

STEMSEL Automotive Project 8 -

Emissions Control

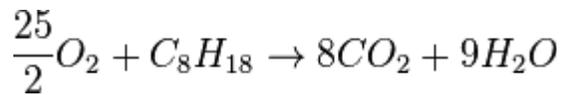
Problem

The correct air to fuel ratio (AFR) is needed for an efficient combustion of fuel in an engine and to minimize harmful emissions produced. This system can be simulated on ezSystem to provide the correct fuel to air ratio.

Background

For fuel to be used in a car, it must be mixed with air by an internal combustion engine. This is done by mixing the fuel with air, producing a force required to move components of an engine. This requires a good air-fuel ratio. Combustion of fuel is done in two ways; fuel injection and a carburetor. A carburetor uses jets or flaps that will push air into combustion chambers without using electronics. A fuel injection system uses electronics to release an ideal amount of fuel and air, to produce an efficient engine with minimal emissions. Fuel injection systems are becoming more popular for cars that want the best performance, regardless of complexity.

In an ideal air-fuel ratio, only carbon dioxide and water is produced in the reaction, as shown in Equation 1 below. However if there is too much air, air pollutants such as Nitrous Oxides (NOX) is produced. If there's too little air, non-combustible fuel is produced, such as Carbon Monoxide which a toxic and odorless gas. In order to determine a correct air-fuel ratio, an oxygen sensor is used in combination with the accelerator pedal.



Equation 1 - Fuel Oxidation Reaction Equation

Ideas

What can be used to move the flap? What type of sensor can be used to take advantage of using a flap in an enclosed environment? What can be used in place of an accelerator?

Plan

A potentiometer can be used to change the oxygen level variably. As a car accelerates, the fuel consumption increases, requiring more air to react. So the amount of air required for combustion is proportional to the fuel required. The valve will be modeled by a servo motor, while the oxygen sensor is replaced with an LDR. The LDR is mounted onto the servo motor with tape, so as the car accelerates, the servo motor turns clockwise, increasing the value of the LDR input. The servo motor should be placed in a position where it can receive light or no light by rotation.

Design

Open ezCircuit and start a new project. Add in a servo motor, using output icon and selecting Servo Motor Output and putting it on the left side of the schematic, and make sure that when connecting the motor, the yellow wire is the one that is closest to the adjustable pins. Also add the LDR and potentiometer to the schematic. When an input icon is clicked the available input ports light up green indicating that the component can be placed there.

Note: the potentiometer can only be held at port C7.

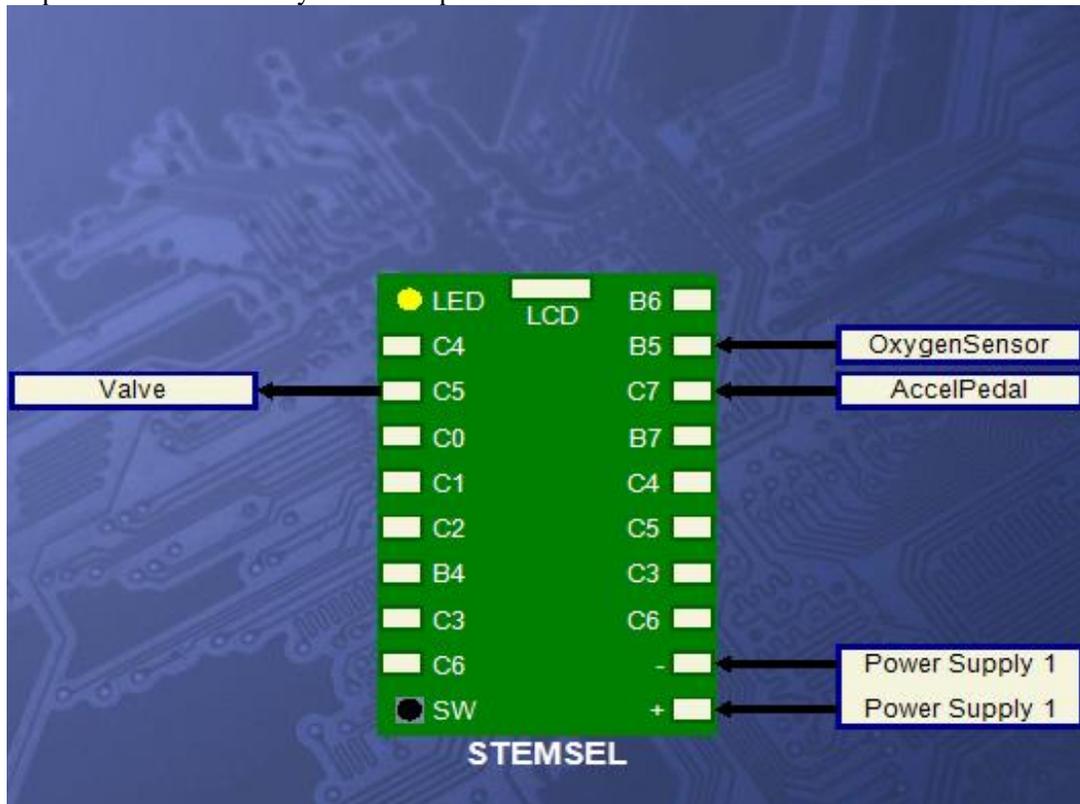


Figure 1 - ezCircuit Design

Build

When connecting the servo motor, make sure that the lightest coloured wire (yellow) is closest to the adjustable pins. Connect the white potentiometer wire into C7 and the white LDR wire into C5. Connect the red wires into the positive terminal and the black wires into the negative terminal.

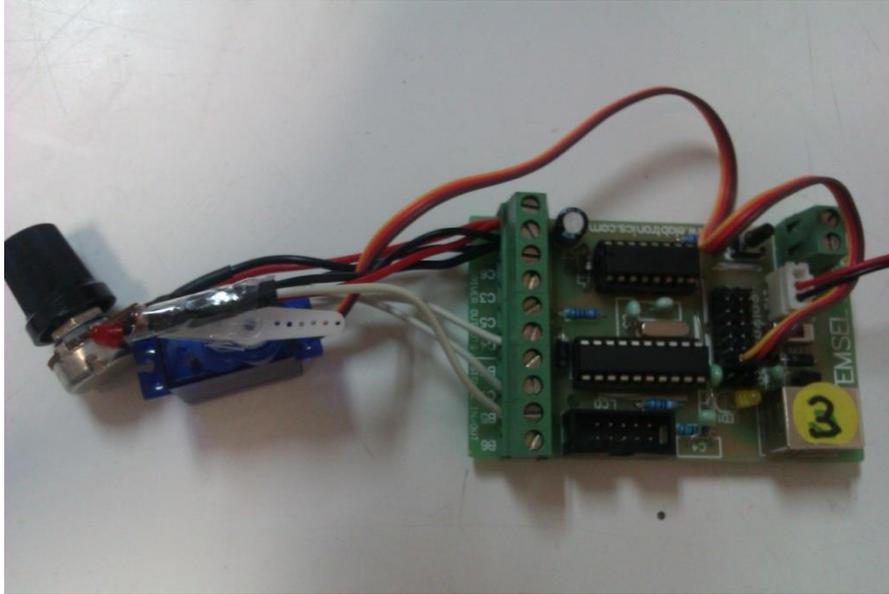


Figure 2 - Circuit design

Programming

With the circuit built, it is now time to program the schematic made earlier. Send the schematic to Corechart by clicking the “Send to Corechart” button. Connect the STEMSEL board by usb while holding the onboard button. In Corechart, test the components by running the test routines. When you have tested the components and they work, delete the test routines. In order to test the Servo motor you can create a small program.

1. Using a “Analogue_in” Input save the “AccelPedal” to “INTERGER”.
2. Use a “ServoMotor” output set pulse width to “INTERGER” the output pin as “Valve” and leave delay as 10.
3. Place a GoTo icon to go back to “Start”.

This small test routine should turn the motor as you turn the potentiometer.

We need to adjust the flap that lets in air depending on whether the car is accelerating or decelerating. This flap will continue to adjust until the air level is able to produce the correct air-fuel ratio. Our AccelPedal will determine the required level of air.

1. In Numbers, insert “Set_Number” and set it to zero, saving as “Level”.
2. Make an address flag by clicking on Address and rename as “Check”.
3. Select Inputs and place an Analog_In icon. Double click on in and make it take in the OxygenSensor value, then save it as “SensorLevel”. This value will be read each time the Check loop executes.
4. Create another Analog input and give it an INPUT of “AccelPedal”, save it as “Acceleration”. Each time the Check loop is run the potentiometer value is also updated.
5. The acceleration needs to be compared against oxygen level to see if they’re equal. Select the Compare icon in the Number selection option. Then compare whether “Acceleration” is above or below the “SensorLevel” by double clicking on the icon.
6. Under the below icon, insert an Add icon from the Numbers menu. Add one to “Level” save it as “Level”.
7. Insert a ServerMotor icon into the chart from the Outputs menu. Change its settings so that pulse width holds “Level” and the Output Pin is “Valve”. Set the time delay to 0.
8. Group these two icons together using the Group function found in the Icons menu and rename it as “Increase”.
9. Place a subtract icon and subtract 1 from “Level”, then save as “Level”. Place another Servomotor under this icon with a pulse width of “Level”, a delay of 0, and the output pin of “Valve”. Group these two icons and name it “Decrease”.
10. Finally place a GoTo icon to go back to “Check”.

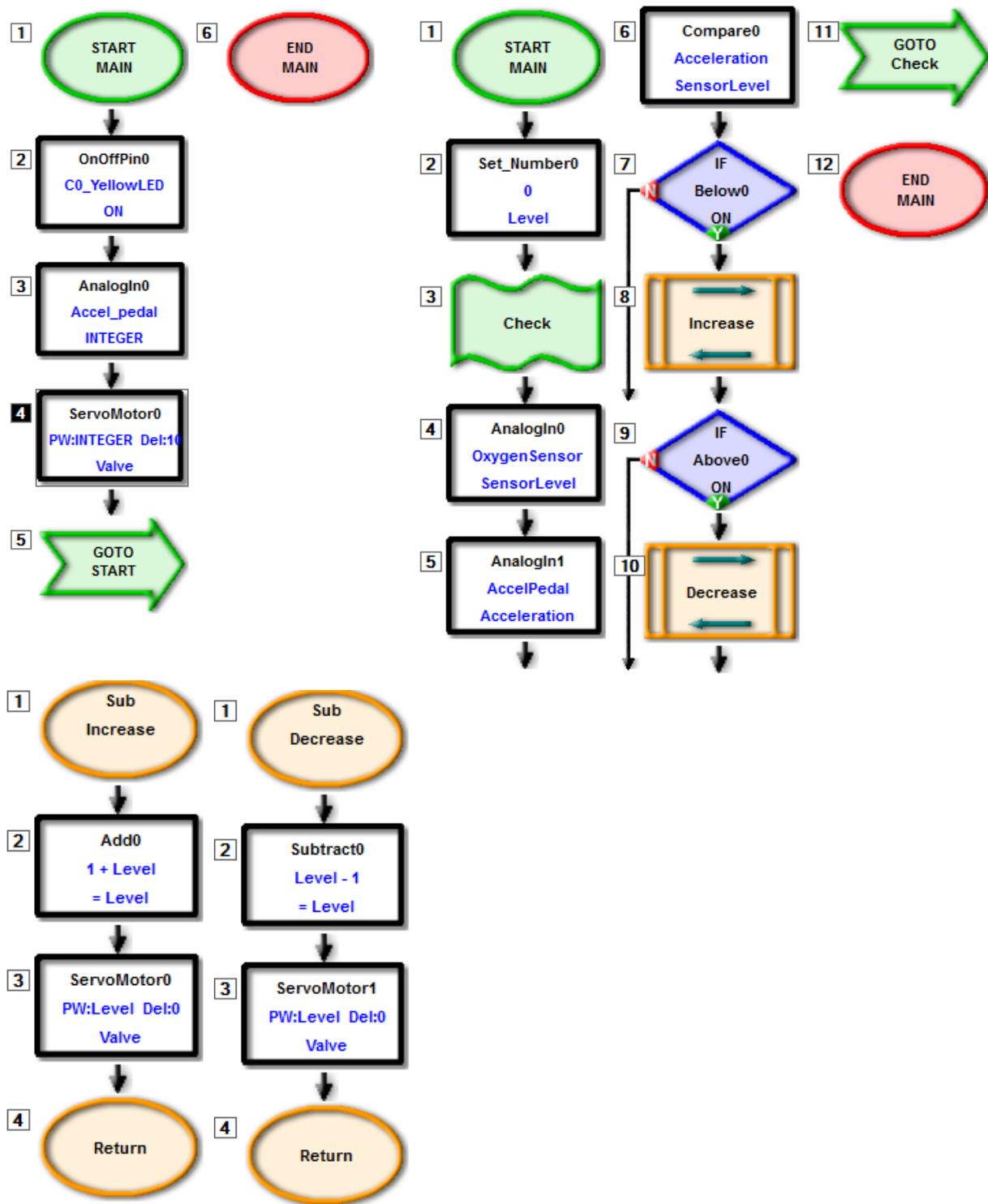


Figure 3 – Test routine, Corechart, and subroutines: Increase and Decrease

Activity/Extension

At certain light levels you will notice the servo motor blade not moving. Why is this? Try altering the time delay for the servo motor, what happens and why? Rather than the servo motor blade not moving when equal, are you able to make it output other signals to indicate equality?

This system was made to fit a carburetor equipped engine. Is there a method for fuel injected cars?

Summary

In this workshop, you have simulated and created a device which can adjust the air fuel ratio of an engine to provide cleaner engine exhaust. Many modern vehicles have similar systems equipped in order to ensure that they are able to run the car as environmentally friendly as possible. Also many countries now have an emissions test that vehicles must pass in order to be useable on public roads. This ensures that the vehicles would have as little impact to the surrounding environments as possible.