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pirecorder: Controlled and automated image and video recording with the raspberry pi

Jolle W. Jolles[1, 2]

1 Department of Collective Behaviour, Max Planck Institute of Animal Behaviour, Konstanz, Germany **2** Zukunftskolleg, Institute of Advanced Study, University of Konstanz, Germany

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Software

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Summary

A fundamental component of empirical research is the acquisition of accurate, consistent, and often significant amounts of data. Specifically, researchers often require large numbers of controlled and often parallel image and video recordings. For this the raspberry pi, a small, single-board computer that brings together open-source principles with sensor and controller interfaces, and highly customisable programming capabilities, provides a great, low cost solution. Indeed, in recent years, the raspberry pi has been increasingly taken up by the scientific community (Fletcher & Mura, 2019) and used in a wide range of projects that required the collection of high quality image data, from sub-micron resolution microscopy (Aidukas, Eckert, Harvey, Waller, & Konda, 2019), and deep sea video recordings (Phillips et al., 2019), to motion-triggered camera trapping (Nazir et al., 2017; Prinz, Taank, Voegeli, & Walters, 2016), high-throughput behavioural assessments (Geissmann et al., 2017; Jolles, Briggs, Araya-Ajoy, & Boogert, 2019; Todd et al., 2017), long-term home cage monitoring (Singh, Bermudez-Contreras, Nazari, Sutherland, & Mohajerani, 2019), and the automated tracking of animal groups (Alarcón-Nieto et al., 2018; Jolles, Laskowski, Boogert, & Manica, 2018).

So far, researchers have often relied on writing their own recordings scripts to take still photographs and videos from the command line (using `raspistill` and `raspivid`), control the camera module with `picamera` in Python (Jones, 2017), or trigger recordings by motion-detection (Motion). Also some specific solutions exist, such as a web-based interface to run recordings (Singh et al., 2019) and advanced software that converts the raspberry pi in a dedicated behavioural profiling machine (Geissmann et al., 2017). What is still missing is a complete solution that helps researchers set up their raspberry pi and camera and configure camera and recording parameters to enable them to run large numbers of (parallel and automated) image and video recordings in a simple way. Here I present `pirecorder` to overcome this need.

`pirecorder` is a Python package, built on the picamera (Jones, 2017) and OpenCV (Bradski, 2000) libraries, that provides a flexible solution for the collection of consistent image and video data. It consists of a number of interconnected modules to facilitate all aspects of media recording, from setting-up, calibrating and configuring the camera, recording of images and videos, time-lapses, and standardised video sequences with automatic file-naming, easy scheduling of future recordings, and converting of recorded media with resize, timestamp, and monitoring options. All modules also work directly from the command line, making it very straightforward to configure, initiate, schedule, and convert recordings. `pirecorder` comes with a dedicated website with detailed documentation and tutorials (jollejolles.github.io/pirecorder) as well as a set of annotated Jupyter Notebooks to help users integrate the raspberry pi and `pirecorder` in their work.

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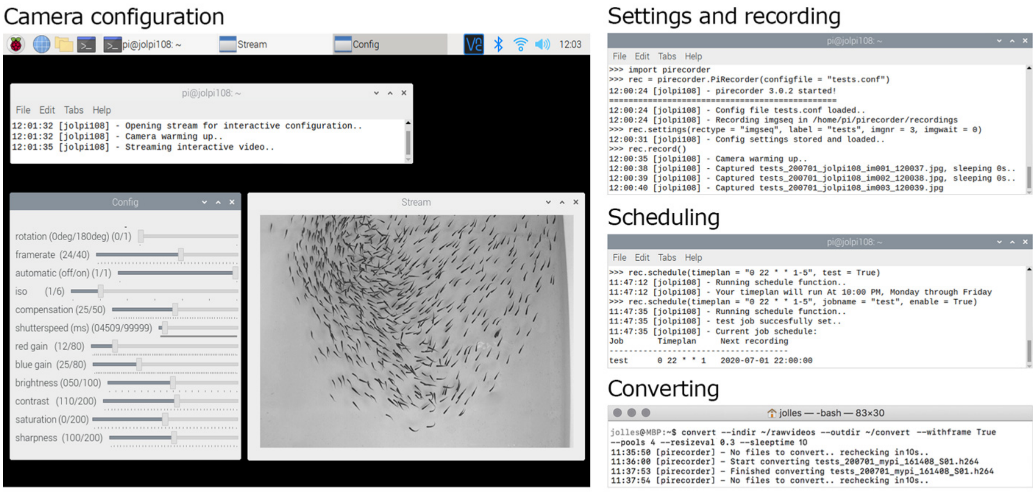

Figure 1: Screenshots of pirecorder in action, from configuring the camera with the interactive video stream, running recordings, testing and scheduling future recordings, and converting recorded media.

A key functionality of `pirecorder` is that it works with configuration files to store a wide range of camera and recording settings that are automatically used for future recordings without requiring further user input. Multiple configuration files can be used that can be edited directly, such as to set the video duration, quality, or number of images, or dynamically via an interactive video stream, such as to draw the region of interest, set the desired white-balance, or get the optimal camera shutter speed. Recordings can be easily initiated remotely, such as via an SSH connection, or scheduled to automatically start and stop at specific times in the future. By its use of configuration files and the automatic naming of files, `pirecorder` also makes it possible to start controlled recordings on multiple raspberry pi's simultaneously, such as with csshX, which sends the same command to multiple computers at once.

`pirecorder` has already been used successfully in a number of studies, such as to facilitate the high-throughput recording of large numbers of individuals and shoals of fish (Jolles, Boogert, Sridhar, Couzin, & Manica, 2017; Jolles et al., 2019, 2018) and more recently, the autonomous long-term recording of fish each day, every day, for the first four-month of their life. By facilitating and streamlining controlled and automated image and video recordings, I hope `pirecorder` will increasingly help scientists simplify and improve their collection of high quality data, and ultimately thereby enhance their research.

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