Specs of the Project “How to build a simple Thermocycler” at SHDB 2015

The aim of the project was to build a thermocycler (https://en.wikipedia.org/wiki/Thermal_cycler) by drilling some holes into an aluminium block and gluing the aluminium block to 2 peltier elements (https://en.wikipedia.org/wiki/Peltier_element) and a CPU cooler. The peltier elements are controlled by a H bridge circuit (https://en.wikipedia.org/wiki/H_bridge) and a Raspberry Pi. The temperature of the aluminium block is probed by a temperature sensor.

Caveat:

- The temperature sensor didn't fit into the PCR tube. A digital probe thermometer probing liquid in a PCR tube could be used to adjust the temperature between the temperature of the aluminium block and the temperature in the liquid.
- The thermocycler lacks a heating lid. A thermal pad could be used for heating up the top of the PCR tubes.
- Build it at own risk

BOM (Bill of Materials):

- Heating block. Aluminium 40x40 mm x 25mm EN AW 6060 (1 pc.)
- Peltier elements: https://www.sparkfun.com/products/10080 (2 pcs.)
- CPU cooler: http://www.alpenfoehn.de/en/cpu-cooler/brocken-eco (1 pc.)
- Thermal Adhesive: http://www.arcticsilver.com/arctic_silver_thermal_adhesive.htm (1 pc.)
- For H bridge circuit to control the peltiers (http://www.bristolwatch.com/ele/h_bridge.htm see Figure 7):
    - N-Channel MOSFET http://www.irf.com/product-info/datasheets/data/irlb8721pbf.pdf (2 pcs.)
    - P-channel MOSFET https://www.fairchildsemi.com/datasheets/FQ/FQPF27P06.pdf (2 pcs)
    - Optocoupler http://www.vishay.com/docs/83717/4n35x.pdf (2 pcs.)
    - Resistors:
        - 220 (2 pcs.)
        - 10k (2 pcs.)
    - Added a 10A fuse (ESKA 5x20 10A flink) http://eska-fuses.de/
- Temperature sensor: DS18B20 waterproof. https://learn.adafruit.com/adafruits-raspberry-pi-lesson-11-ds18b20-temperature-sensing
    - Resistor: 4.7k (1 pc.)
- For circuit to control the Fan (https://electronics.stackexchange.com/questions/17116/how-to-drive-a-mosfet-with-an-optocoupler/17122#17122):
    - Optocoupler http://www.vishay.com/docs/83717/4n35x.pdf (1 pc.)
    - n-Channel MOSFET http://www.irf.com/product-info/datasheets/data/irlb8721pbf.pdf (1 pc.)
    - Resistors:
        - 220 (1 pc.)
        - 10k (1 pc.)
- ATX power supply unit
- Raspberry Pi

How the device was built:

1. Started by drilling 9 (3 x 3) holes into one of the 40x40 mm surfaces of the heating block (diameter 5mm, depth ~ 1cm). The centre hole had a diameter of 6mm, depth ~ 1.5 cm to fit in the temperature sensor.

2. Assembled the 3 circuits (H bridge, fan control, temperature sensor) on a breadboard[1]. AWG28 jumper wires were used for connections.

3. Glued the flat 40x40 mm surface of the heating block onto the first peltier onto the second peltier onto the fan. The red wires of the two peltier were facing left if looked from above and wires pointing towards oneself. The adhesive consists of 2 components A and B. Mixed some adhesive 1:1 and glued it within minutes (see http://www.arcticsilver.com/pdf/appinstruct/asta/ins_asepxy.pdf). Let it cure for several hours.
    - http://www.bristolwatch.com/ele/moshbridge/MOSFETH.png
      Connected the 2 peltier elements in parallel in the position of the 'M' depicted in the circuit. (https://electronics.stackexchange.com/questions/53139/peltier-generators-series-vs-parallel)
    - https://electronics.stackexchange.com/questions/17116/how-to-drive-a-mosfet-with-an-optocoupler/17122#17122 (adapted using an optocoupler and a n-channel MOSFET)
    - https://learn.adafruit.com/adafruits-raspberry-pi-lesson-11-ds18b20-temperature-sensing

4. The H bridge was connected to two GPIO pins and GND of Raspberry Pi (see http://www.raspberrypi-spy.co.uk/2012/06/simple-guide-to-the-rpi-gpio-header-and-pins/ for pin layout). The fan control circuit was connected to one GPIO pin and GND of the Raspberry Pi . The H-bridge and fan control circuit was connected to 12V (yellow) and GND (black) of a +12V rail of the power supply (see https://en.wikipedia.org/w/index.php?title=Power_supply_unit_%28computer%29&oldid=688071544#Wiring_diagrams)

5. Programmed it using Python by adjusting the gpiooutput.py of the book raspberry Pi User Guide. Changed the state of the two GPIO pins of the H bridge for heating, cooling, turning off and the state one GPIO pin of the fan control circuit to turning on, turning off the fan. Measured the temperature of the heating block and plotted it using matplotlib.

Todo: Test it using DNA, mastermix and primers

Thanks for the projects we could use some ideas from.

Some more advanced thermocyclers:

http://openpcr.org/ OpenPCR (https://en.wikipedia.org/wiki/Do-it-yourself_biology#Open_source_equipment)
http://pcr.tori.st/index.php/Main_Page NinjaPCR

1 The breadboard may not be intended for high current
see https://en.wikipedia.org/w/index.php?title=Breadboard&oldid=687324135#Typical_specifications. Soldering the circuit to a stripboard may be preferred. A current of ~ 2.6A was measured at the input of the circuit of peltier and fan.