

1.	Introduction.	1
1.1.	Pollution incidents and overflows in sewerage.	3
1.2.	Analyser and sensor.	5
1.3.	Water scarcity.	6
1.4.	Smart Cities.	6
1.5.	Objectives and hypothesis.	8
1.5.1.	Hypothesis.	8
1.5.2.	Research goals.	9
1.5.3.	Requirements of system.	9
1.6.	Precedents.	11
1.7.	Structure.	11
2	Related work.	13
2.1	Wastewater cycle.	14
2.2	Pollution of wastewater.	16
2.3	Monitoring in sewerage and water bodies.	18
2.3.1	Current systems for sewerage.	18
2.3.2	Related work on water level sensors.	21
2.3.3	Related work on temperature sensors.	22
2.3.4	Related work on conductivity meters.	23
2.3.5	Related work on sensors to measure total solids in water.	24
2.3.6	Related work on oil sensor.	27
2.3.7	Related work on Nutrients, organic matter, acidity and heavy metals.	29
2.4	Discussion and future challenges on sensors.	34
3	Coil inductivity based sensors.	38
3.1	General test bench.	39
3.2	Effect of solids in inductive sensors.	40
3.2.1	Material and methods.	40
3.2.2	Results.	41
3.3	Effect of water level.	44
3.3.1	Difference between water and air.	44
3.3.2	Difference between different water levels.	46
3.4	Conclusions.	50
4	Turbidity Sensor.	51

4.1	Turbidimeter to Eutrophication in water bodies.....	52
4.1.1	System Description.	52
4.1.2	Test Bench.....	54
4.1.3	Results.	54
4.2	Determine solid. Effect on algae and sediment concentrations in mg/l in the turbidity (NTU).65	
4.2.1	Test Bench.....	65
4.2.2	Results.	65
4.3	Turbidity Levels.	69
4.3.1	Proposal.....	69
4.3.2	Test Bench.....	73
4.3.3	Results.	75
4.4	Improve the infrared sensor.....	86
4.4.1	Test Bench.....	86
4.4.2	Results.	87
4.5	Conclusions	93
5	Oil sensor.	95
5.1	Proposal.....	96
5.1.1	Description of the Optical System.....	96
5.1.2	Operational Algorithm.	97
5.2	Test Bench.....	97
5.2.1	Electronic Operation.	97
5.2.2	Sources of Oil.....	98
5.2.3	Samples for Calibration and Verification.....	98
5.3	Results.....	99
5.3.1	Industrial Oil of Diesel Engine.....	99
5.3.2	Industrial Oil of Gasoline Engine.....	103
5.3.3	Verification.....	107
5.3.4	Discussion.	108
5.4	Conclusions.	111
6	Practical deployment analysis.	112
6.1	Scenarios in storm sewerage.	113
6.1.1	Algorithm.	113
6.1.2	Results.	113
6.2	Water level, conductivity and oil sensor.	115

6.2.1	Test bench.	116
6.2.2	Results.	119
6.2.3	Conclusions.	129
7	Application in sewerage.	131
7.1	Selection and Definition of Communication Technology.....	132
7.2	Topology.	132
7.3	Algorithms.....	133
7.4	Cost of sensor node.	135
8	Application to other environments.	137
8.1	Design and Calibration of Moisture Sensor-based on Electro-magnetic Field Measurement for Irrigation Monitoring.	138
8.1.1	Test bench	138
8.1.2	Results.	140
8.1.3	Verification.....	145
8.1.4	Overview and general discussion.	146
8.2	IoT Sensor to Detect Fraudulent use of Dyed Fuels in Smart Cities.....	147
8.2.1	System description.	147
8.2.2	Measurement and Results.....	150
8.3.	Sensors and Biosorption for Better Reuse of Wastewater.....	154
8.4.	Development of Optical Sensor to detect Industrial Oil in Agricultural Irrigation System.	155
8.4.1.	Proposal.....	156
8.4.2.	Test Bench.....	157
8.4.3.	Results.	158
8.5.	Conclusions	160
9	Conclusions.	162
9.1	Conclusions.	163
9.2	Future Work.	163
9.3	Problems Faced and Personal Contributions.....	164
9.4	Publications derived from the PhD.	164
	Reference.....	167