

STEMSEL Beginners Project 6: Temperature Controller

Problem

In some situations it is very important to be able to control the temperature. We want to use our microchip to check and adjust the temperature.

Background

There are many situations where it is important to control the temperature. We use air-conditioning and heating to keep our homes at a nice temperature, and the fridge should be kept cold enough that the food doesn't spoil but not so cold that the food freezes. One application where it is even more important to control the temperature is in an incubator. Incubators are used to keep bird eggs or human babies warm and safe until they are big enough to survive the outside world. If the temperature changes too much then the baby or the chicks could die, so it is vitally important to control the temperature accurately.

Ideas

How can we check the temperature? What can we use to make it cooler? What about to make it hotter?

Plan

This project uses the STEMSEL controller board to maintain the temperature of a temperature sensor by either heating it with a light globe or cooling it with a fan. You may think it's strange to heat something up with a lightbulb, but the way a lightbulb works is to heat a tiny wire up until it glows to emit light. Because of this, lightbulbs give out even more heat energy than light energy!

Once again we will need a threshold value, but how will we know what the temperature is? We can actually use the microchip to first check the initial temperature then keep the thermistor at that temperature. This will need to be done right at the start of the program, then we need to continually check how the temperature changes and turn on the lightbulb or fan as necessary.

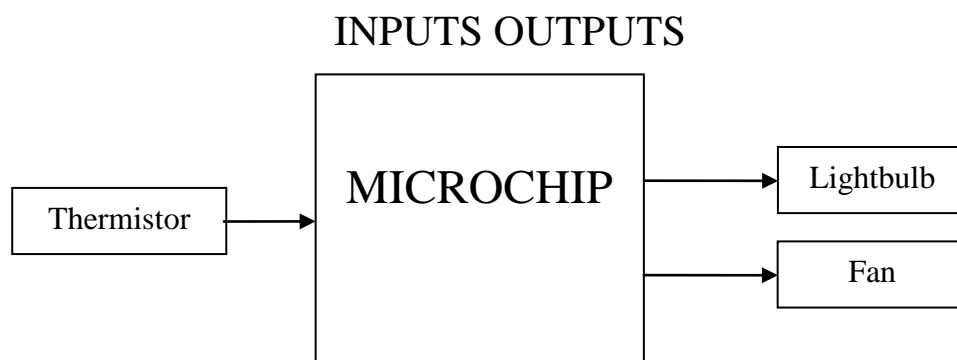


Figure 1

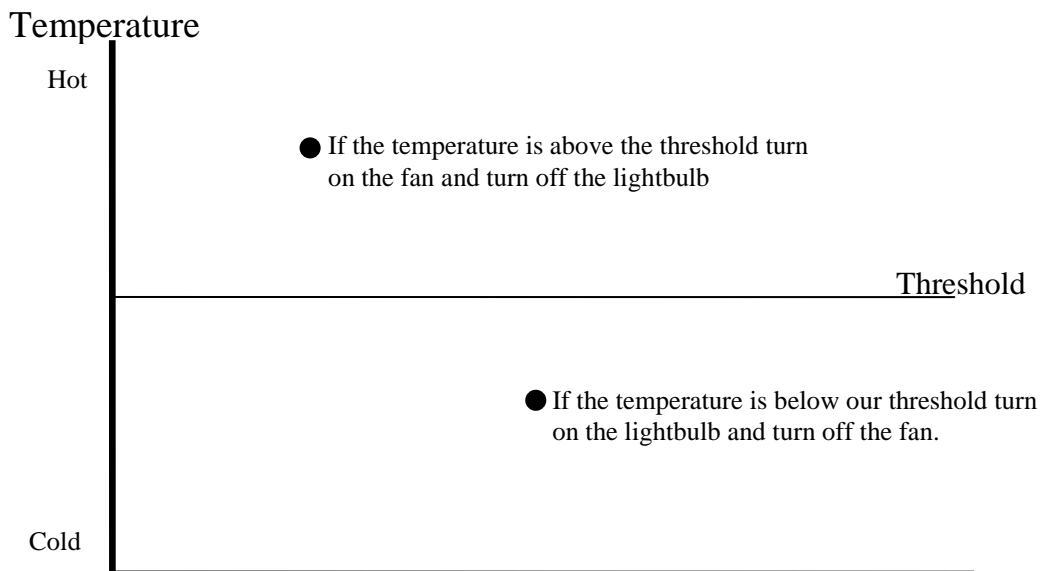


Figure 2

Design the Circuit

Use ezCircuit Designer to construct an input/output (I/O) diagram. Driver icons can be used for both the lightbulb and the fan. Right click to change the names of the components.

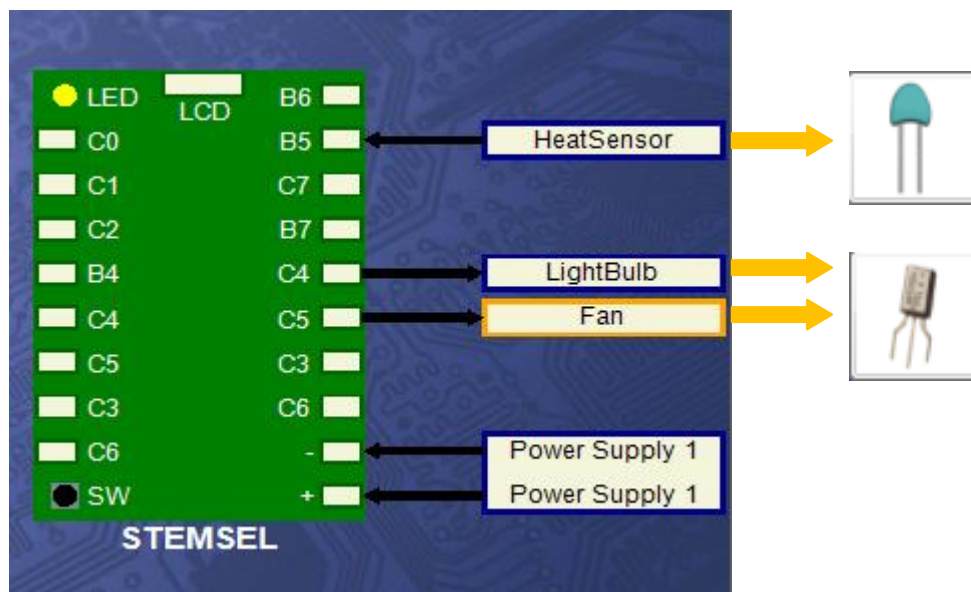


Figure 3

Build the Circuit

Use the ezCircuit Designer I/O diagram to connect the hardware. Red wires go into positive (+), black wires go into negative (-) and white wires go into the pin specified in the circuit design. One of the white wires from the fan should go into C5, and the other into the negative pin.

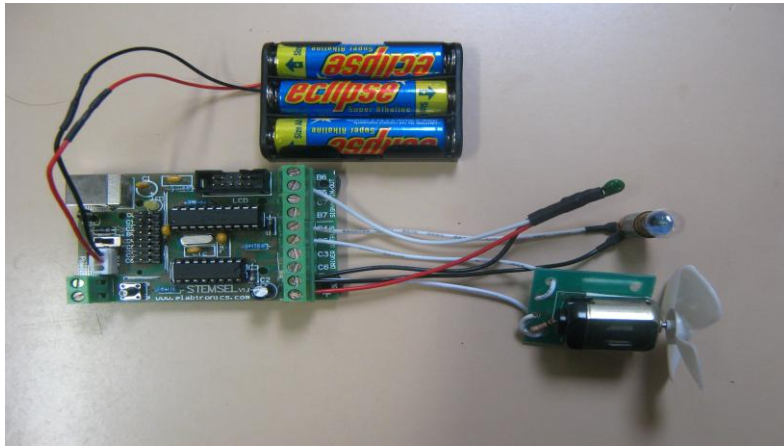


Figure 4

Programming

Use CoreChart to program the functions of the temperature controller. After you have used the test routines to check the outputs, delete them so that we can start writing our own program.

1. According to our plan, we need to first read the initial temperature and use it as our set point. Use an AnalogIn icon to save the reading from HeatSensor as Initial_Temp.
2. Add 2 to Initial_Temp and save it as Initial_Temp again.
3. We will not want to continually reset Initial_Temp, so add an address called Again. When we reach the end of the program we will loop back to this address, not START.
4. Use another AnalogIn to read the current temperature and save it as RESULT.
5. Now we need to check if the temperature is hotter or colder than the threshold we set. Use a Compare icon to compare RESULT with Initial_Temp. Tick both the Above and Below checkboxes.
6. We can see from the graph we made in the plan that if the current temperature is below our set temperature, then it is too cold and we need to warm it up, so turn the lightbulb on. We also don't want it getting any colder, so make sure the fan is off. Group these icons together so they fit underneath the decision icon.
7. Similarly, if the current temperature is above our set temperature, then it is too hot so turn the fan on. We also don't want it getting any hotter, so make sure the lightbulb is off. Group these icons together so they fit underneath the decision icon.
8. Add a short time delay of 20 HUNDREDTHS of a second to give the temperature a bit of time to change.
9. We want the program to go back and check the temperature again, so add a GoTo icon, but make sure it is going back to the Again address and not to START.
10. Your finished program should look like the following. Send it to the chip and check it works.

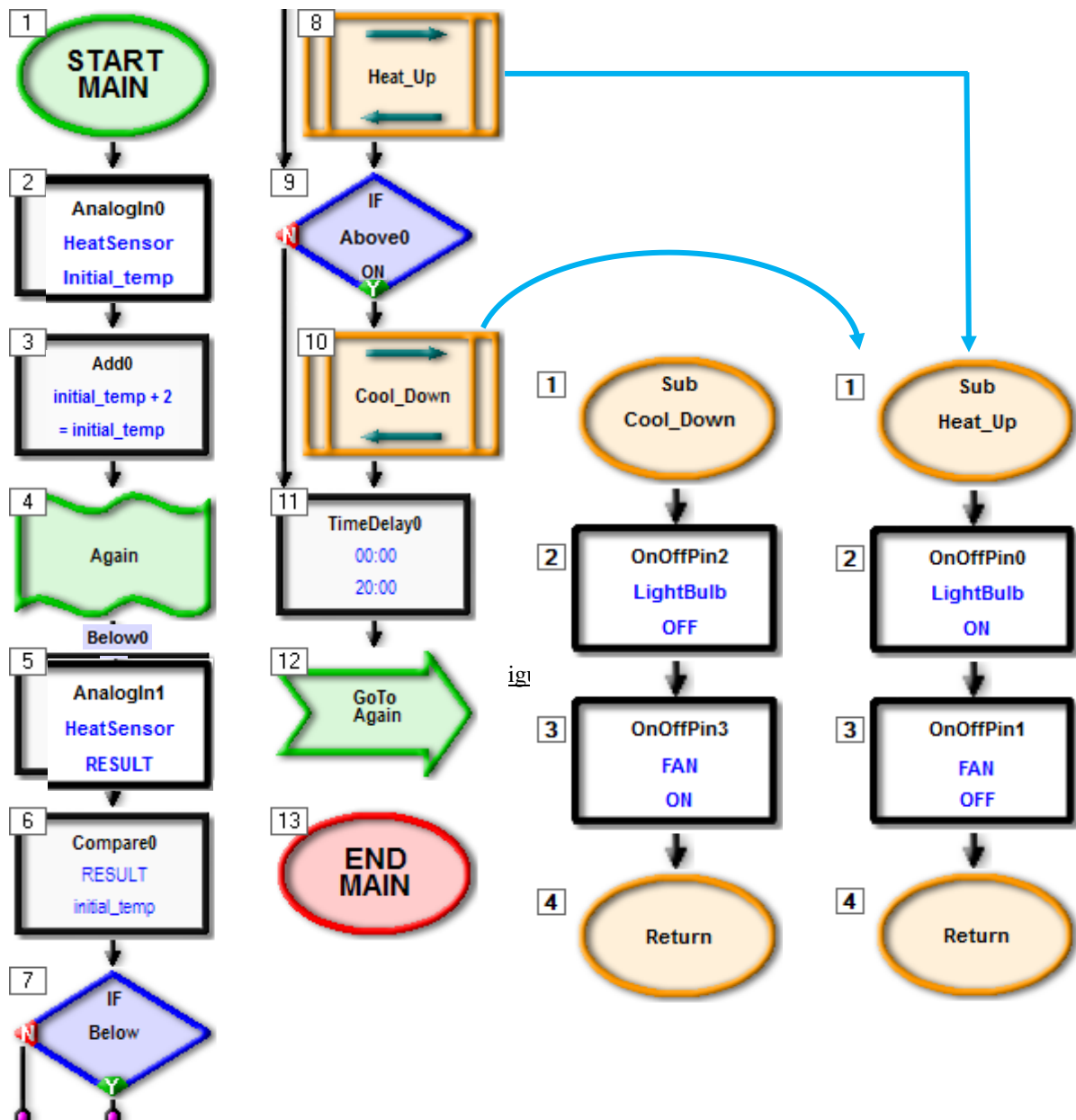


Figure 5

Extension

Currently the temperature controller has only one single set point. It means that either the globe heater or the fan cooler is on at any one time which is wasteful of energy. Less energy will be used if the controller has upper and lower temperature set points.

Modify the program so that the heater is only on when the temperature is below the lower temperature set point and the fan cooler is only on when the temperature is above the upper temperature set point.

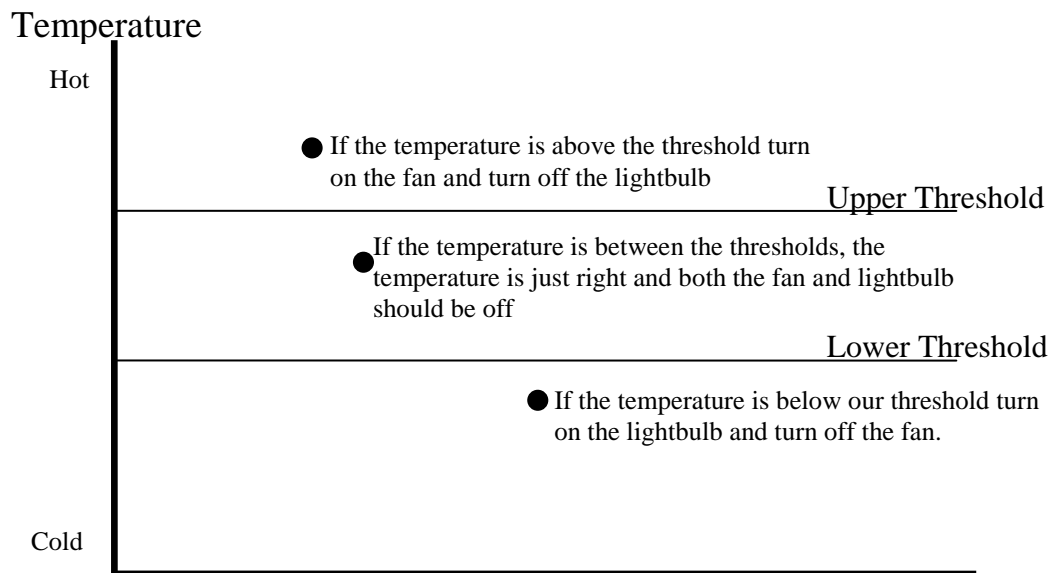


Figure 6

Summary

Although it is uncomfortable for us to be too hot or too cold, for a baby it can easily be life threatening. Therefore it is important that the incubators that keep them alive have very accurate temperature control. Our temperature controller turns on a lightbulb to heat up the incubator, and uses a fan to cool it down again.