Automatic Level Monitoring and Control System

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Abstract*—Power outage is a common phenomenon in some places in Nigeria. With a manual pumping system, a user must be involved in pump switching for water level control. This is sometimes challenging when the user is not available or busy with other activities when the power supply is restored. This can result in water shortage in tanks, wastage from overflow and energy waste operating pump when tank overflows, etc. The use of automatic water level controllers will ensure the availability of water in tanks, conserve energy by turning off the pump when the tank is full and reduces the utility bills by cutting water and electricity wastage. In this work, float switches and a solenoid valve are used to control water levels in the network of tanks comprising two overhead tanks and one ground tank. The system has been found to eliminate human existence and cut the waste of water and electricity due to overflow

Indexed Terms*— power-outage, level control, float switches

I. INTRODUCTION

Water is a very important ingredient required for the existence of human life [1]. It is used in cooking, washing, bathing, farming, and many industrial processes. According to estimation, 75% of the earth's surface is covered with water, and more than 96% of it is too salty for human use [2]. From time immemorial, finding and maintaining a clean water supply for drinking and other activities has been very significant.

Traditionally, water is pumped from underground reservoir to overhead tanks using electric pump. The manual way of detecting when tank is full is by observing overflow and emptiness will be detected when water is not running in the tap. When water overflows there will a waste of both the precious resource and electricity [3]. Water is conserved by avoiding the overflow of overhead tanks [4]. This can be achieved by the use of an automatic water level controller [5].

Furthermore, a power outage is a common occurrence in Nigeria. In periods when the power is restored and everyone is asleep, at work or busy with something very important, the use of automatic water level controllers will ensure the availability of water in tanks and conserve energy by turning off the pump when the tank is full, reduces the utility bills by cutting water and electricity wastage.

There have been many efforts to automate water pumping. In [6], a wireless Water Level Controller Using the Zigbee protocol was developed. It uses two Zigbee transceivers along with two microcontrollers, one installed at the tank side and the other in the household for displaying the status of the tank level. At the tank end, two sensors are placed at two levels, one for detecting the "LOW" water level, when the tank is almost empty and the other for the "HIGH" water level, when the tank is almost full. At the tank end, the microcontroller receives a signal from the Zigbee transceiver module, and depending on the signal received it decides whether to turn the water pump OFF or ON depending on the level of water in the tank. The automatic water level controller implemented was found to be simple, reliable, and cost-effective.

In the work of [2], a water level controller that operates on the conductivity property of water was developed. The water level controller depends on two detection points in the tank, i.e. low and high. The controller produces an alarm when the water level is below the lowest level, L1 and also controls the pump (on). When water just touches the highest-level L8, the pump will be controlled (off).

In another work of [7], an automatic water level detector and pump controller were developed using a

microcontroller. The system uses a reed switch to detect and send the status of the water level in the tank to the microcontroller. When the tank level is low, the microcontroller commands the pump to start to fill the tank to the desired level. The pump will also be instructed to switch off when the water level reaches its set point. The system prevents the wastage of water.

In another work of [8] ultrasonic sensor was used to detect water level in a tank. The sensed level signal is sent to a microcontroller which decides based on the signal received to start or stop the pumping machine. The status of the tank level is also displayed on LCD. IOT based level sensing and control was also considered in a survey paper presented by [9]. In this work, various wireless communication protocols such as WIFI, GSM, zigbee, Bluetooth were considered by different authors in integrating the level sensing and control system to the internet for remote monitoring and control of water level

In this work, float switches and a solenoid valve are used to detect levels in the tanks and control water pumping. The system has been found to eliminate human interference and cut the waste of both water and electricity.
Float switch as the name suggests floats on top of water and follows the changing level of water in a tank. It acts as a mechanical switch and controls devices like pumps, valves or produce alarms to notify users. When the water level is equal to the set point, the floating ball rises and the pump stops working. When the water level is below the set point, the floating ball sink the pump starts working again.

II. METHODOLOGY

A. Description of the process

The process considered in this work is presented by the block diagram in figure 1. It is a network of tanks, pipes, valves, and pumps connected to supply water for the daily needs of various sections in the school of engineering, the federal polytechnic Ilaro. Section 1 comprises of a submersible pump, overhead tank and a manually operated valve. The overhead tank in section 1 supplies water to electrical and mechanical department and also supplies section 2 through a manual valve. Section two comprises a surface tank and a manually operated valve. This tank serves as a reservoir for section three and finally, section three comprises a surface pump and an overhead tank. The pump in this section pumps water to the overhead tank.

The tank in section 3 supplies the civil and computer department. The problem identified includes

1. Tanks overflow leading to water wastage
2. Draining of the overhead tank in section one by the reservoir in section two. The volume of the reservoir is twice the volume of the overhead tank and water flows by gravity due to height difference.

The aim of this work is to proffer solution to these identified problems.

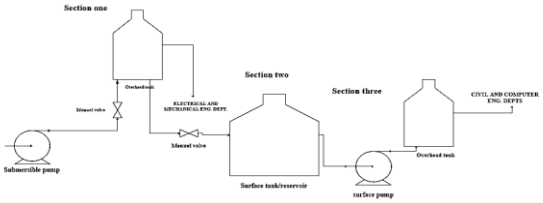

Fig. 1 description of the manual process

B. Control strategy

The operation of the automatic level control system is summarized below

1. A float switch which serves as the sensing element in the system detects water level in the tank.
2. Based on the set point, if the water level is below the set-point, the pump/valve is activated by closing the contacts.
3. The float switch monitors the water level continuously. If the level is equal to the set-point, the pump is deactivated by opening the contact. The flow chart in figure 2 shows how the system works.

A modular design approach is adopted in this work. The overall process was broken into three modules. The modules/sections are represented by block diagrams. Where each block diagram represents a system that monitors and control water level in the tank associated with that particular section.

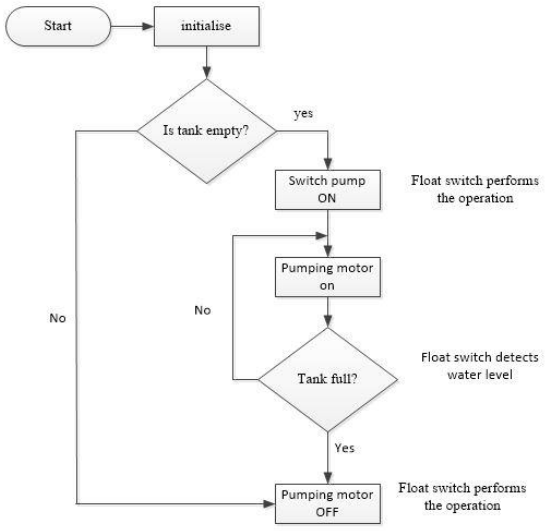

Fig..2 flow chart of the automatic level control system

1) *Section One and Three:* The block diagram in figure 3 explains the working principle and control strategy employed in sections one and three. It comprises a pumping machine, overhead tank, and a float switch. The float switch which acts as a feedback device also decides to either engage or disengage the pump to eliminate the overflow of water in the system. The connection diagram of the components in this section is shown in figure 4.

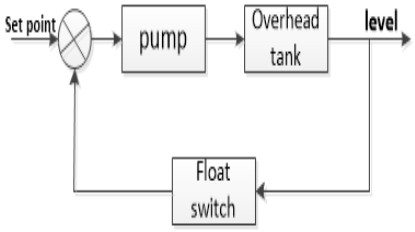

Fig. 3 control strategy in sections one and three

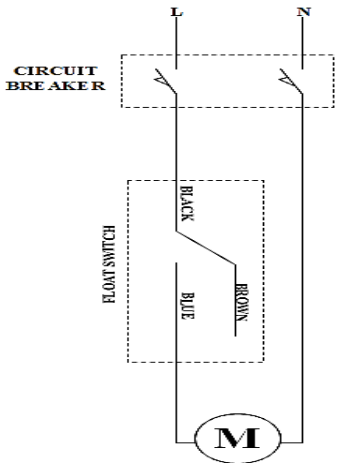

Fig. 4 circuit connection of the components in sections one and three

2) *Section Two:* The block diagram in figure 5 gives an illustration of the closed loop connection of this section. With the float switch acting as a feedback device, the normally closed solenoid valve connected to the tank controls overflow and prevent the natural flow due to gravity from the overhead tank to the reservoir when there is no power supply. The connection diagram of the components in this section is shown in figure 6

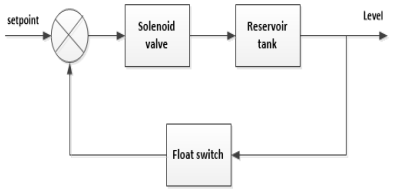

Fig. 5 control strategy in section two

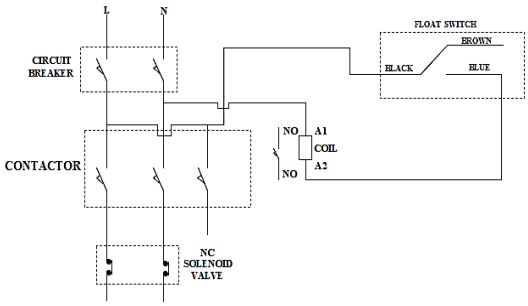

Fig. 6 circuit connection of the components in section two

III. RESULT

The system was tested with a generator and mains power. The variation in the time taken to fill the tanks is presented in table 1

Table 1: time spent to fill the tanks using two different sources of energy

Time (min)	Mains power	Generator power
Tank 1	27	40
Tank 2	45	55
Tank 3	27	40

The observed variation in the time taken to fill the tanks as presented in Table 1 was due to the difference in the voltage level supplied by the power sources. The mains power provides shorter filling time for the tanks as compared to the generator power.

Having successfully installed and integrated the system, it was found to satisfactorily perform the monitoring and control of water levels in the three tanks with no water wastage/overflow was observed to occur in any of the tanks.

CONCLUSION

Population growth and technological advancement necessitate proper management of resources to avoid scarcity. Automatic control of water pumping in home and office environments will avoid water wastage, prolong the life cycle of the pumping machine, and reduce the monthly electricity bill.

Properly used float switches can provide millions of on/off cycles for many years reliably.

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