# Lir: Water contamination detection

**Product Definition ICTE**

## 1 Problem description

Of American homeowners who participated in a survey from the Water Quality association, 54% is concerned about the quality of their tap water. Moreover, this number is on the rise: in 2019, concern over the quality of tap water grew significantly opposed to the numbers in 2017 [Association, 2019]. Furthermore, water quality is important world-wide, as everyone should have clean drinking water available. As of 2020, there are no commercially available water quality measurement devices that provide real-time continuous water quality monitoring. Therefore, the high concern over water quality may stem from simply not knowing whether the water from the tap is contaminated. While it is possible to measure water quality at home, current kits are often chemical-based, which can be time-consuming, is not extremely accurate, and will make it so the sensor reaction substance has to be replaced over time. A real-time continuous water monitoring solution would be a great solution to this problem. A commercially available measurement device should both reassure homeowners on the quality of their tap water, as well as provide warnings in the case of significant pollution.

## 2 Target market

The target market consists of homeowners in the USA. This target market was chosen as it was found that more than half of Americans has concerns about the water quality of the water at their home.

## 3 Technology

The product that is proposed by this paper includes a water quality sensor unit that can be attached to any standard-sized tap. The water quality unit will contain several sensors which will allow the user to determine the water pollution levels of the water

before it comes through the tap. More specifically, the water quality unit will be able to detect chlorine, lead, mercury, chromium, and the pH of water that goes through it. The sensors that will be used to determine the presence of these substances, were determined according to previous research. As was mentioned before, according to "The national study of consumers opinions and perceptions regarding water quality", most Americans are worried about the amount of chloride and lead in their drinking water [Association, 2019]. Furthermore, some other heavy metals like mercury and chromium form a concern [Odobašić et al., 2019].

Early on, it was already found that a planar silicon-based sensor could be used to detect chloride in water by [van den Berg et al., 1993]. Later, in 2012, a green, sensitive and facile sensing system was constructed for the detection of chlorine in water by means of a graphene quantum dot [Dong et al., 2012]. A few years later, a low-cost, graphite-based chlorine sensor was proposed by Pan, Deen and Ghosh [Pan et al., 2015]. As graphite sensors seem to be a proper and low-cost solution, our product will implement the chlorine sensors as proposed by Pan et al.

For the detection of the heavy metals lead, mercury, and chromium, other sensors will need to be utilized [Wang and Hsu, 2019]. In 1995 it was already established that glass chemical sensors can be used to detect all of these heavy metals in environmental monitoring and process control [Legin et al., 1995]. However, as these types of sensors are quite expensive, other solutions were investigated. It was found by Ivask, Virta, and Kahru that recombinant luminescent bacterial sensors can be used for the detection of, among others, mercury and chromium [Ivask et al., 2002]. By Brahvsar, Hurston, Prabhu, and Joseph a fibre optic sensor was proposed for the detection of heavy metals in water [Bhavsar et al., 2017]. This sensor focuses on the principle of method ions detection, which enables it to detect copper, chromium, and mercury.

The use of biosensors was looked into, however, for the purpose of this project they were found to be unfeasible. Bio-sensors tend to use chemical reactions to trigger the detection of certain substances (bronnen). As the reactor substance will eventually run out, this means that the product will not stay functional over longer amounts of time.

# 4 Product features

- The product as proposed will be a water quality unit, containing the different sensors.This unit can be placed under the tap and/or sink and will be installed between the tap and the water connection point.
- The unit will be able to measure chemical and microbial contamination, as described before.
- The product will be accompanied by an application that is available on both Android and iOS.
- This application will provide a complete overview of water quality measurements and hardware information, such as sensor status and whether a part needs replacement.

- This application and the water quality unit will be connected to the internet through an IoT module.
- This application will give a warning when a threshold value as set by the World Health Organisation is crossed [Water et al., 2006].
- This application will be connected with a public database, where anonymised data will show in what areas water is contaminated.

## 5 How to achieve this

The collaboration with experts in the field of water quality and water sensors is highly important. Interviews will be conducted to enrich our knowledge in the field of water sensors and water pollution. These interviews can also be used to change the scope of the product when necessary.

The application will be coded in Python 3.8.x. This is the coding language all the programmers have the most experience in.

If possible, the sensors will be acquired and connected to a Raspberry Pi, which will allow for a demo of the sensoric unit. However, this would be an extra goal of this project, the main focus will be on designing the accompanying software.

The data will be handled through an AWS infrastructure. All the input from the sensors in the water quality unit will be handled through an AWS IoT core. This core will process and store the data in an AWS S3 bucket, from which it can be retrieved for personal use or for the online platform.

## 6 Current market

Currently, the main focus of the water quality industry lies on home water treatment systems and large water treatment systems [Association, 2019][Berry et al., 2005]. Other fields within the water quality industry focus on the quality of the water in the soil, or on irrigation systems using water quality sensors
[Le Dinh et al., 2007][Bauder and Brock, 2001]. As of 2019, two-thirds of American homeowners have a water treatment system installed [Association, 2019]. There are some tools available that allow one to measure water quality at home. First of all, various online stores sell 'pens' that are able to measure total dissolved solids and PH values.

These tools have some downsides, however. Most importantly, these tools provide no way to monitor water quality in real-time. Besides, the sensors used are of such low quality that measurement reliability will be questionable. Another way of home-testing water quality is through chemical-based kits. However, usage of these kits is often time-consuming and inaccurate. Due to their nature they are also unsuitable for real-time measurements.

## 7 Stories

Epic story:

- When water is contaminated, I want to be able to know that it is contaminated, so that I can take appropriate action.

User stories:

- As a water drinker, I want to know when my water is contaminated, so I can avoid drinking it.
- As a person that identified contaminated water, I want to know how my water is contaminated, so I can take the right precautions.
- As a Lir contamination detector user, I want to know whether my unit is working optimally, so I can replace parts when necessary.
- As a government, I want to know where water contamination takes place, so it can be regulated and, if possible, solved.

## 8 Image example

Figure 1: Example of product placement
[filter magazine, 2020]

## References


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