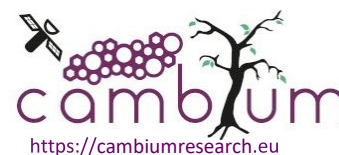# CaptuRING

User Manual
*v.*1.0.0.

Fig. 1. CaptuRING device

A Digitization Project made by Cambium Research Group, 2021.

About

CaptuRING [1] is a Do-It-Yourself tool for wood sample digitization. The main objective of this tool is taking high resolution images from wood samples. However the system could operate to digitize any other kind of samples.

If you use this tool, *please cite*:

Disclaimer

This manual explains the standard CaptuRING configuration through Raspberry Pi/Raspbian based on Debian Buster. Different hardware/software characteristics could require modifications in the CaptuRING® code.

Content

Component Check-List

CaptuRING motion Hardware

1. Photography enlarger base
2. Led lighting
3. C-Beam linear actuator + NEMA 23 stepper motor
4. Endstop switch
5. Linear rails
6. Driver IC for stepper motor
7. Arduino® based 3D printer controller
8. Power supply (12 V DC / 150W source)
9. Sample Holder (3D Print) *
10. Rail adapter (3D Print) *

Optical and controlling devices

1. Raspberry Pi Kit (with microSD, power source, cables and case)
2. Peripherals (Screen monitor, keyboard and mouse)
3. DSLR Camera compatible with the *gphoto2* system **
4. Camera Lens

For an efficient shopping, you can purchase the listed components in a store specialized in electronics or '3D printing'.

The digital camera and 3D Printinng Controller Board must be connected to Raspberry Pi through USB Port. You can use a USB hub if needed.

* The 3D print models provided are just a proposal. Please confirm that the 3D print models and sizes are compatible with the rest of components. We highly recommend developing different sample holders or rail adapters depending on your requirements and share them with the community.

** You can look at the supported cameras here. Select one with Image Capture/Trigger Capture and Configuration options to ensure compatibility.

CaptuRING is a Proposal from Users to Users. This tool has no relationship with the mentioned companies in this manual.

Assembly

Once you have confirmed that all the listed components are compatible you can assemble the whole tool according to the following architecture.

Assembly map

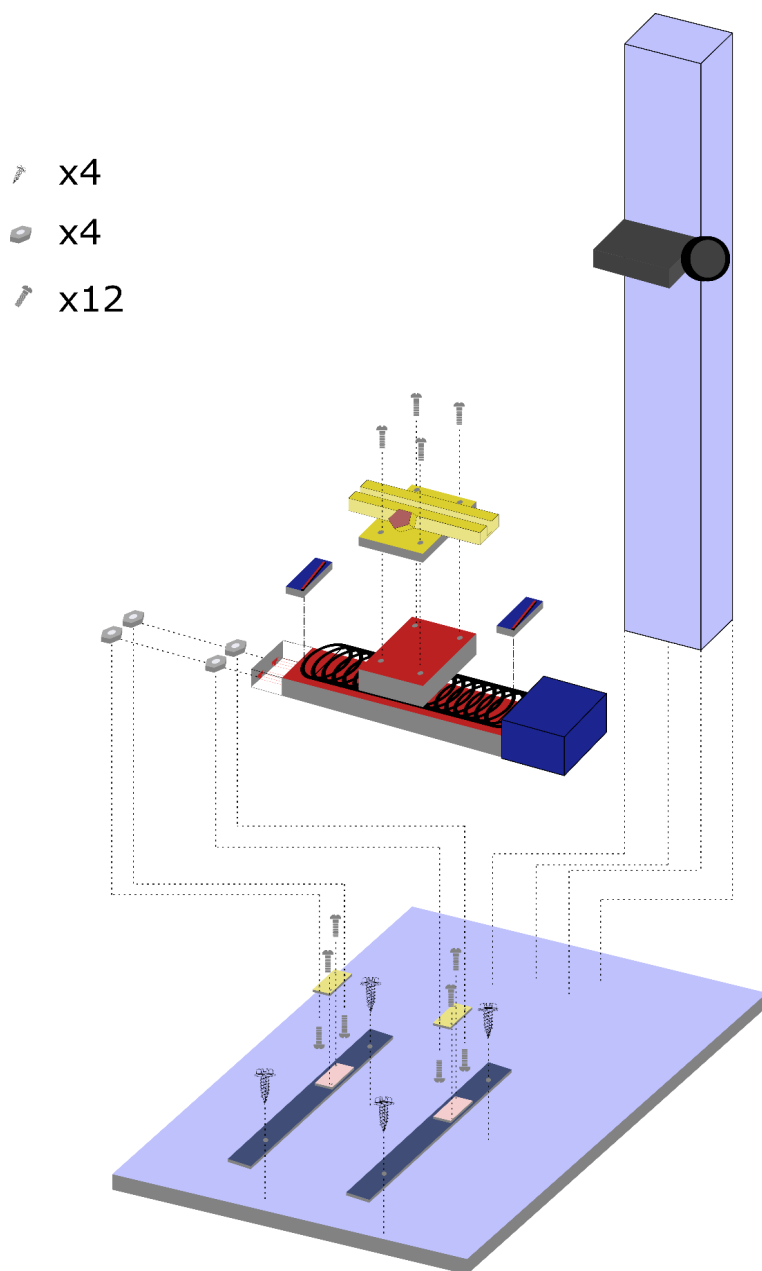See detailed assembling instructions in CRAssembly.pdf

x4

x4

x12

Fig. 2. CaptuRING General scheme

Connection map

See detailed connection map in CRConnection.pdf
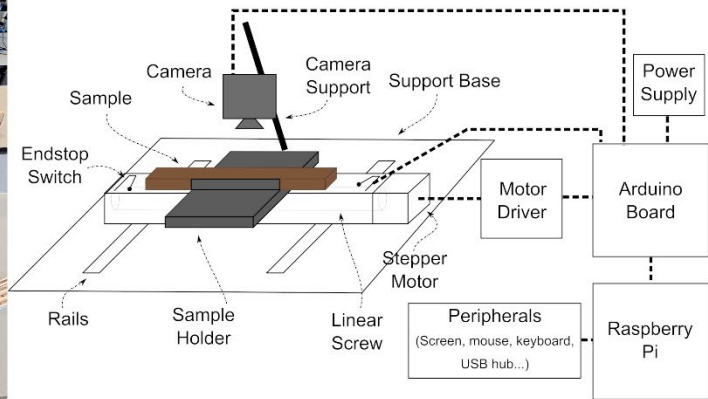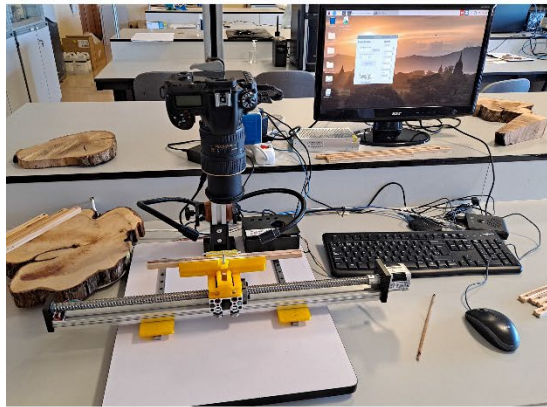

Fig. 3. CaptuRING architecture
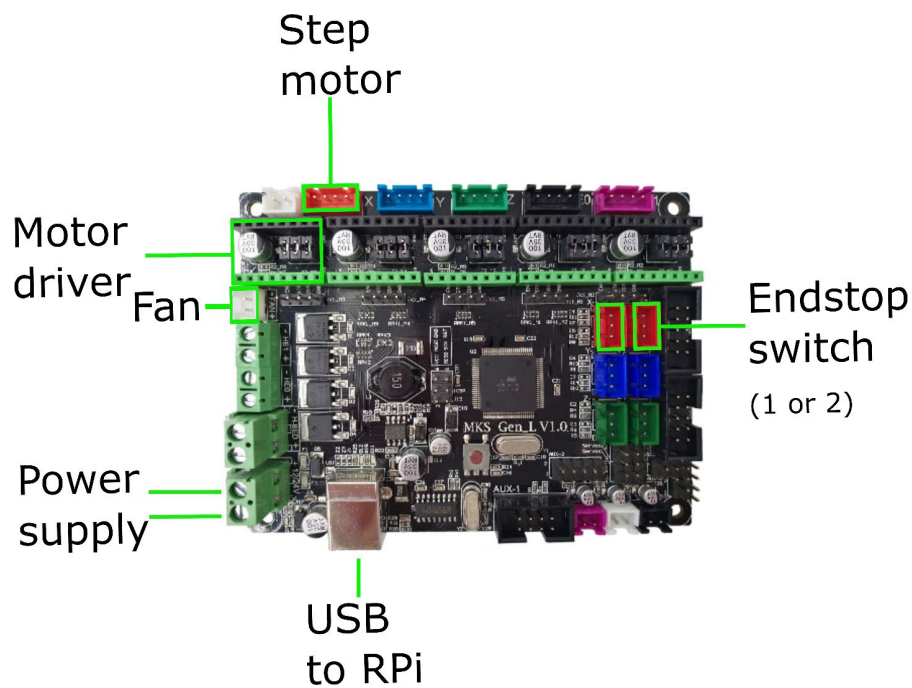
Arduino Board

Fig. 4. MKS L v. 1.0 Arduino Board

Installation and Set-Up

Raspberry Pi Set-Up

Raspberry Pi must be configured according to Raspberry Pi version with Raspbian Operative System.

Here you can visit a friendly and quick manual to configure your Raspberry Pi in just 5 steps.
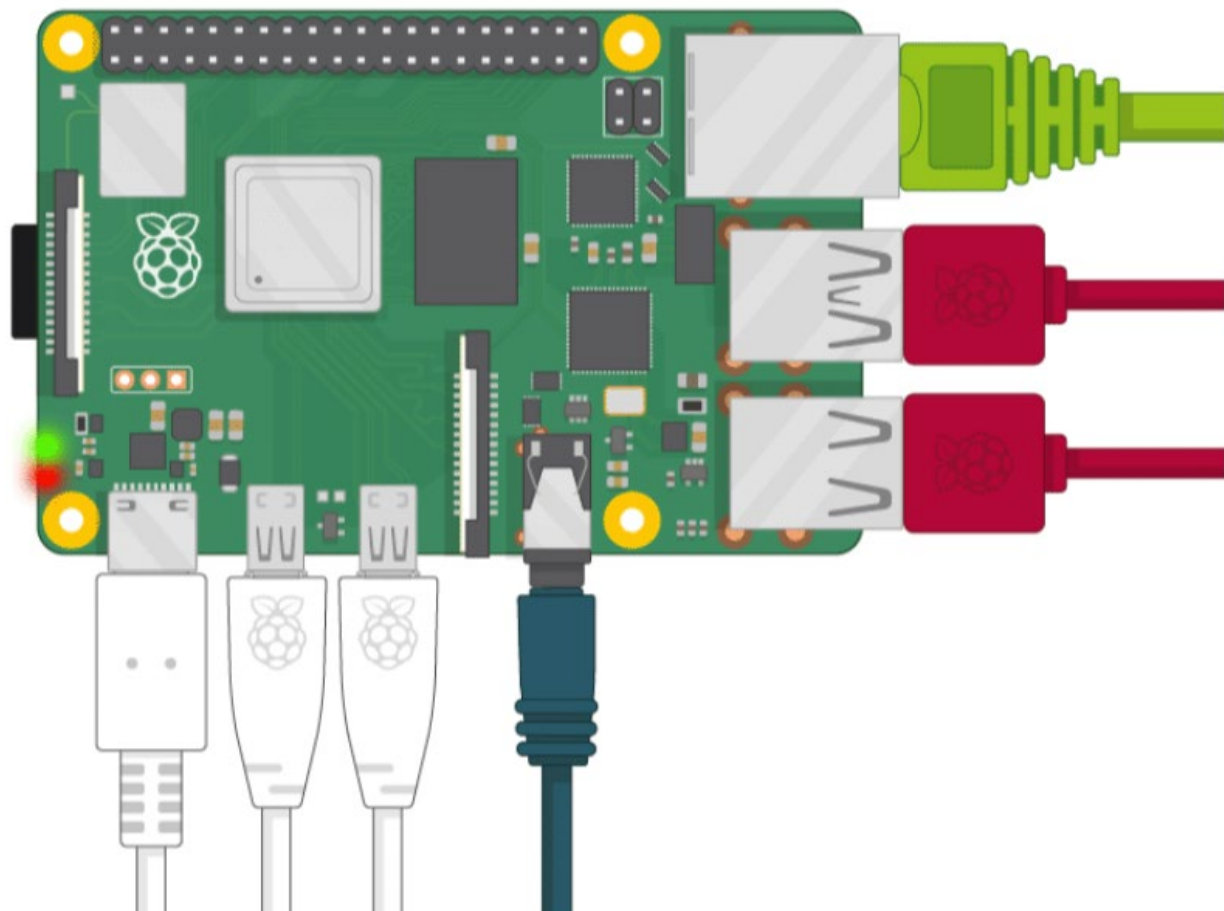

Fig. 5. From *https://projects.raspberrypi.org/*

Arduino Board Set-Up

Configuration of Arduino Board will depend on the model you have, MKS L v. 1.0 in our case. We strongly recommend following the guidelines of your specific model. The main steps are:

1. **Download** firmware (Marlin) from the specific repository for your model into your Raspberry Pi or computer.

2. Open the interface.

   a. **Select** the port to connect the Arduino Board

   b. **Update** firmware.

3. **Configure** the firmware. Fix the specific values for:

   a. Baud rate

   b. Motor driver characteristics

   c. Endstop switch option. (When mechanical, it is activated when pushed)

   d. Spindle size ('X max pos')

   e. Direction of motion rotation

   f. Save parameters.

4. **Push** this firmware in a SD card and attach it to the Arduino Board

5. **Connect** Arduino Board to Raspberry Pi

6. **Confirm and test** the firmware is loaded in the Arduino Board through its specific instructions
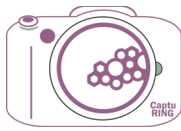
Switch on your Raspberry Pi and you will see the desktop.

1. Open a **new terminal**.
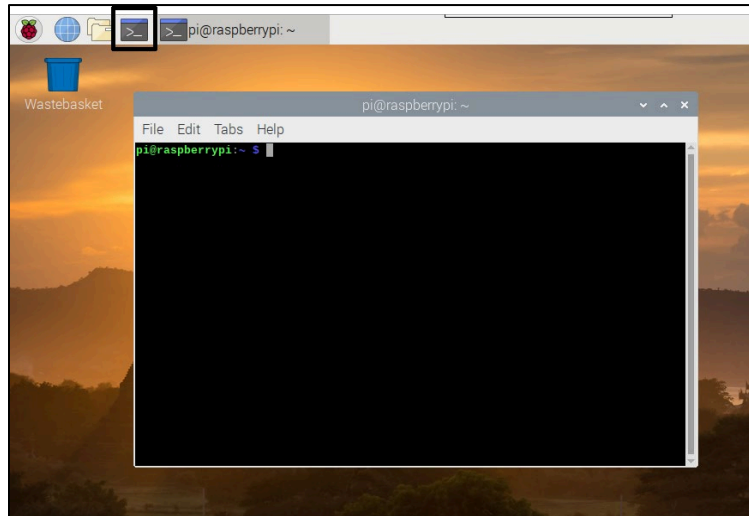

Fig. 6. https://projects.raspberrypi.org/

2. Confirm which is your **python version**. Type:
   ```
   python3 --version
   ```

3. If the response is python 3.7 or newer you can continue. If not, you can install python 3 according to this manual with the desired version

4. **Optional:** Create a new Python environment. This is a new space in which you will install specific libraries for specific tasks (eg., Sample digitization with CaptuRING)

   a. Install the specific package to create environments
   ```
   sudo apt-get install python3-venv
   ```

   b. Go to the base directory
   ```
   cd ~
   ```

   c. Create the new environment with python 3.7 with the desired name (substitute *name_of_environment* with a short name you choose)
   ```
   python3 -m venv name_of_environment
   ```
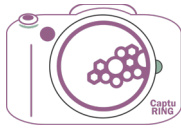
Install dependencies

CaptuRING needs some dependencies for Python 3.7.

1. Activate the virtual environment (optional).
   ```
   source ./name_of_environment/bin/activate
   ```
2. **Install** python dependencies:
   a. PyQt5
      ```
      pip install PyQt5
      ```
   b. serial (pyserial)
      ```
      pip install pyserial
      ```
   c. gphoto2
      ```
      pip install gphoto2
      ```

Confirm gphoto2 configuration

1. To ensure that your camera is properly connected and recognized, type:
   ```
   gphoto2 --auto-detect
   ```
   Your camera should appear in the response. If not, the camera must be *mounted*.
2. Go to the upper bar in the desktop and unmount the camera by clicking with the right button of your mouse on the device icon.
3. Type the previous (1) order in the terminal and your model must appear.

You can control diverse configurations of your camera through gphoto2 and CaptuRING software.

Launch CaptuRING

Download CaptuRING code and store it in a specific folder and unzip it. This folder will be your working directory.

1. Open a **new Terminal** window **from this folder**:

   Right-click on an empty space of the folder select 'Open in terminal'.

2. Optional: Activate a specific python virtual environment

3. Write and **execute**:

   ```
   python main.py
   ```
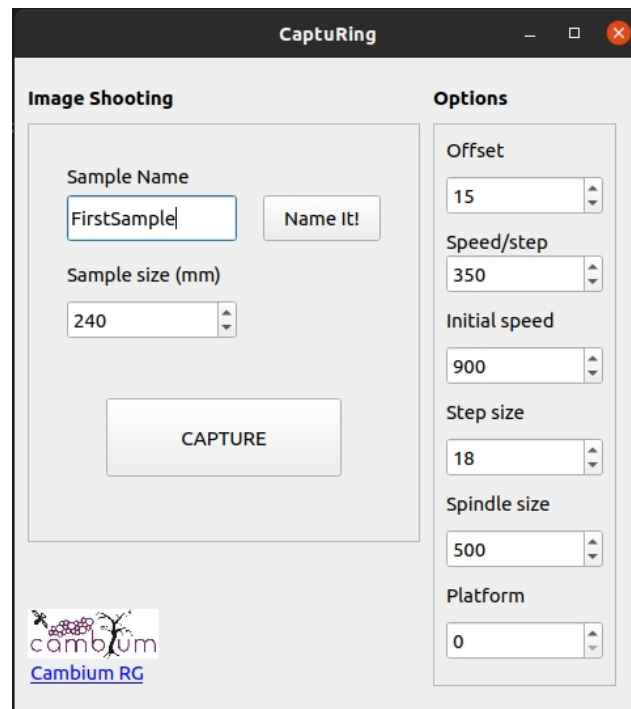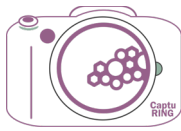
4. See *My First Shoot* instructions

Fig. 7. CaptuRING interface

Current code is the first release of the CaptuRING® software to control the digitization process described in "CaptuRING: A Do-It-Yourself tool for wood sample digitization" (García-Hidalgo et al., 2022).

Original code is registered with number 00 / 2022 / 737 according to the Ley de Propiedad Intelectual (Real Decreto Legislativo 1/1996, de 12 de abril) by Ministry of Culture and Sport of Spain. At the same time, this work is released as Free Open Source to be used and modified according to the user requirements and different hardware characteristics but referencing the original work.

Possible Issues

- *Python error:* Confirm that your python version is 3.7 or higher compatible with CaptuRING code and dependencies. If it is not, you can create a specific virtual environment with Python 3.7 and the compatible dependencies.
- *Dependencies error:* Make sure you installed all the dependencies. Depending on Python version, more dependencies could be necessary.
- Some of the *dependencies* must be configured following their respective instructions.

My First Shoot

Sample placement

1. **Measure** the length of your sample
2. **Place** the sample centered on the sample holder
3. **Switch on** all the electronic components.
4. **Confirm** that the camera is placed in a height on the enlarger base that allows a sharp caption of the sample

Shooting Process

Once CaptuRING software is launched:

1. **Enter** your device characteristics in the Options sections. (Only for the first time)
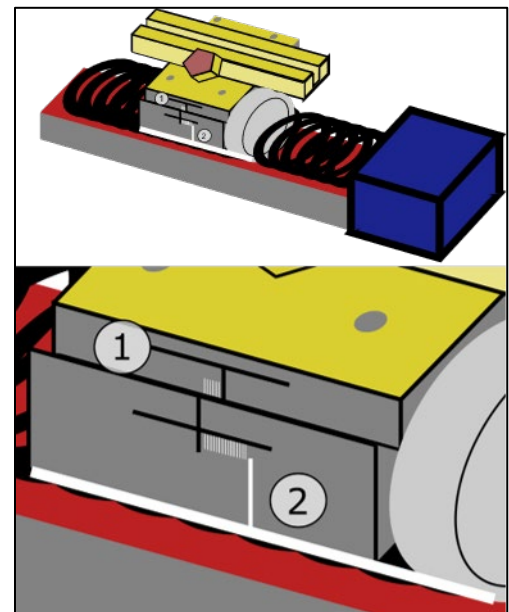   a. *Offset:* Variation between the center of the specimen/sample holder and the center of the sample holder/screw platform respectively (*Fig. 8*.1)

Fig. 8. Offset (1) and Platform (2)

   b. *Speed/step:* Screw speed in the caption process (example values in Fig. 7)
   c. *Initial speed:* Screw speed for start-up (high values can damage the device, see Fig. 7)
   d. *Step size:* Distance of screw run in each step
   e. *Spindle size:* Total length of the screw
   f. *Platform:* Variation between the center of the sample holder and the screw platform (*Fig. 8*.2)
2. **Enter** the Sample Name
3. Click on '**Name it!**'
4. **Enter** sample size (sample length) in mm
5. Click on '**CAPTURE**'
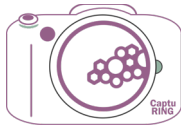6. Digitized images are stored in the Output/'Sample Name' folder

More info at:

https://github.com/CambiumRG/

https://cambiumresearch.eu

García-Hidalgo, M., García-Pedrero, Á., Colón, D., Sangüesa-Barreda, G., García-Cervigón, A. I., López-Molina, J., Hernández-Alonso, H., Rozas, V., Olano, J. M. & Alonso-Gómez, V. (2022). CaptuRING: A do-it-yourself tool for wood sample digitization. *Methods in Ecology and Evolution*, 00, 1– 7. https://doi.org/10.1111/2041-210X.13847l