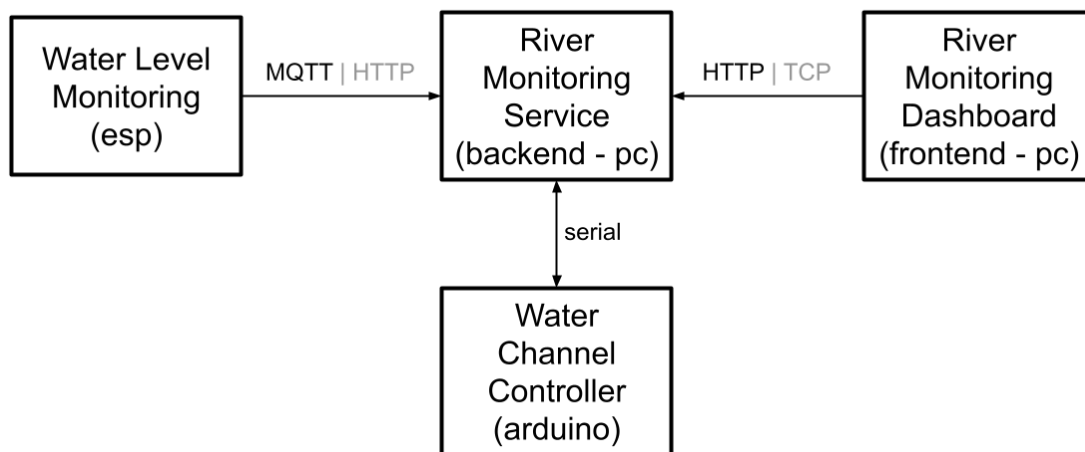


Assignment #03 - Smart River Monitoring

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We want to realise an IoT system implementing a simplified version of a *smart river monitoring system*, as a system monitoring the water level of rivers and controlling related water channels. The system is composed of 4 subsystems:



- **Water Level Monitoring subsystem (based on ESP)**
 - embedded system to monitor the water level of a river
 - It interacts with the River Monitoring Service subsystem (preferably via MQTT¹ - HTTP can be used as a second option)
- **River Monitoring Service subsystem (backend - running on a PC server)**
 - service functioning as the main unit governing the management of the smart river system
 - it interacts through the serial line with the Controller
 - it interacts via MQTT¹ with the Water Level Monitoring
 - it interacts via HTTP² with the Dashboard
- **Water Channel Controller subsystem (Arduino)**
 - embedded system controlling the gate/valve of a water channel
 - it interacts via serial line with the River Monitoring System
- **River Monitoring Dashboard subsystem (Frontend/web app on the PC)**
 - front-end to visualise and track the state of the river monitoring
 - it interacts with the River Monitoring Service

¹ HTTP can be used instead of MQTT as a secondary choice, if have problems using MQTT

² TCP can be used instead of HTTP as a secondary choice, if you have problems using HTTP

Hardware components

- Water Level Monitoring subsystem
 - SoC ESP32 board (or ESP8266) including
 - 1 green led
 - 1 red led
 - 1 sonar
- Water Channel Controller subsystem
 - Microcontroller Arduino UNO board including:
 - 1 servo motor
 - 1 button
 - 1 potentiometer
 - 1 LCD display

General Behaviour of the system

The Smart River Monitoring system is meant to monitor the water level of a river and - depending on the level - controlling a valve to distribute the water to some channels. Details:

- About the Water Level Monitoring subsystem
 - The water level monitoring subsystem is responsible for continuously monitoring the level of the water, by means of the sonar.
 - The water level is sampled and sent to the River Monitor Service with some frequency F
 - This frequency depends on the state of the system and is established by the River Monitoring Service (see later).
 - When the system is working correctly (network ok, sending data ok) the green led is on and the red is off; otherwise – in the case of network problems – the red led should be on and the green led off.
- About the Water Channel Controller subsystem
 - The Water Channel Controller subsystem is responsible for controlling the valve establishing how much water should flow to the channels, and this is determined by the valve opening level – from 0% = full closed (no water flows from river to channels), up to 100% = full open
 - The valve is implemented by the servo motor – angle 0° corresponds to valve opening level 0%, angle 180° corresponds to valve opening level 100%
 - The valve opening level depends on the state of the system, established by the River Monitoring Service (see later)
 - The Water Channel Controller provides also a button to enable a manual control modality
 - When the button is pressed, the controller enters in manual mode, so that the valve opening level can be manually controlled by operators using a

potentiometer. To exit from the manual model, the button should be pressed again.

- The Water Channel Controller subsystem is equipped also with an LCD display reporting the current valve opening level and current modality (AUTOMATIC or MANUAL)
 - About the River Monitoring Service
 - This is the subsystem deciding the overall policy and behaviour of the river monitoring system, depending on the water level as measured by the Water Level Monitoring subsystem
 - Policy:
 - When the water level is in the range $[WL1, WL2]$, then the system is considered in a NORMAL state. In the NORMAL state:
 - the frequency to be used for monitoring the water level is F1
 - the valve opening level should be 25%
 - When the water level is $< WL1$, the system is in an ALARM-TOO-LOW state.
 - In this state, the valve opening level should be 0%
 - When the water level is $> WL2$, there are three further cases
 - $WL2 < \text{water-level} \leq WL3 \rightarrow$ the system is in a PRE-ALARM-TOO-HIGH state.
 - In this state, the frequency to be used for monitoring the water level should be increased to F2 (where $F2 > F1$)
 - $WL3 < \text{water-level} \leq WL4 \rightarrow$ ALARM-TOO-HIGH state
 - In this state the frequency is still F2, but the valve opening level must be 50%
 - $\text{water-level} > WL4 \rightarrow$ ALARM-TOO-HIGH-CRITIC state
 - In this state, the frequency is still F2, but the valve opening level should be 100%
 - About the River Monitoring Dashboard
 - The dashboard has two main responsibilities:
 - To visualise the state of the River Monitoring system. In particular:
 - The graph of water level trend, considering a certain temporal window (the last N minutes)
 - The state of the system
 - NORMAL, ALARM-TOO-LOW, PRE-ALARM-TOO-HIGH, ALARM-TOO-HIGH, ALARM-TOO-HIGH-CRITIC
 - The valve opening level
 - To allow a user for controlling manually, from remote, the valve opening level
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The assignment

Design and develop a prototype of the Smart River Monitoring system, considering as further requirements:

- **Water Level Monitoring subsystem**
 - Run on ESP32 or ESP8266
 - Must use preferably MQTT to communicate with the River Monitoring Service
- **Water Channel Controller**
 - Run on Arduino
 - The control logic must be designed and implemented using finite state machines (synchronous or asynchronous)
 - Communicate with the River Monitoring Service via serial line
- **River Monitoring Service**
 - Run on a PC
 - No specific constraints about the programming/sw technology to be used
 - Use preferably MQTT to communicate with the Water Level Monitoring subsystem
- **River Monitoring Dashboard**
 - Run on a PC
 - No specific constraints on the technologies to be used
 - Can be implemented as a web app running in a browser interacting via HTTP with the service or a PC app based on sockets or HTTP

The Deliverable

The deliverable consists in a zipped folder **assignment-03.zip** including:

- 4 subfolders (one for each subsystem)
 - water-level-monitoring-subsystem
 - river-monitoring-service
 - water-channel-controller
 - river-monitoring-dashboard
- **doc** folder
 - including a brief report (**report.pdf**) describing the system, including also a description of FSMs, a representation of the schema/breadboard and the link to a short video demonstrating the system.