Proximity warning for the blind

This Raspberry Pi-based device informs a blind person about the distance to nearby objects using sound and vibration.

The idea is to mount it on a cane, as shown in the accompanying diagram. It automatically measures the distance to the nearest object in front of the cane and reads it out to the user. It also vibrates the handle if that distance is below one of two programmed thresholds.

There isn't much to this circuit. Besides the Raspberry Pi, it uses the ubiquitous HC-SR04 ultrasonic distance measurement module, a DS18B20 1-wire digital temperature sensor, MCP23008 I/O expander module, alphanumeric LCD module (admittedly not very useful to the blind person!), two 5V DC coil relays with driving transistors and back-EMF quenching diodes, plus a small speaker or pair of earphones.

The relays drive two vibration units which are basically unbalanced motors which produce noticeable shaking when they are powered from 5V. These are often used in mobile phones and can be purchased cheaply online.

The LCD screen and I/O expander could be left off and the device will still work; they are primarily debugging aids. The I/O expander is controlled from the Raspberry Pi over an I^{2}C bus and is used so that the Pi's 3.3V outputs can drive the LCD which runs from 5V.

The I^{2}C address for IC1 is set to 0x20 by tying its pins A0-A2 to ground; if you change these connections, you also need to modify the contents of the file named lcd23008.py to match (more on the software later).

Similarly to the July 2019 project on Speech Synthesis with a Raspberry Pi Zero (siliconchip.com.au/Article/11703), this project uses the "espeak" software for speech synthesis. This allows it to convert measured distances into spoken words for the blind person to hear.

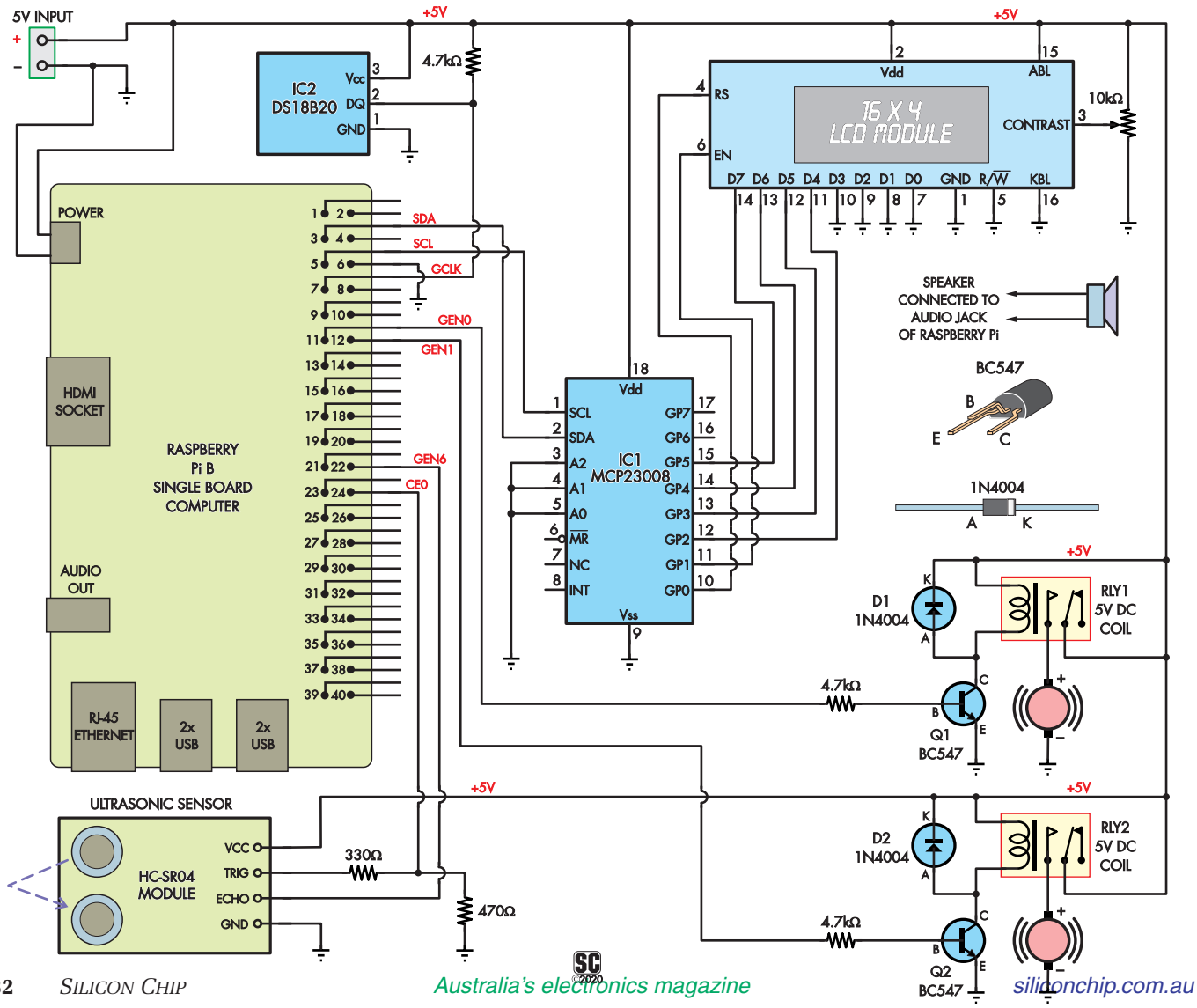
To install espeak on a freshly installed Raspberry Pi, use the following sequence of commands:

```
sudo apt-get update
sudo apt-get upgrade
sudo apt-get install alsa-utils
  mplayer espeak espeak-gui
sudo 'echo snd_bcm2835>>/etc/
  modules'
sudo reboot
```

Once the Pi has rebooted, connect a speaker or earphones/headphones to its audio output and then use the following command to check that espeak is working:

```
espeak "Testing: 1, 2, 3"
```

The other software that we need is "rpi-gpio". You can download and



install the latest version from: https://pypi.org/project/RPi.GPIO/

In operation, the Raspberry Pi software continually checks the output of the ultrasonic distance sensor. If it changes by more than about 2cm, it uses espeak to read out the new distance measurement. The sensor responds to objects in an arc approximately 15° either side of its primary axis, up to around 2m away.

The software is written in Python and consists of four .py files, all of which are contained within a ZIP package which can be downloaded from siliconchip.com.au/Shop/6

Copy this onto your Raspberry Pi "/home/pi" folder and unzip it.

If you are using a speaker or earphones with built-in volume control, the default audio volume level should be suitable.

Otherwise, open up the ultra3.py file in a text editor to change the volume setting to something more reasonable. Look for the line with the value "-a220" and change the number. "-a200" is full volume; increasing the value after the "a" lowers the volume. You can then test it by running the following command:

```
sudo python /home/pi/ultra3.py
```

It takes a little time to initialise the first time you run it. You will hear a greeting message, and then the program goes into a loop, measuring the distance and reporting it if it changes.

If the measurement is over 2m (essentially, upon first detection), then pin 11 (GPIO 17) goes high, energising RLY1 and causing one vibration motor to spin. If the measurement is below 1m then pin 12 (GPIO 18) goes high, energising RLY2 and causing the other vibration motor to spin. You can change these thresholds in the software files.

The reason for the different thresholds is to give the user an early warning when an object is first detected in their path, then a more urgent warning when they get closer to that object. The two motors can be located such that the user can distinguish where the vibration is coming from.

You can set the software to start automatically after the Raspberry Pi has finished booting by adding the following line to the bottom of the "/etc/rc.local file", before the exit line:

```
sudo python /home/pi/ultra3.py
```

The whole thing can be powered from a 6V rechargeable battery, either lead-acid battery or NiCad (4-5 cells).

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Vindhyanagar, India. ($80)