AUTOMATED DOMESTIC WATER CONTROL SYSTEM

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Abstract

The lack of efficient operation of most state water corporations forces most landlords and property owners to produce their own water from borehole or well. With a well or borehole as the source of water to buildings which could either be residential, commercial or government, a water pump is required to draw up water to an overhead tank from where it serves the building but with this arrangement in place, residents unintentionally allow the water pump to work continuously even when the overhead tank has reached full capacity thereby, leading to wastage of water, electricity and reduction in the lifespan of the machine. In other to prevent this, an automated water supply system that is able to sense water levels at the overhead tank as well as in the water source (borehole or well) and act accordingly is developed. The water system consist of water level sensors, alarm, relays, Arduino Uno, display unit and water pump. The automated domestic water control system was designed, constructed and tested to be working as desired. This proposed system is easy to implement and operates without human intervention however it would stop operating once there is no electricity supply to the control unit to power the water pump. It is therefore recommended that the design be improved upon by connecting it to a continuous source of power supply such as solar power. This will ensure that the system does not stop working once the power supply is cut off.

Keywords: Arduino Uno, automated, control system, sensors, and water pump

Introduction

Water is one of the major resources needed to sustain life (Ahmad & Hamzah, 2017). It is essential for human existence but with most state water corporations in the nation not existing or partially existing, individual property-owners are forced to produce their own water for domestic use either by drilling a borehole or digging well as a source of water. Using a borehole (or a well in most cases) require that a pumping machine be used to pump water into a reservoir such as an overhead tank from where it serves the house.

Often than not, when the pumping machine is turned on, the residents unintentionally allow the water pump to continuously run even when the overhead tank is full thereby, leading to wastage of water, electricity and reduction in the lifespan of the machine. In other to prevent this, an automated water supply system that is able to sense water levels at the overhead tank as well as in the water source (borehole or well) and act accordingly is developed. The water system consist of water level sensors, alarm, relays, Arduino Uno, display unit and water pump. This is illustrated in the block diagram displayed in figure 1. The control system operates by switching on the water pump when it has detected that the water level in the overhead tank is low and then automatically switches off when the water level in the overhead tank is full. The control system is also able to work with the level of water detected at the water source, once the level of water in the water source reaches a certain point as detected by the water sensor placed in the water source; the water pump is automatically cut off by the relay. This is done so as to preserve the lifespan of the water pump and prevent it from been damaged as a result of continuously operating it without water. This is required particularly during the dry season when the water level in the water source is drastically reduced.

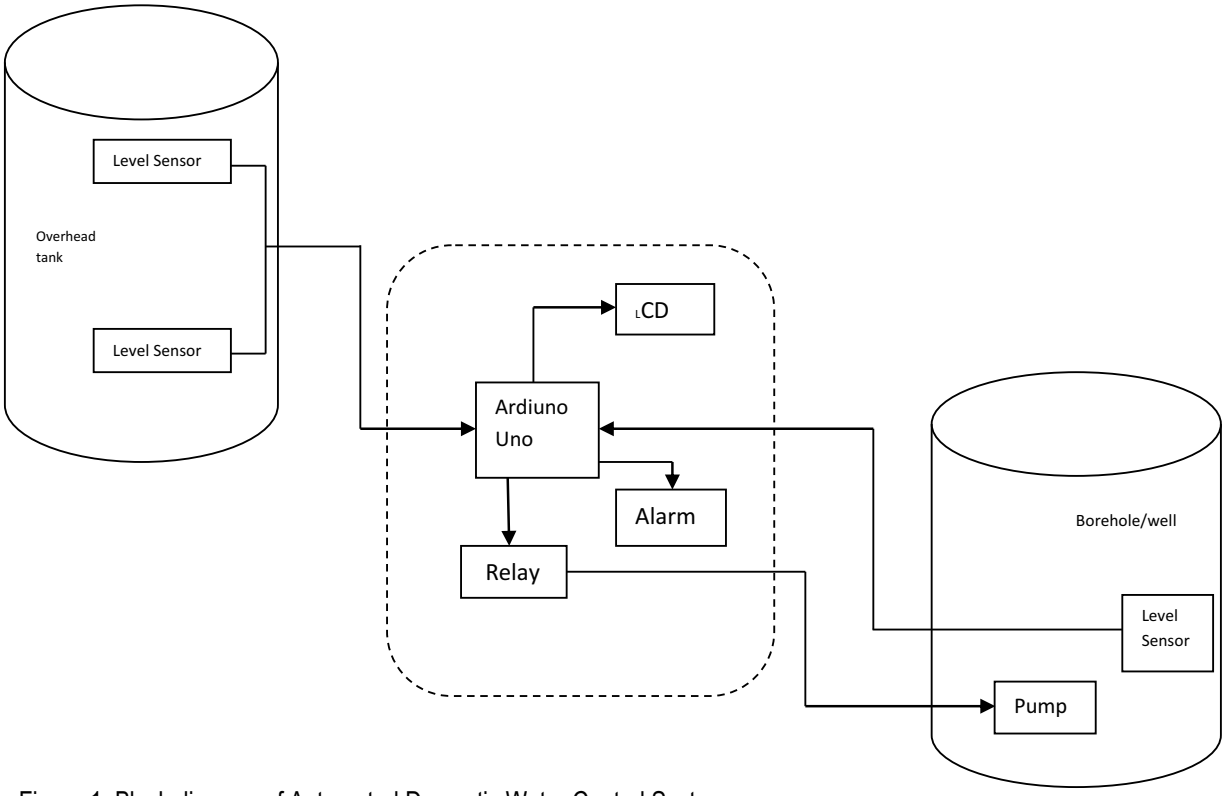

Figure 1: Block diagram of Automated Domestic Water Control System

Review of related works

Ejiofor and Oladipo (2013) proposed a microcontroller based automatic water level control system with the use of sensors, comparator circuit, microcontroller, display unit and a pump. The proposed system is able to determine the water level in the overhead tank to turn the pump ON or OFF accordingly. With the use of a microcontroller, the system monitors the water level in an overhead tank, switch on the water pump when the tank is empty and switch off the same pump when the tank is full. Kinge et al (2017) proposed a water control system that can combat water theft in urban areas as well as monitoring the amount of water supplied to residential areas. The system is able to control water distribution to various areas, calculate water bill on the bases of water utilization by various residents and send status updates through GSM module to a registered mobile device. Their proposed system consists of a microcontroller, sensor, DC water pump, solenoid valve, relay and GSM module.

Ayisha et al (2018) designed a water control system that is able to estimate how much water is being consumed in a home as well as deliver that required amount needed in other to reduce water wastage. The proposed system consists of a microcontroller programmed to regulate and control the required quantity of water that is allowed to pass through the valve at the right time interval. Electrically actuated solenoid valve shuts down automatically when the limit reaches the determined threshold value. With the help of the internal predefined limit in the system, the flow of water through the value is controlled. The water control system is connected to a Wi-Fi module used for wireless communication to the admin in a control room.

All these works are based on industrial applications of water control from an overhead tank only while this present work takes care of domestic applications as well as control from both the overhead tank and at the water source.

Materials and methods

The proposed domestic water control system consist of water level sensors, relays, Arduino Uno, display unit, alarm and water pump. This is illustrated in the block diagram displayed in figure 1. The system uses

level probe sensor to sense the level of water in the overhead tank and the water source, the water pump is turned on or off automatically depending on the level of water in the overhead tank and as well as that at the water source. This work also uses a 16×2 LCD to display the operations of the Arduino Uno per time; a buzzer gives a beep in case the device is faulty. The proposed system controls the pumping of water automatically without any user intervention.

The basic operation of control unit is to control the water pump by the Arduino Uno which is programmed using integrated development environment (IDE). The water pump is controlled by connecting it with an output pin of the Arduino Uno via a motor driver circuit (Relay). When the Arduino Uno transmits a positive signal (+5v) to the motor driver circuit, then the water pump is automatically turned on but when the Arduino Uno transmits a ground signal (0v) to the motor driver circuit, then the water pump is automatically turned off. The voltage level transmitted by the Arduino Uno is determined by the level of water sensed by the level probe sensor.

The sensor assembly consists of four aluminum wires arranged at 1/4, 1/2, 3/4 and full levels in the overhead tank. The dry ends of these wires are connected to analog input pins A1, A2, A3 and A4 of the Arduino Uno respectively. A fifth wire is positioned at the bottom of the overhead tank. The dry end of the wire is connected to the +5V DC supply. When water touches a particular probe, electrical connection is established between that probe and the dry end of the wire connected to the +5V DC as a result, current flows through that probe to the pull down resistors. The Arduino Uno reads the voltage across each pull down resistor and detects the level of water in the overhead tank which makes it to respond accordingly. For example, if the water level at the overhead tank is low and that at the water source is high, the Arduino then triggers the relay to turn the water pump on. The action taken by the Arduino per time is displayed by the LCD.

Discussion of results

The control unit was constructed as shown in the block diagram of figure 1. The constructed circuit is shown in figure 2 (a and b), it represents the control unit. Figure 2a is the diagram with the case closed while figure 2(b) is the diagram with the case opened showing the Arduino, relay, LCD, alarm and power supply. This circuit works as it has been described in the previous section.

Figure 2a

Figure 2b

Figure 2: The constructed circuit for the control unit. (a) closed case (b) open case

Figure 3: Setup of proposed domestic water control system

Figure 3 shows the interconnected water control system in which the pump and sensor in the borehole is connected to the control unit and sensors in the overhead tank are also connected to the control unit. All these work together to produce the desired results.

Figure 4: Test running the proposed domestic water control system

The connection as shown in figure 3 is then powered and the working system is shown in figure 4. When the control unit is powered, it first detects the water level at the overhead tank as well as the water level in the borehole or well (water source), if the level of water in the overhead tank is low (as it was the case before the water began to flow as shown in figure 4) and that at the water source is high, it triggers the Arduino Uno to turn the water pump on, but when the sensor detects that the water level in the overhead tank is high/full or the water level at the water source is low, then it transmits signal to the Arduino Uno to turn the water pump off. All these processes are done without human intervention, however it should be noted that the human hand seen in figure 4 was just to provide balance for the entire system since at the point of taking this particular snapshot, the pipe supplying water to the supposed overhead tank was not adequately fitted with proper support.

Conclusion

The automated domestic water control system was designed, constructed and tested to be working as desired. When implemented in a residential building for example, the proposed system will ensure that water is not wasted when allowed to overflow from the overhead tank after the capacity of the tank is reached by turning the water pump off as soon as the capacity of the overhead tank is reached, it will ensure that electricity consumption is properly utilized by turning the water pump off when the overhead tank has reached its maximum capacity also, it will ensure that the lifespan of the water pump is extended by turning the pump off as soon as the water level in the water source is very low so as not to operate without water, a condition that can damage the water pump. This proposed system is easy to implement and operates without human intervention however it would stop operating once there is no electricity supply to power the water pump.

Recommendation

It is therefore recommended that the design be improved upon by connecting it to a continuous source of power supply such as solar power. This will ensure that the system does not stop working once the power supply is off.

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