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David has been making projects for the Raspberry Pi since the early days. These include a Camera Controller, TimeLapse Rail, Focus Stacker, and even a Bark-Activated Doggy Door Opener. Oh, and let's not forget the PiPhone!

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WATER DROPLET PHOTOGRAPHY

Have you ever wanted to capture those split-second photographs of water droplets colliding? Now you can with a Raspberry Pi-controlled solenoid and camera trigger!

You'll Need

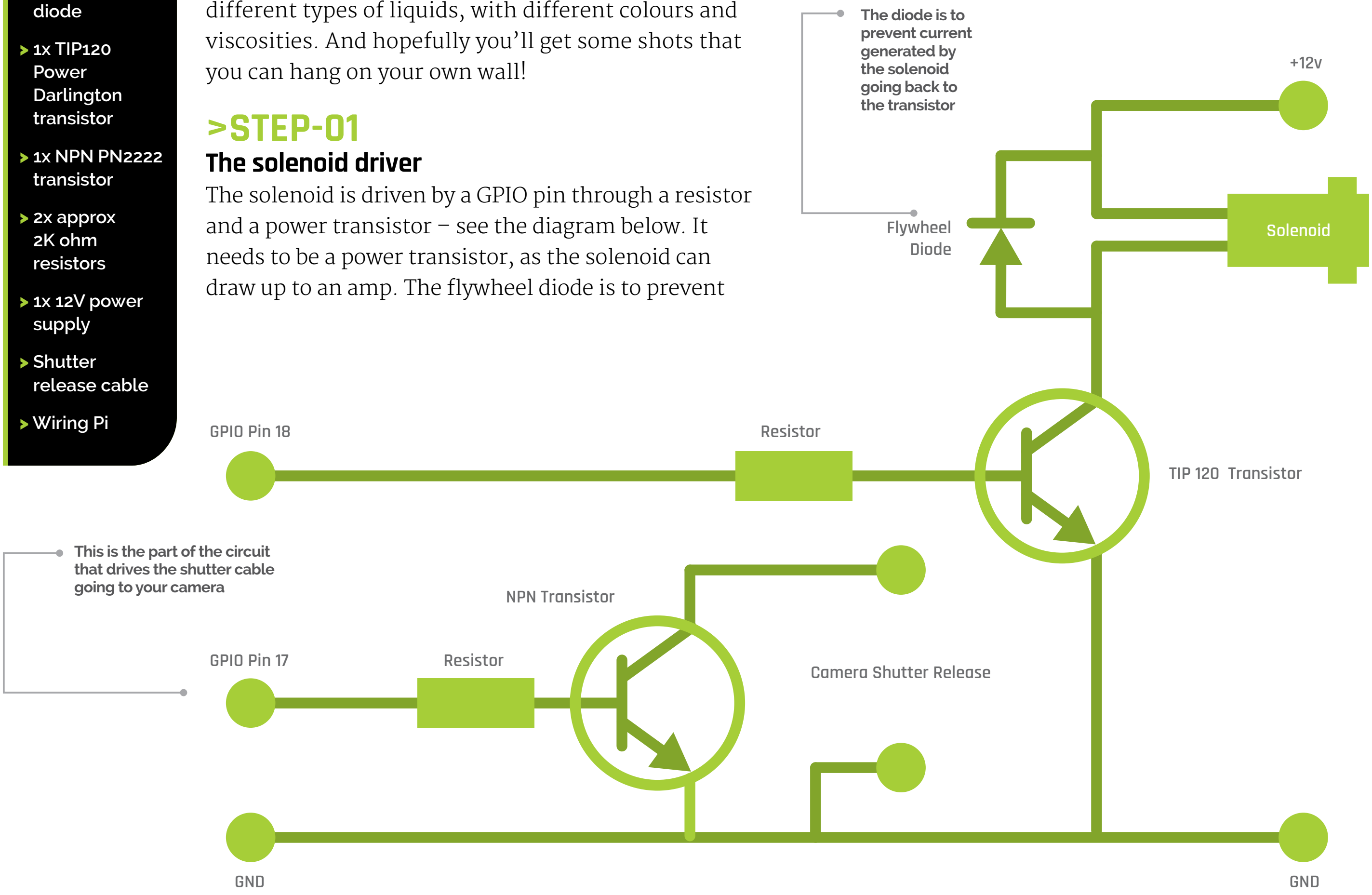
- Solenoid Valve
- 1x IN4001 diode
- 1x TIP120 Power Darlington transistor
- 1x NPN PN2222 transistor
- 2x approx 2K ohm resistors
- 1x 12V power supply
- Shutter release cable
- Wiring Pi

This tutorial shows you how to build a project that will allow you to capture those beautiful, carefully-timed photographs where water droplets are colliding. From assembling the hardware with a solenoid, to writing the code to drive it, you'll be doing your own droplet collision photography in no time. After that, you can have all sorts of fun using different types of liquids, with different colours and viscosities. And hopefully you'll get some shots that you can hang on your own wall!

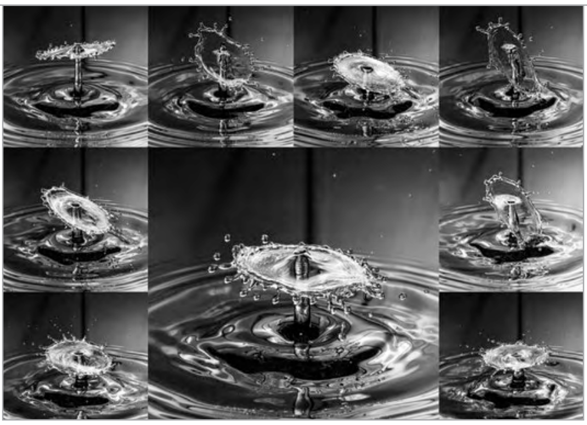
>STEP-01

The solenoid driver

The solenoid is driven by a GPIO pin through a resistor and a power transistor – see the diagram below. It needs to be a power transistor, as the solenoid can draw up to an amp. The flywheel diode is to prevent any current generated by the solenoid from going back into the NPN transistor. Once the GPIO pin goes high, the current can flow from 12V to GND, enabling the solenoid to open the valve and allowing the liquid to pass through. We only open the valve briefly, just enough to allow a drop through at a time.



The diode is to prevent current generated by the solenoid going back to the transistor
+12v
Flywheel Diode
Solenoid
GPIO Pin 18
Resistor
TIP 120 Transistor
This is the part of the circuit that drives the shutter cable going to your camera
NPN Transistor
GPIO Pin 17
Resistor
Camera Shutter Release
GND
GND



Above An example of the type of image that can be achieved

>STEP-02

The camera shutter driver

The camera shutter is triggered by a low-power NPN transistor. DSLRs usually have a shutter release input which is shorted to ground, causing the camera to take a picture. In this project we're using a signal transistor to cause that (usually 3.3V) input to short, so we can get the camera to take a picture from the Python script on our Pi. You'll need to get the correct shutter release for your camera, but they can be sourced on eBay for under £5.

>STEP-03

Setting up the solenoid

This is the messy part! A drinks bottle with a small opening is ideal for attaching to the input of the solenoid. This type is often used for sports drinks, and can usually be pushed onto the solenoid input without any leaks. You can cut the bottle in half for easy top-ups. Apply 12V to the solenoid and you should get a stream of liquid through the valve; remove power and the valve should close. Attach it to the circuit you built in step 1.

>STEP-04

Trigger the camera

Now connect up your camera circuit and test it with the Python code. You will need to adjust the timings to get the camera to trigger at the right moment. But initially, you should hear two clicks of the solenoid and one click of the camera. You can adjust the timing in two ways: by changing the Python code, or altering the distance between the solenoid and the liquid container. In the code provided, the timings were good for a 50cm fall.

>STEP-05

Get the lighting right

You'll need to use a flash to freeze the movement of the liquid. Otherwise you'll get blurred images, even if your camera is on a tripod. An off-camera flashgun triggered by a sync cable is a really good idea, as it allows you to move the flash into all kinds of interesting positions. Oh, and keep the flash power low for shorter flash durations, giving you sharper images. And you can always use two or three flash units at lower power for shorter flashes still.

Drop.py

Code Language
>PYTHON

```python
# Import the relevant Modules
import wiringpi2 #Learn more about this library at wiringpi.com
from time import sleep

# Set up the GPIO Pins
gpio = wiringpi.GPIO(wiringpi.GPIO.WPI_MODE_GPIO)
shutterpin = 17
solenoidpin = 18
gpio.pinMode(shutterpin,gpio.OUTPUT)
gpio.pinMode(solenoidpin,gpio.OUTPUT)
wiringpi.pinMode(shutterpin,1)
wiringpi.pinMode(solenoidpin,1)

# Release a drop of liquid
gpio.digitalWrite(solenoidpin,gpio.HIGH)
sleep(0.06)
gpio.digitalWrite(solenoidpin,gpio.LOW)

sleep(0.1)

# Release a second drop
gpio.digitalWrite(solenoidpin,gpio.HIGH)
sleep(0.05)
gpio.digitalWrite(solenoidpin,gpio.LOW)

# Wait for the droplet to hit the liquid container
sleep(0.12)

# Trigger the camera (which is set to manual mode)
gpio.digitalWrite(shutterpin,gpio.HIGH)
sleep(0.1)
gpio.digitalWrite(shutterpin,gpio.LOW)
```

>STEP-06

Adjust the camera settings

You should be shooting on manual setting, with a shutter speed as high as your camera will allow for flash. For Canons this is about 1/160th of a second, and maybe 1/250th of a second for Nikons. Use ISO 100-400 and then adjust your aperture till you get a decent exposure. You can then tweak the flash power down to get shorter flash durations, which will tend to freeze the motion of the liquid more. Open up the aperture more if you need to, but be aware that your depth-of-field will be reduced.