Solar Powered Trash Collector and Water Quality Analyser

Presented By: -

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Domain : Environment\ Freshwater

Current Trends :

These are the techniques used in currently trending water purifying technologies.

- Activated Carbon
- Electrodeionization
- Ion Exchange
- Pressure
- Reverse Osmosis
- Sub-Micron Filtration
- Ultraviolet

List of Issues :

I. Every year, unsafe water *sickens* about **1 billion people**. Rivers, lakes and aquifers are *drying up* or becoming too *polluted* to use.

II. **Over 80%** of the *waste generated* on land finds its way into oceans; *plastic* forms a major part of the waste. In India today more than **25,000 tonnes** of *plastic waste* is produced daily, of which **10,000 tonnes** goes to landfill. In some *least-developed countries*, the figure tops **95 percent**.

III. *Harmful bacteria* from *human waste* contaminates water and makes it unfit to drink or swim in. Wastewater (also called *effluent*) discharged legally or illegally by a manufacturer, oil refinery, or wastewater treatment facility leads to pollution of the lakes which later go and merge with massive water bodies like oceans decreasing their quality too.

IV. *Nutrient pollution*, which includes nitrates and phosphates, is the leading type of contamination in these freshwater sources. *Radioactive waste* on the other hand can persist in the environment for **thousands of years**, making disposal a major challenge.

V. Water pollution has caused **1.8 million deaths in 2015**, according to a study published in The Lancet. Contaminated water can also make you ill. And low-income communities are disproportionately at risk because their homes are often closest to the most polluting industries.

VI. When water pollution causes an *algal bloom* in a lake or marine environment, the proliferation of newly introduced nutrients stimulates plant and algae growth, which in turn *reduces oxygen levels* in the water. 330 elephants in Botswana died recently due to the cyanobacteria bloom in their drinking water sources.

VII. Climate change is altering weather patterns and water around the world, causing famines and droughts in some areas and floods in others.

VIII. Concern about water availability grows as freshwater use continues at unsustainable levels. Furthermore, the addition of new faces also need food, shelter, and clothing, thus resulting in additional pressure on freshwater through the production of commodities and energy.

IX. **Agriculture uses 70%** of the world's accessible freshwater, but some **60% of this is wasted** due to leaky irrigation systems, inefficient application methods as well as the cultivation of crops that are too thirsty. Added to these thirsty crops are the fact that *agriculture also generates considerable freshwater pollution* – both through *fertilizers* as well as *pesticides* – all of which affect both humans and other species.

Issue in focus :

As we know the population of India is increasing day by day and due to this pollution also is increasing. The garbage produced by the people is the main cause of pollution. Even the wastewater from houses of people and industries in India have a major impact on the quality of water which affects the environment as well as the humans. To overcome this problem, we introduce our project **"Solar Powered Trash Collector and Water Quality Analyser"** which *collects the garbage floating on the surface of water* and measures the *levels of oxygen*, pH, turbidity, chlorine and nitrate contents, to ensure the quality of water remains intact by integrating various sensors. This project involves an autonomous bot working on solar energy, saving the manpower and energy both.

Objectives :

I. This project is conducted to help clean the environment, using renewable energy, the sun, as a more efficient power source.
II. The present design of this prototype is to minimize human efforts on manual picking of wastes, without risking their health as well.
III. It also helps test water quality, so that the consumer can ensure that the water is safe and clean.

Socio economic stance :

I. **Government:-** The Central Pollution Control Board (CPCB) in association with State Pollution Control Boards (SPCBs) / Pollution Control Committees(PPCs) is monitoring the quality of water bodies at 2500 locations across the country under National Water Quality Monitoring Programme (NWQMP) which indicate that organic pollution is the predominant cause of water pollution.

The steps taken by the Government to address the issues of water pollution include the following:-

- ❑ Preparation of action plan and Installation of Online Effluent Monitoring System for sewage management and restoration of water quality in aquatic resources by State Governments;
- ❑ Action to comply with effluent standards is taken by SPCBs / PCCs to improve the water quality of the rivers;
- ❑ Financial assistance for installation of Common Effluent Treatment Plants for cluster of Small Scale Industrial units;
- ❑ Issuance of directions for implementation of Zero Liquid Discharge;
- ❑ Implementation of National Lake Conservation Plan (NLCP) and National Wetland Conservation Programme (NWCP) for conservation and management of identified lakes and wetlands in the country.

II. Funding Agencies:-

FUNDING TYPE	DESCRIPTION	ADVANTAGES	DISADVANTAGES
Government spending (mostly from taxes) From citizens and companies (income, VAT, customs, etc.) paid to government entity	• Mostly fund construction/rehab. of water/irrigation networks/structures (capital investments for public utilities/agencies) • Also fund operations and maintenance (O&M) costs (e.g., staff, maintenance, spare parts) as subsidies to public utilities/agencies • Used for some management activities (e.g., water monitoring), but rarely for green infrastructure or awareness-raising	• Main funding; enables availability of basic water/ irrigation services and water management activities • Used as a form of social welfare	• Depends on fiscal health of country, which can vary and be unreliable • Subject to poor or corrupt water sector governance • May distort market value
Tariffs/User fees Paid to water/irrigation utility by customers	• Mostly cover some to all O&M costs of water utilities and irrigation agencies • Rarely contribute to capital investments or other activities	• Enable direct economic valuation of water services • Reduce reliance on government subsidies	• Depending on tariff and fee amounts and structures, can encourage or discourage better water use behaviors
Transfers: International funds Loans, grants, donations from multilateral and bilateral donors and foundations	• Usually complement government spending, notably to fund capital investment projects • Often used for construction/ rehabilitation of water and irrigation structures and networks	• Available to financially constrained countries • Often integrated projects that cover activities other than infrastructure	• May create a culture of dependency and room for official corruption • Cannot cover recurrent O&M costs
Private-sector investments (private infrastructure, concessions, water bonds)	• Build-operate-transfer, concessions, service contracts, and other private-sector outsourcing for construction/ rehabilitation and O&M of water networks and structures	• Large source of water sector investment; decreases the tax burden on traditional funding source	• Expect returns on investment • May ignore poor areas/ neighborhoods • Require solid regulation and creditworthiness
Philanthropy or corporate social responsibility; other funds expecting non-financial returns	• Sometimes used to fund construction/ rehabilitation of small water infrastructure • Can improve O&M of water utilities through twinning and technology transfer solutions	• Makes new funds available for the water sector; can develop long-term partnerships	• Usually limited amounts • Expects returns on branding/image

Statistics :

I. More than **80% of the world's wastewater** flows back into the environment without being treated or reused, according to the United Nations; in some *least-developed countries*, the figure tops **95 percent**.

II. In India today more than **25,000 tonnes** of *plastic waste* is produced daily, of which **10,000 tonnes** goes to landfill.

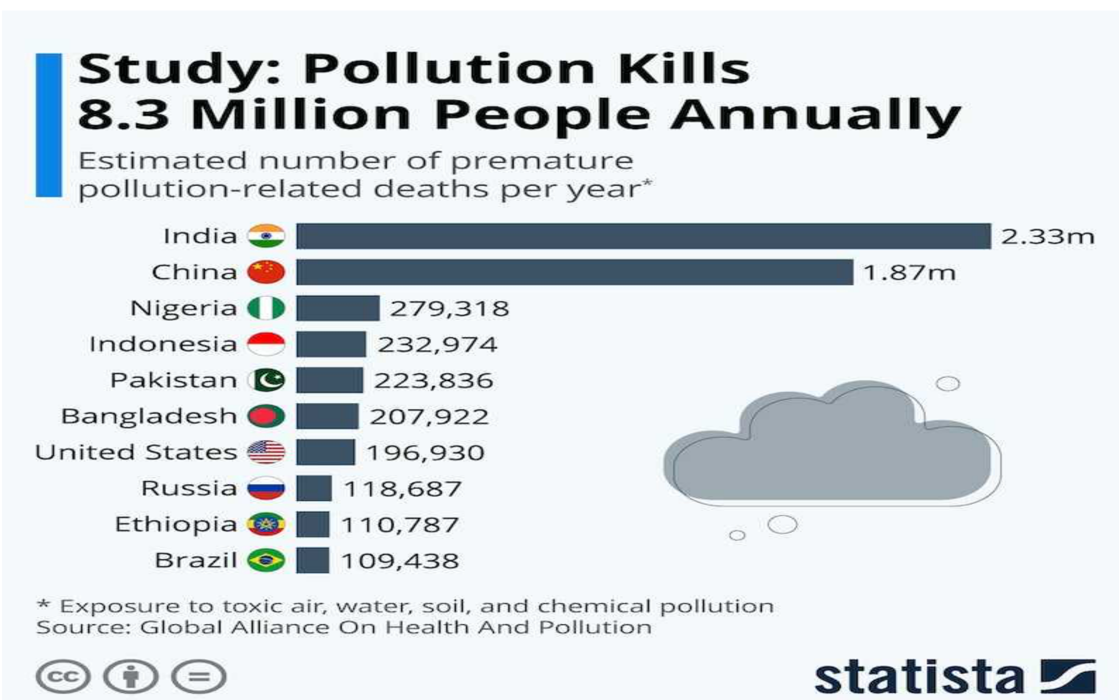
III. Water pollution has caused **1.8 million deaths in 2015.** Every year, unsafe water *sickens* about **1 billion people**.

IV. **Agriculture uses 70%** of the world's accessible freshwater. **60% of this is wasted** due to leaky irrigation systems, inefficient application methods as well as the cultivation of crops that are too thirsty.

V. In 2019, **387 districts in India were contaminated by Nitrate**, thereby being the prime contaminant source. As per Niti Aayog, overall, **70 percent** of the freshwater sources in the country were found to be contaminated and **India ranks 120 out of 122 countries** in terms of water quality.

VI. The cost of environmental degradation in India is estimated to be INR **3.75 trillion ($80 billion)** a year. The health costs relating to water pollution are alone estimated at about **INR 470-610 billion ($6.7-8.7 billion per year).**

Water pollution is the cause of millions of deaths around the world and thus it needs to be taken in focus, which our project handles till an extent reducing manpower and energy.



Technology perspective :

The issue in focus uses technology in a very helpful and exciting way. The autonomous bot works on the basic principles involving use of motors and is powered by solar panels.The bot is further outfitted with sensors and is integrated by a microcontroller to help in controlling water pollution in places difficult for man to reach.

Ultrasonic Sensor (for effective mobility):

The ultrasonic sensor will send pulses all around and receive back the reflected pulses to determine the object direction and distance, according to which the collector would approach the garbage. It is also used for detecting the remaining capacity of the garbage collector.

How Sensors Can Measure Water Quality?

Sensors can indicate water quality conditions for various applications. In particular, a water quality monitoring system can supply crucial data to researchers, operators and engineers for use in laboratory research, quality control, hydraulic model calibration, compliance and tracking shifts in the quality of a water system over a period time.

To maintain quality, tracking water parameters like dissolved oxygen, pH, and turbidity is essential. There are many kinds of water quality sensors currently in use. Below is a short list of the most commonly used sensors.

- **DO Sensor**

  Dissolved oxygen is a key measure of water quality relied upon in various applications. In industrial water treatment, dissolved oxygen levels can be an indicator of water quality issues that lead to corrosion of equipment. In aquaculture, fish transport, and aquarium applications, dissolved oxygen is monitored to ensure that aquatic species have enough oxygen in their habitat to survive, grow, and reproduce. In municipal water treatment facilities, dissolved oxygen in wastewater is monitored during aeration in water treatment processes.

- **pH Sensor**

  Measuring the pH can provide indications of pipe corrosion, solids accumulation, and other harmful byproducts of an industrial process. In an environmental setting, the changing pH could also be an early indicator increasing pollution. If the pH level reaches above 8.5, the water would be considered hard, which would likely cause scale development in boilers and pipes.

- **Nitrate Sensor**

  Nitrate Sensors can be used to determine the concentration of harmful substances like nitrates to determine if the water is even safe to be in contact with. Nitrate pollution can result in hypoxic dead zones and die-offs of various species—not to mention undrinkable water, as high enough nitrate levels in water are toxic to warm-blooded animals.

- **Residual Chlorine Sensor**

  Determining residual chlorine in water treatment centers and distribution systems is essential and has been important as long as chlorine has been used to disinfect water. Chlorine sensors evaluate free chlorine, monochloramine, and total chlorine. The principal application is drinking water disinfection, although total chlorine is also often assessed in treated wastewater.

- **Turbidity Sensor**

  Turbidity sensors gauge suspended solids in water, normally by determining the amount of light that is able to pass through the water. These sensors are used in river and stream testing, wastewater measurements, drinking water treatment operations, settling ponds management, sediment transport study and laboratory testing. Turbidity has adverse effects on fishes as:

  - ❏ acting directly on fish, killing them or reducing their growth rate, resistance to disease,etc
  - ❏ preventing successful development of fish eggs and larvae
  - ❏ modifying natural movements and migrations
  - ❏ reducing the amount of food available
  - ❏ affecting the efficiency of methods for catching fish.

- **TOC Sensor**

  Total organic carbon (TOC) is both a direct indicator and a surrogate is a crucial parameter for water quality evaluation. There are two types of TOC sensors currently available: TOC analyzers and TOC sensors. If used for regulatory reporting, governing an essential process-control variable or quality control, instrument reliability is crucial. If used for general TOC tracking - not for making important quality decisions, then other sensor qualities may be more essential than accuracy.

Mathematical Model :

Governing Equation:

The global formula to estimate the electricity generated in output of a photovoltaic system is,

$$E = A.r.H.PR$$

where,

E is the Energy in kWh,

A is the total solar panel area in m^2,

r is the solar panel yield or efficiency in %,

H is the average solar radiation on tilted panels, and

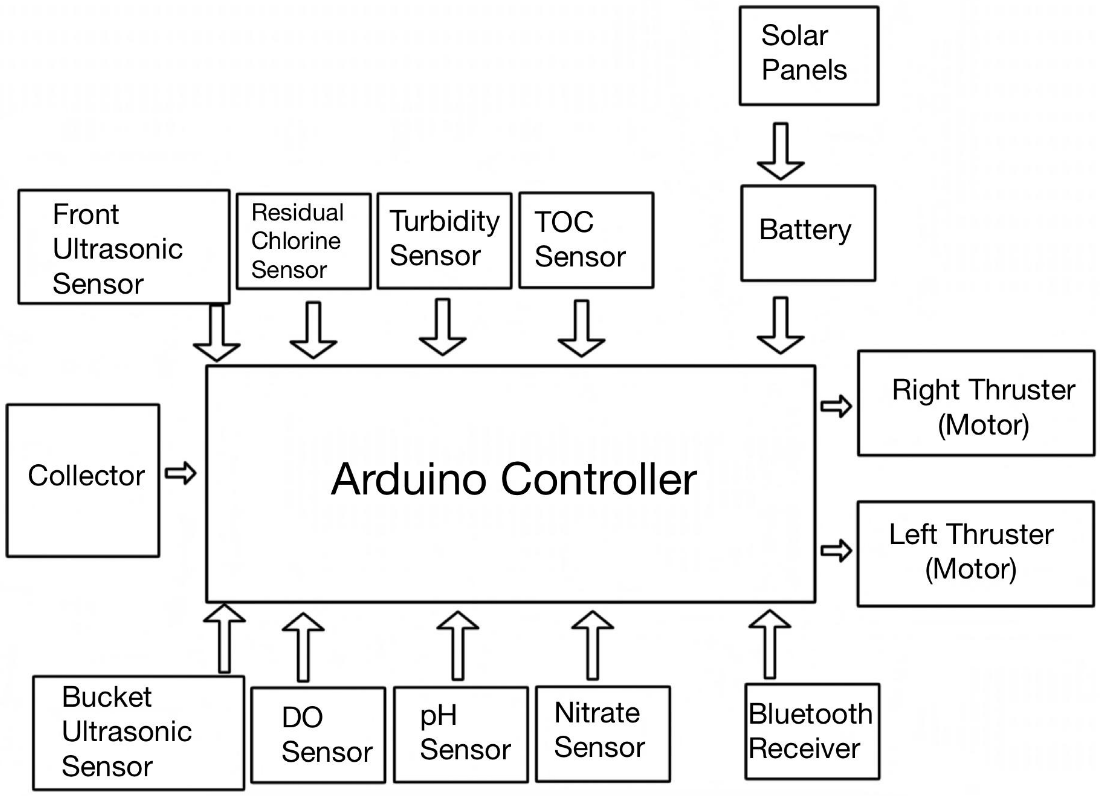
PR is the performance ratio or the coefficient for losses, default value of 0.75.

The weight of the model needs to be in limit so that the device does not sink. The density of water 1 g/cm^3 so Styrofoam(almost equal density) is used to avoid sinking.

$$F_B = w_{fl},$$

where F_B is the buoyant force and w_{fl} is the weight of the fluid displaced by the object according to Archimedes' principle.

Proposed solution architecture - generic framework :



The sun rays incident on **solar panels** gets converted from light energy to electrical energy. This generated energy is stored in the battery, and the supply is taken from battery to all electronics and electrical devices.

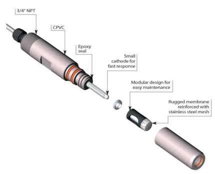
The **Arduino** is the microcontroller powered by the solar panel, programmed for taking sensory inputs from the sensors or getting commands through the integrated bluetooth module and giving command instructions to change the nature of motion of the boat using the motors accordingly.

The Bluetooth module is connected to the Arduino which can be operated by using mobile app i.e. Bluetooth controller app or any other application downloaded from the internet.

The model also involves the use of seven different types of sensors.

1. Ultrasonic Sensors : The ultrasonic sensors will detect the obstacles using transmitting and receiving signal, later sending the signal to Arduino. The container also consists of an ultrasonic sensor which will sense the level of garbage and alert the user accordingly. If the box fills up a message of “AT CAPACITY” will be displayed to the user.

2. DO Sensor :To measure the dissolved oxygen in the water body.



3. pH Sensor : To determine acidity of the water body and to see if it is favourable.

4. Nitrate Sensor : To calculate the nitrate concentration.

5. Residual Chlorine Sensor : To measure the dissolved chlorine content.

6. Turbidity Sensor : To determine the purity of the water body and extent of dissolved particles.

7. TOC Sensor : To measure the organic contamination of the water body.

   These sensors will be connected to the microcontroller and will give the collective information to the user so that they can take measures accordingly *thus ending our approach to ensure that the water quality is good enough for both humans and aquatic species and keep it clean without involving a lot of manpower and energy.*

Challenges :

1. Since the power source is not very strong and the bot involves motors and sensors, the device has to work efficiently.
2. The weight of the autonomous bot has to be kept precise enough for it to not sink.
3. Modifying it for larger water bodies.

Citations :

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