

IoT based Smart Water Quality Monitoring System

Introduction:

Four physical parameters: temperature, pH, conductivity and turbidity of different water samples are measured via four separate sensors equipped with Arduino Uno. The extracted sensor data are analyzed using the fast forest binary classifier to see if water is drinkable or not. A desktop application is developed in .NET platform to identify whether the tested water samples are safe or unsafe for human consumption.

- Turbidity sensor SEN0189 is used in the design to detect the presence of suspended particles by using light.
- The pH sensor SEN0161 is used to measure the presence of acidity or alkalinity of any solution in logarithmic scale.
- The digital temperature sensor DFR0198 provides accurate reading between -55 to 125°C .
- To measure the electrical conductivity of water sample, the analog sensor DFR0300 is utilized

Machine learning algorithm is implemented at the backend to predict the water quality based on the measured data. Since the system will predict either the test water sample is "Drinkable" or "Not Drinkable", the fast forest binary classifier algorithm is employed.

Water sources are divided into three categories: natural, impure and potable water sources. We will compare our sensor data with the general guideline for pH level in drinking water suggested by WHO which is around 6.5-8.5.

60 different water samples have been collected from nearby tap, filter, soft drinks and other sources. The prediction accuracy of the designed system is compared for the experimented data in ML Algorithm.

Need of concept:

Due to the fast growing urbanization supply of safe drinking water is a challenge for the every city authority. Water can be polluted any time. So the water we reserved in the water tank at our roof top or basement in our society or apartment may not be safe. Still in India most of the people use simple water purifier that is not enough to get surety of pure water. Sometimes the water has dangerous particles or chemical mixed and general purpose water purifier cannot purify that. And it's impossible to check the quality of water manually in every time. So an automatic real-time monitoring system is required to monitor the health of the water reserved in our water tank of the society or apartment. So it can warn us automatically if there is any problem with the reserved water. And we can check the quality of the water anytime and from anywhere. By keeping this mind we designed this system especially for residential areas.

System requirements:

Hardware Requirements:-

- 1)Arduino UNO
- 2)Temperature sensor- DFR0198
- 3)PH Sensor - SEN0161
- 4)Turbidity Sensor - SEN0189
- 5)Conductivity Sensor - DFR0300
- 6)ESP8266- Wifi module
- 7)Breadboard

Software Requirements:-

- 1)Mobile

Design methodology:

Step 1: Purpose and Requirement Specifications

1. Purpose:-

Purpose of Water quality monitoring system in IoT (Internet of Things) platform which would help in monitoring different physical parameters of the drinkable water rather than relying on manual process.

2. Behaviour:-

System will capture the sensor data and send it to the application where ML Algo is Applied in backend to predict water quality via ESP8266 attached to Arduino uno.

3. Data Analysis Requirements:-

Data is sent to cloud and then result is processed in Application.

4. System Management Requirements:-

The system should provide remote monitoring.

5. Data Privacy and Security Requirements:-

Authentication provides the means to validate the identity of the user before user interacts with the system. Access control is used to regulate access to data and services

6. User Interface/Application Deployment Requirements:-

Application is connected to controller for accessing the sensor data and processing result.

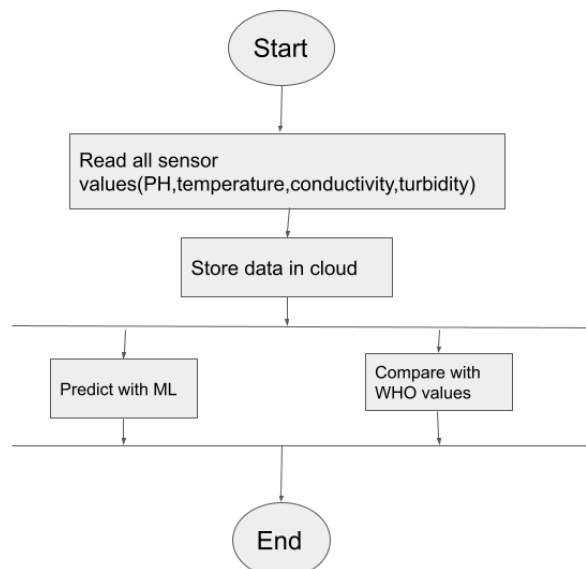
Hardware Requirements:-

- 1) Arduino UNO
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- 6) Breadboard
- 7) ESP8266

Software Requirements:-

- 1) Mobile

Step 2: Process Specification



Arduino Uno will read all the sensors value namely PH, temperature, turbidity and conductivity and send this data to the cloud where processing will be done with fast forest binary classifier and also compared with WHO standard values and then the result will be shown to all the application with MQTT Protocol of Application layer.

Step 3:Domain Model Specification

Physical Entity:-

Here water is the physical entity which is discrete and identifiable in physical environment and the IoT System provides information about water.

Virtual Entity:-

Representation of physical entity in digital world is virtual entity and in our case virtual entity of water will be there.

Device:-

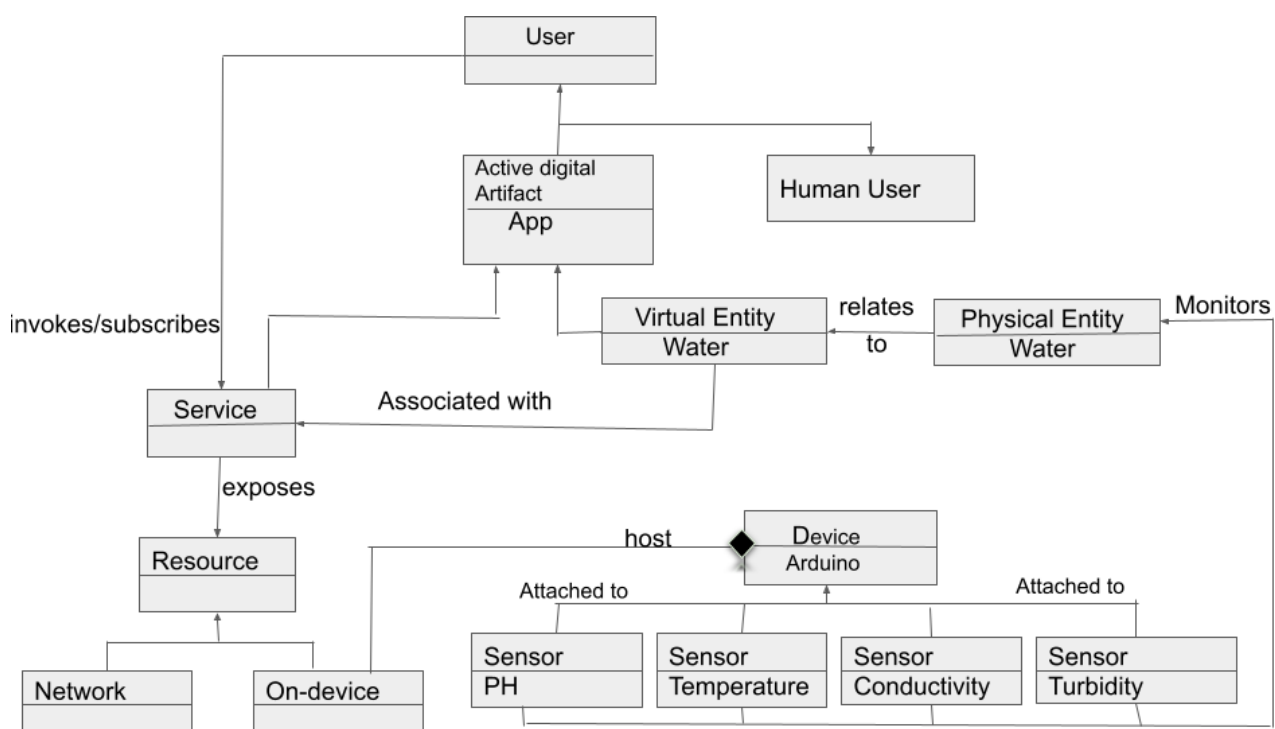
We are using Arduino interfaced with sensors and WIFI module to provide medium for interaction between physical and virtual entities.

Resource:-

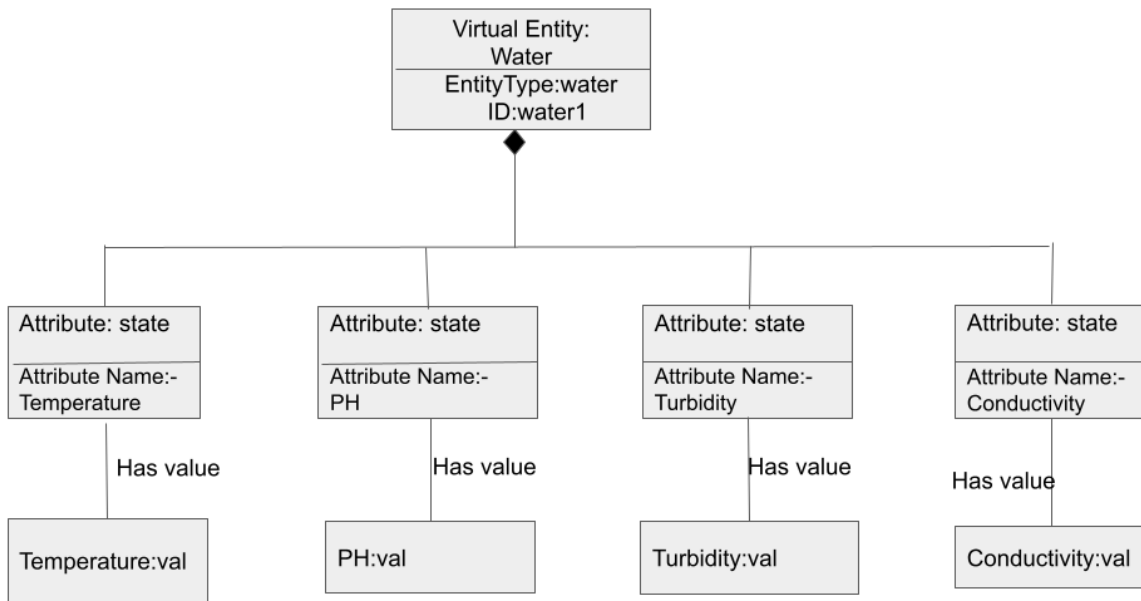
On device resources is Arduino uno 16 bit processor.

Service:-

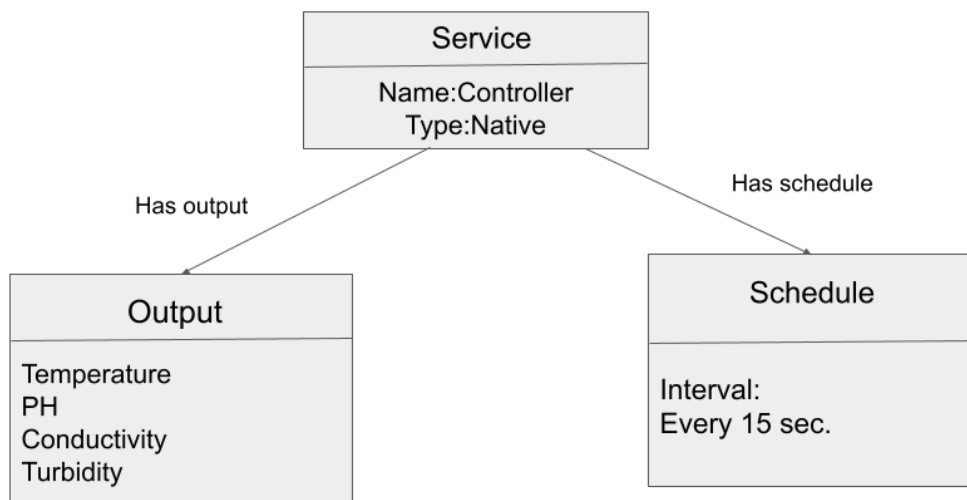
Controller is the native service which runs on the device and measures the sensor values.The controller service calls REST service to store these values on cloud.Platform-as-a service called Xively is used for creating solutions for IoT.An implementation of controller service that calls Xively REST API to store data in Xively cloud.

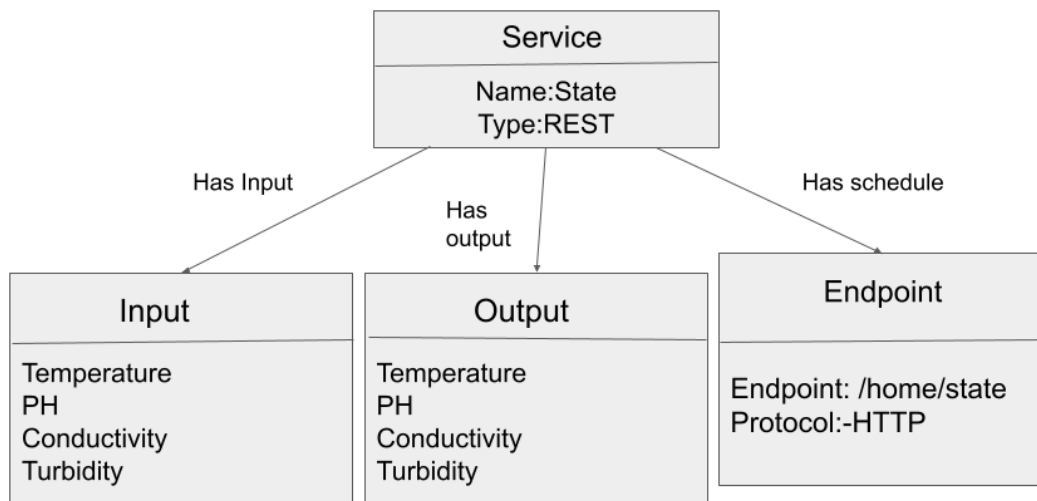


Step 4:Information Model Specification



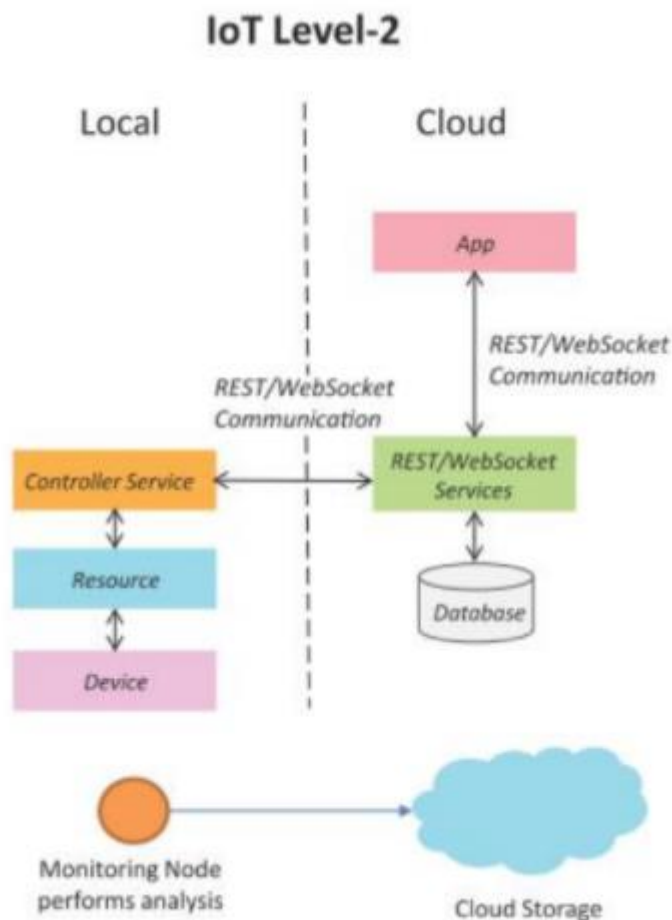
Step 5:Service Specification





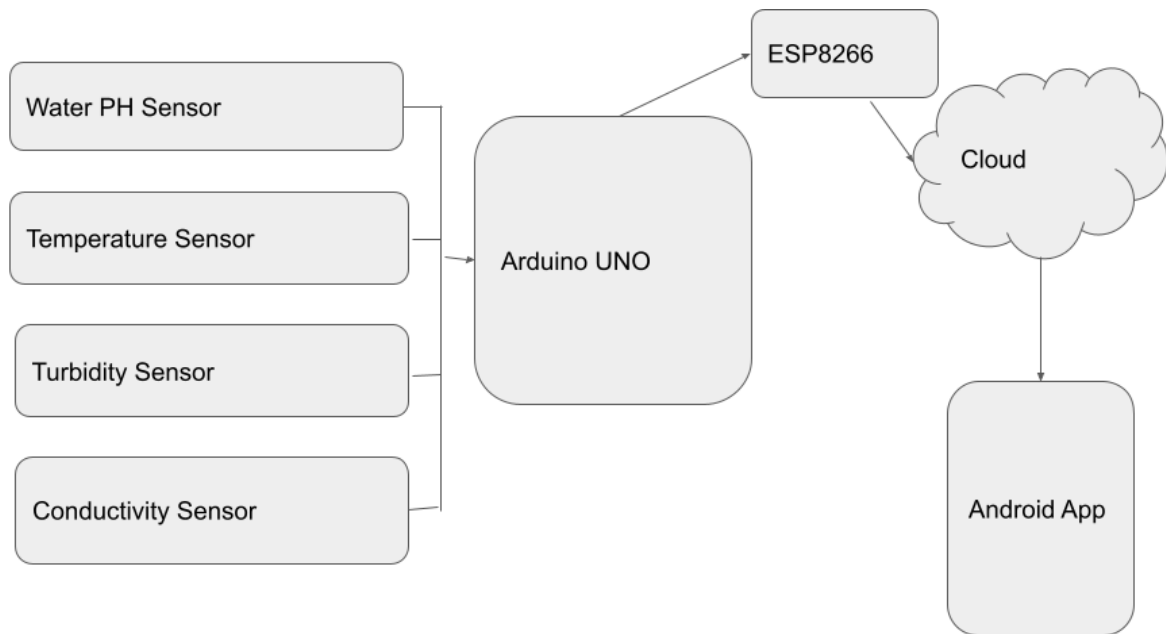
The Controller service runs a native service on device and monitors the sensor values every 15 seconds. The Controller service calls the REST service to store this data on cloud.

Step 6:IoT Level Specification



A level-2 IoT system has a single monitoring node. The monitoring node has multiple Sensors like temperature, turbidity, conductivity and pH sensor. The values are stored in the cloud and the application is cloud-based.

Step 10:Application Development



(a)Application

1) Firstly, ports connected with the arduino are selected. Then, data are read with the assistance of the sensors. These data are used to check whether the water sample is drinkable or not drinkable with backend ML algo and comparing with WHO values, and the result is saved into the database. During the processing of data, only three parameters (pH, Conductivity and Turbidity are considered, because temperature is used in the experiment as a factor of conductivity.

2)Based on MQTT, Secure Message Queue Telemetry Transport (SMQTT) protocol is an encryption based light weight messaging protocol. Compared to an MQTT session, SMQTT session has four stages – setup, encryption, publish and decryption. It has broker based architecture similar to MQTT, however, in this protocol both subscriber and publisher need to register with the broker using a secret master key. The data is also encrypted before being published by the publisher and then is decrypted at the subscriber end. There can be any encryption algorithm can be used by the developer.

This can be used when we are using this setup for detecting water quality stored in the tank of the apartment/society. Where each of the client can subscribe and the server publish the data by getting it from Arduino.

Application

Read Data

temperature

PH

turbidity

Conductivity

Predict with ML

WHO Values

Result