MicroEDS

What, why , how and benefits

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What is a MicroEDS

MicroEDS stands for **micro–Early Detection System.** MicroEDS brings the capabilities of abnormal detection based on **Machine Learning** algorithms to the arena of edge computing. It enables to run of self-learning abnormal situation detection on SBC (Single Board Computer). Data processing of the MicroEDS is performed in a real-time or near real time frame as close as possible to the IoT source. The strength of the hardware mainly influences time resolution and detection capabilities.

The following document demonstrates some of the MicroEDS benefits over a traditional data processing of IoT in the cloud. It presents several data quality cases in which a standard, SCADA-based control system is incapable to won't identify, while a MicroEDS will identify and alert.

Why using MicroEDS

A MicroEDS system should be considered under several conditions.

Condition 1: Detection should be as close as possible to the monitored device.

Condition 2: Using IOT technology to transfer data from field devices to the cloud for processing is non-economic.

Condition 3: Due to security reasons, it is not recommended to allow data to travel from field devices to the cloud.

How MicroEDS works

MicroEDS runs on top of any SBC (Single Board Computer), which runs a Linux-compatible operating system. It has been tested with several standard SBCs such as Raspberry Pi and equivalent products.

   

The tiniest SBC capable of running MicroEDS is Raspberry Pi zero (which has 0.5 G memory).

On the input side, the MicroEDS can read data from field devices with common protocols such as MODBUS/TCP.

On the output side, the MicroEDS can communicate with any server or notification target using channels such as FTP, SFTP, SSH, MSMQ, various EMAIL protocols, and others.

In and Out communication is performed in parallel to data processing.

An On-Board user interface enables to setup the MicroEDS parameters.

The MicroEDS may read and process up to 16 variables.

In what follows, some of the capabilities of the MicroEDS are explained.

Case 1: Predicting future measurments

The MicroEDS enables selecting any of the quality variables (output) for prediction from other input variables (input). Prediction can be performed starting from few minutes ahead and up to several hours ahead with the resolution based on the learning records timestamp resolution.

The model can generate three types of alarms.

Type one; actual value deviates from the predicted value.

Type two; confidence intervals for prediction are too wide.

Type three; predicted value deviates from the target optimum.

In each one of the cases, the user receives a notification by email or text message.

Case 2: Single sensor short deviation

A second example is a sensor that reports a short-term change in its measured value. As you can see from figure 1, the chlorine measurement at the station does not change much. Also, the width of the abnormal signal of the turbidity is about an hour

This signal indicates that this is not an electrical problem. In most cases, this signal results from a small amount of dirt at the measuring chamber. In addition, the was no violation of user limits, which indicates that the amount of affecting substance is low.

long. This hints at a small amount of organic material that may have penetrated the water system. In many cases, this is a symptom of sand intrusion into the water system due to minor cracks in pipes.

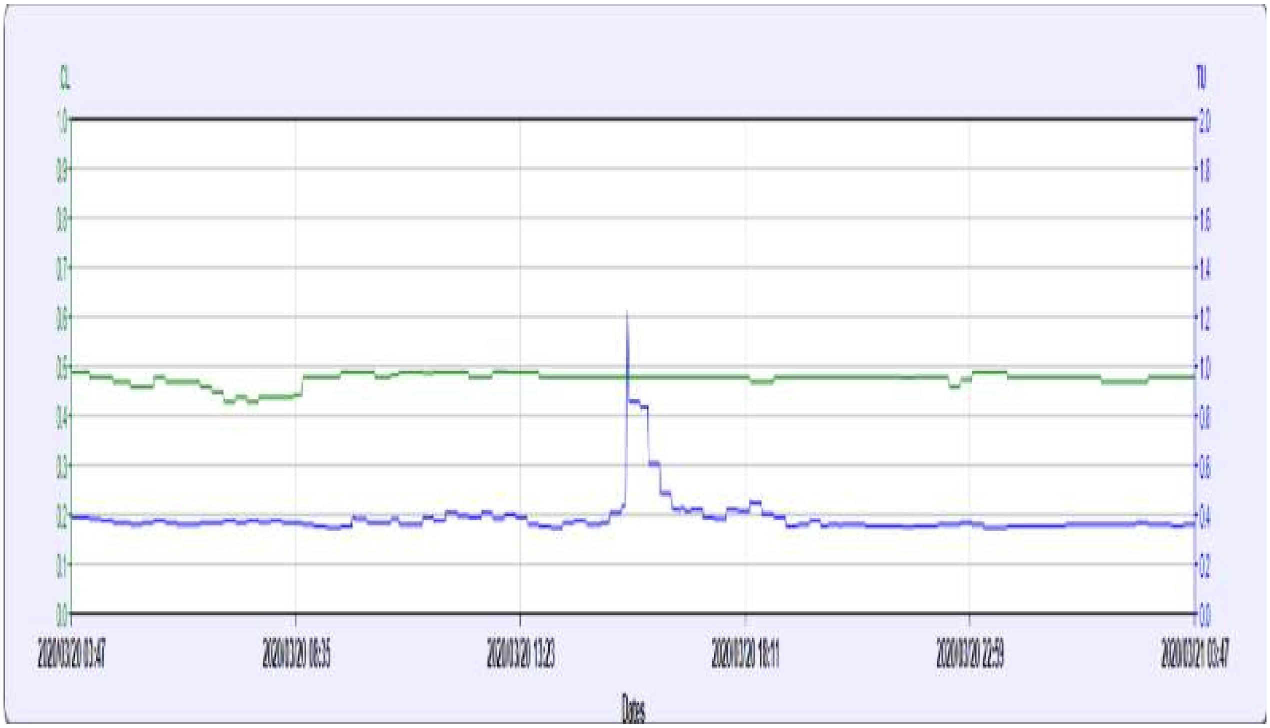

Figure 1: Single sensor short deviation

Case 3: Communication problem

A coordinated drop of several sensors sharply from a standard value to zero indicates a communication problem. For example, distributed systems often transmit their data using a cellular network. Cellular communication malfunction can cause several sensors to display a zero value for a while.

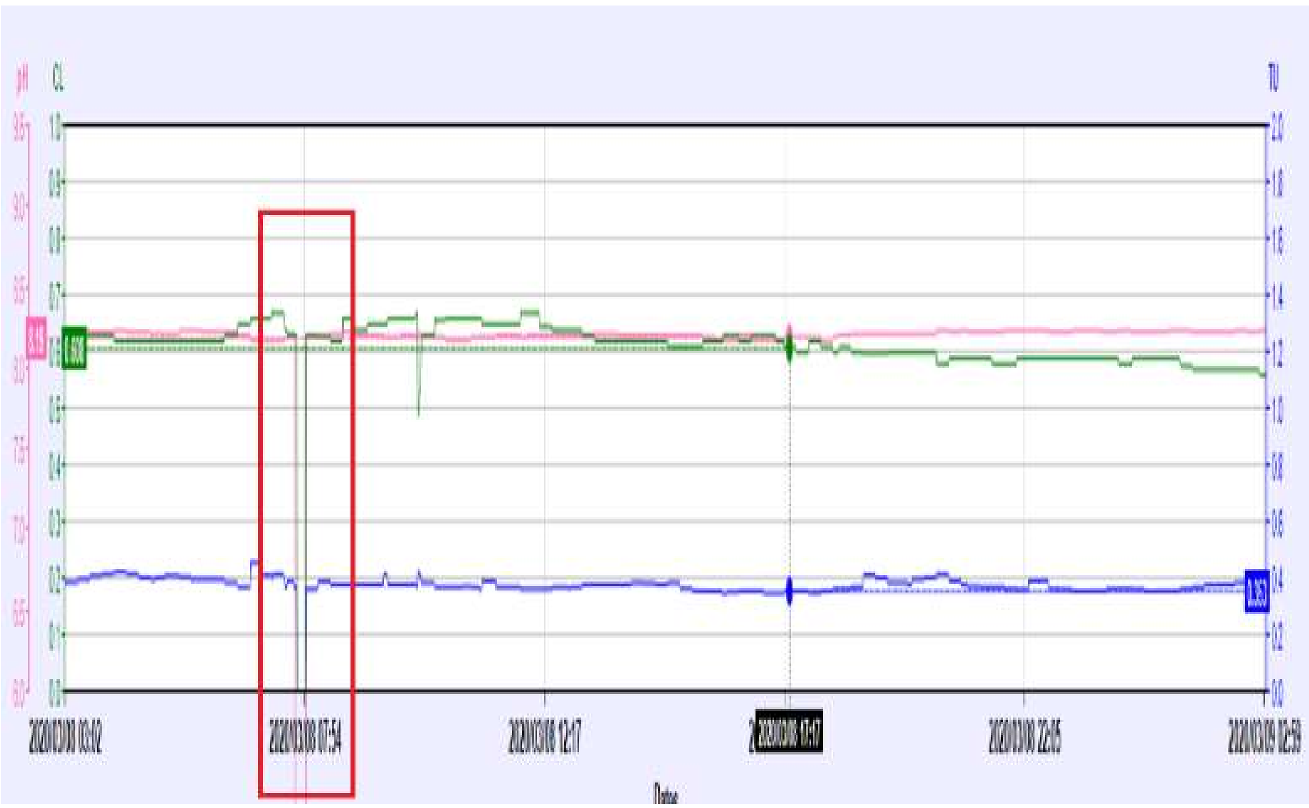

Figure 2: Communication problem

Case 4: Fixed value

The following example is a fixed value. In many systems, which measure flow, day and night temperature change and air penetration affect the quality of the measurement,

The MicroEDS system is typically able to learn the typical period in which a fixed value appears. Beyond this time, an alert should come up.

so a constant quality value is rare. When this happens, the cause is usually a sensor malfunction or incorrect definition of data processing.

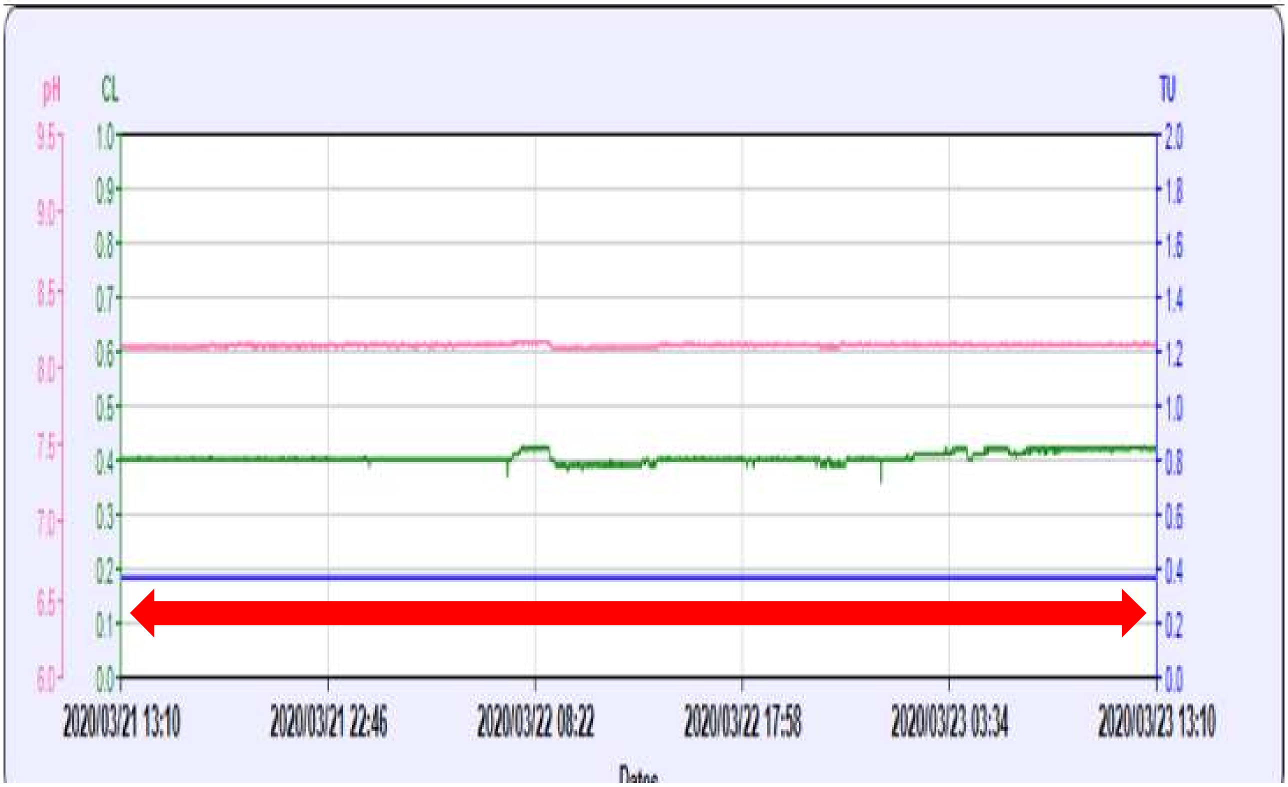

Figure 3: Fixed value

Case 5: Sensors maintenance

The next example is maintenance activities. Many sensors require periodic maintenance activities. Such an event involves a short period (usually of less few minutes) during which the sensors are being cleaned.

When this happens, the value of the sensors quickly changes from one endpoint to the other. The MicroEDS system is usually supposed to detect such a situation and not create a false alert.

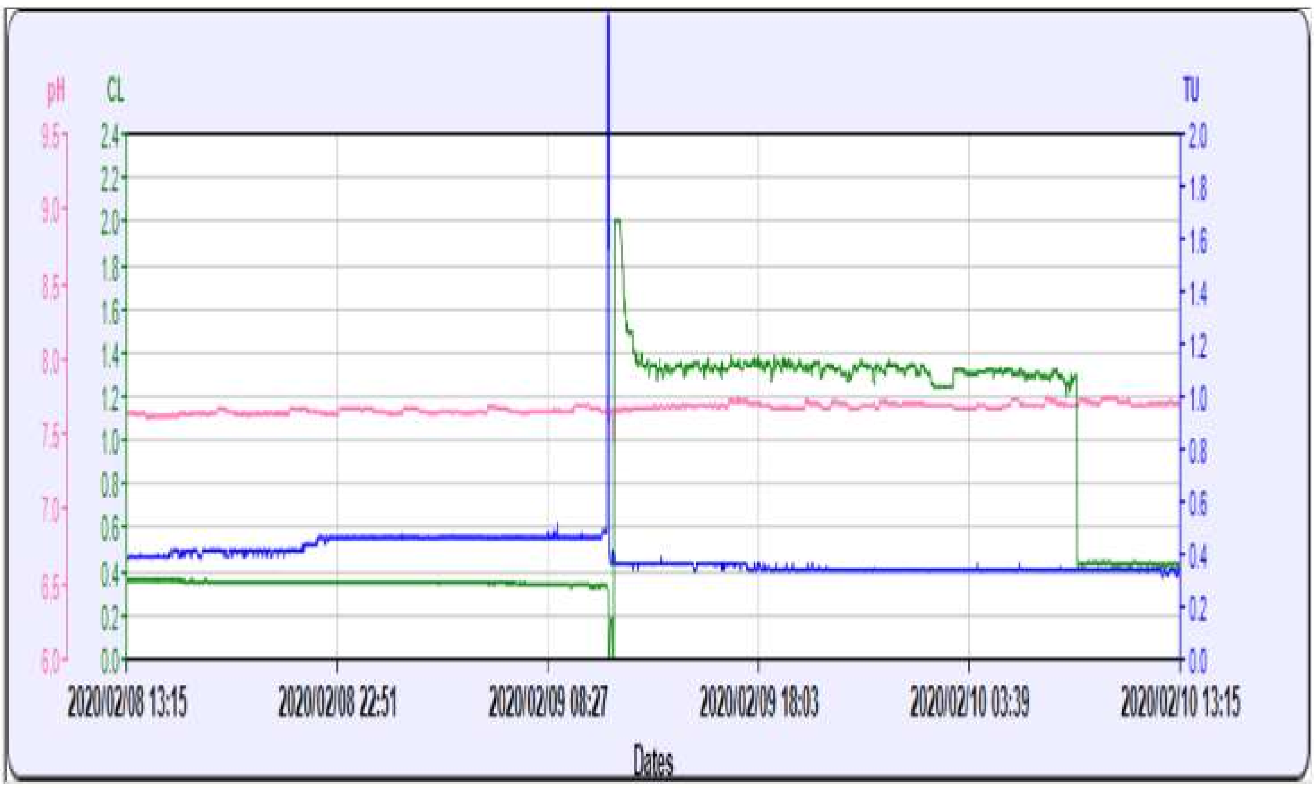

Figure 4: Sensors maintenance

Case 6: Abnormal jump

The next example is a coordinated jump to a high-level value and a return to normal of some sensors' measurement. This condition is usually caused by electrical interference with several sensors fed by the same voltage source.

Sometimes the sensors all go to a maximum value, and sometimes each one reaches a different level on the scale.

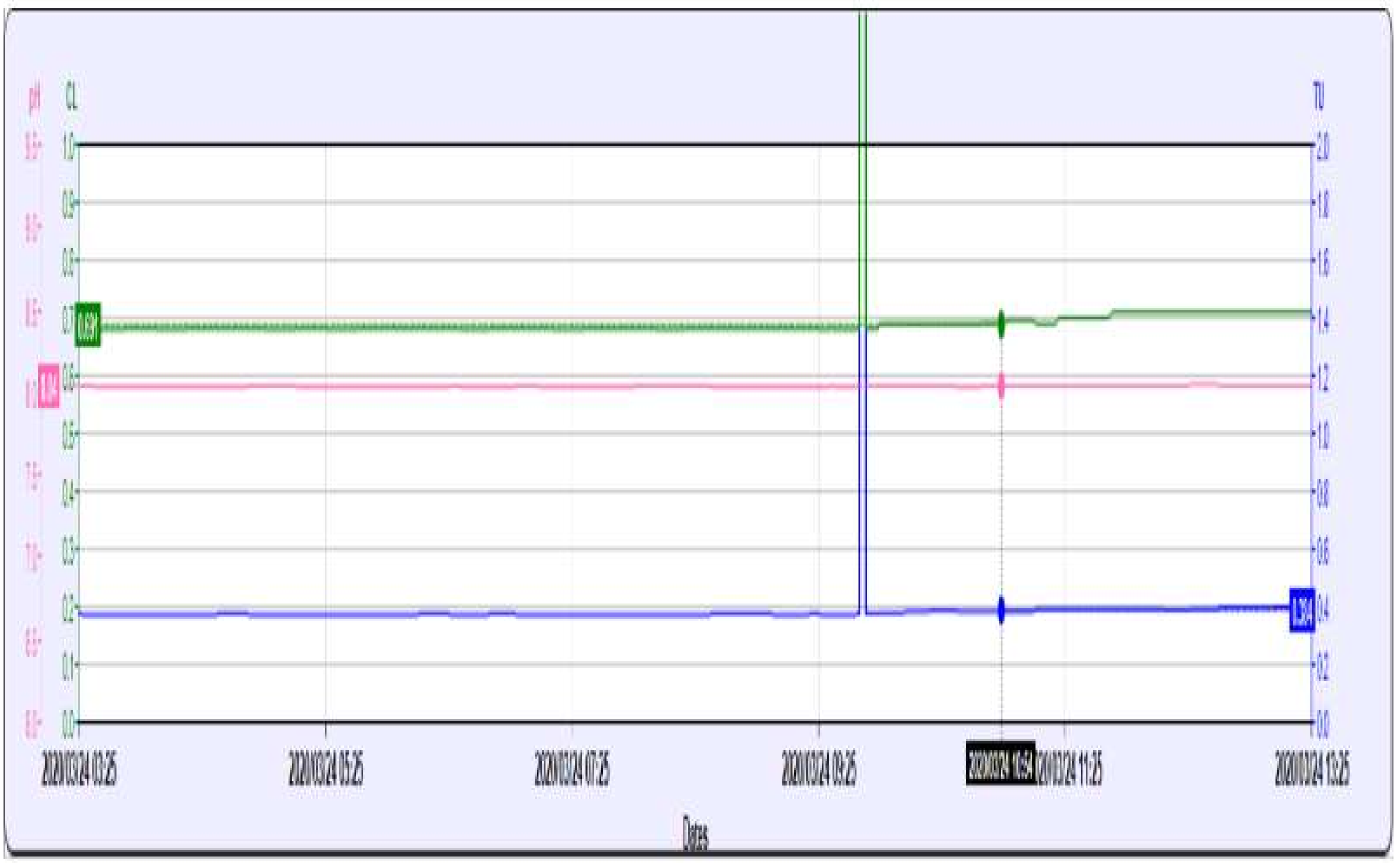

Figure 5: Abnormal jump

Case 7: Change in baseline, pattern and noise

The following example is three changes that co-occur. The first is a change in baseline. The graph shows an array ranging from 0.3 to 0.4, and the system moves to an average of close to 0.7. Surprisingly both the decrease in the amount of noise and the pattern of the graph is still noticeable.

This decrease can be caused, for example, by a change of a pump inlet that controls the line pressure or a change in a water sampling somewhere from the line center to the point of measurement. Sometimes, a change in the control system or a malfunction of the equipment can cause this.

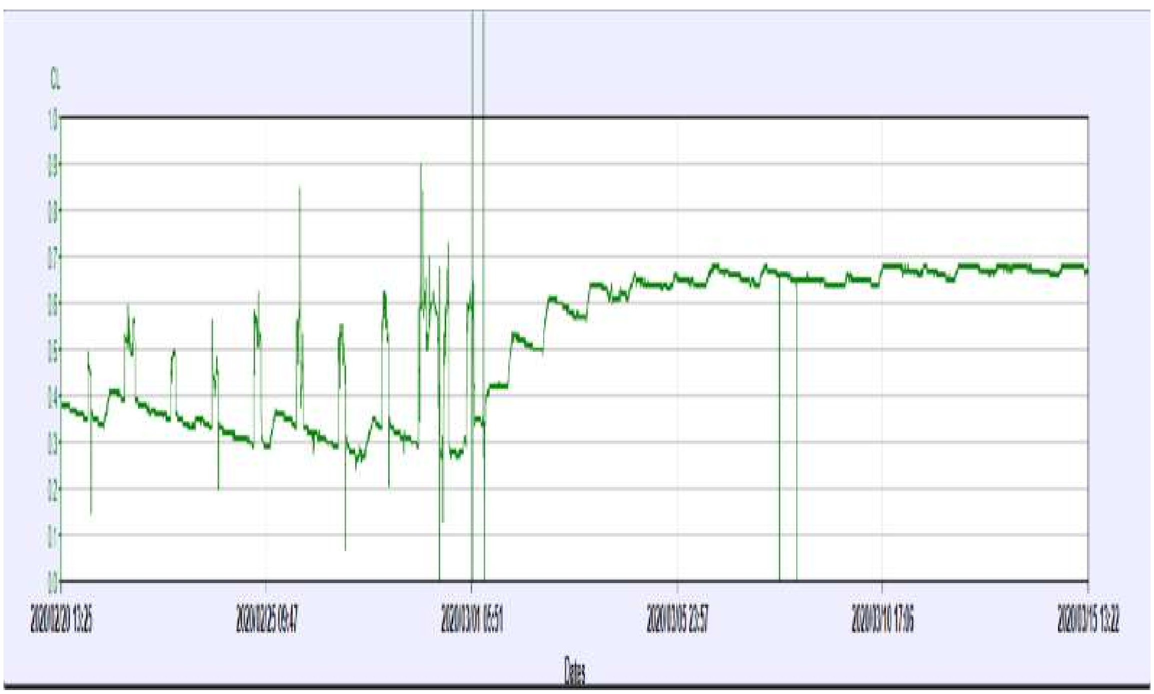

Figure 6: Change in baseline, pattern and noise

Case 8: Effect of physical measurement on quality measurements

The next example is the physical measurements' effect on quality measurements. In the graph shown, the green line indicates noise measurement in physical variables. E.g., pressure or flow. The blue line indicates noise in quality variables.

One can see from the graph that noise in quality variables appears many times after noise in physical variables. In this case, there is no need to create an alert.

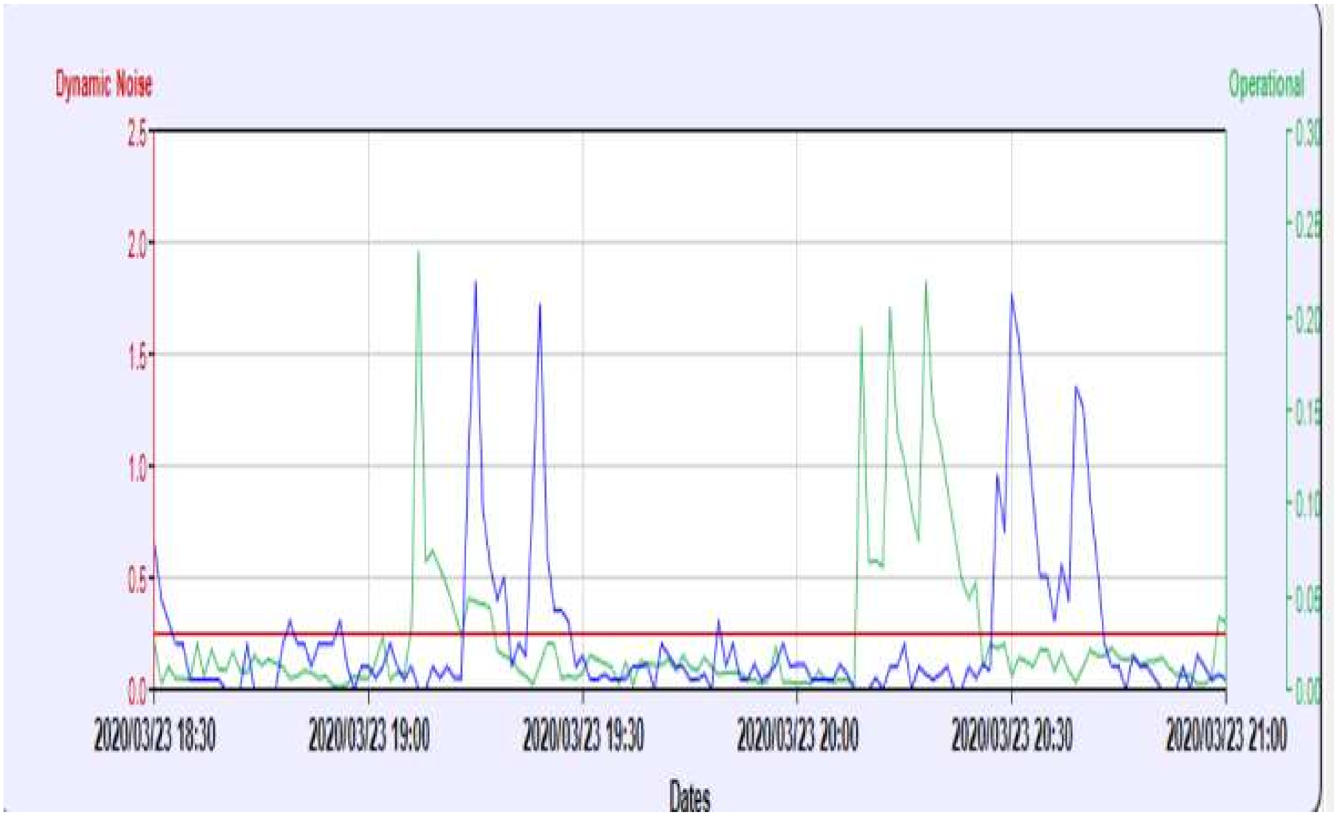

Figure 7: Effect of physical measurement on quality measurements

Case 9: Constant drifted

The next example is the drift of the measurement value. One may see that the green line, in this case, chlorine measurement, is gradually rising within a few weeks. The reason for this behavior can be environmental changes (e.g., temp). But in many cases, this is an indication of a gradual departure from the calibration of the sensor.

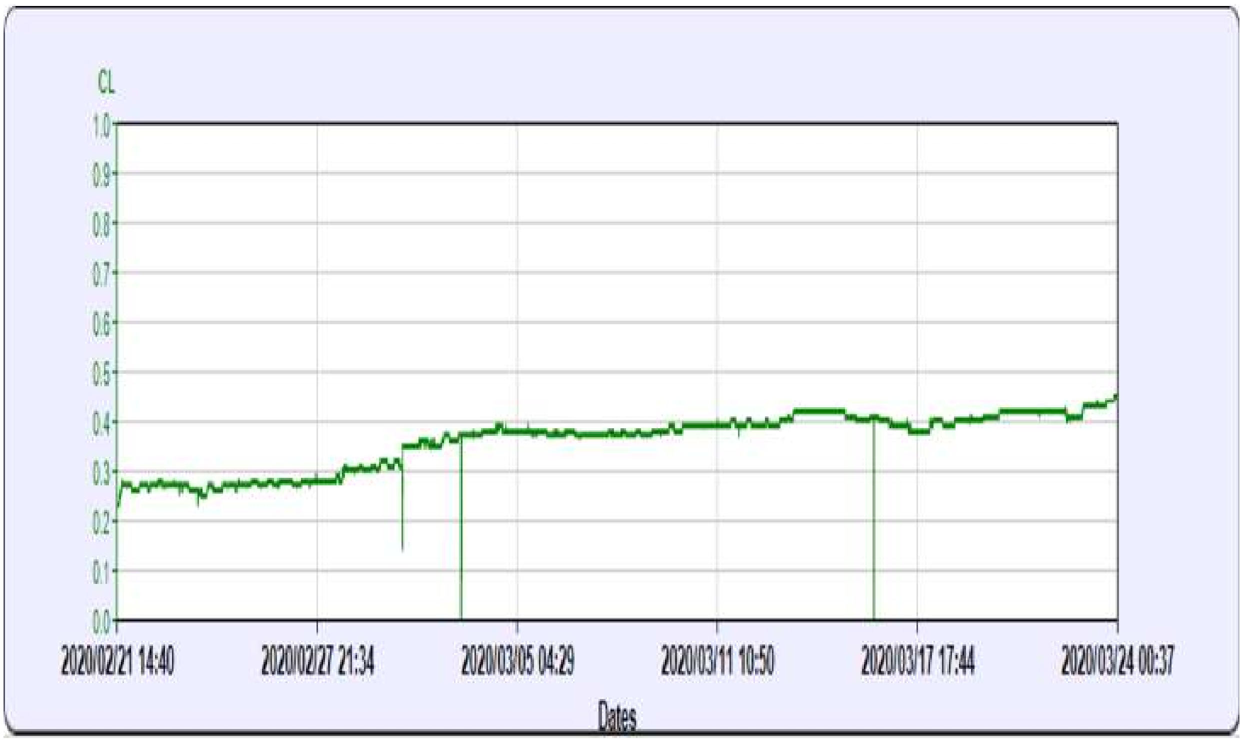

Figure 8: Constant drifted

Case 10: Deterioration of quality

The last example is a gradual decline in substance quality. It is customary in the MicroEDS system to assess the overall quality of the substance being measured. The optimal situation is where each of the quality values is at the optimal value. Give water a quality value 1.

As you move away from the optimum measurements, the substance quality index moves away from a value of 1. The attached graph shows a gradual decrease in the quality indicated by the green line over several months.

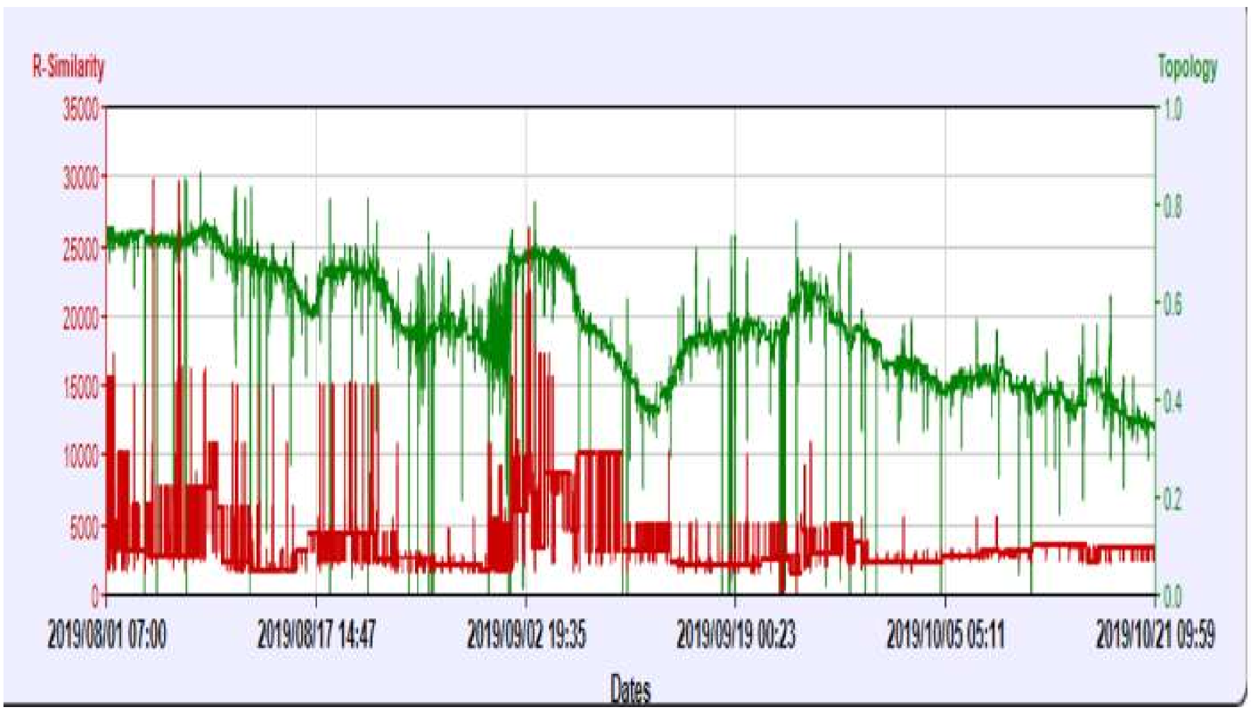

Figure 9: Deterioration of quality

Summary

The ten cases presented show quality issues that need attention from the user. Addressing these issues will allow the user to identify the actual issues when they appear and take care of them before becoming a crisis.

As explained at the beginning of the document, such issues are detectable by the MicroEDS system but are not detectable by the SCADA system. This difference hence shows the benefits of installing a MicroEDS system alongside the SCADA system.