SUMMER PROJECTS

Let's take this outside

Summer's here, so why don't you unplug your Pi and go outside? Use a battery pack to take your Pi with you, of course! In this issue, we celebrate the great outdoors with twelve ideas you can use to make the most of the (hopefully) good weather. You'll see how to build a weather station, how to launch a high-altitude balloon with a Raspberry Pi tracker, and how to photograph the wildlife in your garden with hidden Pi-powered cameras. If you're a sporty type, we've got some upgrades for your bike or skateboard too. Let's go!

BUILD A WEATHER STATION

PETER KODERMAC
Peter Kodermac is a technology enthusiast from Slovenia. All of his Pis are always hard at work.
raspberryweather.com

Is it me, or is it hot today?

Temperature sensor
The DS18B20 is a waterproof temperature sensor that gives consistent and fast results. You could use the DHT22 sensor instead, which also measures humidity
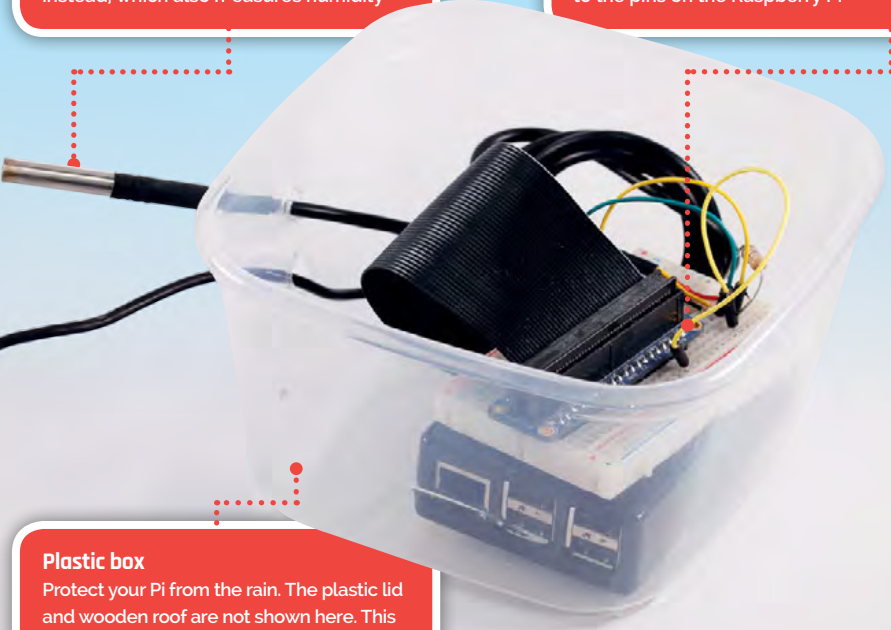
Pi Cobbler breakout cable
The Pi Cobbler breakout cable connects all the GPIO pins to the breadboard, making it easy to connect the sensor to the pins on the Raspberry Pi

Plastic box
Protect your Pi from the rain. The plastic lid and wooden roof are not shown here. This Pi is externally powered, but you could use a sealed box with a battery inside

C ome rain or shine, a weather station makes a great project for your Raspberry Pi. With a budget of around $100, Peter Kodermac built a Pi-powered weather station that captures temperature data, graphs it, and publishes it online. His website provides step-by-step instructions to walk you through the process, which involves some simple wiring, and setting up the Raspberry Pi as a web server.

For the sensor, Peter recommends the DS18B20. It's waterproof and comes with a long cable so you can keep the sensor away from the weather station, which might generate heat. The DS18B20 doesn't measure humidity, so if you want to track humidity, try the DHT22 instead. Peter warns that the DHT22 tends to give less consistent values and can take more than one attempt to get a reading.

YOU'LL NEED

- Raspberry Pi
- Breadboard
- DS18B20 or DHT22 sensor
- Plastic box
- 4.7 kΩ resistor
- Adafruit Pi Cobbler breakout kit (26- or 40-pin)
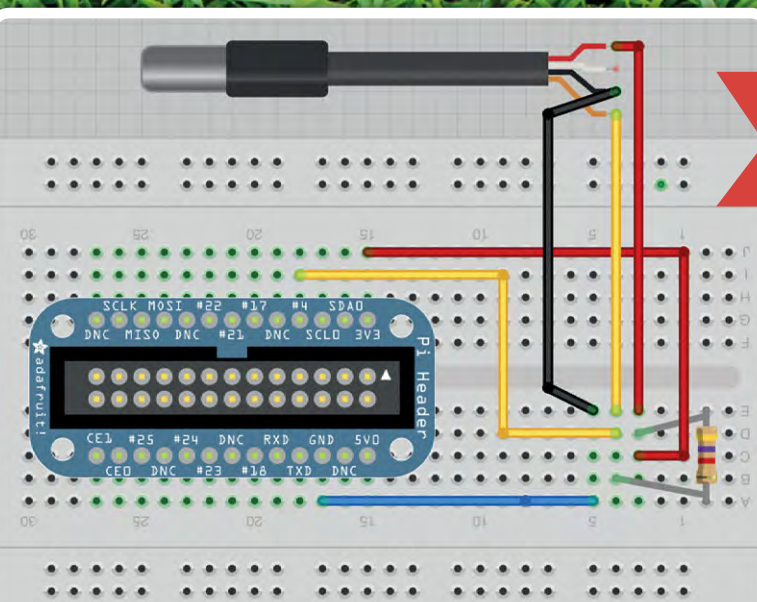
Connecting the sensor to the Pi. Image: Simon Monk (CC-BY 3.0), made with Fritzing v0.7.5. Image is creative commons cc-by (**magpi.cc/2sxjBhu**) from **magpi.cc/2sYABdM**

Peter's code, available through GitHub, is designed to compensate for that, automatically retrying where necessary.

Peter uses a Pi Cobbler breakout cable and a breadboard to make it easy to connect the sensor to the Raspberry Pi. Make sure you buy the correct Cobbler cable for the model of Raspberry Pi you are using! Everything is housed in a plastic food box, with a hole for the power cable to go in, and for the sensor cable to come out. A wooden roof offers shelter, and Peter puts silica gel sachets inside the box to offer additional protection from moisture.

There were several stages involved in setting up the software for Peter's project. First, he installed MySQL and used it to create a database for WordPress, which he uses to store the weather data. Then he installed and configured Apache and WordPress. He installed the Raspberry Weather plugin for WordPress, to generate a graph of the latest temperatures when anybody viewed the webpage. Finally, he used a Python script to query the sensor and put its data into the database, and Cron to schedule the script to run every

30 minutes. "The whole process of setting up a web server can be a bit frustrating at times, but it is totally worth the time and effort," Peter says. "It's just so great to build your site from scratch and see other people visit it and give you feedback!"

Peter has run the project on almost all versions of the Raspberry Pi. "WordPress is a bit of a memory hog, so the website loads more slowly on the Pi Zero, or older versions of the Pi. That's why I also included a neat caching trick to speed up things a bit."

You can also monitor the results on your Android phone, using an application called My Weather Station. It displays the latest data from an XML file, which is updated in parallel with the main WordPress database.

Since Peter shared his weather station design, other makers have added cameras, wind-speed and air-pressure sensors, and are calculating forecasts. If you build one, let Peter know. "I have always felt great pride in publishing links to the people who have completed the guide," he says. "I get a nice fuzzy feeling when other people improve my code, too – all thanks to open source."

THREE WEATHER STATION PROJECTS

MAKE A WEATHER MAP
Even if you don't have a weather station, you can access the database of Pi Weather Station readings, and use it to plot temperatures on a map using Python. **magpi.cc/2sebENH**

USE THE WEATHER STATION HAT
The official Weather Station HAT is being used by schools to record data, including humidity, pressure, and air quality readings, in an Oracle database. **magpi.cc/2tbMCvF**

REPORT THE WEATHER IN SCRATCH
Use Scratch to display your weather data, including a thermometer, along with a visual indicator for wind speed and direction. A Python script is used to feed the data to Scratch. **magpi.cc/2ssQCLK**
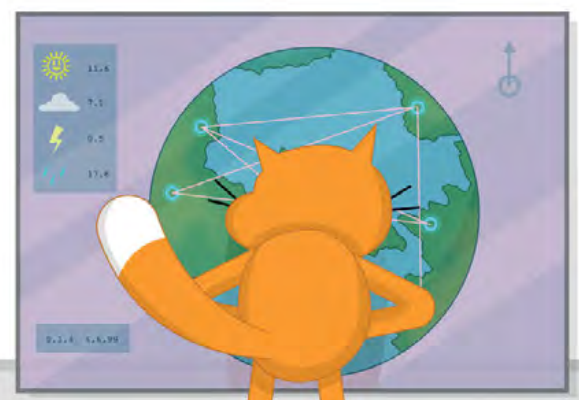
DAVE AKERMAN
Dave Akerman is a high-altitude balloonist who, in his spare time, is a self-employed software engineer working on PCs and embedded solutions.
daveakerman.com

LAUNCH A
RASPBERRY PI BALLOON

Up, up and away: send your Pi sky high!

GET PERMISSION

Before flying your balloon in the UK, you need to request permission from the Civil Aviation Authority at least 28 days in advance. Avoid areas near airports and air shows, and send an email to confirm (or cancel) your plans a few days before launch. Outside the UK, try asking for advice on the #highaltitude IRC channel on Freenode.
Don't launch without permission: you might endanger aircraft.

As Neil Armstrong took a giant leap for mankind, he inspired one boy, watching at home, to send a bear into space.

As an adult, Dave Akerman launched Babbage on a high-altitude balloon with a camera, sending the teddy bear 39 km above the Earth. In a stunt that replicated Felix Baumgartner's record-breaking skydive, Babbage was released for a free fall.

"At that height, there's the slight curvature of the Earth, and the thin blue line of the atmosphere separating the ground below from the blackness of space above," says Dave. "On a clear day, with a wide-angle lens, I've had the whole of southern England from Cornwall to Kent in the same shot."

A high-altitude balloon (HAB) flight works like this: the balloon is filled with hydrogen so it rises at a speed of about 5 m/s. On the line between the payload and the balloon is a parachute, which is pulled closed during the ascent. After a typical flight of

THREE THINGS YOU NEED TO
BUILD A HIGH-ALTITUDE BALLOON

PI IN THE SKY KIT
You can build your own tracking system, but the simplest option is to use the Pi in the Sky kit, which includes the GPS antenna and a radio transmitter.
magpi.cc/2rablQk

CAMERA
Using a Raspberry Pi with the Camera Module, you can program the camera to shoot at certain altitudes only. Don't use a case: it will trap moisture and ruin your images.
magpi.cc/28IjIsz
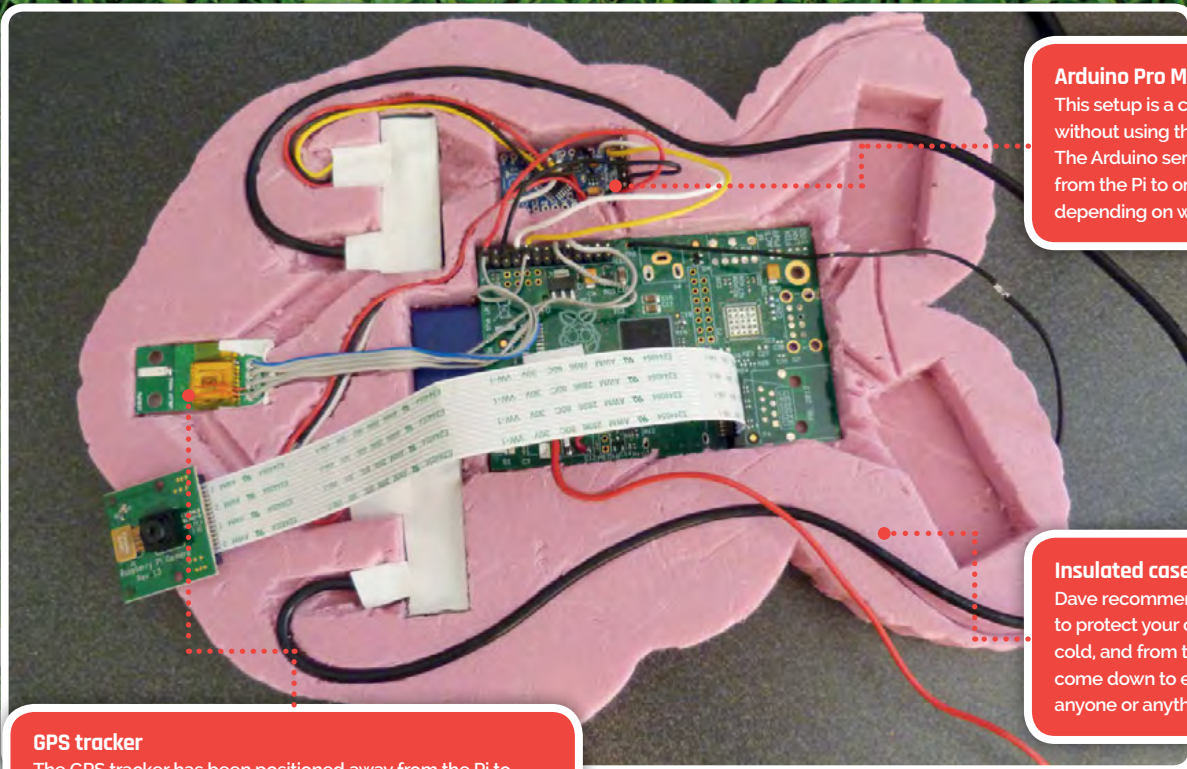
Arduino Pro Mini
This setup is a custom build, created without using the Pi in the Sky kit. The Arduino sends image data from the Pi to one of two radios, depending on which one is available.

Insulated case
Dave recommends plenty of insulation to protect your components from the cold, and from the impact when they come down to earth. It also protects anyone or anything your kit lands on!

GPS tracker
The GPS tracker has been positioned away from the Pi to provide a clear signal. Put your GPS aerial near the top of your container, and make sure it has an unobstructed view.

High-altitude photo from a Raspberry Pi flying over Swindon, looking over Devon and Cornwall

BALLOON
The balloon (shown here bursting) carries your payload. Use the online calculator to work out which size you need: typically 800 g or 1000 g, depending on the weight of your payload.
magpi.cc/2rRPZKr

two to three hours, the balloon bursts at high altitude, and the payload drops. The parachute opens, and the payload returns to the ground. The payload includes a GPS tracker and a radio transmitter so you can follow its journey from the ground, and be ready to recover it. You can also receive images during the flight.

There are several options for the radio transmissions. Most people in the UK use RTTY (Radio Teletype) transmissions, but some also use LoRa, a proprietary long-range radio system that enables images to be downloaded more quickly. In some countries (but not the UK), APRS can be used, if you have an amateur radio licence.

"In the UK we have a widespread network of other hobbyists who will help during the flight, meaning that even if the chase car loses signal (e.g. it's in a tunnel or on the wrong side of a hill) then the rest of the receiver network will fill in the gaps," says Dave. Data from flights is fed into a distributed mapping system called Habhub.

"With a well-tested radio tracker, the chance of not knowing where the payload has landed is pretty close to zero."

Dave started out building his own tracking and transmission systems, but the Pi in the Sky (PITS) kit can now do this for you. Among other things, it enables data from the Sense HAT to be sent back during the flight.

"Some of my flights have had a 3G link at low altitudes (useful for streaming video to YouTube), or have predicted their own landing position during descent," Dave says. "My current project is to use a gliding parachute or parafoil to land at a particular target location, using wind data measured during ascent to feed the guidance algorithm during descent."

Dave advises new launchers to read as much as they can to avoid mistakes others have already made. "Read the UK High Altitude Society website (**ukhas.org.uk**), read various HAB blogs, and join the #highaltitude IRC channel on Freenode and introduce yourself," he says. "Do all three!"
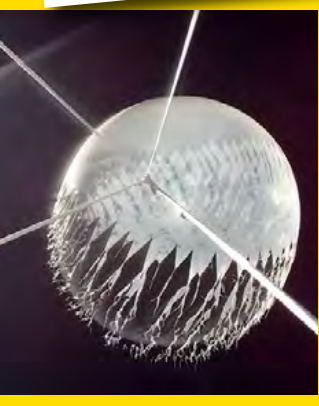
10 GREAT OUTDOOR PROJECTS

Get close to nature, pimp your ride, and see the world differently with these brilliant projects

SUPERSIZE YOUR BIKE COMPUTER

David Schneider replaced the tiny computer on his bike with a Kindle Touch. Reed switches on the wheel and chain ring are used to measure the speed and cadence. The Kindle browser displays the stats, which a GPS-equipped Pi in the saddlebag uploads to a webpage.

magpi.cc/2tcc8ky

GET THE BEST HARVEST

Whether you're growing flowers or veg, Devon Bray's PiPlanter project can help. It automates watering, based on a schedule or soil moisture levels. It also monitors light and temperature, and creates a time-lapse video. Relax on holiday, knowing the plants are cared for, and watch their progress on Twitter.

magpi.cc/2seoFqx

BUILD A MINIBEAST HABITAT

Invite snails or your favourite insects to move into a new home. Computing teacher Allen Heard and his son Lincoln made a Minecraft-themed minibeast habitat from a cereal box. A webcam connected to a Raspberry Pi streams video to the iCamViewer iOS app.
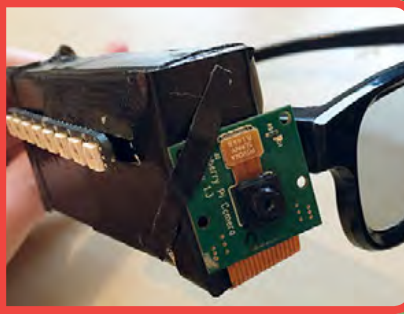
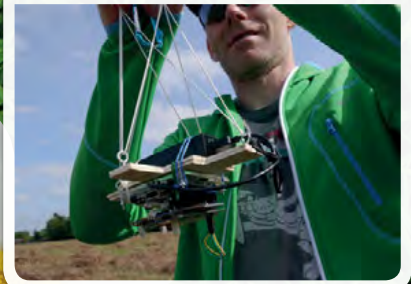**magpi.cc/2stfDq6**

BUILD A WEARABLE CAMERA

With these glasses, you can capture everything you see, automatically taking a photo every 30 seconds. A Raspberry Pi Zero inside the box controls a Camera Module, and an optional Blinkt! module flashes when a shot is taken. Cherry-pick your best shots, or turn them all into a film.
magpi.cc/2rhBbl6

WATCH THE WILDLIFE

Photograph passing squirrels, woodpeckers, and partridges with the Naturebytes Wildlife Camera Kit (see our review in issue 48). It uses a movement sensor to snap pictures of passing birds and animals, and has a green case so it blends in with your foliage.
naturebytes.org

FLY A KITE

Want a cheaper way to take aerial photos? Richard Hayler sent a Raspberry Pi up on a kite. He used the Xtrinsic Sensor Board to measure altitude, the Camera Module to take photos, and **mapknitter.org** to combine the aerial shots. At maximum resolution with image stabilisation, the photos look great.
magpi.cc/2s26F0a

BROADCAST BIG BROTHER FOR BIRDS

Discover the secret life of birds, with this project to add an infrared camera to a bird box. When the blue tits move in, the Pi NoIR Camera Module can video them in black and white, by the light of an infrared LED. You can then stream your footage to YouTube.
magpi.cc/2c8P2rr

TAKE YOUR PI ANYWHERE

The Zero LiPo device (see our review in issue 51) enables you to safely power your Raspberry Pi from a battery pack (sold separately). Despite the name, it works with the Raspberry Pi 3, 2, B+, A+, Zero, and Zero W. What will you make with a portable Pi?
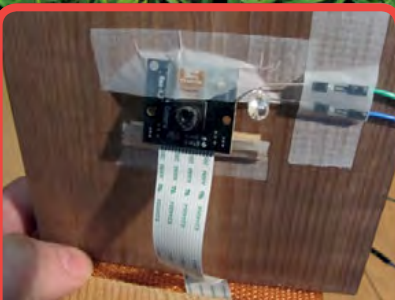**magpi.cc/2c0JyZ2**

MAKE SPINNING FLOWERS

If the weather forces you into the great indoors, you can bring nature inside by making your own spinning flowers. Use the Explorer HAT with a motor and mount your own flower design on the wheel. The code is in Python, and this makes a great first motor project.
magpi.cc/2ralmNy

MOTORISE YOUR SKATEBOARD

Put some zip into your trips around town with an electric skateboard. YouTuber TheRaspberryPiGuy used a Raspberry Pi Zero to control an Alien Power System motor, and a Wii Remote to control the speed and acceleration over Bluetooth. He hit speeds as fast as 30 km/h, and he says the range is at least 10 km.
magpi.cc/2oyuWrU