

An Efficient Control Strategy for an Optimal Operation on Clear Water Process Station

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Abstract

Water process stations are very common nowadays, that can be noticed everywhere from a small house to very big industrial area. The main objective of the water process stations are to reduce the hardness of the drinking water. In order to attain such a clear drinking water, the process station will work over several stages like sediment filter, carbon filter and RO membrane. Usually all these stages will be taken into account by the process stations on the feed water irrespective on its hardness measurement. The control strategy imposed in the paper verifies the hardness of the feed water at the very first step to avoid several stages for making the process simpler and faster. In the same way, at the stage of each filtering process huge amount of water will be wasted in the traditional process station. Due to the implementation of an efficient control strategy such wastages can also be minimized in the proposed work. The experimental study performed based on the proposed methodology explores the amount of water saved during the clear water processes as well as the time requirement for processing the feed water.

Keywords: Water process station, clear water process, water filters control

1. Introduction

Water is one of the primary source needed for all natural living things. The quality of water may differ place to place based on the chemical properties of the soil contents. Most of the soil properties mixed in the water are good for the health of humans. Though the excess amount of certain soil properties may leads to several health issues like kidney stone and minor viral infections on the urinary bladder. The water quality is measured by analysing its TDS (Total Dissolved Salts) presence and it is represented in ppm (parts per million) unit [1, 2]. The value of TDS may vary depends upon the calcium, chlorine, iron, phosphates, sodium and potassium contents presence available in the ground water. A common ground water TDS range usually varies from 200 to 2000ppm. However, some micro processed water from Municipal Corporation may project the ppm values between 1 to 2000ppm [3]. Table 1 indicates that the kind of water process stages required for some of the specific ppm levels.

Table 1. Recommended water process stages on different ppm level

Water Source	Levels in ppm	Required Water Process Stages
Ground Water (Pond, Well)	200 to 2000	UV + UF + RO
Municipal Water (Bore)	1 to 200	UV + UF
Multiple Source Water (Bore + Pond)	1 to 2000	UV + UF + RO + EAT

UV – Ultraviolet; UF – Ultra Filtration; RO – Reverse Osmosis;

EAT – Electro Adsorption Technology

From the Table 1 it is clear that the required water process stages may vary depends upon the different level of ppm available in the source water. In all of the given water process stages, UF (Ultra Filtration) is a primary water process stage works without electricity. It removes the presence of cysts, salts, dust, sand and bacteria from the water through gravity based pulling technology. These kind of filters usually have two cabins, one at the top for filling

up the available water and the other cabin is at the bottom for receiving the pure water from the UF stage due to gravity pulling principle. These type of UF process never removes the dissolved impurities in the water and it cannot be efficient for removing viruses from a hard water. Though, the UF water process stages are used where the ppm levels are naturally very low [4, 5].

The UV (Ultraviolet) technology is also called as invisible radiation technology used to block the multiplication of microorganisms presence in the water. However, it does not has the ability to remove the disinfected microorganisms from the water. The UV process is comparatively very fast than the UF and it can able to remove viruses, bacteria, cysts and protozoa particles available in a water [6, 7].

The RO (Reverse Osmosis) process are widely implemented to water ppm ranges between 200 to 2000ppm. The process is very efficient in reducing the calcium and salt contents presence available in a normal water. The RO process also has the ability to minimize the chemical contents diluted in the water naturally. The water is allowed in RO process to flow in a very thin membrane of 0.0001micron and this process also mostly used to convert the salt water for drinking purposes [8, 9].

EAT (Electro Adsorption Technology) is suitable for water contents which has ppm less than of 500 value. The technology has five stages of purification which mostly requires an electric power. The first stage has a prefilter which removes the hard particle presence from a water. By removing the hard particles like sand, dirt and dust the life time of the further filters are improved in this process. The second stage of the EAT has a mechanical filter which removes the sediment solids presence left from the first stage of prefilter. Further an electro adhesion filter is placed for removing the cysts, bacteria and viruses from the water. The fourth stage is also called as ion exchange, which works to remove lead and other heavy metal particles through carbon granules included in the stage. The final stage used to reduce the harmful chemical contents and pesticides presence available in the water and the final stage is called as electro adsorption stage [10, 11].

2. Related Work

A system made to operate with respect to some specify tasks are called algorithm. The algorithms are usually made to be operate by changing the digital and analog output of an microcontroller based on the input signal received from a sensor devices or other input sources. The routing algorithms are widely implemented on network algorithms for finding a better path for reaching the destinations [12, 13]. The primary role of the network routing algorithms are to identify an optimum path in terms of saving energy, reducing delay and efficiency on data transmission [14]. In the same way, there are several routing algorithms are implemented on process stations for minimizing their operation time and cost required for the overall operations.

In recent years, the automation are comes up in collaboration with IoT and deep learning algorithms on many applications like agriculture, energy production and health monitoring applications [15]. The primary requirement of implementing all these IoT and deep learning algorithms are training process. The training process of a deep learning algorithm requires a huge amount of data. Therefore so many IoT sensors are utilized nowadays for data collection on many scenarios. All these collected data are transmitted to a base station for doing preprocessing. The preprocessing of data is a first step in deep learning algorithms used to find out the irregular and irrelevant data identified from the sensor source station. All such collected data are further categorized into their respective class and attributes for providing training information to a neural network algorithms [16]. As the data collected through IoT sensors are in huge quantity, the collected informations are technically called as big data and the data processing are technically termed are data mining process [17, 18].

Making an efficient big data is challenging task, it requires a trained person for categorizing the collected data into their respective category on the dataset. Sometimes, the categorizing work can be made using some simple algorithmic tool or simulation tool for the ease of processing. This kind of processes are widely used on medical datasets, where the unlabelled data informations are categorized into their respective classes with the help of

feature and attribute information collected from a medical image. All such numerical values extracted from the image informations are verified with a trained medical practitioner for categorizing the image [19]. In some medical applications the data mining processes are used to predict a disease on their early stage from a human body. Coronary artery disease prediction is one among them and it is used to predict the disease condition through extracting feature informations from the dataset samples. The collected feature informations are again represented as feature database. The feature database informations are further categorized into training and testing samples for training a classification network [20].

The data mining process are also applied to crop yield estimation process by analysing the variations in water content due to climate change on different month of a year. Change in minerals and chemical variations of a water content may affect the crop growth. This is verified using artificial neural network, support vector machine and genetic programming algorithms. The results indicates that the change in water content affects the crop yield growth from 6 to 42% in nature [21]. A credit card fraud detection application is also generated based on data mining approach with the help of deep convolution neural network algorithms. The algorithm detects the transaction status within 45 seconds of time with 99% of accuracy [22]. The work is verified with a real-time online transaction dataset comprises of 30 feature attributes including time, class, amount and other sensitive informations on the transaction. The weightages given to the data attributes can be changes to some desired value on the training process of neural network algorithm for attaining a best accuracy.

A data mining based approach for electricity demand analysis is presented with a help of smart energy meter [23]. The smart energy meter is designed to transmit the collected informations on power consumption at some regular time interval to the source station through internet of things. The collected informations are pre-processed for providing a better prediction output. The data mining approaches are even applied to fault detection estimation on electrical motors [24], where the vibration changes are observed from a motor on different health conditions and are processed for making a big data. The change in vibrations are related

to stator fault, broken rotor fault and bearing faults. In the recent years, the customer informations are also collected for making a big data for estimating their future needs on purchases and telemarketing [25]. However, to secure the most precious informations of a customer, certain data securing algorithms like blockchain are developed in the recent years [26].

Regarding the recent advancements in water process stations, a deep learning based water quality classification algorithm was developed with respect to the feature extraction techniques [27]. The system utilizes a hybrid neural network algorithm in combination of long short term memory network with recurrent neural network algorithms. Similarly the system employs a principal component analysis along with linear discriminant analysis for feature extraction process. Independent component analysis were employed in the model for reducing the data informations collected from the overall extracted features. The experimental results obtained the accuracy of 99.72% with holdout implementation. The water quality index of a river water is estimated through deep learning based algorithm [28] with a klang river dataset. The experimental work carries the information of pH value along with chemical oxygen demands and suspended solid contents extracted from the river water. The experimental work utilizes the random forest and decision tree algorithm for the classification process. The values are extracted from five various area in the river channel and the experiment observed accuracy of 89% on random forest and 83% on decision tree algorithms.

3. Proposed Method

The motive of the proposed work is to design a control system for water process stations with respect to the ppm values measured by the sensors fitted at the inlet side. Figure 1 indicates an overview of the proposed model. Here various ppm level of water are given as input to a water process station comprises of UV, UF, RO and EAT filters for observing a clear drinking water in the storage tank. A TDS sensor is fitted before all of these process stations for

observing the ppm level of the inlet water. The sensor is directly connected to a microcontroller unit for enabling the RO and EAT modules through a solenoid valves connected from a relay.

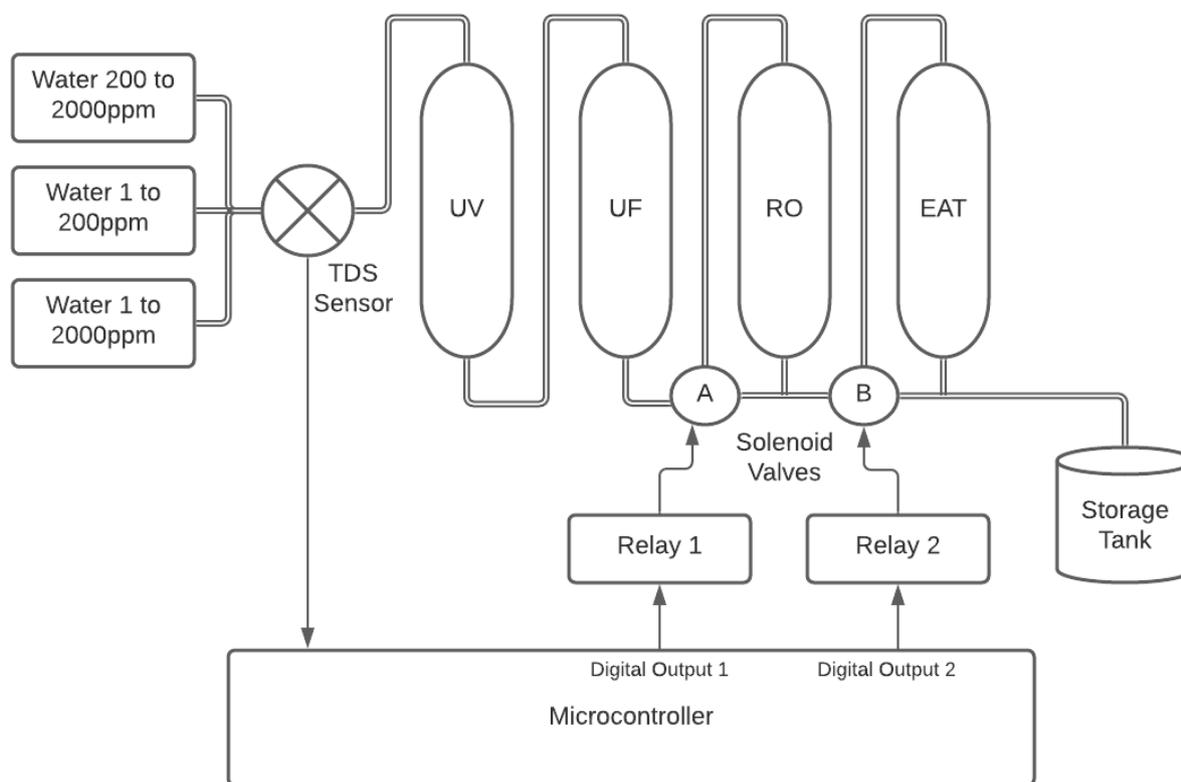


Figure 1. Architecture of the proposed model

The workflow of the proposed algorithm is represented in Figure 2. Here the solenoid valves connected to the RO and EAT modules are get activated on their respective time only. The RO module gets activated when the ppm value ranges between 200 - 2000 for 'n' seconds. The value 'n' can be altered in the microcontroller program at any time. In the proposed work the 'n' value represents 15 seconds of time duration. The ppm values of the inlet water gets change time to time and it be consolidated by the microcontroller for every 15 seconds. If there is any change observed in the ppm value, the microcontroller activates the corresponding relay for the operation.

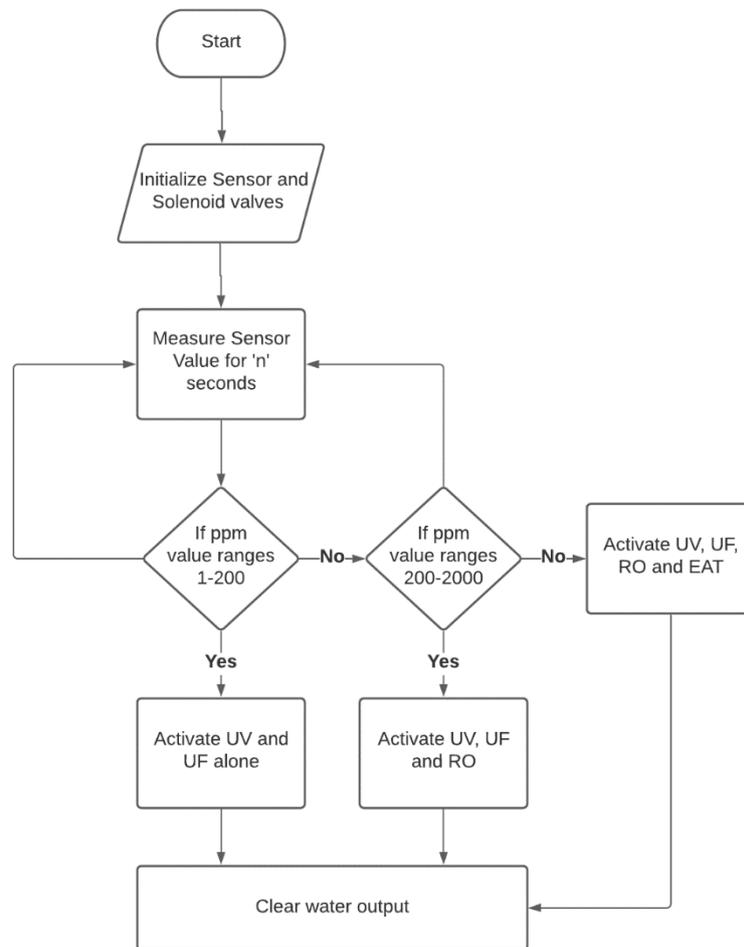


Figure 2. Workflow of the proposed control system

4. Experimental Analysis

The proposed model is verified with an experimental setup to determine its operating time efficiency and accuracy. The experiment also analyses the amount of water saved by the proposed model on avoiding certain unnecessary water filter modules. The work is experimented with a 25 litres of water from all the three major category of ppm ranges from 1 to 200, 200 to 2000 and 1 to 2000. The amount of water wasted on filtration process are measured with a standard tanks and considered for the water output efficiency.

Table 2. Performance of the proposed system on water management

Input	Output Water (litres)		Wasted Water (litres)	
	Traditional 4 stage water purifier	Proposed water purifier	Traditional 4 stage water purifier	Proposed water purifier
25 litres of water with 1-200ppm	15	19	10	6
25 litres of water with 200-2000ppm	11	16	14	9
25 litres of water with 1-2000ppm	9	10.5	16	14.5

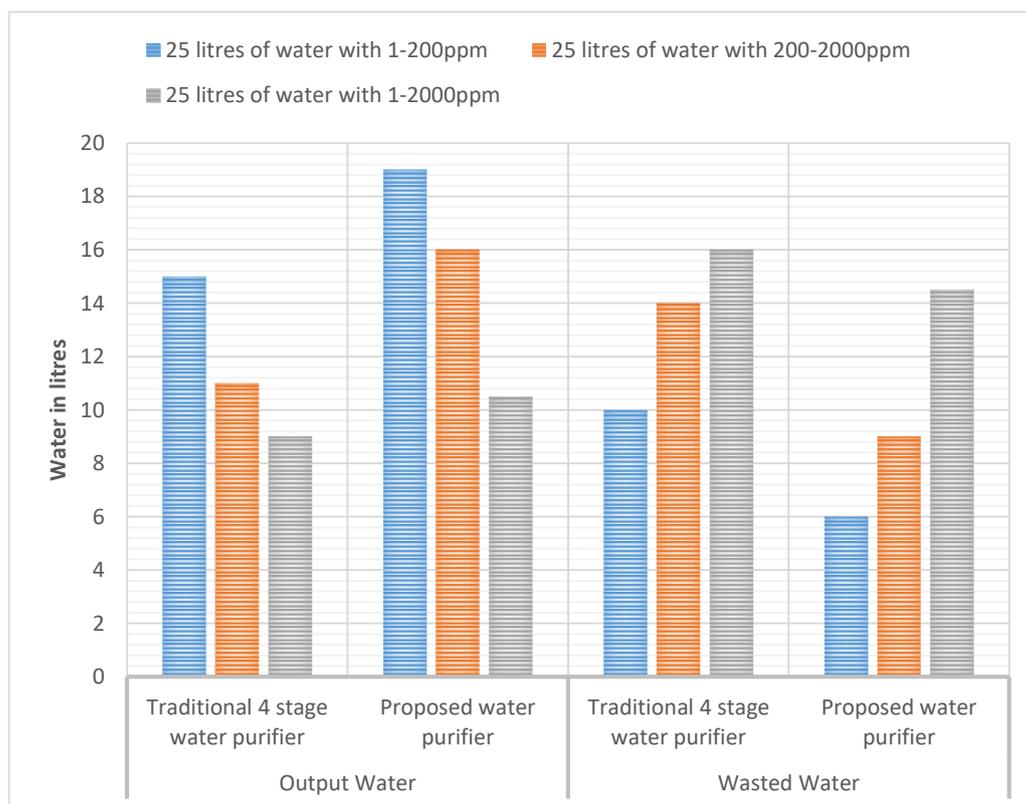


Figure 3. Analysis of the proposed model on water management

The observations on Table 2 and Figure 3 indicates that the proposed clear water process station performs better in terms of water management over the traditional 4 stage water purifiers. The performance of water ranges with 1 to 2000ppm gives only a minor change because of water quality fluctuations observed from the sensor in-between. The system disables EAT for certain time ppm of the water ranges between 200 and 2000ppm.

Table 3. Performance time comparison of the proposed model to the traditional model

Input	Process time in minutes and seconds	
	Traditional 4 stage water purifier	Proposed water purifier
25 litres of water with 1-200ppm	10mins and 14secs	6mins and 11secs
25 litres of water with 200-2000ppm	15min and 6secs	9mins and 2secs
25 litres of water with 1-2000ppm	16min and 35secs	13mins and 12secs

Table 3 explores the time consumption of the proposed model to the traditional 4 stage water purifiers. It clearly indicates that the proposed system saves lot of time and it will be resulting in lot of electricity energy savings. The minor changes in these operation time and water management will be resulting in a huge attainments when the calculation takes place on yearly basis.

5. Conclusion

An efficient control strategy on clear water process station is proposed for observing a quality water output with less electric charge and time consumption for purification process. An experimental work is carried out on the proposed system in comparison with a standard four stage water purification system for ensuring the proposed model efficiency on time and water management. The experimental results exploits that the proposed model gives a better output than the traditional systems. The proposed model is employed with a simple

microcontroller along with a TDS sensor for controlling the operation of a standard four stage water process stations through the solenoid valves connected from a relay module.

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