Level Measurement defect classification using ML

Features for the dataset:

1.water_level → directly measured by the tank sensor in the model.

2.level_rate → can be computed using a derivative block on water_level.

3.valve_position \rightarrow available as the actuator output (pump control voltage or valve opening).

4.pump_status → you can create a binary signal based on whether the pump voltage is above a threshold.

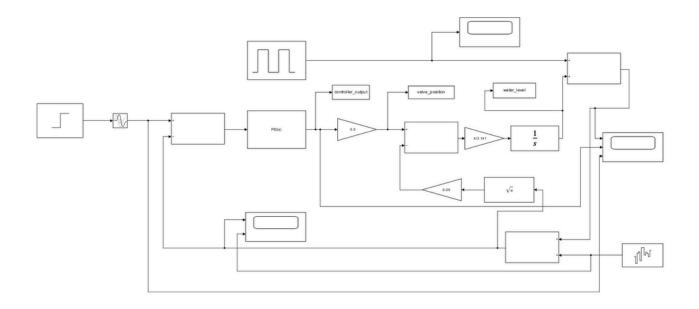
5.controller_output → PID controller output is available.

6.setpoint → the reference water level input to the system.

7.error_signal \rightarrow can be computed as setpoint - water_level.

Target Values:

Output Label	Description		
0	Normal operation		
1	Leakage		
2	Overflow		
3	Clogged valve		
4	Pump failure		
5	Sensor fault		
6	Controller fault		



Faults:

1 Leakage

Water leaks OUT of the tank continuously

Water level drops faster than normal

Pump works harder (controller output increases)

Valve opens more to compensate

2 Overflow

Water level rises above normal setpoint

Too much inflow OR restricted outflow

Controller tries to close valve

3 CLOGGED VALVE FAULT

Valve stuck partially closed

Water cannot flow out properly

Water level rises

Controller output tries to open valve more (but fails)

4 PUMP FAILURE FAULT

Pump not working at full capacity

Less water pumped into tank

Water level drops

Controller output maxes out trying to compensate

5 SENSOR FAULT

Level sensor gives noisy/incorrect readings

Controller receives wrong information

Erratic control actions

Actual level may be OK, but measured level is noisy

6 CONTROLLER FAULT

PID controller poorly tuned

Wrong gains cause poor control

Oscillations, slow response, or instability

System never settles properly