

STEMSEL Beginners Project 3: Washing Machine Control

Problem

Many machines need to perform steps in a specific order to perform their tasks. We want to investigate this by making a washing machine.

Background

Before the invention of the washing machine, it was necessary to wash all our clothes by hand. Now we can just put the clothes and washing detergent in and go off and do other things while the machine does the job for us. However, it is necessary for the machine to do the right steps in the right order. After all, it would be no good if the machine tried to spin the clothes dry first, then added the water! Many other devices around the home need to perform tasks in the right order, such as microwaves, dishwashers, and bread makers. Machines that perform a step-by-step process are also used in industry, such as in bottling plants and car factories. Can you think of any other machines that need to have a step-by-step process?

Ideas

What are the steps we need our washing machine to perform? How can we show each of these processes using our kits?

Plan

The user will need to put the dirty clothes and detergent in, so the first thing we want our washing machine to do is fill the tub with water, then to wash the clothes by spinning the tub back and forth. Once the clothes are washed, the washing machine should pump out the dirty water. We may then want to add a rinse cycle or a spin cycle to our washing machine.

This project uses the STEMSEL controller board, a yellow LED (on board), a red LED, and an electric motor. The washing machine controller will start a wash cycle by pumping water into the washing machine, indicated by a yellow LED. The motor will then turn in one direction and pause, turn in the opposite direction, pause and repeat five times to “wash” the clothes. After that the water will be pumped out indicated by a red LED.

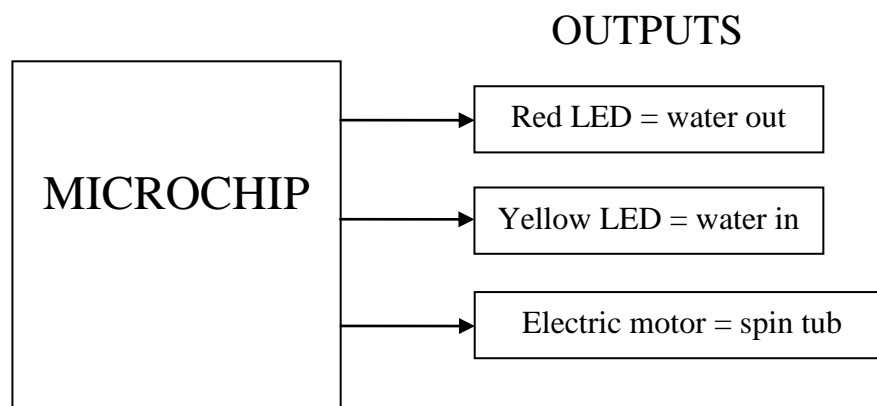


Figure 1

Design the Circuit

Use ezCircuit Designer to construct an input/output (I/O) diagram. Remember to right click to rename the components.

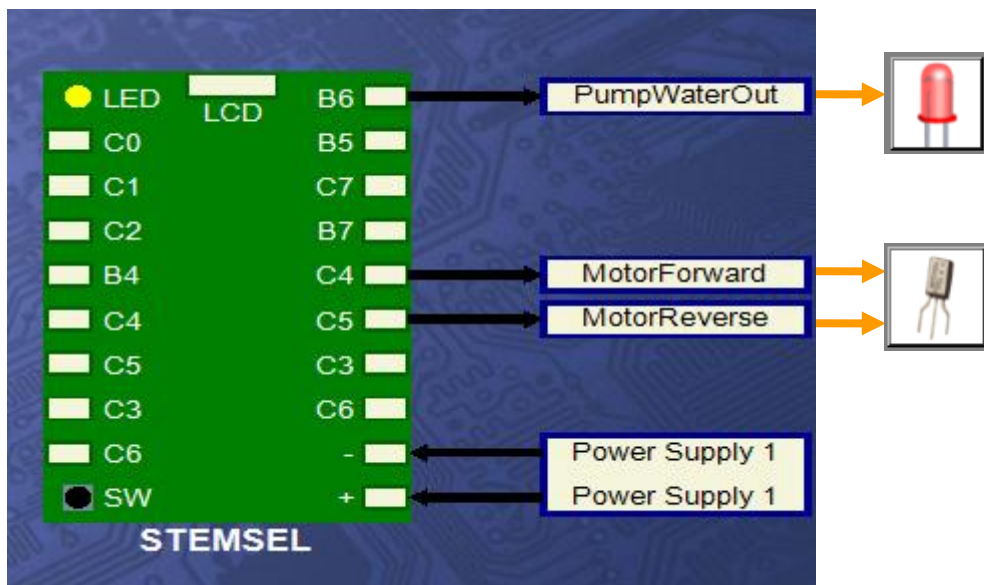


Figure 2

Build the Circuit

Use the ezCircuit Designer I/O diagram to connect the hardware. The black wire from the PumpWaterOut LED goes in the negative (-) port, and the white wire in B6. The two wires from the motor go into C4 and C5 respectively so that we can control the motor's direction.

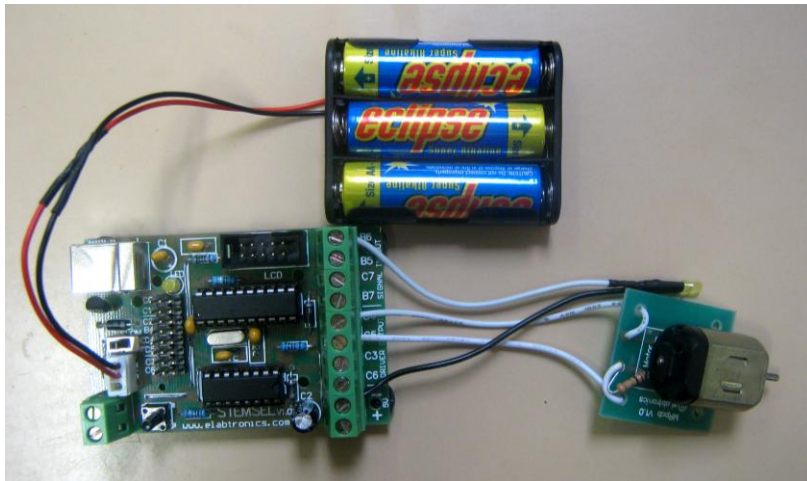


Figure 3

Programming

Use CoreChart to program the functions of the washing machine. 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, the first step is to fill the washing machine up with water, which we will show using the on-board C0_YellowLED. Use OnOffPin and TimeDelay icons to turn on the C0_YellowLED for 5 seconds, then turn it off again.

2. Group the filling routine into one group by clicking the first OnOffPin icon, then while holding the Shift key click the last OnOffPin icon. Then click the Group button and name it Fill_Water.
3. Spin the tub to wash the clothes by using OnOffPin and TimeDelay icons to turn MotorForward on for 10 seconds. Group these icons together into a subroutine called Wash_Cycle
4. Now the water needs to be pumped out again. Turn on the PumpWaterOut LED for 5 seconds to empty the tub. Once again group these icons together into a group called Pump_Water_Out.
5. Send the program to chip and check it.

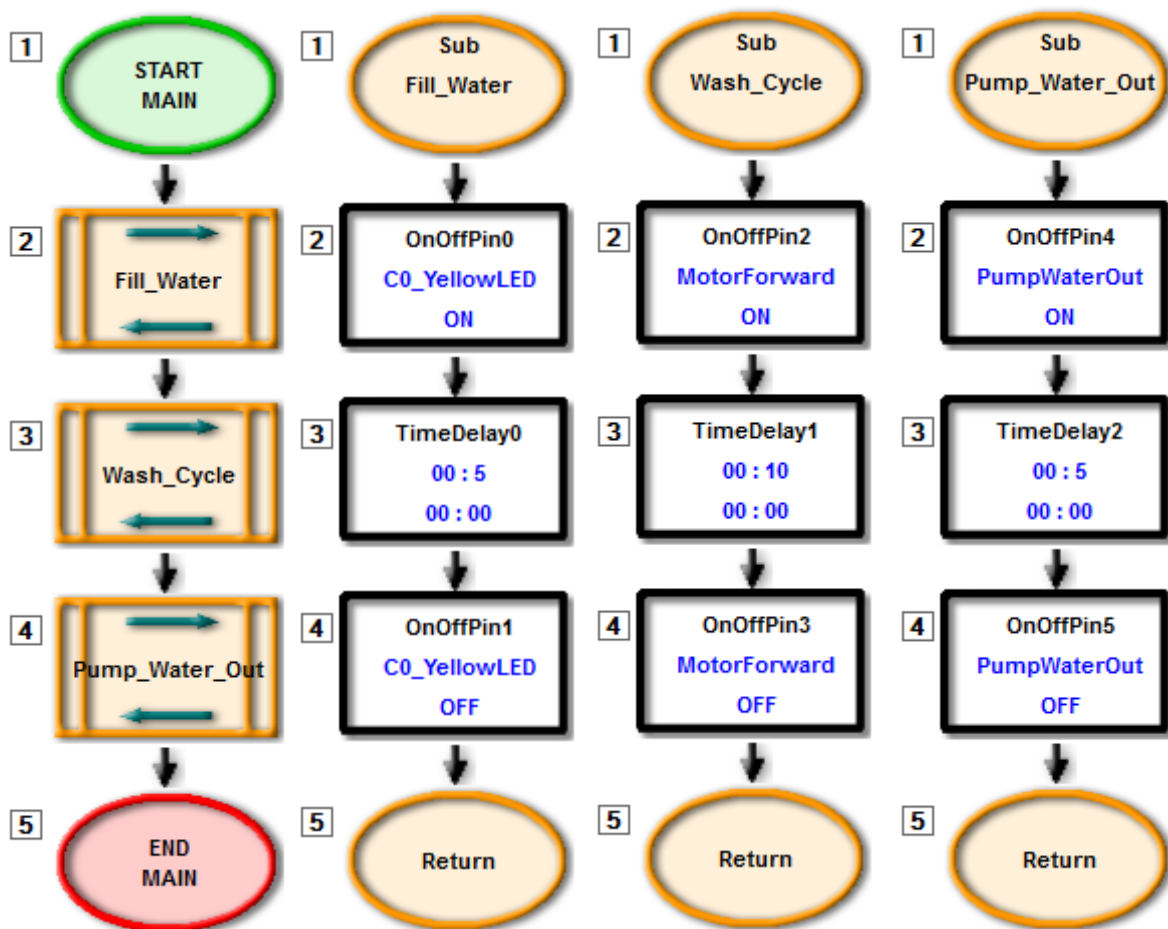


Figure 4

Normally, a washing machine would spin the tub in both directions in order to wash the clothes better. It is possible to do this by copying and pasting groups, but this is not the best way. In this project we will rotate the tub back and forth 5 times by using a counting loop. This will cause the program to add one to a number every time the wash cycle finishes, and when that number reaches a certain value (in this case 5) the program will know the wash cycle is finished and it should start the next step.

6. Click the Numbers button and select Set_Number from the Icon Properties list. Double click this icon and use it to set Wash_cycle_repeat to 5.
7. Add another Set_Number icon and use it to set Count to 0.
8. Next we want the machine to wash the clothes by rotating the tub back and forth. Double click the Wash_Cycle group to open it, and change it to spin the motor forwards for 1 second, then turn it off again.
9. At the end of the subroutine, add another 1 second time delay to give the motor time to slow down.
10. Now spin the motor in reverse for one second, and add another 1 second time delay to give the motor time to slow down.
11. Click the Numbers button and select the Add option from the Icon Properties list. Use it to add 1 to Count.
12. Now use a Compare icon to compare Count and Wash_cycle_repeat. Tick the below checkbox only. The program will automatically add a GoTo Wash_Cycle, which is what we want.
13. Every time the program goes through the wash cycle, it will increase the value of Count by one, so on the first run through it will increase from 0 to 1, then 2, then 3, and so on. For the first 4 times it will be less than our Wash_cycle_repeat value of 5, so it will do the wash cycle again. On the 5th time it will be equal to 5, so the program will jump over that GoTo and continue on to the Pump_Water_Out group.
14. Double click the Return icon to go back to the main program, then send it to chip.

The number Wash_Cycle_Repeat and Count are what we call variables, since the number they represent changes. The easiest way to think of a variable is as a labelled box that can hold exactly one number. We can look in the box and check what the number is, and we can also change what number is in there but we have to throw away the old number first. So for example when we add one to Count, the microchip looks in the box, sees what number is in there and works out what the new number should be, then takes out the old number and puts the new number in instead.

A counting loop is more useful than copying and pasting icons since it makes the program shorter and overall easier to read, and it is also easier to change the length of the wash cycle because we can just change the value of Wash_cycle_repeat instead of having to copy and paste even more icons.

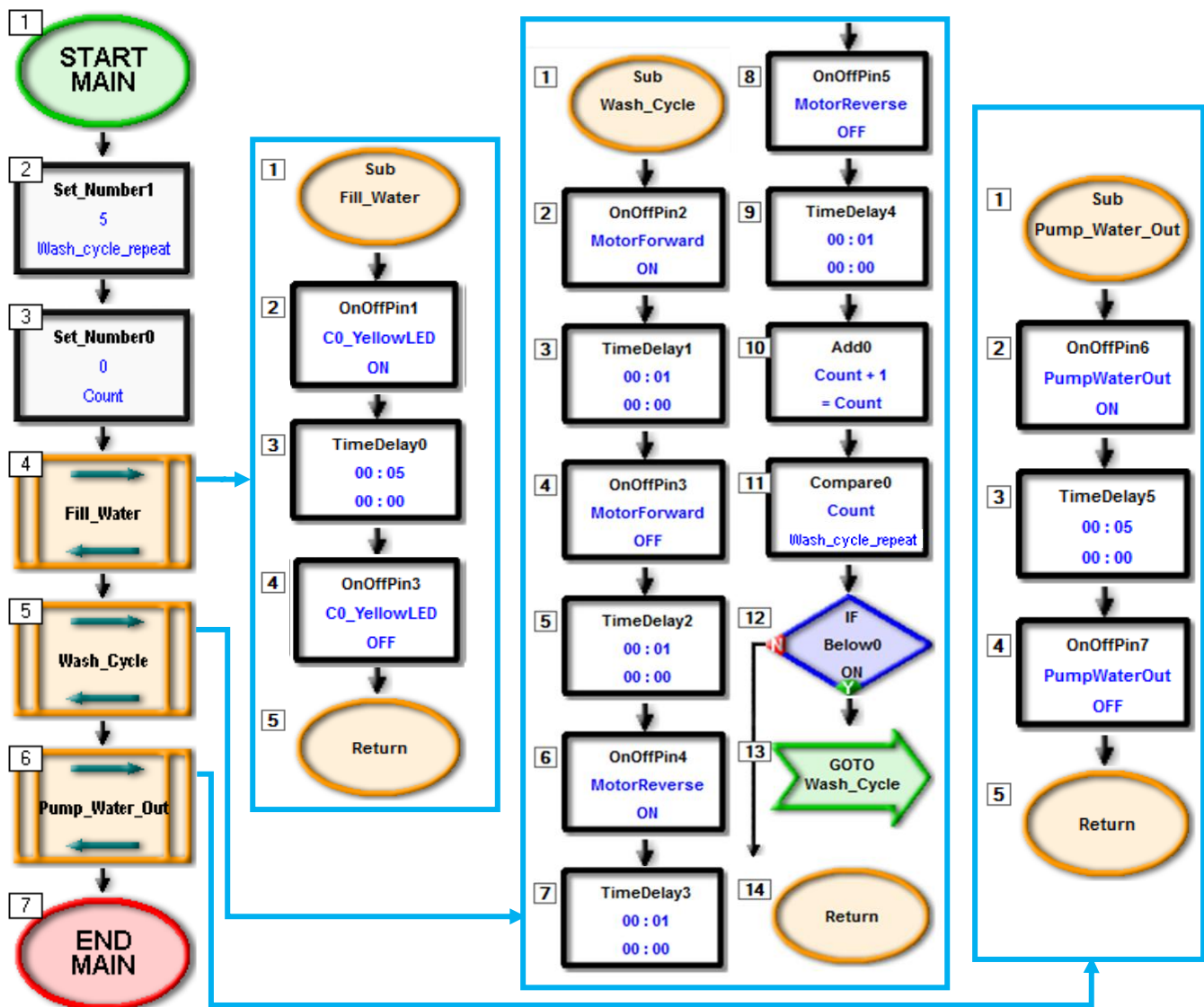


Figure 5

Extension

Devise a solution to the extension problems. Make small changes to the program and test the program regularly.

1. There may be some soap left on the clothes after the wash cycle. We could add another Fill->wash->empty cycle to add clean water, agitate the clothes, then pump the last of the dirty water out. You can group and copy the first 3 cycles.
2. Add a spin cycle to the program. Start the motor for fifteen seconds to remove excess water from the clothes. Make sure you group it so that it is still easy to see what the program does, and remember to pump the excess water away!

Summary

Washing machines save a lot of time around the house, but it is important that they perform the correct tasks at the right time. This is also important in the manufacturing industry, since a similar step-by-step process is often used. By grouping our icons together, it is easy to see these tasks so that we know our washing machine is working correctly.