HardwareX 1 (2017) 13–21

Contents lists available at ScienceDirect

HardwareX

journal homepage: www.elsevier.com/locate/ohx

An open source automatic feeder for animal experiments

Jinook Oh *[,1], Riccardo Hofer [1], W. Tecumseh Fitch

Cognitive Biology Department, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria

ARTICLE INFO

Article history:
Received 26 June 2016
Received in revised form 6 September 2016

Keywords:
Automatic feeder
Open source hardware
Animal experiments
Operant conditioning

ABSTRACT

Automatic feeders are widely used in animal experiments to dispense an accurate amount of food reward for each trial. Several commercial automatic feeders for animal experiments are available which are specific to certain species and food types. However, it would be beneficial for researchers if they could easily build their own experimental feeders customized for their study species, food types, and other experimental considerations. In this paper, we describe an open source experimental feeder using an Arduino microcontroller. The design of the feeder is focused on simplicity to provide a straight-forward building process and allow custom modifications for various requirements. The cost for building this feeder is less than €200 and we have successfully tested our design with three different food types for pigeons, cats, and marmoset monkeys.

1. Introduction

In cognitive biology, psychology, neuroscience and other disciplines studying animal behavior, many experiments have been conducted using automatic machine feeders [1–4] to coax animals to participate in trials and provide food rewards to facilitate learning processes. Commercial automatic feeders for animal experiments from several companies are widely used. However, each commercial feeder type is specifically designed for a particular animal species and/or a food type. Furthermore, these devices are independently designed without knowledge of any specific animal experiment or experimental paradigm. Fully customized systems such as [5–7] have also been built and used in animal experiments, however, most existing custom solutions are entirely or partially closed-source and again specifically designed for a specific species and/or experiment type. Also, descriptions of hardware components even in open source systems are not systematically described in detail for other researchers to build one. Many animal experiments have specific requirements depending on subject species, specifications of experimental apparatus and other experimental details. Therefore, adjustments to the experimental apparatus or purchases of new devices are often required. Making a device for animal experiments as an open source project would be beneficial to many researchers, especially considering the need for frequent adjustments as well as a desire for reduced cost. To our knowledge, the benefits of open source custom devices have not yet been fully exploited in animal studies, perhaps because building a machine was considered to be a difficult and time-consuming task for biologists, psychologists and other researchers focused on the study of animal behavior. Recently, building a custom machine has become a much more feasible task, thanks to inexpensive, open source microcontrollers, laser cutters, 3D printers and other recently developed "maker" technologies.

* Corresponding author.
E-mail addresses: jinook.oh@univie.ac.at (J. Oh), riccardo.hofer@univie.ac.at (R. Hofer), tecumseh.fitch@univie.ac.at (W.T. Fitch).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.ohx.2016.09.001
2468-0672/

This paper describes an open source automatic feeder for animal experiments. This feeder can be used for most sizes of dry food pellets with the potential modification of a single component; also, it can be built at a low cost by researchers without detailed knowledge of engineering. We built and tested the feeder for three different food types, seeds for pigeons (*Columba livia*), pellets for cats (*Felis catus*) and pellets for common marmoset monkeys (*Callithrix jacchus*), showing that the design is applicable to a range of animal species.

2. Results

All the necessary files to build the feeder including schematic drawing, diagrams, arduino code and testing video files are stored in Open Science Framework (`osf.io/j57dp`) and Github (`github.com/jinook0707/openfeeder`). The feeder, shown in Fig. 1, was tested with three different types of foods shown in Fig. 2. We tested the feeder with each food type for 1000 dispenses and the result is depicted in Fig. 3.

In testing seeds for pigeons, eight errors (no or negligible amount of food was dispensed) occurred because small seeds were temporarily stuck around the dispensing hole and dropped onto the piezo-electric sensor at an inappropriate time. One to two pellets for cats were dispensed at a time. No specific error in cat pellets occurred during this test. In the error cases of pellets for marmoset monkeys, the feeder dispensed two pellets at a time because the piezo-electric sensor failed to sense an impact of a pellet due to its small size and the location of an impact. This error occurred 12 times in total.

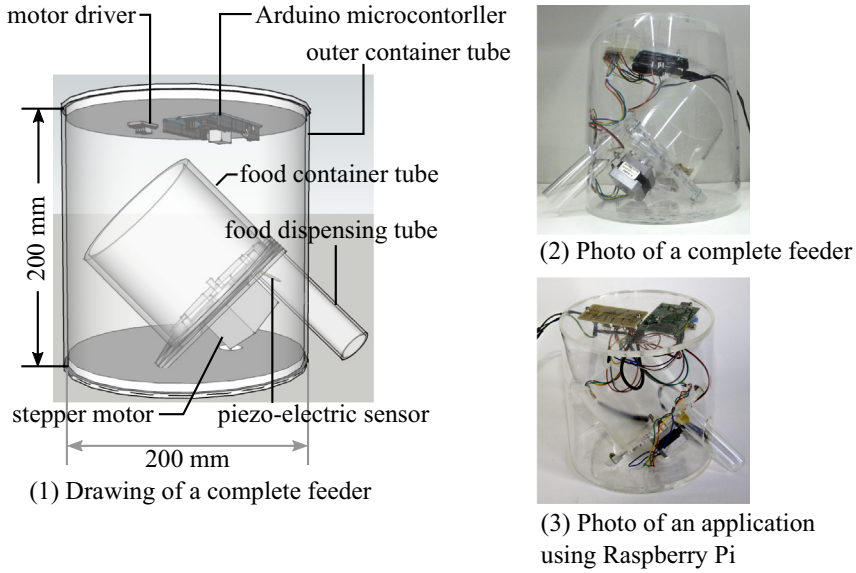

Fig. 1. Complete feeders.

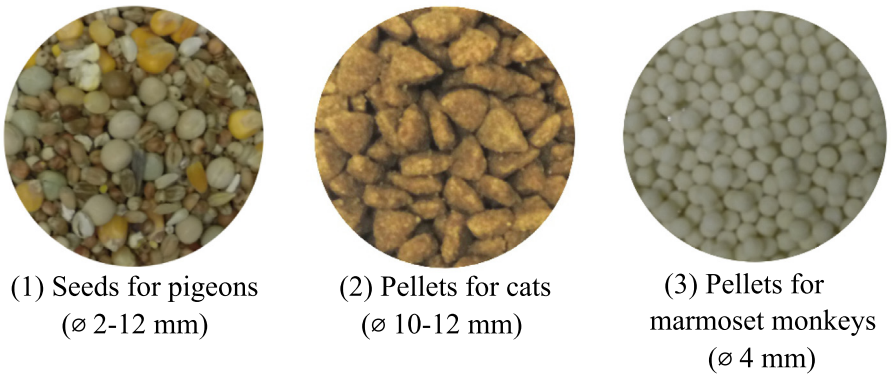

Fig. 2. Three tested food types for three species.