How to build and install your own CaptuRING

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ARTICLE INFO

ABSTRACT

CaptuRING is a reliable and affordable tool to transform tree-ring samples into digital images combining open source software and do-it-yourself philosophies. A Raspberry Pi runs the system through an Arduino board that controls the wood sample movement across a linear screw at the time that a digital camera takes sequential high resolution (>4500 dpi) images from a wood sample. Here, we present three video tutorials, with English and Spanish subtitles, to construct and install CaptuRING (github.com/CambiumRG/CaptuRING) from scratch. First video tutorial explains the necessary components and how to assemble them to construct the CaptuRING platform, second tutorial covers Arduino board and Raspberry Pi connections, and the third tutorial is devoted to hardware configuration, software installation and CaptuRING use.

1. Introduction

Image acquisition of wood samples is already a common task in many tree-ring laboratories worldwide. The ease of storing, processing, analyzing, and exchanging images of wood samples is moving dendrochronology towards digitization (Maxwell and Larsson, 2021; Rademacher et al., 2021). Initially, high-resolution flatbed scanners led this transformation (Maxwell et al., 2011), but digital photography has emerged as a solid alternative due to its many benefits over scanning for irregular samples (Soille and Misson, 2001; Fonti and García-González, 2008). First, digital photography is less constrained by physical sample size as well as slices can be photographed, i.e core length acquisition is not limited by the size of the scanner working area. Second, image sharpness increases while processing times for digitization are reduced using digital cameras comparing to flatbed scanners. Third, autofocus option in digital photography enables sharp captures even in non-perfectly flat surfaces (Bonet-Sanz et al., 2022). All in all, different photography-based devices have appeared in the last years (Griffin et al., 2021; García-Hidalgo et al., 2022; Schauer et al., 2022), promoting digitization in dendrochronology.

CaptuRING tool is based on a Do-It-Yourself hardware and open-source software for wood cores digitization (García-Hidalgo et al., 2022), while an adaptation for wood slices is coming soon. The greatest advantage of CaptuRING is its relatively low cost (approximately 1 700 €), affordable for small-budget tree-ring laboratories and, being open-source hardware and software, it empowers users to customize their devices to research needs. CaptuRING can be assembled with just basic manual skills to connect the components. However, detailed video tutorials on CaptuRING hardware and software set up and installation makes this task much easier for the community.

Here, we present three video tutorials with associated subtitles in English and Spanish to show step by step 'How to build and install your own CaptuRING' from hardware assembly to electronic connection and configuration.

2. Tutorial one overview

In the first video, we show how to construct the CaptuRING platform. The first part of the video shows all the hardware components needed to build CaptuRING: 1 enlarger base, 1 C-Beam actuator with step motor, 1 or 2 endstop switches, 2 linear rails, 1 Arduino controlling board for a 3D printer, 1 power supply, 4 wood screws for the linear rails, 8 nuts, and 12 machine screws. All the components can be acquired in an electronic or 3D printing store for an efficient purchase. In addition, we need to 3D print the sample holder and 2 rail adapters. 3D designs and further information on required materials can be consulted directly at

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Video S1. A video clip is available online. Supplementary material related to this article can be found online at doi:10.1016/j.dendro.2022.126021.

Video S2. A video clip is available online. Supplementary material related to this article can be found online at doi:10.1016/j.dendro.2022.126021.

CambiumRG github repository (https://github.com/CambiumRG/CaptuRING). In the second part of the video, we show step by step how to assemble all the components. At the end of this video, we will have built the CaptuRING structure.

3. Tutorial two overview

In the second video, we show how to connect the electronic components with the Arduino board and Raspberry Pi. In this phase, we need: 1 Arduino board with and associated power supply, 1 Raspberry Pi kit and the components cited in the previous video. After this video, we will be done with CaptuRING hardware. CaptuRING is based on

Video S3. A video clip is available online. Supplementary material related to this article can be found online at doi:10.1016/j.dendro.2022.126021.

multiplatform open source software and, with few modifications, could run in any operative system (e.g., MacOS or Windows). However, the complete acquiring process is optimized using a low-cost computer such as Raspberry Pi (Linux based).

4. Tutorial three overview

In the third video, we show step-by-step how to configure all the electronic components and install and launch CaptuRING from scratch. We follow specific guidelines on the terminal window in the Raspberry Pi to configure the caption system. Once we have completed this task, we can acquire our dendrochronological samples in high resolution.

5. Final steps

The individual images are then stitched following the standards for image analysis to avoid image artifacts. We recommend the guidelines proposed by von Arx et al. (2016) using PTGui (New House Internet Services B.V., Rotterdam, NL) for quantitative wood anatomy. Other options include open source programs for image analysis as ImageJ (Schneider et al., 2012), or OpenCV (Bradski and Kaehler, 2000).

We encourage the dendro community to make developments in CaptuRING to increase the usability and versatility of the system. Further information for CaptuRING set up is available through Cambium Research Group website (cambiumresearch.eu) and github repository (github.com/CambiumRG/CaptuRING).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.dendro.2022.126021.

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