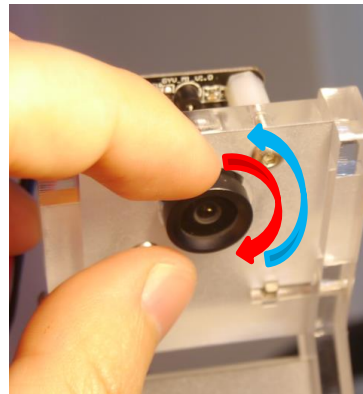


Correctly focused, the image is clear

Please adjust the focus by tuning the camera lens and watch the images displayed on the signal processing software windows. When you see a clear image of the finger top, the focus adjustment is finished.



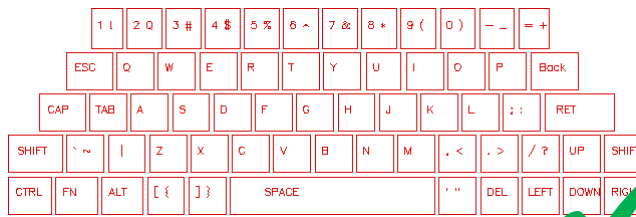
v2



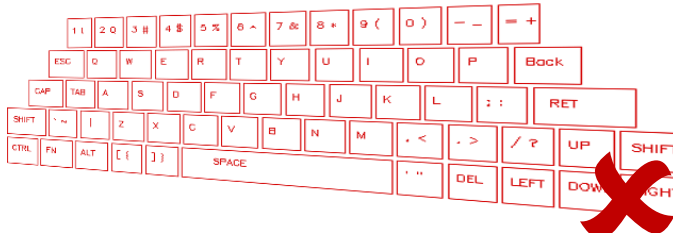
v1

2.4. Calibrating the Projected Keyboard Pattern

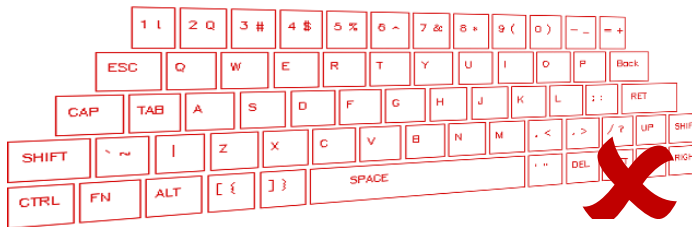
Please check the projected keyboard pattern on your desktop. A good projection image should look like the first figure below. If you find the projected image looks like one of the following distorted sample image below, you need to tune the pattern projector.



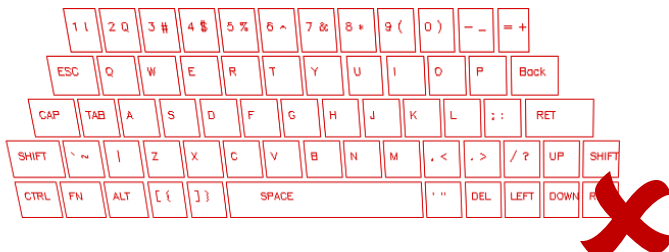
A Good projected keyboard pattern image



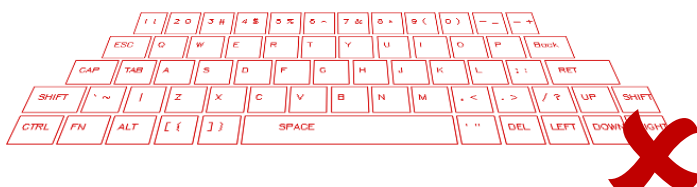
The left side is distorted



The right side is distorted



The bottom of the image is distorted

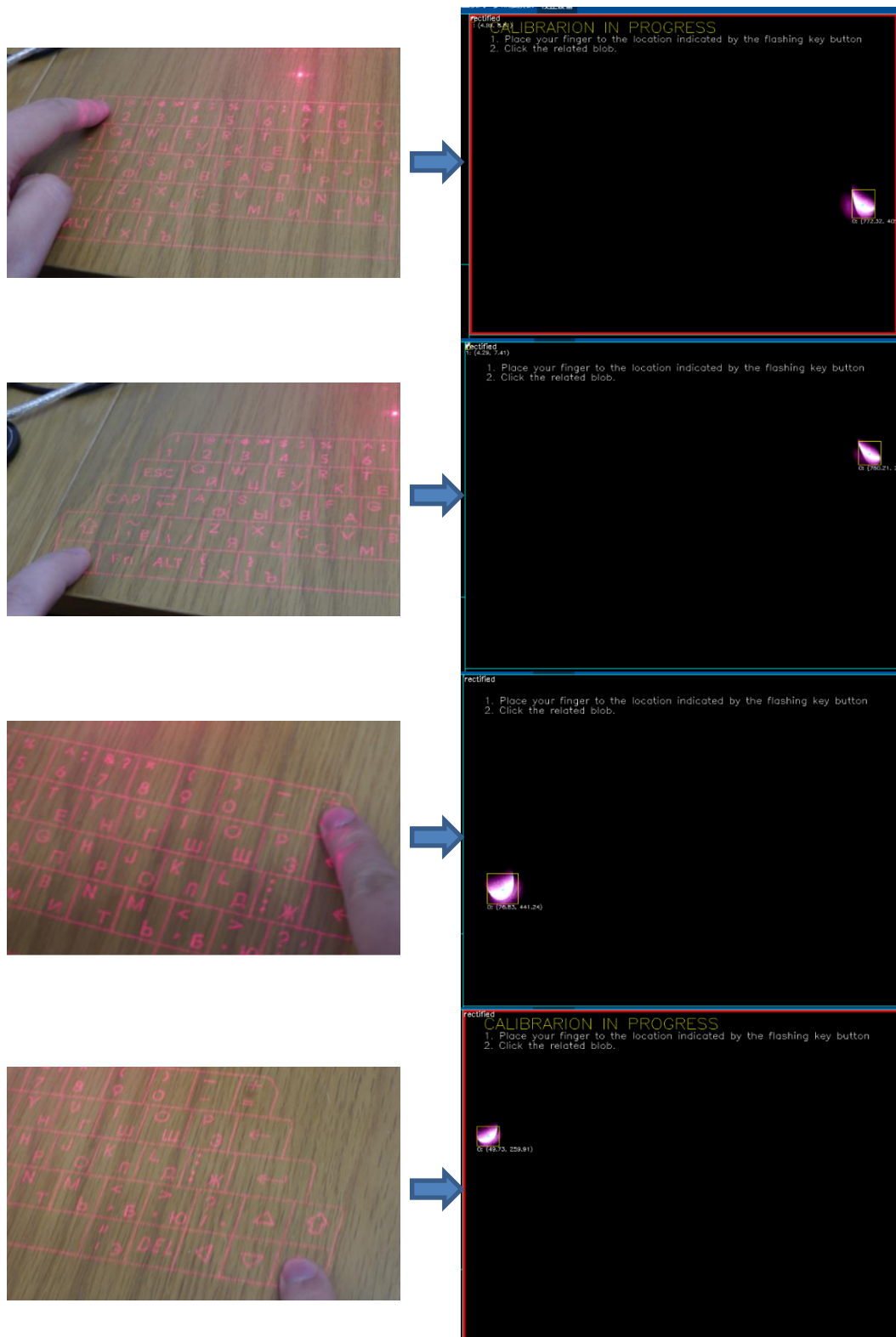


The top of the image is distorted

2.5. Camera Angle Adjustment

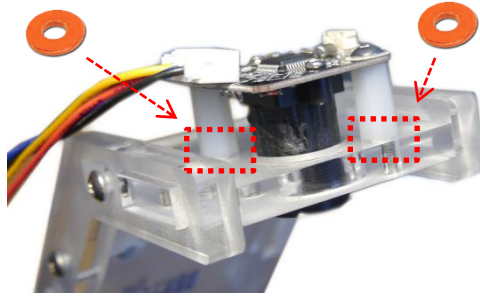
The infrared light camera should capture the whole area of the projected keyboard pattern image on the desktop. The signal processing software can be used to help you adjust the camera field of view angle if necessary.

Please place your finger on the 4 corner of the projected keyboard pattern image on the desktop one-by-one and check whether the illuminated finger top has been captured by the camera.

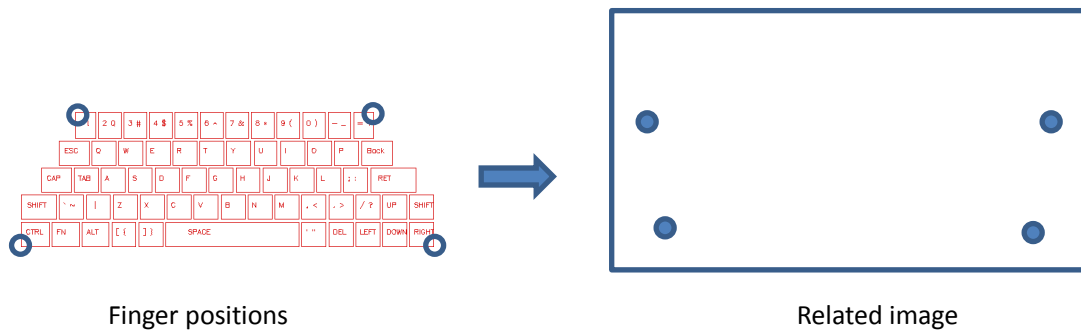


For Kit Version I only:

If you cannot find the illuminated finger shown on the software window, please use the extra screw pad provided in the kit to make adjustment.

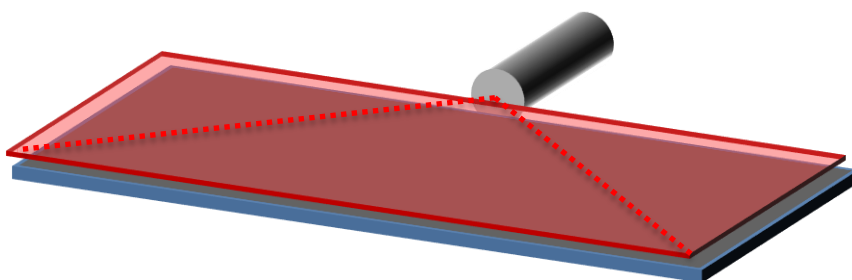


The related illuminated finger top image is recommended to be displayed in the areas like the following figure



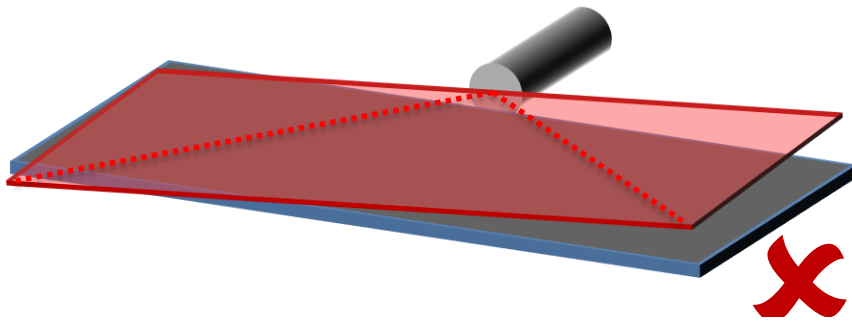
2.6. Linear Laser Adjustment (for Kit Version I only)

The line strip generated by the linear laser should be closely cover to desktop and be parallel with desk surface to make the laser keyboard work.



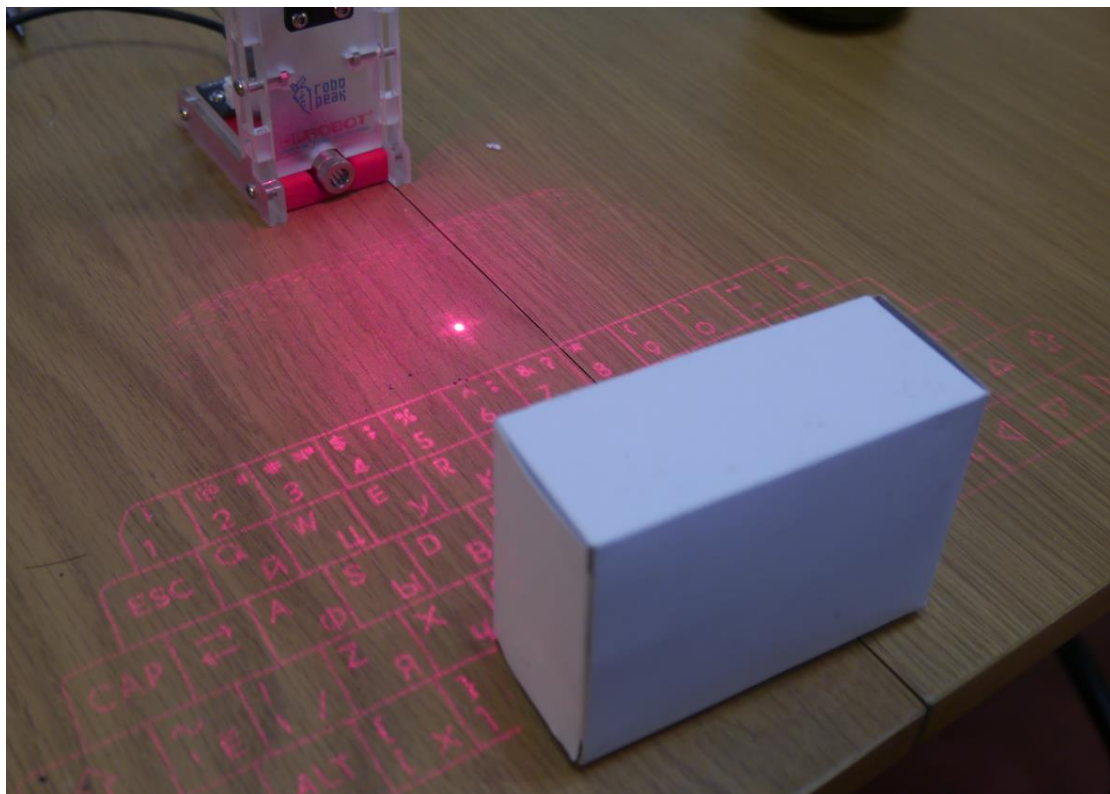
2.6.1. Adjusting the laser head

When the linear laser beam isn't parallel with the desk surface (as following figure depicts), you need to adjust the laser head by tuning it.



As the linear laser generates infrared laser which is invisible to human eyes. You need the help of the signal processing software.

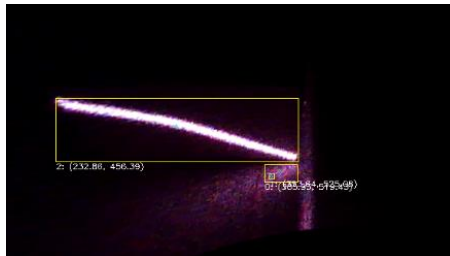
Please prepare a square box with white color (like the below figure) and place it in front of the laser keyboard. Make sure it is parallel with the projected keyboard pattern:



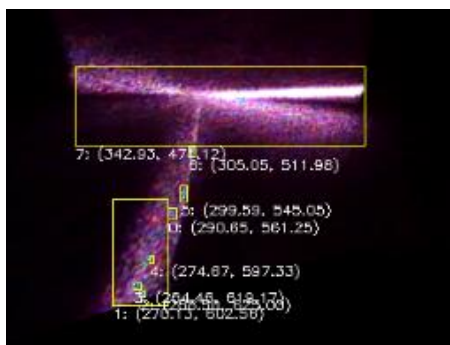
Then check the image on the signal processing software window. If the linear laser beam is parallel with the desktop, you will see a horizontal linear light pattern on the image. Otherwise, you will get a tilted linear light pattern or the pattern is incomplete.



A horizontal linear light pattern means the linear laser beam is parallel with the desktop

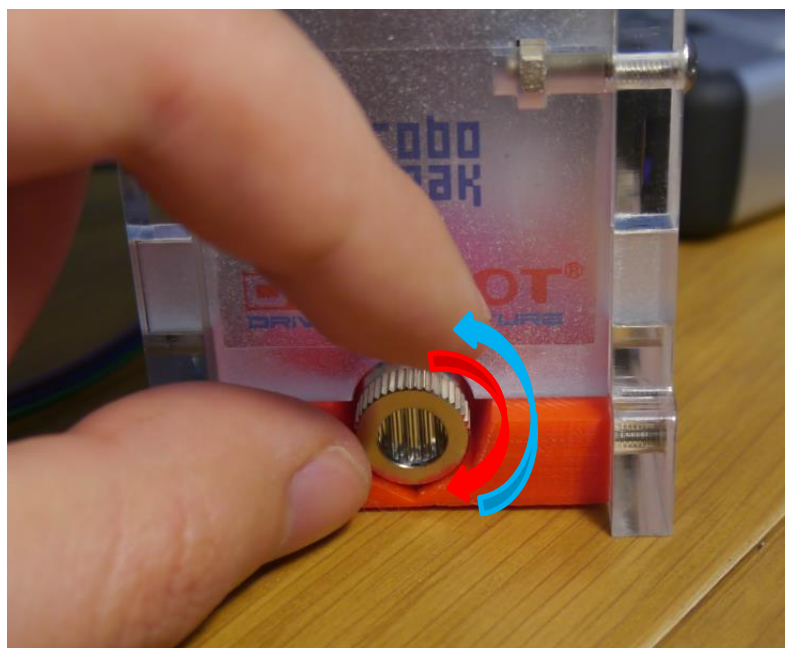


A tilted linear light pattern means the linear laser beam is not parallel with the desktop



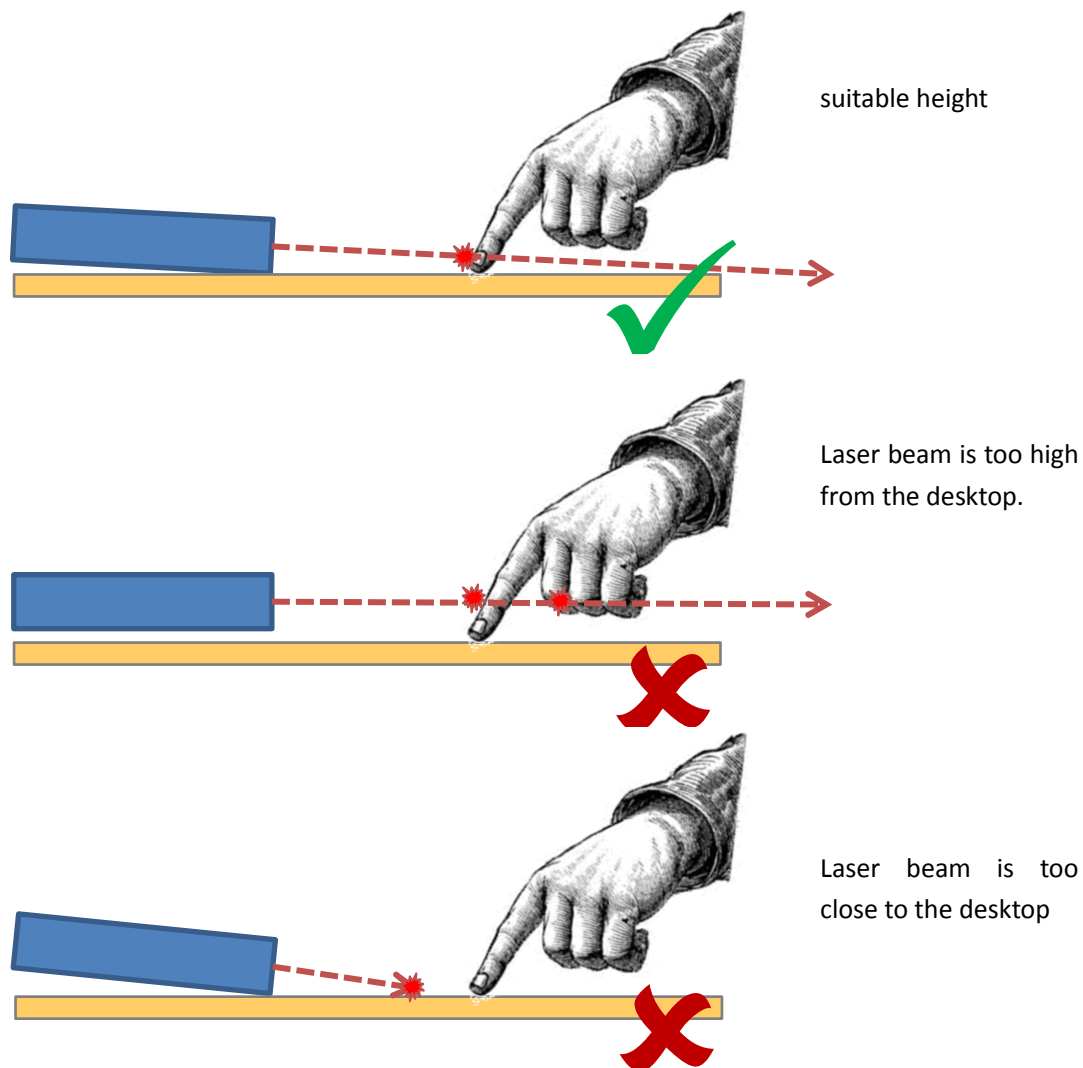
An incomplete linear light pattern means the linear laser beam is not parallel with the

You can adjust the angle of the linear laser beam by tuning the head of the linear laser like the following figure:



2.6.2. Height adjustment

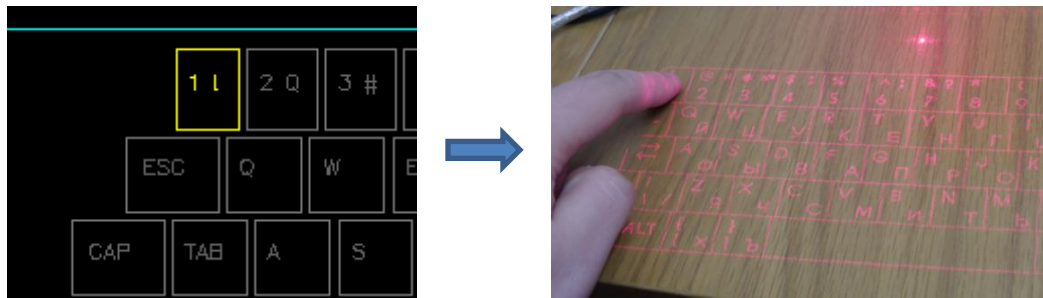
The generated linear laser beam should be kept close to the desktop enough in order to let the laser keyboard generate precise key input events. If the laser beam is too high, the laser keyboard will falsely generate key events for those fingers not touching the desktop. If the laser beam is too close to the desktop, the desktop may be illuminated and a false key input event will be generated as well.



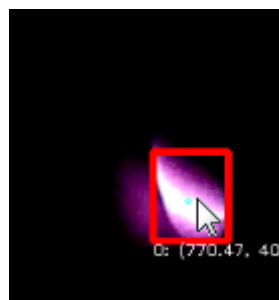
The height of the linear laser beam can be adjusted via the adjustment screw.

2.7. Final Calibration

It is the last step of the calibration process. After this step, your laser projection keyboard will work. The signal processing software will help you to complete this step. The software will prompt you to place your fingers to the point by flashed the related key button:

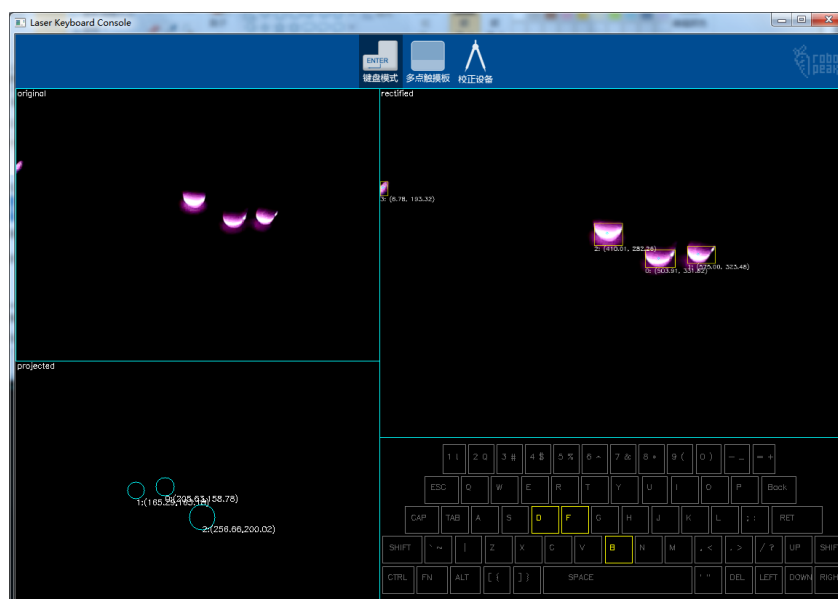


After placing your finger to the required place, please don't move the finger. Use mouse to click the light blob that is related to your finger:



You will be asked to repeat the above steps several times. After about 10 “key pressing”, the calibration process is completed. The calibration data is stored in the software folder for next uses. You don't need to recalibrate your laser keyboard as long as the laser keyboard structure won't be changed.

The software will enter keyboard mode when the calibration is finished. In this mode you can use your laser projection keyboard just as a normal keyboard device.



3. Usage of the Signal Processing Software

The signal processing software is specifically designed to be used together with the laser projection keyboard kit by RoboPeak team. Besides the standard keyboard input feature, the software also supports turning the laser keyboard kit into a multi-touch pad which tracks up to 10 points at the same time.

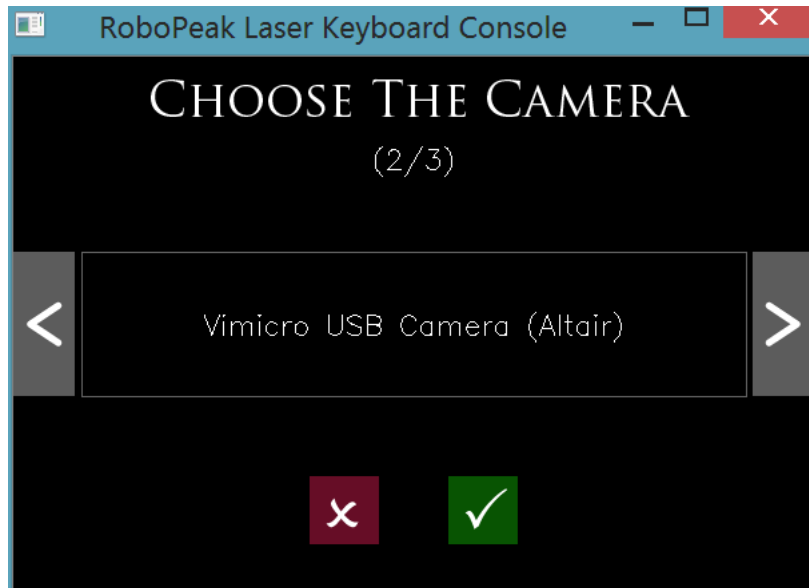
The software also provides calibration features for users to calibrate the keyboard.

The software is software, you can download its source code and new updates submitted by RoboPeak.

3.1. Camera Selection

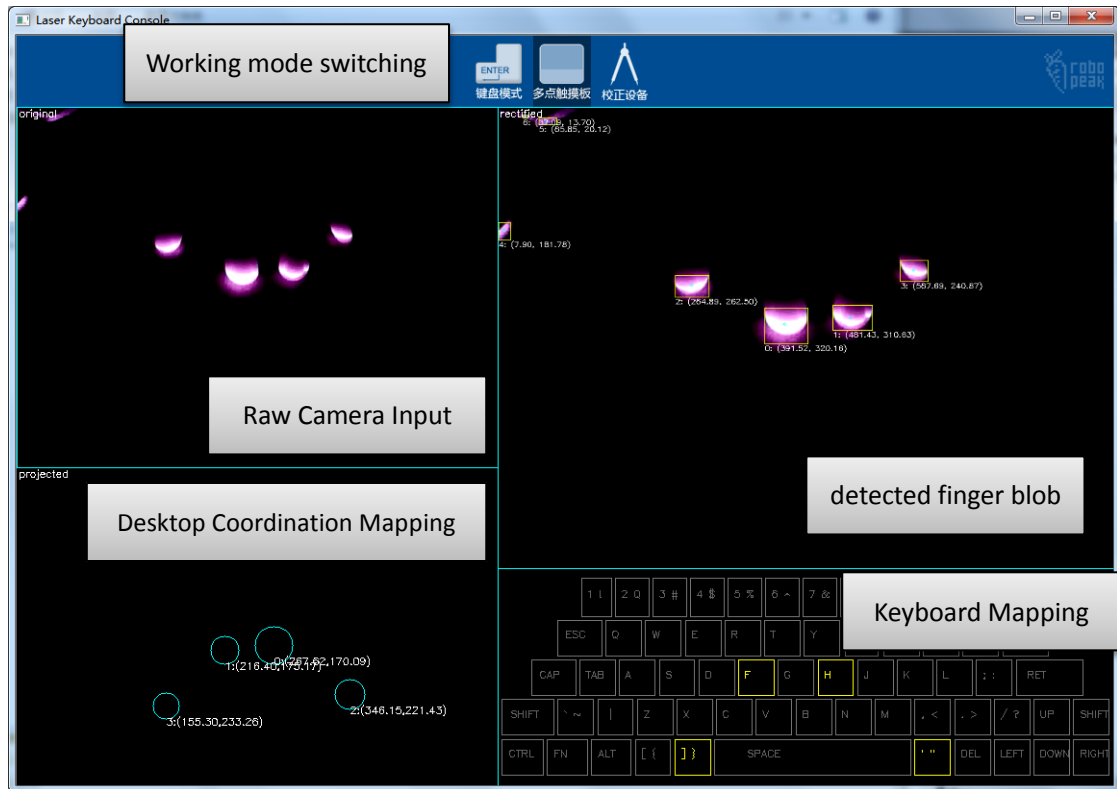
The software allows you to select a camera that is used by the laser keyboard kit when multiple cameras have been connected to your machine.

After the software is started, it shows the camera selection window. For the laser projection keyboard kit, the camera should be named with: **Vimicro USB Camera(Altair)**. The software remembers your choice and the related camera will be selected by default in the next software launch.



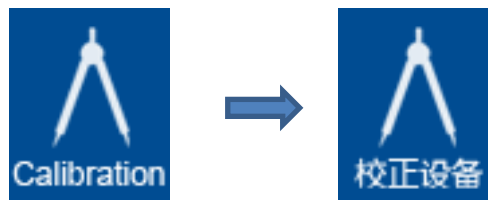
3.2. the Working UI

The following working UI window will be appear when the camera has been connected.



3.3. Multi-language Support

The software supports English and Chinese as its UI languages. The related language will be selected automatically based on the current UI language setting of your machine's OS.



3.4. Keyboard Mode

The Keyboard Mode is the default working mode of the software. After the calibration has been done, the software will switch to this mode as well.

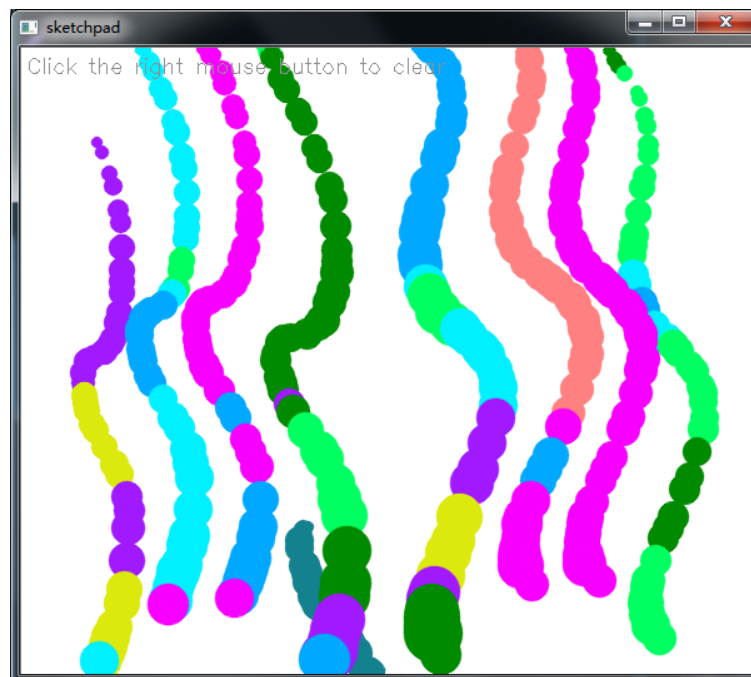
The detected user key input events will be injected to the OS in this mode. It supports multiple key stroke and auto repeat features.

NOTE: the key events will be sent to the signal processing software's window as well when the window is active. The software will quit when you press the ESC button.



3.5. Multi-touch Pad Moe

When in this mode, the software supports up to 10 points' multi input sketch pad. Move your fingers in the areas of the projected keyboard pattern image, and you will see your masterpiece displayed on the sketchpad window.

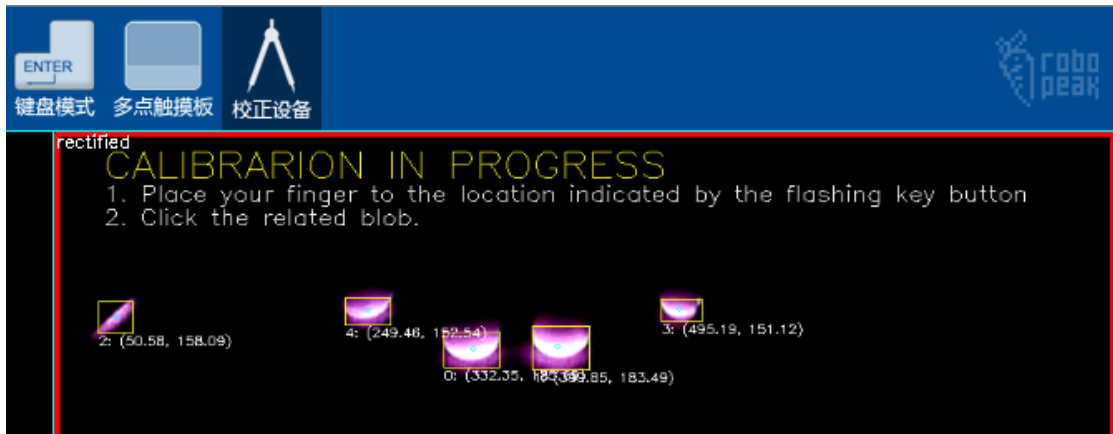


The sketch image can be cleared by right clicking the mouse.

3.6. Calibration Mode

The calibration mode can be entered any time when you need to calibrate your keyboard. The quality of a calibration will greatly affect the keyboard performance.

Once entering the calibration mode, the software will guide you to perform the calibration process. You can also refer to the section 3.6 of this document for details.



3.7. Command Lines

You can change the default behavior of the software by specifying command line arguments to the software. Use the `–help` parameter to see all the available options.

The following command line format is used:

`laser_kbd [options] [camera id]`

Options	Descriptions	Example
-m	Default working mode Available values: calib Keyboard sketch	Entering the multi touch pad mode when the software started: <code>laserkbd –m sketch</code>
Camera id	The camera to be connected without prompting. Starts from 0	Make the software to connect the second camera of the system without display the camera selection window: <code>laserkbd 1</code>

3.8. Parameter Tuning

- Window Users:

The software will read the file named **config/general.txt** under the same folder where the software locates.

- Mac Users:

The software will read the file under the user's home folder with the path:
`~/Library/rp_laserkbd/config/general.txt`

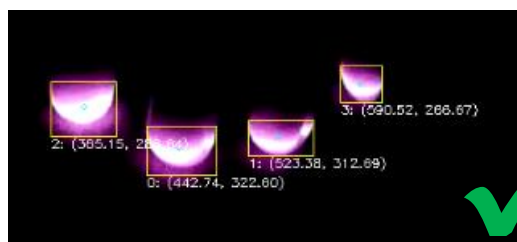
Users can change the configurations inside this file for extra tuning.

3.8.1. The exposure value of the camera

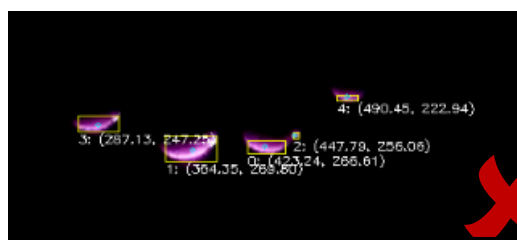
The software will disable the auto-exposure feature of the camera to work correctly. The exposure value will be set to a fix value. You can modify this value when you think the current exposure is not suitable for your keyboard.

```
exposure_level = -7
```

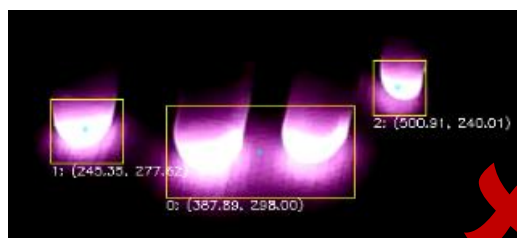
You can reference to the following figures to determine which exposure value is suitable for you.



suitable exposure value
Only the finger top parts
is sensed by the camera



under-exposure. The
sensed finger top is too
small



Over-exposure. The
sensed finger top areas
are mixed up.

3.8.2. Key stroke delay and repeating interval

You can modified the general.txt to change the intervals of key stroke delay and repeating:

```
keyrefire_delay = 1000  
keyrefire_interval = 100
```

The values are measured in the unit of millisecond (ms).

4. Source-code and Documents

Please visit the official website of RoboPeak team for the details of the openosource laser projection keyboard design.

The related source code can be obtained via Github:

URL:<https://github.com/robopeak/laserkbd>