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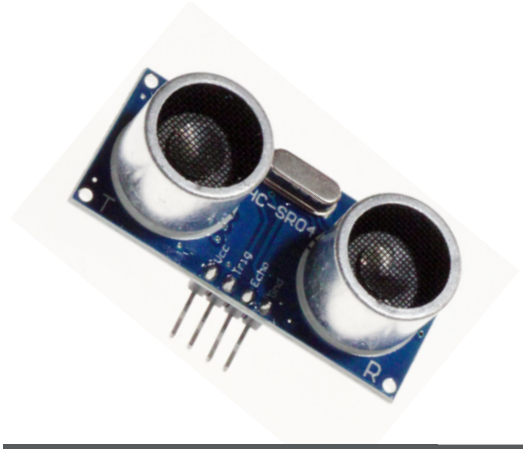
Ultrasonic distance sensor



Goal: Use of a distance sensor

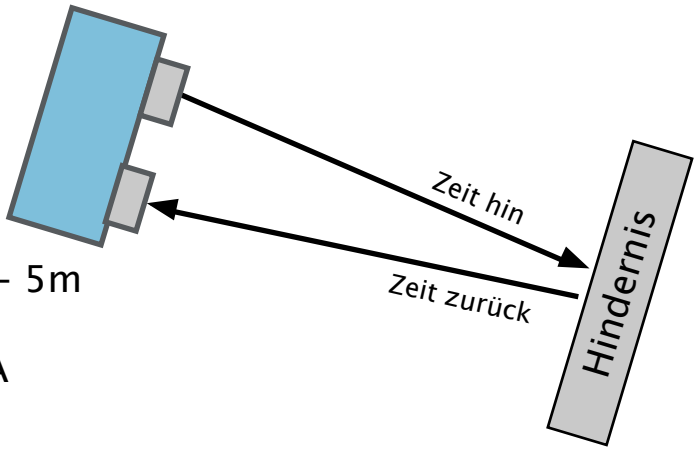
Contents: Function and data (HC-SR04)
Possible application
Theory
Programming

Function

An ultrasonic distance sensor measures its distance to an obstacle or object. This is realised by emission of an ultrasonic signal which cannot be heard by humans and is then reflected by the obstacle. The distance is then determined depending on the time between emission and reception.

Data (HC-SR04)

Supply Voltage:	5V
Accuracy:	3mm
Measuring range:	2cm – 5m
Measuring angle:	15°C
Power consumption:	15mA
Max. measurements/second:	50



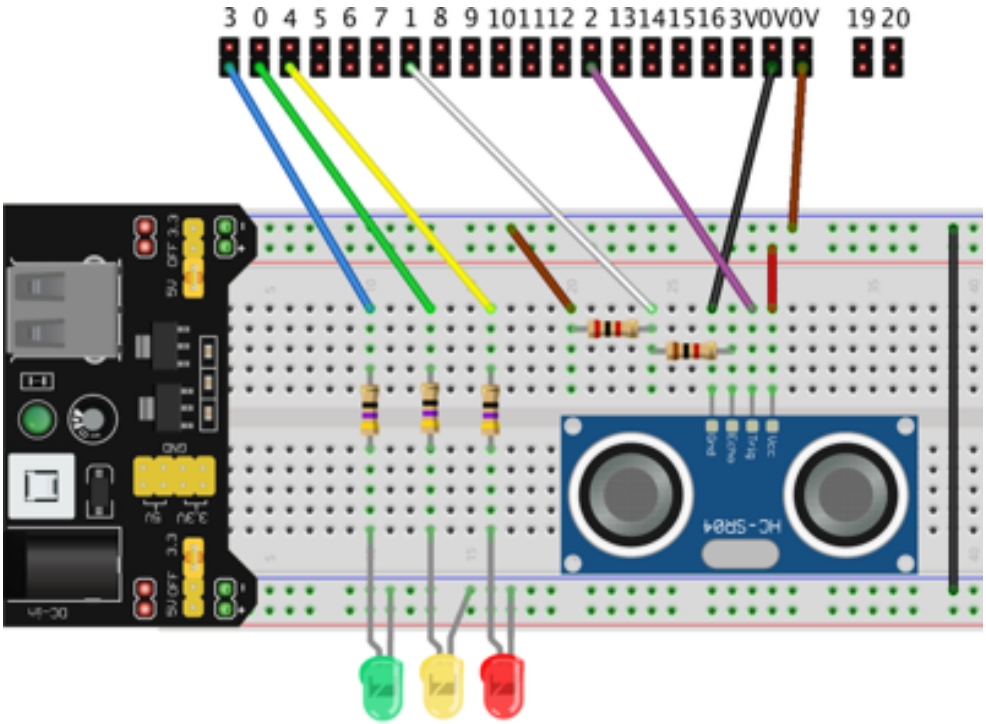
Possible application

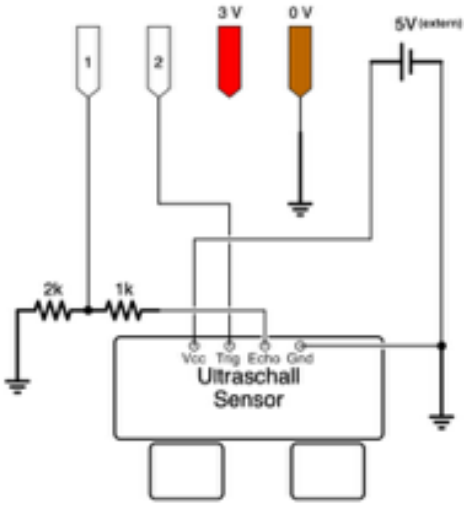
Car parking assistance: Depending on the distance between the bumper and the obstacle, a sound signal with different length is emitted to support parking in narrow spaces.

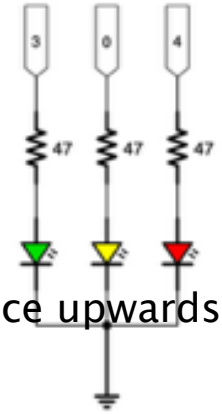
Industrial applications: Some machinery (e.g. CNC milling machine) carry out an automatic tool change (milling cutter). This requires distance sensors with a very high accuracy (1/100mm).

Filling level indicator: As the sensor also enables recognition of fluids, it can also be used to indicate filling levels (e.g. water in a well).

Circuit set-up



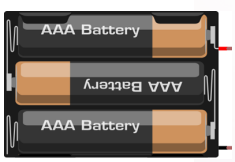


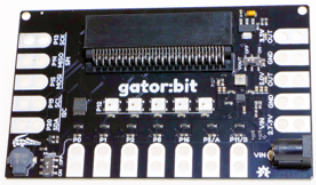


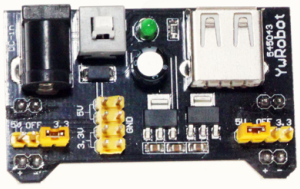
- Position the LEDs as illustrated. The long pins (anodes) face upwards towards the series resistors. The short pins (cathodes) are routed to the common Gnd (– pole).
- The long pins are routed to the output pins of the Micro Bit via series resistors (47 Ohm).
  [**Blue cable – Pin3** I **Green – Pin0** I **Yellow cable – Pin4**]
- Plug the ultrasonic module on the breadboard and connect the Gnd to the common ground or the 0V pin of the Micro Bit, and the VCC pin via the red cable to 5V of the external voltage source.
  [**Black cable – 0V** I **Red cable – 5V external**]
- Afterwards, the echo pin is connected to pin 1 and the trig pin to pin 0.
- For the voltage divider, as illustrated, a 1kOhm resistor is positioned on the right and a 2kOhm resistor on the left. The common centre is connected to pin 1 with the white cable. The end of the voltage divider is connected with the brown cable to the common ground.
- In the end, the 2 ground bars (Gnd – 0V) are connected to the Micro Bit.
  [**Black cable – 0V**]

Info

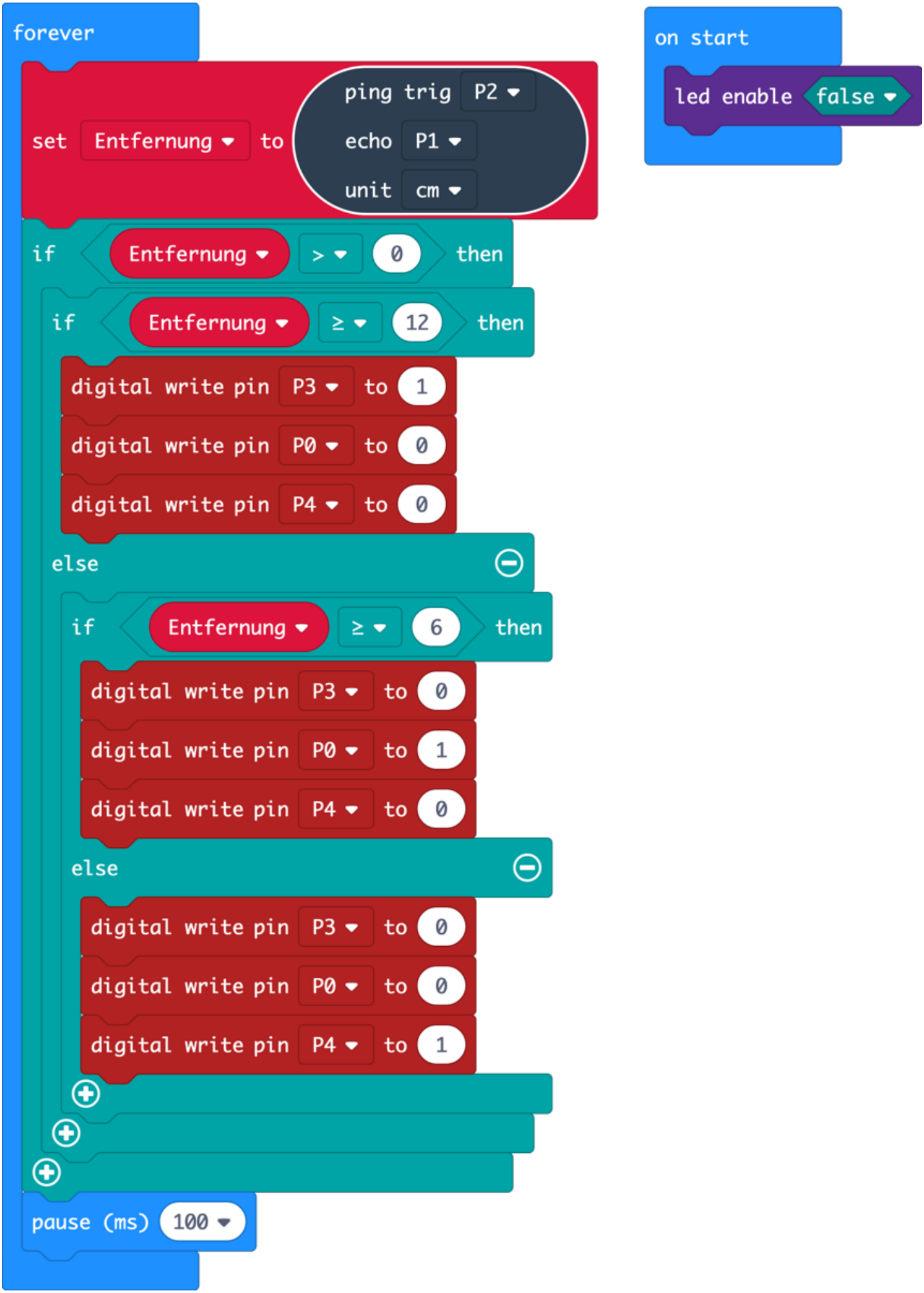
The ultrasonic module requires 5V supply voltage. For this reason, an external voltage source must be used. This can be a power supply for the breadboard (see top), a battery combination, a power bank, a PSU, a breakout board for the Micro Bit etc.







Program code



Information on block code

- In the variable "Distance", settings for the module ar made.
- Trig pin is connected to pin 2.
- Echo pin is connected to pin 1.
- Unit is cm (optionally, inch).

As the pins 3.0 and 4 used for the LED are overlapping with the display, the display must be deactivated with "led enable (false)".

If a distance is recognised (over 0cm) ...

If distance > 12cm …

LEDs activation:
green on - yellow/red off

If distance > 6cm ...

LEDs activation:
yellow on - green/red off

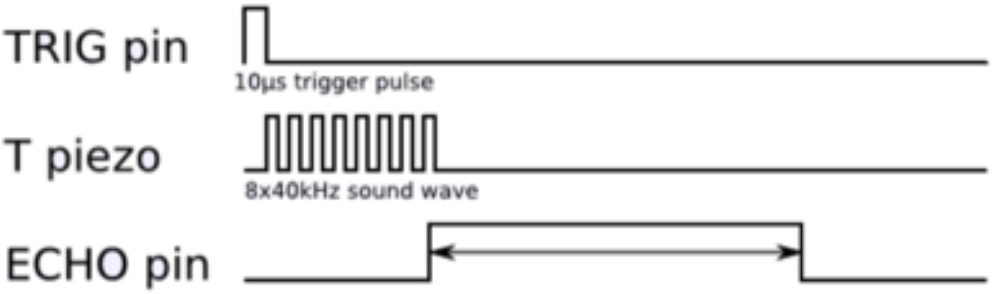
If distance < 6cm ...

LEDs activation:
red on - green/yellow off

Theory

Besides the 2 pins for power supply (5V and Gnd), there are 2 more pins – TRIG and ECHO.
While the measurement is initiated by the trigger, successfully recognised measurements are detected by the echo pin to

Sequence



The measuring process starts with a high pulse at the TRIG pin for 10 µs (10 microseconds).
This is followed by automatic sending of a 4kHz signal of 8 pulses by the ultrasonic module.
Afterwards, the ECHO output is set to HIGH and waits for the echo signal (reflected sound waves). If an echo is recognised, the ECHO output is reset to LOW. The time passed in between is proportional to the distance.

Calculation

The measured distance can be calculated with the following

Distance = (Spedd of sound * runtime) / 2 [m,s]
(as the sound is travelling the way there and back, division by 2 is needed)

The speed of sound is approx. 340 m/s =>
Distance = (340m * runtime(in s)) / 2
Distance = (34cm * runtime(in ms) / 2
Distance [cm] = runtime(in ms) * 17

Please note

The speed of sound depends on the temperature. This means, the temperature must be taken into account in the formula for precise calculation of the distance:

Speed of sound = 331,5 + temperature * 0,6 m/s
Speed of sound (20°C) = 331,5 + 20*0,6 = 343,5 m/s