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Automation of a Solar Energy Powered Domestic Well-Water Treatment Plant

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Abstract

Water automation is all about controlling, monitoring and even billing of water usage in different places like hotel, house, irrigation land and industry with less human effort. Water is precious gift to mankind and we need to preserve quality of this natural resource. This paper presents a model showing how efficiently water can be distributed in urban areas through pipelines and how corrosion of pipes driving water to individuals can be prevented along with theft identification system which shows theft of water from a particular pipeline by giving visual presentation. The researchers done water automation based on different purposes using different types of hardware and technologies. This paper develops an automatic domestic well-water supply distribution system and treatment plant which can monitor water tank by measuring the water flow, water level, water temperature, cut ON/OFF water supply and send notifications to the user through mobile messaging. All of the component like water level and flow switch was connected through an android application that is much more efficient and easier to control the whole process.

Keywords: Water automation, well-water treatment plan, mobile messaging, mobile application and android application.

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I. Introduction

Water is basic need of human being. Water Distribution is one of the important process. Automation provides optimized solution to all problems of distribution of water system. Nowaday, Water distribution system faces so many problems like water leakage and improper water supply (Cheng, Yu, and Xu, 2021).

Water is important resource for all the livings in the earth. Some people are not getting the sufficient amount of water because of unequal distribution of water (Vrachimis, Eliades, and Polycarpou, 2019). Water is an essential element of life. Still, there is a lack of enough fresh water resources to meet water demands. Many people daily face the situation of an inadequate supply of water. The inadequacy in the supply and access to water has only recently taken centre stage in global reflection as a serious and threatening phenomenon. The water that exists today would be sufficient to address human issues just on the off chance that it was even handedly conveyed. Since it is not, there emerge circumstances of shortage due to natural causes and others due to a range of human activities (Bargiela, 2018). The water services

in many countries are however still plainly inadequate in providing safe water supplies. Many people living in poverty, daily face enormous hardship because of fresh water supply. The root cause of water difficulty today is not because of scarcity but rather of the distribution system. Water crisis is much more related to management than to a real crisis of scarcity (Powell, 2021). The complexity of the water crisis is due to real problems of availability and increased demand, and to the management process that responds to problems without a systematic approach that tries to foresee them. Due to improper fresh water supply systems, distribution of water does not take place in an even manner. This research is used to distributing the water equally. So that everyone gets the equal amount of fresh water. It also used to prevent the water theft during the distribution period. In previous research method, person in charge will go to that place and open the valve for a particular time period. Once the time over again the in charge person will go to the same place and close the valve (Mazharul Islam Nayeem, and Mahfida Amjad, 2018).This wastage of time. The proposed system is fully automated. Here human work and time is reduced. The water wastages such as leakages, mankind laziness and operating error can be avoided (Davidson and Bouchart, 2017).

In this modern world we live in, the mobile application has brought many benefits to individuals, organizations and industries. With the help of the internet it is also possible to make a better water monitoring system for monitoring water pump, making water surface organize to take action for any type of problem, solve and disturbing water easily and even for billing.

The automatic use of water can be called water automation which is a process to ensure the proper use of water and reduce the human effort. It is used for different purposes such as irrigation in the agricultural land, water pump controlling, water usage monitoring, billing of water usage etc. in different places like household, agricultural land, industry, hotel etc, (Mazharul Islam Nayeem, and Mahfida Amjad, 2018).

In manual system of water tank the user needs to present at the water pump to turn it ON and OFF. On the other hand, an automated system uses android application to turn the water pump ON and OFF

Researchers have implemented several water automation systems [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12] based on water pump controller, water level detection, water billing with detection and control of water leakage by using different types of hardware and technology(Davidson and Bouchart, 2017). An automatic domestic well-water supply distribution system and treatment plant is an automated system for domestic well-water supply to make daily life easy and efficient through the use of mobile application. It can control water distribution and take action for any current situation which created in the water tank according to the water surface by using sensors and data results. WMS is providing a system which can observe water tank and take action if water surface is high or low, it can auto generate to on/off motor and also if any user wants to change water temperature then he/she can also do it. When a user used his/her maximum rate of water then it must be cut off line automatically. By using mobile messaging user get notifications before cut off human beings line and also show how much water he/she already used.

Water is one of the most common substances known. It is a good solvent for many substances and rarely occurs in its pure form in nature. These exists which natural water includes rain water, spring water, lake water, river water, well-water and sea water (Ayamal Alinhussein and Mohammed Adedalati; 2021). Rain water is the purest form of natural water because it is formed as a result of the condensation of water vapour in the atmosphere. Spring water contains a considerable amount of mineral salts but very little suspended impurities such as dust, sand and dirt, so it is a good source of drinking water when treated. Some well-water contains a lot of clay and other mineral salts. A well that is used as a source of drinking water should be sited away from sources of underground water pollution such as pit latrine and lined with bricks and covered. Water from deep wells tends to be less polluted than that from surface wells. Generally, it is safer to boil well-water before drinking. River water, lake water and sea water contain a lot of dissolved air, mineral salts, bacteria and organic remains. These waters have to be specifically purified before they can be used for drinking (Raykar, Parijata Vinod, Parinita Vinod, Preethi, and Jain, 2020). Water source means either surface water includes streams, rivers, lakes or reservoirs and underground water such as springs, well and boreholes of or all these waters, well water can be easily accessible.

Providing a better water supply can therefore significantly improve the quality of life and its household community. (RamleelaKhare, Fillliperodrigues, and Mela, 2019). Some diseases in poor or developing

countries are related to insufficient or unsafe water, together with local factors as climate, density of population and local practices (Gowri, Pranathi, and Sravya, 2018). To control these diseases, a sufficient amount of safe drinking water is important. This implies that not only limited to improve the design and planning of water supplies that matters but also sanitation and hygiene behaviour. This research work is focus on automation of well water treatment plant using solar energy due to its easy accessibility.

II. Methodology

Development of Design System

Description of the Study Area: The study was conducted in Road Q Plot 17, Oba Ile Housing Estate, Akure North Local Government Area, Ondo State, Nigeria. This house is a storey building of 23 occupants of four flats of 3-bedrooms and one Boy's Quarters (BQ).

The following are the major steps adopted to develop this software for domestic well-water treatment plant and without up gradation.

The cost model considered: well-water unit, pressure filter, dosing, clean water holding tank, installation material and labour cost.

Nomenclature

Q is quantity of each item
P is price per unit item
Tp is total price of a set of similar components
EC is estimated cost of the whole project.
TE is total estimate to be charged by contractor.
TC is total cost of the major components.
IR is interest rate (percentage) = (n%)
$U_{1\text{-}6}C$ is total cost of the whole processing unit with labour and other miscellaneous expenses.
U_1C is cost of components in processing unit 1 (Well-Water Unit)
U_2C is cost of components in processing unit 2 (Pressure Filter Unit)
U_3C is cost of components in processing unit 3 (Dosing Unit)
U_4C is cost of components in processing unit 4 (Clean Water Holding Tank Unit)
U_5C is installation material cost
n is the number of items
U_6C is cost of labour

$$T_p = Q_i \times P_i = q_1p_1, q_2p_2, q_3p_3, \dots \dots q_np_n \quad (1)$$

$$TC = \left[\sum_{i=1}^{4} q_ip_i\right] = q_1p_1 + q_2p_2 + \dots + q_4p_4 \quad (2)$$

$$U_{1-6}C = \left[\sum_{i=1}^{n} q_ip_i\right] = \left[\sum_{i=1}^{n} q_1p_1\right]u_1 + \left[\sum_{i=1}^{n} q_1p_1\right]u_2 + \dots \left[\sum_{i=1}^{n} q_1p_1\right]u_n \text{ (Powell 2021)} \quad (3)$$

V. Cost of Well-Water Unit Components

$$U_1C_1 = [pq]_{11} + [pq]_{12} + [pq]_{13} + [pq]_{14} + [pq]_{15} + [pq]_{16} + [pq]_{17} + [pq]_{18} + [pq]_{19} = \left[\sum_{i=1}^{9} q_1p_1\right]u_1 \quad (4)$$

Where $[qp]_{11}$ to $[qp]_{19}$ are:
Pumping machine, PVC conduit pipe, valve fitting, socket fitting, elbow fitting, union fitting, well submersible pump, marine rope and T-fitting cost respectively.

Cost of Pressure Filter Unit Components

$$U_2C = [pq]_{21} + [pq]_{22} + [pq]_{23} + [pq]_{24} + [pq]_{25} = \left[\sum_{i=1}^{5} p_iq_i\right]u_2 \quad (5)$$

Where $[pq]_{21}$ to $[pq]_{25}$ are;
Filter tank, activated carbon, fine sand, coarse sand and gravel respectively.
Cost of Dosing Unit Components

$$U_3C = [qp]_{31} + [qp]_{32} + [qp]_{33} = \left[\sum_{i=1}^{3} q_ip_i\right]u_3 \quad (6)$$

Where $[qp]_{31}$ to $[qp]_{33}$ are;
Dosing pump, chemical solution tank and chlorine drum costs respectively.
Cost of Retention Water Tanks Unit Components

$$U_4C = [qp]_{41} + [qp]_{42} = [\sum_{i=1}^{2} q_i p_i]u_4 \quad (7)$$

Where $[qp]_{41}$ and $[qp]_{42}$ are;
Clean water holding tank, and raw water tank costs (Retention Tanks)
Cost of Installation Material (IMC)

$$U_5C = [qp]_{51} + [qp]_{52} + [qp]_{53} + [qp]_{54} + [qp]_{55} = [\sum_{i=1}^{5} q_i p_i]u_5 \quad (8)$$

Where $[qp]_{51}$ to $[qp]_{52}$ are;
Electric cable, electric switch, tipper of sharp sand, tipper of granite and a bag of cement costs respectively.
Cost of Labour Cost (LC) Components

$$U_6C = [qp]_{61} + [qp]_{62} + [qp]_{63} + [qp]_{64} = [\sum_{i=1}^{4} q_i p_i]u_6 \quad (9)$$

Where $[qp]_{61}$ to $[qp]_{64}$ are;
Cost of plumbing labour, masonry labour, cost of electrical labour, and miscellaneous expenses respectively.

$$U_{1-6}C = [\sum_{i=1}^{6} q_i p_i]u_{1-6} = [\sum_{i=1}^{6} U_i C] = U_1C + U_2C + \ldots\ldots U_6C \quad (10)$$

$$IR = n/100 \quad (11)$$

$$EC = [\sum_{i=1}^{6} q_i p_i]u_{1-6} + TE \quad (12)$$

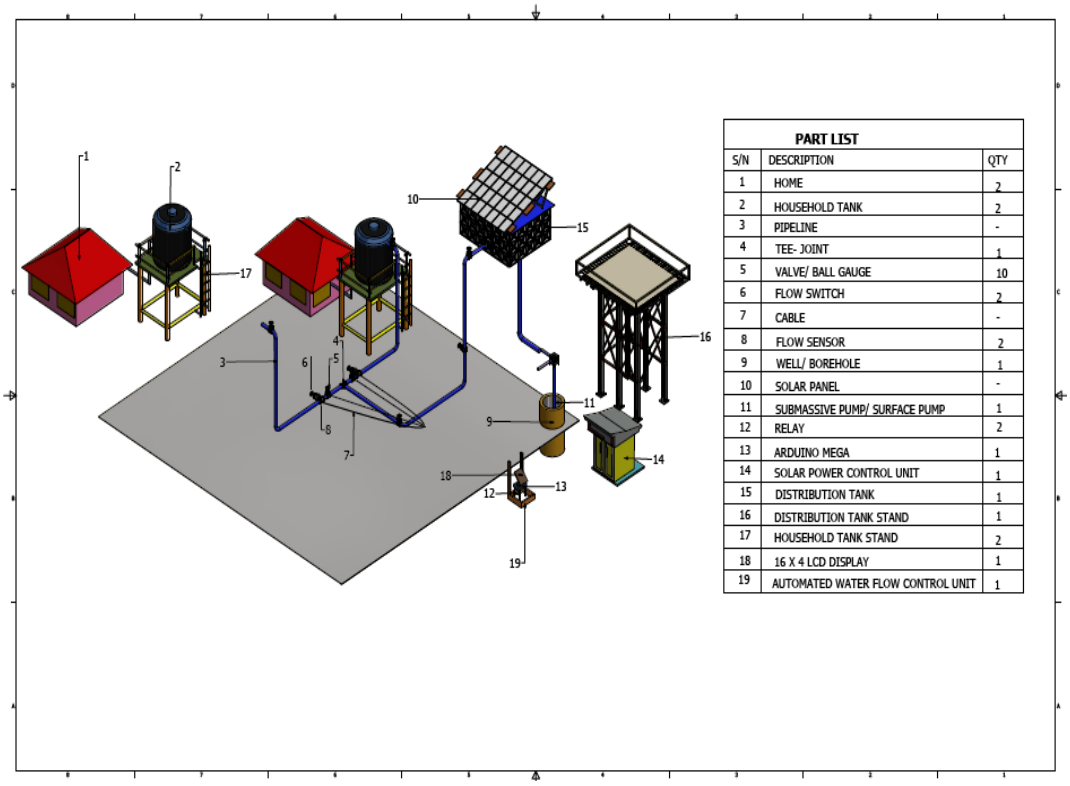
$$TE = [\sum_{i=1}^{6} q_i p_i]u_{1-6} \times IR \quad \text{(Powell 2021)} \quad (13)$$

The solution of the system of equations1-13 corresponds to the case of minimizing,efficiency,automted turning,accuracy,flexibility,computational economyand metrics evaluation.

III Results and Discussion

The parameters determined for developed of an automatic system are the pumping power, pumping rate, tank capacity while the parameters for the due-date prediction expected time, variance, standard deviation and total number of periods were determined as well as probability on the project completion successful and risk involved. Materials required were identified and cost analysis carried out which are well-water unit components, pressure filter and dosing unit, retention tanks, materials installation cost, and cost of labour.

Design for **Framework of the Proposed Automatic Control System for**



Domestic Well-Water Distribution System

Figure 1: Framework of the Proposed Automatic Control System for Domestic Well-Water Distribution System.

Source: Fadiji Research Work (2025)

Design of the Proposed 3D Side View for Domestic Well-Water Treatment Plant

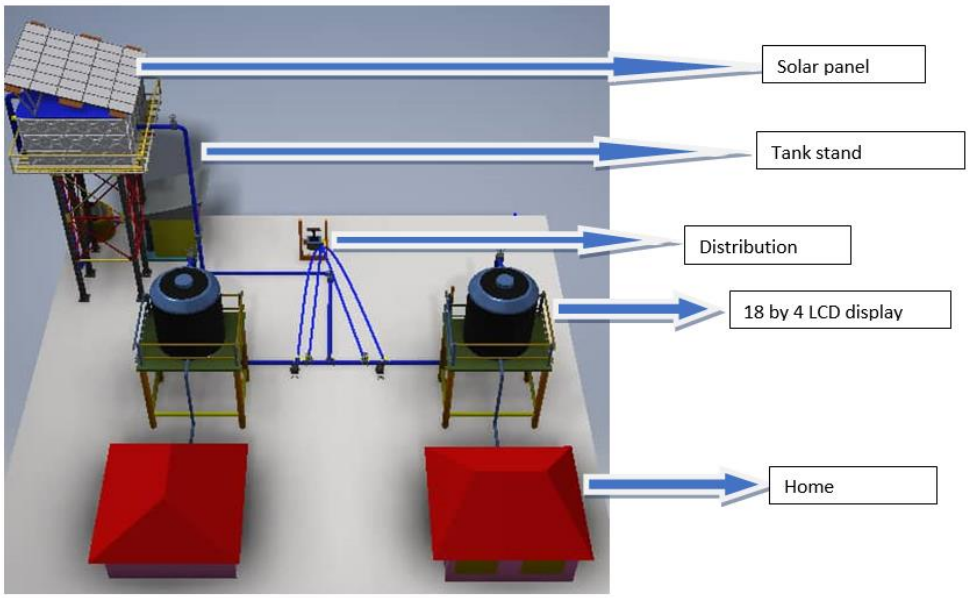


Figure 2: *3D Side View* of the Proposed Automatic Control System for Domestic Well-Water Distribution System.

Source: Fadiji Research Work (2025)

Design of the Proposed Side View of Domestic Well-Water Treatment Plant

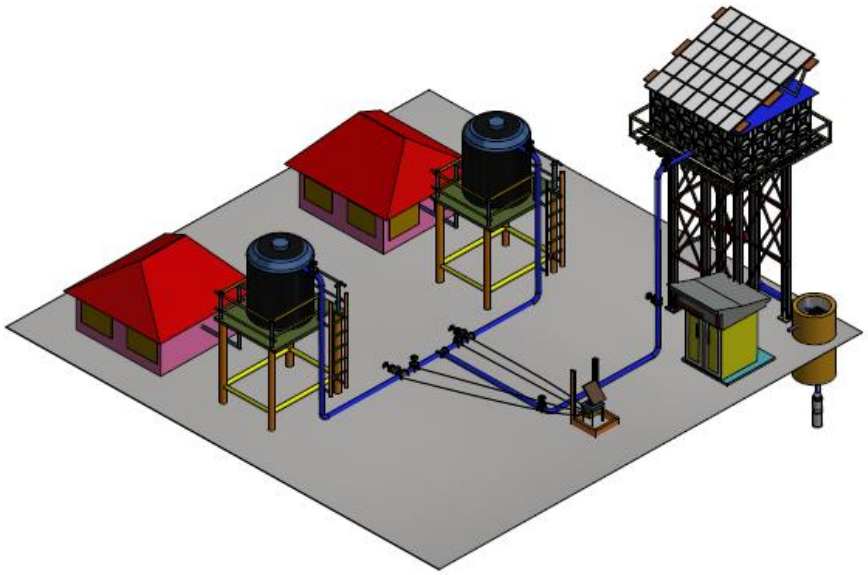


Figure 3: Framework of the Proposed Automatic Control System for Domestic Well-Water Distribution System.
Source: Fadiji Research Work (2025)

These stirrer motors are turned 'ON' and 'OFF' using submersible pumping machine according to the purification of domestic well water. A water container of about 60 Liters capacity was filled with water and a submersible pump of not more than one horse power (1 hp) capacity submersed into the water container was set out in Figures 1-3.

Therefore, connected to the pump is a solar powered which was expected to generate enough electrical power directly to a luminous charged battery for power storage. This is to enable the facility perform even at sunset (at angle 90^0) or at night as the power generated from the sun in the afternoon could be retained for use at any hour of the day, once the control switch box of the submersible pumping machine is put on, the power stored in the battery capacity (12V dc=220Ah) is released and runs the submersible pumping machine which in turns draws and pumps out the water in the container through the pipes (4ft) or (1.32 m) connected to it into the water tank already provided to store the water in Figure 3. However, to be able to control water distribution system was connected to the treatment plant. This is to enable the user to time or control the regularity of water flow. It was observed that, at the trial stage, all the apparatus has been set up, the control switch box was put on to test run the system and it was discovered that the power from the solar powered was able to run the submersible pump machine which eventually pump water into the storage tank. It can be concluded that, the automation control system for domestic well water treatment plant was achievable using solar powered and digital control timers. It was recommended that, the micro-processor devices as stated above, for Figures 1-3 referring to the working principle of an automation of a solar energy powered for water distribution system.

IV Conclusion

This research has identified the parameters for budgeting and development of cost estimation for domestic well-water treatment plant.

The required strategic of automatic control system have been identified as: solar powered, water tank, valve, flow sensor, Arduino, pipeline and relays and residential comfort through design, construction and application of no fuel require. It is intended also to encourage job creation and self-reliance, thereby reducing unemployment in the country. The approved of this proposal work will lead to the implementation and the actualization of the work. This research is expected to serve as basis of proper planning and to avoid project failure, helps to control the following parameters; solar powered, water tank, valve, flow sensor, Arduino, pipeline and relays that consultants, engineers and project managers will use to calculate the amount of domestic well water used in the system and the product of this research which is elimination of water wastage, reduces the man power, supply of portable water to rural and urban areas.

V Recommendation

This research has identified the parameters for budgeting and development of a cost estimation for domestic well-water treatment plant installation. This has been done to avoid project failure, maximize limited budget available and minimize value. The automation of water distribution system eliminates water wastage. Automation system provides continuous water flow according to the set point. This project is automatic so it reduces lots of man power. The automation implemented in water distribution system ensures to avoid wastage of water and reduces time. Also we can completely avoid the water theft in the pipelines. So that people could get equal share of water. An automatic domestic well-water supply distribution system and treatment plant is an automated system for water to make daily life easy and comfortable through the use of mobile application.

An automatic domestic well-water supply distribution system and treatment plant is providing a system which can observe water tank and take action if water surface is high or low, it can automatically turn ON/OFF motor and also if any user wants to change water temperature then he/she can also do it. By using mobile messaging user get notifications before cut off his/her line and also show how much water he/she already used. Hence the proposed system will be successfully implemented with Arduino that controls the supply of water based on the programmed time set up.to make power available at the right quantity.

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