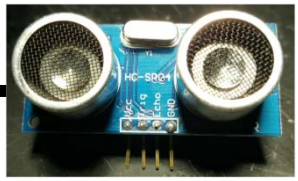
Ponce, Genecin, Perez and Livingstone (2016) – SCHEMATICS (for code, please see Repository at https://github.com/crponce/chairTraining.git)

How we put together our Arduino portable system:

1. We first programmed the Arduino and confirmed that all sensors behaved as expected.
2. We made holes in our monkey chairs to fit the sensors.
3. We built a portable rig using 80/20 Erector set (https://www.8020.net/)
4. We assembled the reward circuit and made sure that water flowed at our preferred levels.

Arduino Uno



HC-SR04 ultrasonic range detectors

Aluminium touch bar (in chair)

AT42QT1010 capacitative touch sensor

20-V solenoid valve circuit and water reservoir

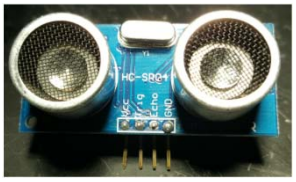
Water reservoir (different view)

1. **Arduino and sensors.** After downloading the Arduino program, practice using sample scripts (File→Scripts). We started with "Blink," copied below. Feel free to review our code (included in this Github repository).

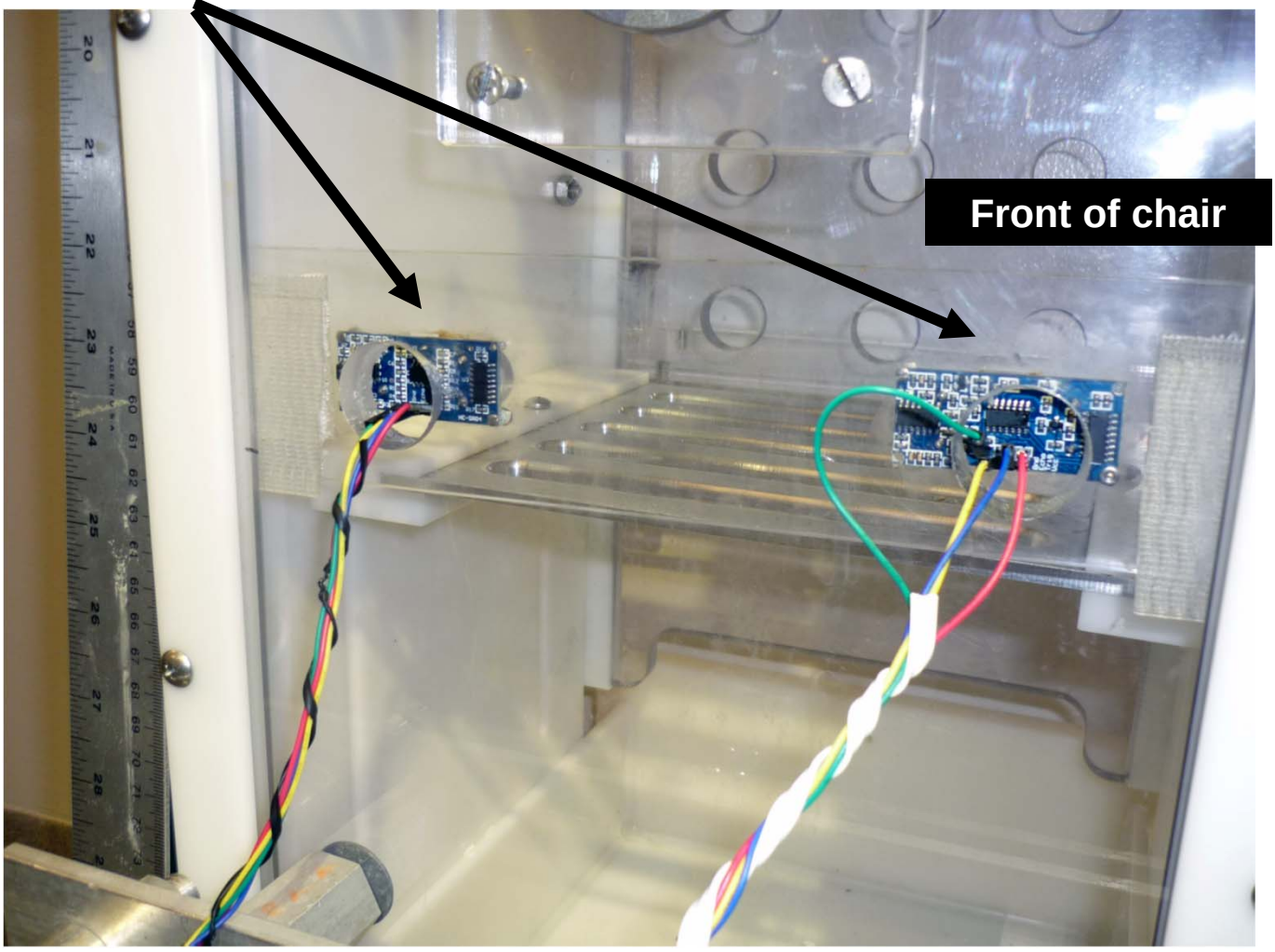
```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

  Most Arduinos have an on-board LED you can control. On the Uno and
  Leonardo, it is attached to digital pin 13. If you're unsure what
  pin the on-board LED is connected to on your Arduino model, check
  the documentation at http://arduino.cc

  This example code is in the public domain.

  modified 8 May 2014
  by Scott Fitzgerald
 */


// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin 13 as an output.
  pinMode(13, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(13, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);              // wait for a second
}
```

2. Prepare the chair for the sensors.

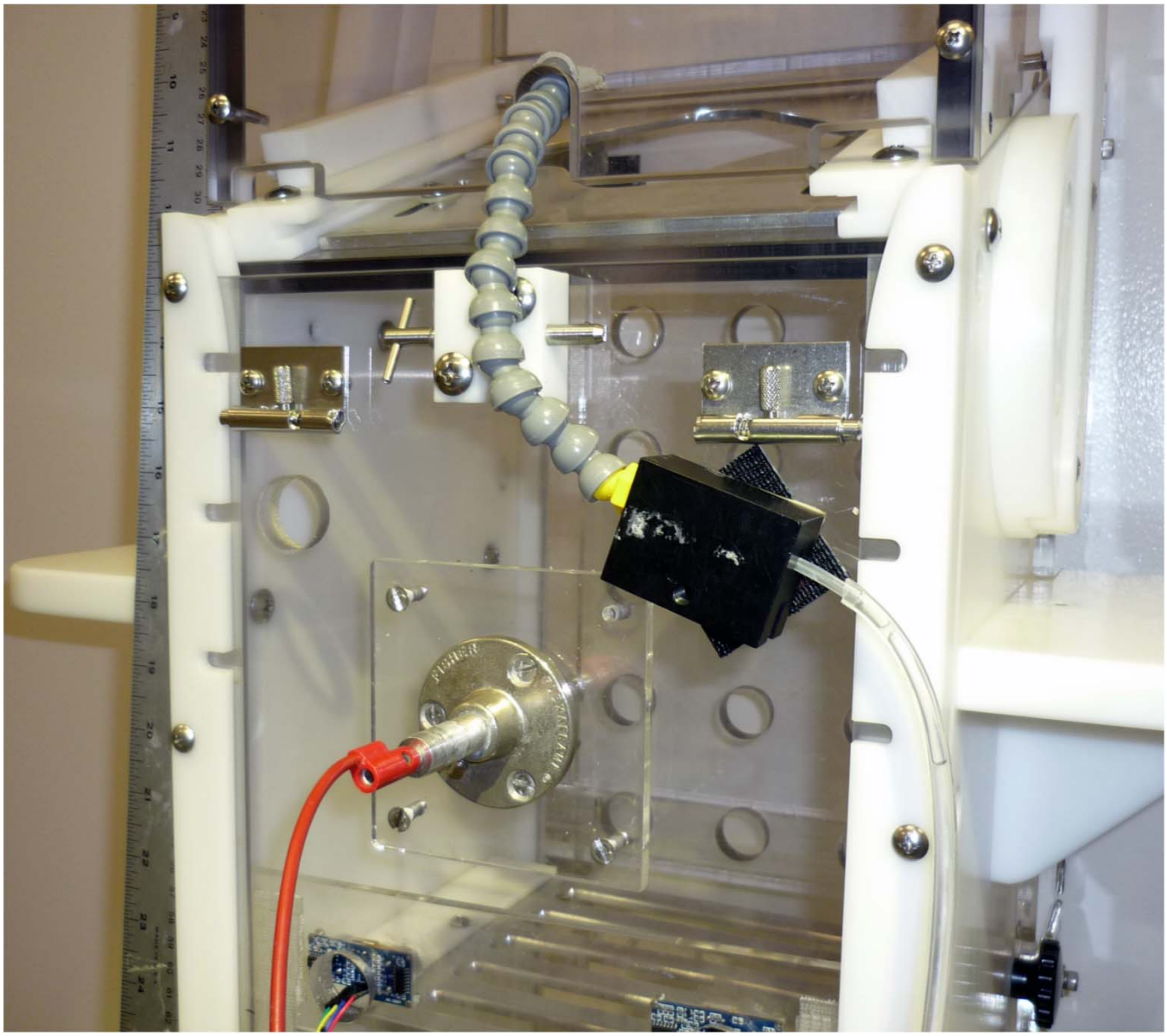
Touch bar in acrylic base: can be fixed to cage or chair



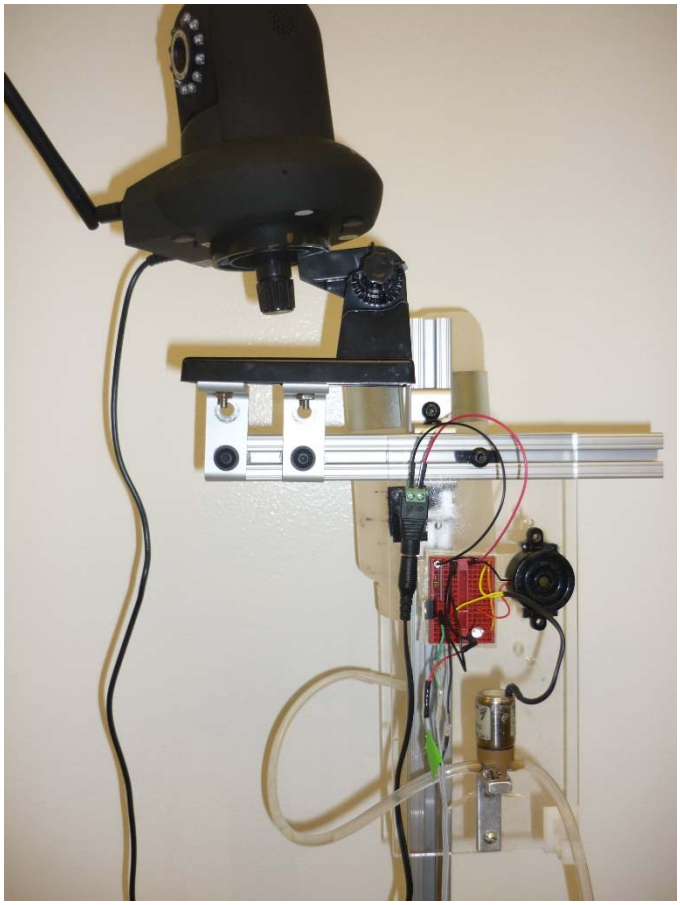
HC-SR04 ultrasonic range detectors



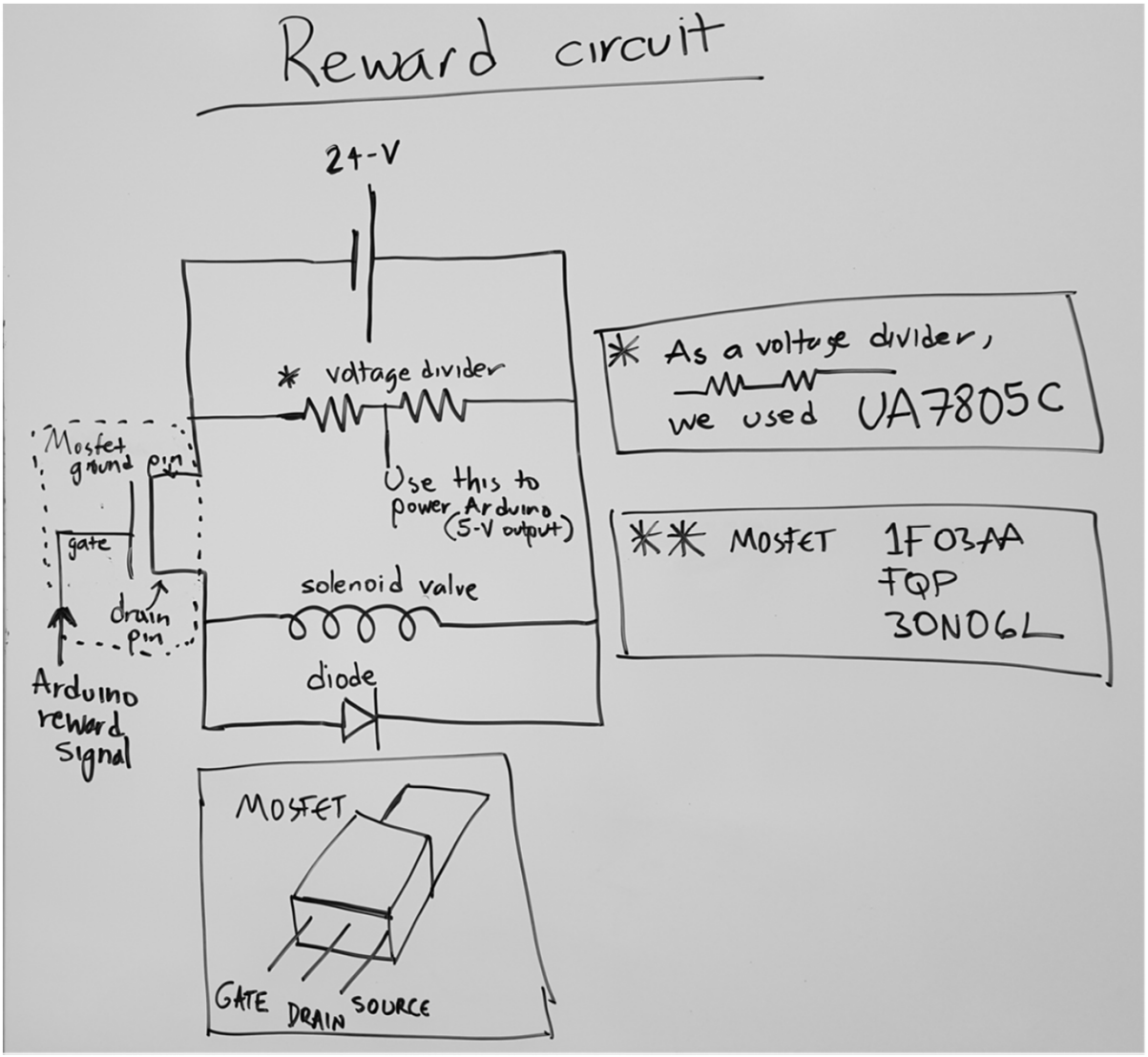
Chair with lixit, touch bar and proximity sensors in place

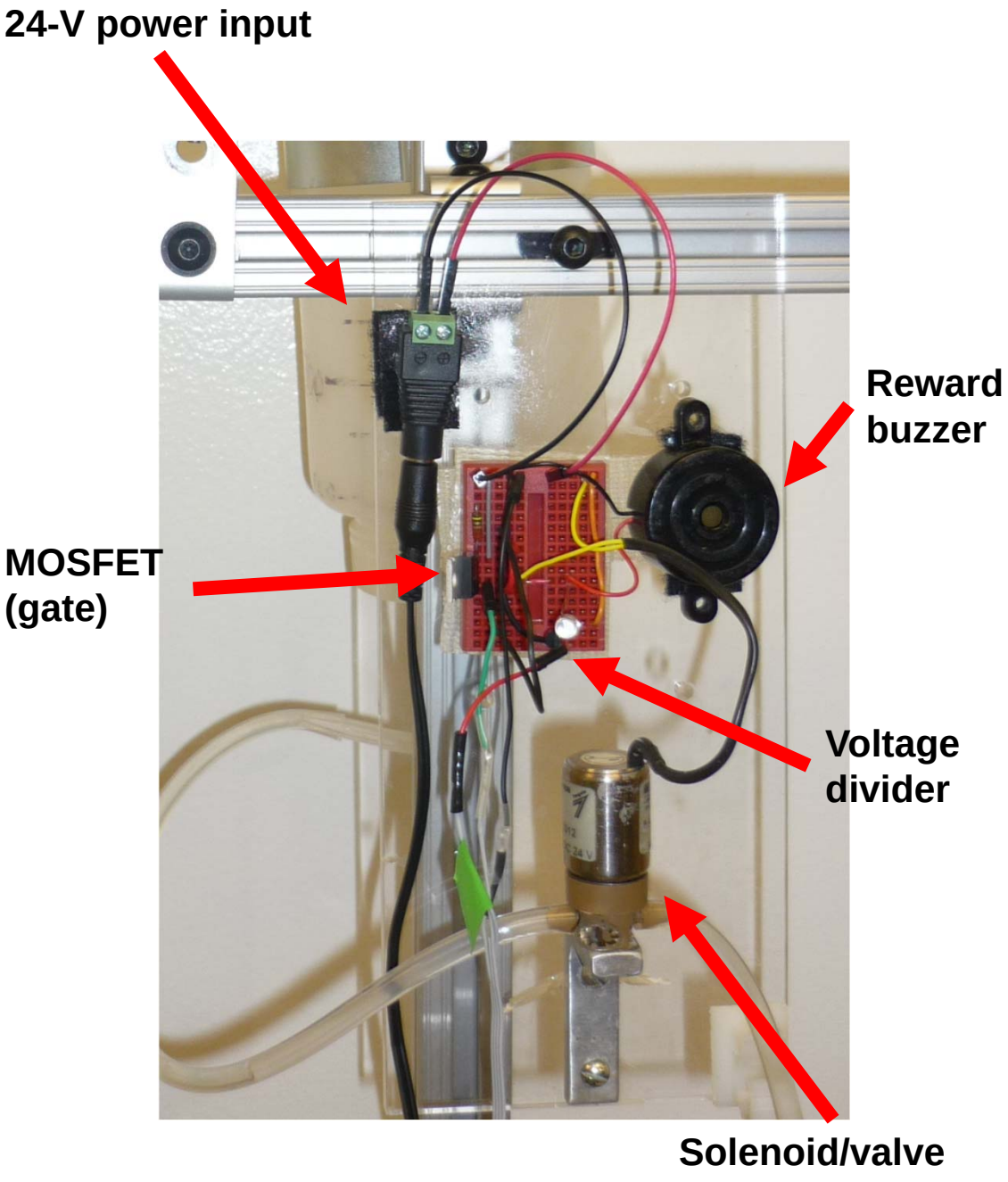


3. Portable rig. We used 80/20 erector set parts to put together a portable rig (https://www.8020.net/). This can be used to hold the water bottle, reward circuit, laptop and camera. The design is guided by personal preferences.

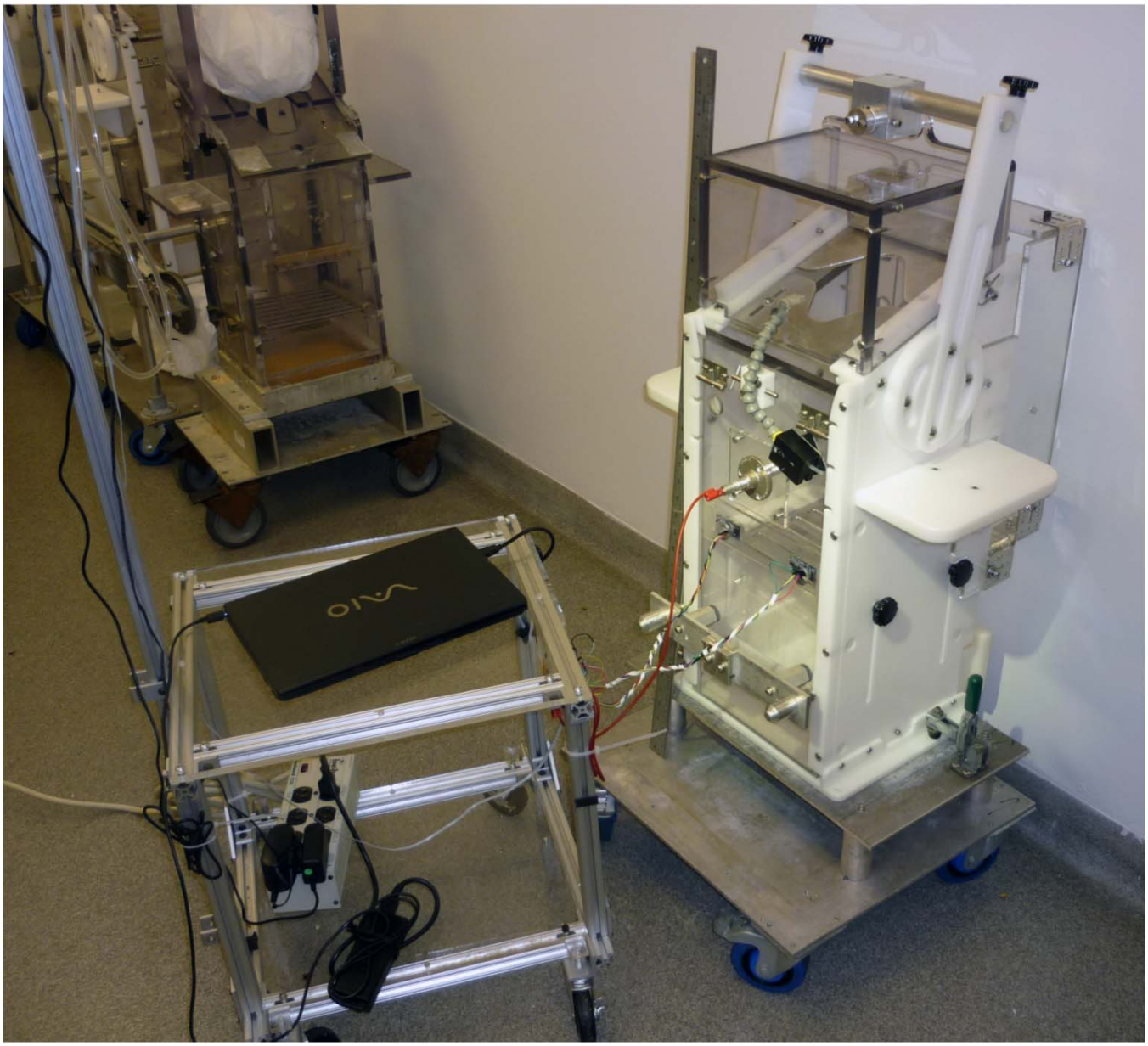


3. Reward circuit. The Arduino and its sensors can be powered by a 5-V source, but the solenoid valve requires a higher voltage (24-V). Thus we built a peripheral circuit that could be activated by the Arduino reward signal pin. The circuit used a MOSFET gate, which conducted current through the solenoid when its 5-V gate was activated by the Arduino output.




24-V power input
Reward buzzer
MOSFET (gate)
Voltage divider
Solenoid/valve

Final setup



Starter kit

Electronics		Approximate cost per unit (USD)
Arduino Uno	http://store-usa.arduino.cc/	30
Capacitive touch sensor (AT42QT1010)	www.sparkfun.com	5-10
Ultrasonic range detectors (HC-SR04)	www.sunfounder.com	5-10
Breadboards, jumpers	www.sparkfun.com	
Microtivity IL611 5mm Diffused RGB Controllable LED, Common Cathode (Pack of 12)	www.amazon.com	6
SYB-170 Color Board Mini Small Bread Board	www.amazon.com	9
Power Adapter for Arduino AC to DC 9V	www.amazon.com	6
Microtivity IB400 400-point Experiment Breadboard	www.amazon.com	5
Solderless Flexible Breadboard Jumper Wires	www.amazon.com	7
Portable rig		
Aluminum T-Slotted Framing Extrusion, Single Profile, 1" Size, Solid	http://www.mcmaster.com/	32
Reusable Nylon Cable Tie Squeeze Release, 8" Long, 2" Max Bundle Dia, Black	http://www.mcmaster.com/	7
Clamping Hanger Galvanized STL W/Bolt & Nut, 3-1/2" ID, 160 lb Cap.	http://www.mcmaster.com/	8
Threaded-Stem Swivel Caster W/Brake, 3/8"-16 Stem, 3" X 13/16" Rubber Whl, 125#Cap	http://www.mcmaster.com/	11
Aluminum T-Slotted Framing Extrusion 90 Degree Bracket	http://www.mcmaster.com/	4
Aluminum T-Slotted Framing Extrusion 90 Degree Plate	http://www.mcmaster.com/	7
Compact End-Feed Fastener, 1/4"-20 Thread for Aluminum T-Slotted Framing Extrusion	http://www.mcmaster.com/	2
Aluminum T-Slotted Framing Extrusion 90 Degree Bracket, Sngl, 2-Hole, for 1-1/2" Extrusion	http://www.mcmaster.com/	4
VWR BOTTLE RED CAP 1000ML (16650-322)	www.vwr.com	7
Wireless IP camera (Foscam FI8910W)	Amazon.com	40
Reward circuit		
Two-way solenoid valve (3-111-900, VAC 50PSIG)	www.parker.com	10
Voltage regulator (497-15681-5-ND)	www.digikey.com	0.6
Gate (FET) transistor (FQP30N06L-ND)	www.digikey.com	1
AC/DC mount adapter 24-V (T1073-P5P-ND)	www.digikey.com	14