

Smart Water Quality Measurement and Filtration System

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ABSTRACT

Water is the most valuable resource in the world essential for human existence and well-being. In modern environment, the rate of pollution has increased. Many fresh water sources become useless. Due to the use of polluted water many health issues are occurring in the society. For measuring the water quality laboratory facilities are commonly used. It takes a lot of time for obtaining the result and it will be costly.

When we find that the water is contaminated we need cleaning and filtering procedures. These works are costly and sometimes requires chemical and water wastage during the cleaning process. We are trying to implement an automated water quality monitoring system along with an automated purification system which would ease the job of finding the pollution source and filtering it. Thus we can monitor the water quality and filter the water automatically when it gets contaminated by the use of a low cost system.

KEYWORDS: Water quality, Pollution, Quality measurement, Filtration, Automation.

1. INTRODUCTION

Water plays a vital role within the world economy. Water covers 71% of the Earth's surface. Water has many properties that are critical for the proliferation of life. Water quality refers to the chemical, physical, biological and radiological characteristics of water. It is an analysis of the condition of water relative to the necessities of 1 or additional organic phenomenon species and or to any human want or purpose. It is most often employed by relation to a collection of standards against that compliance, usually achieved through treatment of the water may be assessed. Water quality can be measured using standards in health of ecosystems, human contact safety and drinking water

We are implementing an automatic water quality measurement and filtration system based on standards of drinking water. Water quality can be monitored from anywhere in the world by using our system and pure drinking water can be also obtained in low cost.

2. SOCIOECONOMIC IMPORTANCE

For humans water resources are sources of water. For life to exist it is essential. At present water is the natural resource which is most polluted. Fresh water is the most important natural resource needed now. So an automated water monitoring and filtering system is an essential requirement of this era.

3. WORKING

A. Water Quality Measurement

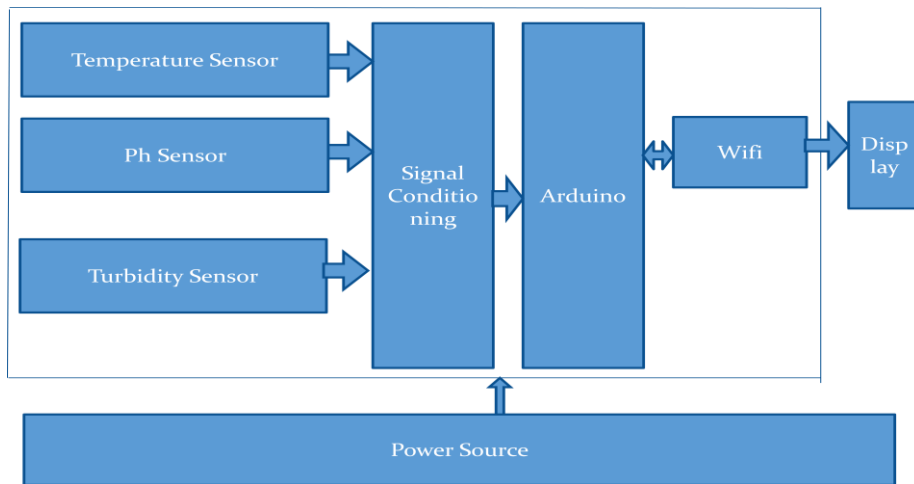


Fig 1. Block diagram of water quality measurement

B. Water Filtration

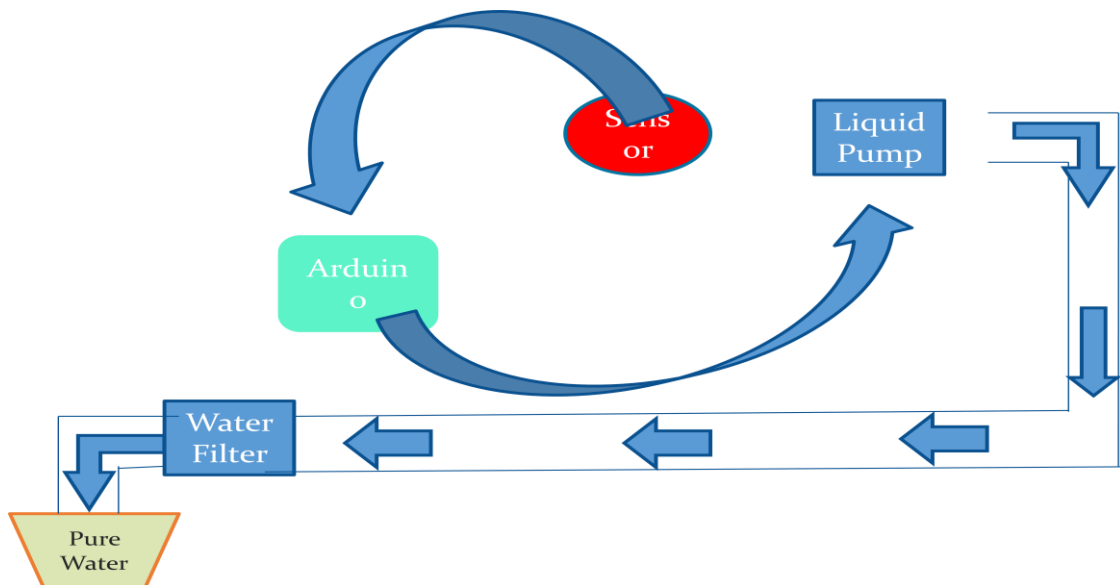


Fig2. Block diagram of water filtration

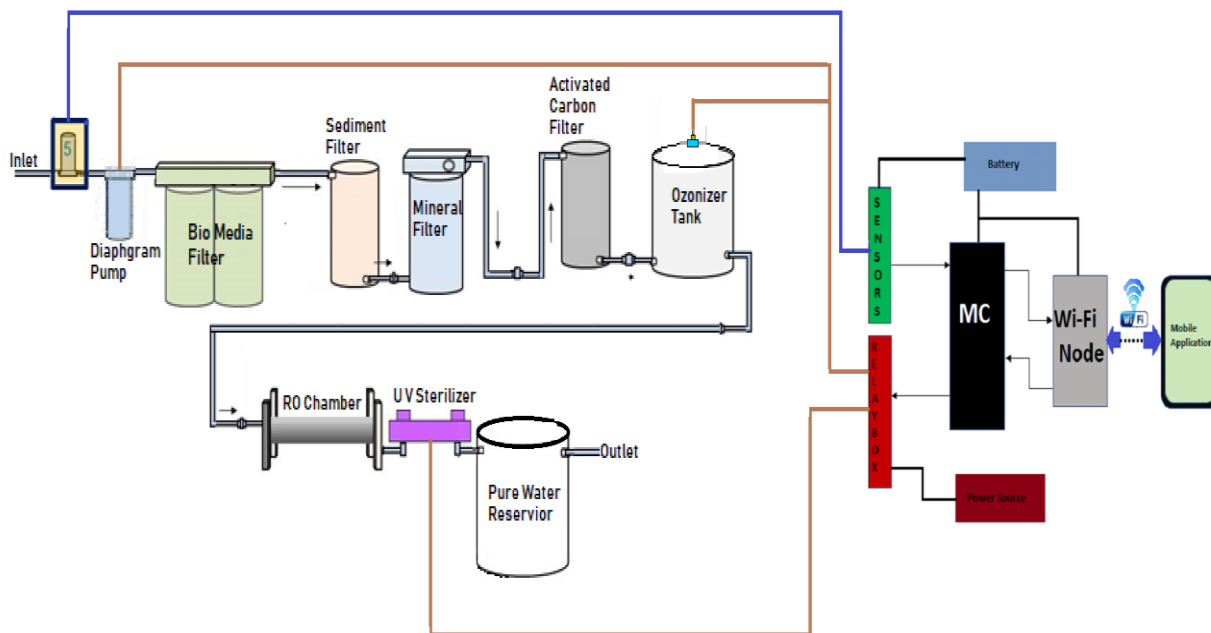


Fig3.Full process working diagram

Impure water will be pumped to impure water tank. Sensors will be kept in this tank for monitoring the various components. The raw values from the sensors are read and manipulated using a Atmega 2560 microcontroller (Arduino Mega). Then the values are sent to a wifi node. The wifi node will save the data in a cloud platform and a mobile app is used to display the value in real time. The data from the cloud can be accessed from anywhere in the world. It uses a modern technology called iot to send and receive data.

The whole process controller in this project is arduino mega. Water after measurement will be pumped to the different section of filter. First the water is pumped using a diaphragm pump to a biomedica filter. It controls water impurity by a bioreactor with living materials to degrade and capture impurities. Then the water is passed to sediment filter where sediments are filtered and then it is passed to mineral filter which removes heavy metals and alkalinity of water. Then the water is passed to an activated carbon filter that used activated carbon for filtration. It removes impurities by chemical adsorption. Then an ozone generator is used to increase oxygen content, remove odour and taste etc. Then the water is passed to a reverse osmosis filter which is used to remove dissolved and suspended particles present in water. A UV light sterilization is used for disinfection which kills inactive microorganisms. Thus pure drinking water can be obtained.

- **Arduino Mega**

The Arduino Mega is the microcontroller used here. It is based on the ATmega2560. Arduino Mega is having 54 digital input/output pins. 14 pins can be used as PWM outputs. It has 16 analog inputs and 4 UARTs. It also has a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It has everything that is needed to support the microcontroller. We can easily connect it to a pc with a USB cable or power it with a Ac-to-DC adapter or battery.

- **Diaphragm pump**

A diaphragm pump is additionally referred to as a membrane pump, It's a positive displacement pump. It uses the mix of reciprocal action of rubber, thermoplastic or teflon diaphragm and appropriate valves on either side of the diaphragm. Their flow rates do not vary much with the discharge "head" or pressure the pump is working against for a given pump speed. Diaphragm Pumps will transfer liquids with low, medium or high viscosities and also liquids with a large solids content. They can additionally handle several aggressive chemicals like acids as a result of they will be created with a large type of body materials and diaphragms.

- **Bio media filter**

Biofiltration is a pollution control technique using bioreactor. It contains living material to capture and biologically degrade pollutants. It includes processing waste water, capturing harmful chemicals or silt from surface runoff, and microbiotic oxidation of contaminants in air. It is a bed of media on that microorganisms attach and grow to create a biological layer referred to as biofilm. Biofiltration is thus usually referred to as a fixed-film process. Generally, the biofilm is formed by a community of different microorganisms, macro-organisms and extracellular polymeric substances (EPS) The aspect of the biofilm is usually slimy and muddy. Water to be treated are often applied intermittently or unceasingly over the media, via upflow or downflow.

- ***Sediment filter***

Sediment is any material which will be transported by fluid flow and that eventually is deposited as a layer of solid particles on the bed or bottom of a body of water or other liquid. Sedimentation is a physical water treatment process using gravity to remove suspended solids from water. A sediment filter acts as a sieve to remove these particles. The necessary factor to stay in mind concerning sediment filters is that they reduce sediment. They don't take away chemicals or significant metals or build the water taste or smell better. In general, sediment filters are rated by a "micron" number. This refers to the particle size which will be trapped by the filter.

- ***Mineral filter***

Mineral filter removes heavy metals, bacteria, and corrects the alkalinity of water.

- ***Activated carbon filter***

Carbon filtering is a technique of filtering that uses a bed of activated charcoal to get rid of contaminants and impurities, using chemical adsorption. Each particle, or granule, of carbon provides an outsized area, or pore structure, permitting contaminants the most possible exposure to the active sites among the filter media. One gram of activated carbon contains a area in excess of 3,000 m² (32,000 sq ft). Activated carbon works via a method known as adsorption, whereby pollutant molecules within the fluid to be treated are trapped within the pore structure of the carbon substrate.

Active charcoal carbon filters are most effective at removing chlorine, particles such as sediment, volatile organic compounds (VOCs), taste and odor from water. Activated carbon filter are not effective in removing minerals, salts, and dissolved inorganic substances. Typical particle sizes that may be removed by carbon filters vary from 0.5 to 50 micrometres. The particle size are used as a part of the filter description. The efficacy of a carbon filter is additionally primarily based upon the rate of flow regulation. When the water is allowed to flow through the filter at a slower rate, the contaminants are exposed to the filter media for a extended quantity of your time.

- ***Ozone generator***

Ozone generator has excellent disinfection and oxidation qualities, ozone is widely used for water treatment. Ozone is added at many points throughout the treatment system, like during pre-oxidation, intermediate oxidation or final disinfection. Usually, it's suggested to use ozone for pre-oxidation, before a sand filter or an active carbon filter (GAC).

After ozonization these filters can remove the remaining organic matter (important for final disinfection). This combination has several benefits:

- Removal of organic and inorganic matter
- Removal of micro-pollutants, such as pesticides
- Enhancement of the flocculation/coagulation-decantation process
- Enhanced disinfection and reduction of disinfection byproducts
- Odor and taste elimination

Ozone is a more practical disinfectant than chlorine, chloramines, and even chlorine dioxide. An ozone dose of 0,4 mg L⁻¹ for four minutes is typically effective for pre-treated water. Several studies proved that ozone, unlike chlorine products, can deactivate resistant micro-organisms. Another very important benefit of water purification using ozone is that no chemicals are added to the water. Ozone is a naturally occurring substance and once used for water purification functions it instantly degrades back to oxygen leaving no trace. Ozone is composed of three oxygen atoms. One of the atoms is connected to the others weakly and can transfer itself to other substances like viruses and microorganism, causing them to oxidize by binding itself onto them.

- ***Reverse osmosis filter***

Reverse osmosis (RO) is a more powerful water purification technology that uses a semipermeable membrane to eliminate ions, molecules and larger particles from water. In RO filter, applied pressure is used to overcome the osmotic pressure, that's driven by chemical potential variations of the solvent. Reverse osmosis can remove many types of dissolved and suspended chemical species as well as biological ones from water, and is used in both industrial processes and the production of potable water. The result's that the solute is retained on the pressurised side of the membrane and also the pure solvent is allowed to pass to the opposite side. To be "selective", this membrane shouldn't permit massive molecules or ions through the pores (holes), however should enable smaller elements of the water to pass freely.

In the traditional osmosis method, the solvent naturally moves from a region of low substance concentration (high water potential), through a membrane, to a region of high substance concentration (low water potential). The drive for the movement of the solvent is that the reduction within the free energy of the system once the difference in solvent concentration on either side of a membrane is reduced, generating osmotic pressure due to the solvent getting into the more focused solution.

The process is similar to alternative membrane technology applications. Reverse osmosis differs from filtration in this the mechanism of fluid flow is by osmosis across a membrane. Reverse osmosis instead involves solvent diffusion across a membrane that is either nonporous or uses nano filtration with pores 0.001 micrometers in size. The predominant removal mechanism is from variations in solubility or diffusivity, and also the method depends on pressure, solute concentration, and other conditions.

Reverse osmosis is most typically known for its use in water purification from saltwater, removing the salt and different effluent materials from the water molecules. Reverse osmosis is capable of removing up to ninety nine % of sixty five totally different contaminants including lead, fluoride, chlorine, dissolved salts, and more.

- ***UV light sterilization***

Ultraviolet water purification is the best technique for disinfecting microorganism from the water. Ultraviolet (UV) rays penetrate harmful pathogens in water and destroy illness-causing microorganisms by attacking their genetic core (DNA). This is very efficient in eliminating their ability to breed. Disinfecting your water with Ultraviolet light is exceptionally simple, effective and environmentally safe. UV sterilization kills 99.99% of harmful bacterias without the use of chemicals and without changing taste and odour of water. UV water purification is typically used with different types of filtration like reverse osmosis systems or carbon block filters.

4. ARDUINO IDE

The programming for both quality measurement and filtration is done using Arduino IDE software. The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures.

User-written code only needs 2 basic functions, for beginning the sketch and therefore the main program loop, that are compiled and joined with a program stub main() into an workable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

5. PURE WATER PARAMETERS

- Temperature range for pure water should be 20-25 degree celsius
- pH for
Ideal water = 7
Surface water = 6.5-8.5
Ground Water = 6-8.5
- According WHO Turbidity for ideal water should be less 1 NTU. It should never be greater than 5NTU.

**NTU-Nephelometric Turbidity Unit

6. APPLICATIONS

- This system can be used in commercial and domestic use.
- Water supply agencies.

- For health department to identify the reason of water diseases.

7. BENEFITS

- Low cost system
- Water quality can be monitored at any time anywhere
- Simple system
- Errors in the system can be easily detected and resolved
- Automation reduces time of operation
- Low maintenance cost

8. CONCLUSION

The system can monitor water quality automatically, and it is low cost and does not require people on duty. Thus the quality measurement of water becomes more easier, economical and time saving. The operation is simple.

The system has good flexibility. By adding more sensors and with relevant software programs other water quality parameters can also be measured. Thus a low cost system for water quality measurement and filtration can be obtained.

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