Module-03: Water level control

The mighty Brahmaputra has lots of tributaries. The flow of water from these tributaries to Brahmaputra is controlled using various sluice gates. When the water level of Brahmaputra is low, these sluice gates are open and water from tributaries flow into the river. However, during monsoon season, due to excessive rain, the water level of Brahmaputra rises and it floods the neighbouring area. In order to stop this overflow, the sluice gates are closed. These gates are opened/closed using motors connected to a geared system. Our task in this module is to design a water level control system. While doing so, we assume that we have installed a water pumping system on the river that pumps out water from the river and supplies it to areas in India where there is dearth of water.

Objectives: In the prototype that we are designing, a container is used to represent the river: see Figure 1. The inflow of water in the river will be mimicked by adding water to the

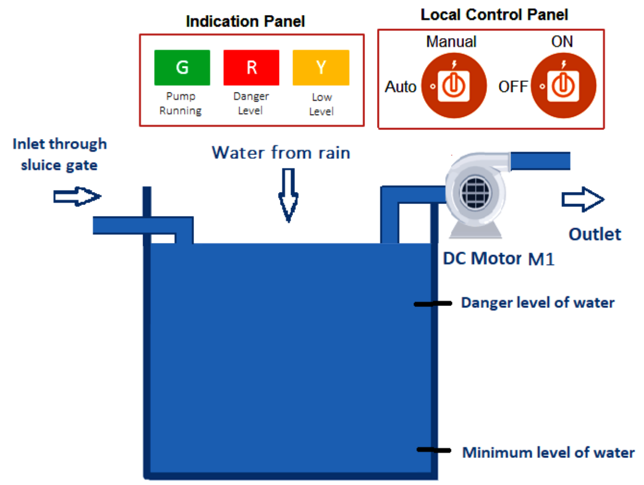

Figure 1: A water level controller

container manually. The outflow of water from the container will be using a 5V submersible water pump. The operation of opening-closing of the sluice gates are modelled using a 9V DC Motor. Thus, there are two DC motors being used, one for pumping out water (we call it M1) and the other for sluice gate operation (we call it M2). Your task is to design a on-off controller that makes sure that the water level in the container is not above danger level. Hence, the objective is to design a prototype that fulfils the following objective:

1. The pump should operate in two modes viz., automatic and manual. A switch should be used to indicate the mode of operation. This will form the local control panel. The

various states of the motor are:

Motor	*State*	*Action*
$M1$	ON	Water pumped out of container
$M1$	OFF	No water pumped out
$M2$	ON	Means sluice gate is closed
$M2$	OFF	Means sluice gate is open

2. During the automatic mode, the operations in the table above should be automated. In the manual mode, the same operations should be carried out using DIP switches. While performing the mentioned operations the following points are to be considered:
    - The pump M1 always need to ensure that it has enough time to stop and come to rest before water overflows.
    - The pump M1 needs to be driven using a transistor as switch. Design an appropriate circuit for the same. Ensure that the motor M1 is always submerged in water, i.e., when water is pumped out of the container you need to ensure that the pumping action stops at a point when the water level reaches the minimum mark.
    - The 9V motor M2 needs to be driven using a L293D Motor driver module.
    - The controller that you have designed in this case (auto mode) is an ON-OFF controller. One of the known disadvantages of ON-OFF controllers is the *chattering effect*. While implementing the controller make sure that chattering effect is minimized.
3. Interface an ultra-sonic sensor to the Arduino and position the sensor appropriately. The sensor will provide the necessary water level information to the controller.
4. Make an indication panel to indicate pump running, low water level, and danger water level status.

N.B. The set-up designed in this module will be required in upcoming modules as well.

Steps to be followed: The module is divided into three sub modules.

Module 3A:

1. Interface M2 to the Arduino first using L293D Motor driver module. Ensure that you are able to switch it on and off using the Arduino and L293D.
2. Interface the ultrasonic sensor to the Arduino and ensure that you are able to read off data from the sensor. Use the serial port to check the data being read from the sensor. (see https://www.arduino.cc/reference/en/language/functions/communication/serial/begin/)
3. Implement the code to change the states of motor M2 in the automatic mode based on the level of water.

Module 3B:

4. Interface M1 to the Arduino using a transistor. Ensure that you are able to switch it on and off using the Arduino and transistor.

5. Implement the code to change the states of M1 in the automatic mode based on the level of water.

   Module 3C:

6. Integrate the codes in Module 3A and Module 3B. Ensure that the local control panel and indication panels have been implemented.

Pre-lab work:

1. Read about the working principle of ultra-sonic sensor and method to interface it with Arduino Uno.
2. Read about DC motor and method to interface it with Arduino Uno.
   (see https://microcontrollerslab.com/dc-motor-l293d-motor-driver-ic-arduino-tutorial/)
3. Read about on/off controllers (see https://x-engineer.org/on-off-control-system/)

Report Guidelines: The report to be submitted must have the following:

1. Objectives of the module.
2. Circuit diagram with proper labelling.
3. Block diagram of the system designed.
4. Flowchart of the algorithm.
5. Observations, if any.
6. Answers to the questions below.

Answer the following:

1. Draw the block diagram of the closed loop system you have implemented in this module. What is the set point of your system?
2. How do you compute distance from the data obtained from the ultra-sonic sensor?
3. Why did not you connect the motors M1 and M2 to the Arduino pins and switched them on and off?
4. Could we have used 2N2222 or BC547 transistor to drive motor[1] M1?
5. Could we have used the L293D module to drive motor M1 to implement the objectives of the present module?
6. Explain the working of the circuits driving the motors M1 and M2.
7. How did you eliminate chattering effect? If you are given the freedom of using some other controller other than ON-OFF controllers, which would you choose such that the effect of chattering is reduced? Justify your answer.

[1]Specifications of M1: Operating Voltage: 2.5 - 6V, Operating Current: 130 - 220mA, Flow Rate: 80 - 120 L/H, Maximum Lift: 40 - 110 mm.