**SMART WATER MANAGEMENT**

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**1. Introduction**

The objective of this document is to provide an advanced technology and data –driven strategies to efficiently and sustainably manage water resources. It involves the application of sensors, data analytics and automation to monitor, control and optimize water usage across various sectors including agriculture, park, garden and urban areas. Smart water management aims to reduce the water wastage, improve water quality and enhance overall water resource sustainability.

**2. Problem Statement**

To develop smart water management and reduce water scarcity in urban areas (parks and gardens) by using software tools.We have software tools (SKYSPARK & SENSEYE pdm) that detects if there is any malfunction in sensor that is used in the garden. The sensor is monitored by the software tools 24/7.This sensor helps us to reduce the water scarcity.

**3. Design and Enhancement Strategies :**



**3.1. Methods:**

The phases included data acquisition, communication, stor age, pre-processing, analyzing, and web interfaces carried

out by the following:

1. Collecting water level (consumption) data from water tanks.

2 Performing pre-processing steps on the data.

3. Analyzing the data and applying SVM for forecasting

water consumption, leakage detection and leakage

rate.

4. Designing a web interface for the users for visualization

purposes.

**3.2. System Architecture**

The following list details the hardware components provided,along with the technical specifications for the ultrasonicsensor, data acquisition architecture, and the Wi-Fi.

**Sensor and data acquisition hardware**

* 1 × Breadboard
* 1 × Arduino Uno R3
* 1 × ULTRASONIC Sensor (HC-SR04)
* 1 × LCD 16 × 2
* ESP module
* Connecting wires

**Technical specifications for ultrasonic sensor**

* Power supply þ5 V DC
* Quiescent current <2 mA
* Working current 15 mA
* Effectual angle <15
* Ranging distance 2–400 cm (1 inch–13 ft)

**Data acquisition, communication, storage**

The data used for the project were collecteed from a complex of 16 households. The height plays an important role in determining the working of the whole process of starting and stopping the motor. The water tanks which is installed can be any size

**3.3 Working:**

**Working of ultrasonic sensor:**

The Arduino kit, including the UV sensor, was installed on the top of one of the two tanks to monitor the water level every 10s. This ultrasonic sensor sends UV rays to measure the distance of the water level from the top of the tank using sonar. The sensor sends ultrasonic waves to the water, whisch are reflected by the water surface and returned to the sensor. The sensor uses this time of wave propagation to calculate the distance between the sensor and the water level. The time taken by the pulse is actually to and for travel of the ultrasonic signals, which only half of tthis is needed. Therefore, the time is time/2.

Distance calculation:

Distance = speed\*time/2

Speed of sound at sea level = 343m/s or 34,300 cm/s

Thus the distance measured = 17,150\*time (cm) (Boyleet al. 2013)

Using that distance, the water level and hence the volume of water consumed can be calculated because the height and radiuus of the tanl are fixed.

**Working of Arduino board**

The Arduino is programmed by sending a set of instructions to the microcontroller on the board. The water level, which is monitored by the Arduino Kit, is continuously sent to the server using the Wi-Fi module installed on the kit.

**Working of Wi-Fi module**

The Wi-Fi module can cannect to the Internet via a hotspot using its service set identifier (SSID) and password. It has been programmed to implement logic statements as per requirements of the project. The ultrasonic sensor reads the distance of the water surface and returns it to the module.The module , when connected to the Internet, uploads this value to the database. The water level monitored for each tank is collected by the ultrasonic sensor and the data are simultaneously transferred to the server via ESP12-e.

**4. Data description and pre-processing**

**4.1 Time step**

The time step denotes the time interval for recording the water consumption values, and is dependent on which model is used. The model can be hourly, daily, or monthly. In our case, the time step is 10 s.

**4.2 Handling missing data**

In order to complete the missing values in our observed data, the mean values were taken from the observed data after observing that the consumption values did not vary greatly at the same temperature. The data were recorded for an average of 4–5 h per day over 21 days, with a total of 102 h of readings being noted. The readings were taken at the same time on different days.

**5. Data analytics**

**5.1 Feature space and response variables**

We considered the following parameters in defining the feature space for the SVM algorithm: (a) volume of water consumed (cm3 ), (b) number of users, (c) temperature (C), and (d) precipitation (mm). The response variables for SVM consist of: (a) average water consumption per user per day and (b) prediction of water consumption per user per day. The algorithm for leakage detection considered the following parameters:

(a) Input variables: water level initial, water level final and n use.

(b) Response variables: leakage detected (yes/No) and leakage rate (cm3 /s).

**5.2 SVM-based classification**

SVM was used for analysis purposes because it is accurate and is the preferred method for data sets of small sizes . SVM is also less prone to over-fitting than other methods and it facilitates compact models for classification. Kernel function, radial basis function (RBF), is used because the data are not linearly separable and it is the most commonly used kernel in SVM. Finally, the optimal hyper-plane is found, which creates maximum empty space at two sides of the coordinate. The independent variables used for training

**Steps for the training algorithm**

**Step 1:** The data set is divided into two sets: training data and testing data set. As we have data for around 25 days we take the initial 7 days’ data.

**Step 2:** From the next day, we predict the total consumption values using the training data set by applying the SVM algorithm.

**Step 3:** The predicted value for the 8th day is compared to the actual water consumption value for that day. The error value is calculated by finding the difference between the actual and the predicted value.

**Step 4:** For predicting the consumption value for the next day, i.e. for the 9th day, we take the 8th days’ value in the training data set. This is recursively repeated and we predict the value for nth day using the previous n 1 day’s value in the training data set.

**Step 5:** Every time we increase the data set for training data, the error value shows a significant reduction, i.e. we approach a more accurate prediction.

**6. Leakage detection:**

The leakage detection system is another major feature of this project. Water leakage is a major cause of unwanted water loss, which needs to be avoided. It can be monitored and controlled only by detecting the leakages in the first place. At the basic level, the proposed leakage detection algorithm illustrated in Figure 3 can detect leakage in households. The important condition is that the water supply should not be on and the users should not be using water when the leak is being detected. Initially, the initial water level (A) is noted. After t time (which can be in seconds or minutes), the present water level (B) is noted. If A ¼ B, there is no leakage; otherwise a leakage is detected and the rate of leakage is calculated. It sends a message notification to the user in case any leakage is detected in the tank and they can take actions accordingly

**7. Conclusion**

Water wastage has become a huge problem and therefore this paper proposes an IoT-based water management system for collecting data, predicting average requirement of water per person in a household and in society, and monitoring their consumption. An algorithm to detect leakage has been proposed and can be used to calculate the rate of leakage. A web interface allows the user to visualize the water usage. The results show that the error between the predicted and actual values is reduced as the size of data set increases