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Arduino-Based RF Water Level Monitoring System for Overhead or Underground Water Tank

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Abstract
Water plays a vital role in our day to day life. Most houses, especially in urban areas, uses overhead or underground water tanks for water storage and usage. Overhead and underground water storage tanks are normally opaque, which means the water level in it cannot be observed or monitored visually from the outside, thus the need for water level monitoring systems. This work proposed an RF wireless water level monitoring system that uses RF for communicating the water level data from the transmitter section to the remote receiver section of the system. In the study, two circuits are used, first is the transmitter and second is the receiver. An Ultrasonic sensor is used in the transmitter circuit, which measures the distance of water level from the upper point of the Tank. The distance is measured in centimeters and sent to receiver circuit using RF communication. the result were collected shows that, at a transmission distance of X_{TR}=1m to 10m, and 10 to 20m, (i.e. the distance between the transmitter and the receiver) the readings collected at the receiver is the same with the calibrated readings on the water tank. Which shows that the system performs accurately at a distance of $X_{TR=}$1m to 20m. When the X_{TR} distance is increased to 30m, there was little or no reception by the receiver, thus, no reading was recorded at $X_{TR=}$30m. This shows that the system performs at a maximum of X_{TR}=20m, i.e. the range of transmission of the system. Though theoretically, the RF module specification shows that with antenna attached, the transmission range can cover a distance of 100m.

Keywords: *Arduino, RF Transmitter & Receiver, Water Level, Monitoring, Control*

Introduction

Water plays a vital role in our day to day life. Most houses, especially in urban areas, uses overhead or underground water tanks for water storage and usage. Overhead and underground water storage tanks are normally opaque, which means the water level in it cannot be observed or monitored visually from the outside, thus the need for water level monitoring systems. With the current advancements in IoT devices and technologies, more and more devices can now be connected to communicate with one another. These connections enable remote monitoring of devices and also enable them to directly communicate with one another. This reduces direct human intervention and thus makes automation easier thereby reducing the cost of human labor and increasing the speed of system operation. Cheap and affordable single board computers, such as Arduino, was used by Akinwole (2020) to develop a water level monitoring system that controls the level of water in a tank. The system uses a 16x2 LCD to display the level of water in a tank as very low, low, high, or very high. The disadvantage of the system is that it doesn't give the quantitative value of the water level in the tank. In another work by Vaishnavi et.al. (2019) a low cost, water proof system was develop to monitor and control the water level in an overhead water tank. The system is capable of switching ON and OFF the water pump thereby reducing wastage and electricity bills incurred by the pump. It uses Arduino as the microcontroller with ultrasonic sensor, which displays the output in percentage (with an accuracy of 10%) on an LCD screen.

Pooja et.al. developed a water level monitoring system using Arduino development board. The system presents the water level on the scale of 1 to 6, were 1 means low, and 6 mean full. Saraswati, Kuantamac, & Mardjoko (2012*)* developed a system for measuring water level and communicating the measured value via SMS. The system was proposed to be used for remote notification, were the owner gets notification on the water level where ever he is. The system uses a GSM module which must be recharged before it can send data to the receiver.

This work proposed an RF wireless water level monitoring system that uses RF for communicating the water level data from the transmitter section to the remote receiver section of the system. The system will be used for a define range of not more than 100m.

MATERIALS AND METHODS

Principle of Operation

In the study, two circuits are used, first is the transmitter and second is the receiver. An Ultrasonic sensor is used in the transmitter circuit, which measures the distance of water level from the upper point of the bottle or Tank. The distance is measured in centimetres and sent to receiver circuit using RF communication. Transmitter Circuit – Transmitter circuit is shown in figure below. Fig1, in this circuit an Ultrasonic sensor is connected to pin D9 and D10 pin of Arduino. Ultrasonic sensor is powered by Vcc and GND pin, these pins are connected to Vcc and GND pin of the Arduino. The measured data is transmitted by RF transmitter. RF transmitter's data pin is connected to D4 pin of Arduino Nano. RF transmitter's Vcc and GND pins are connected to Vcc and GND pins of the Arduino. In this transmitter circuit an Antenna is used which is connected to ANT pin of RF transmitter, whole circuit is powered by 9 volt battery. The battery is connected to Vin and GND pin of Arduino.

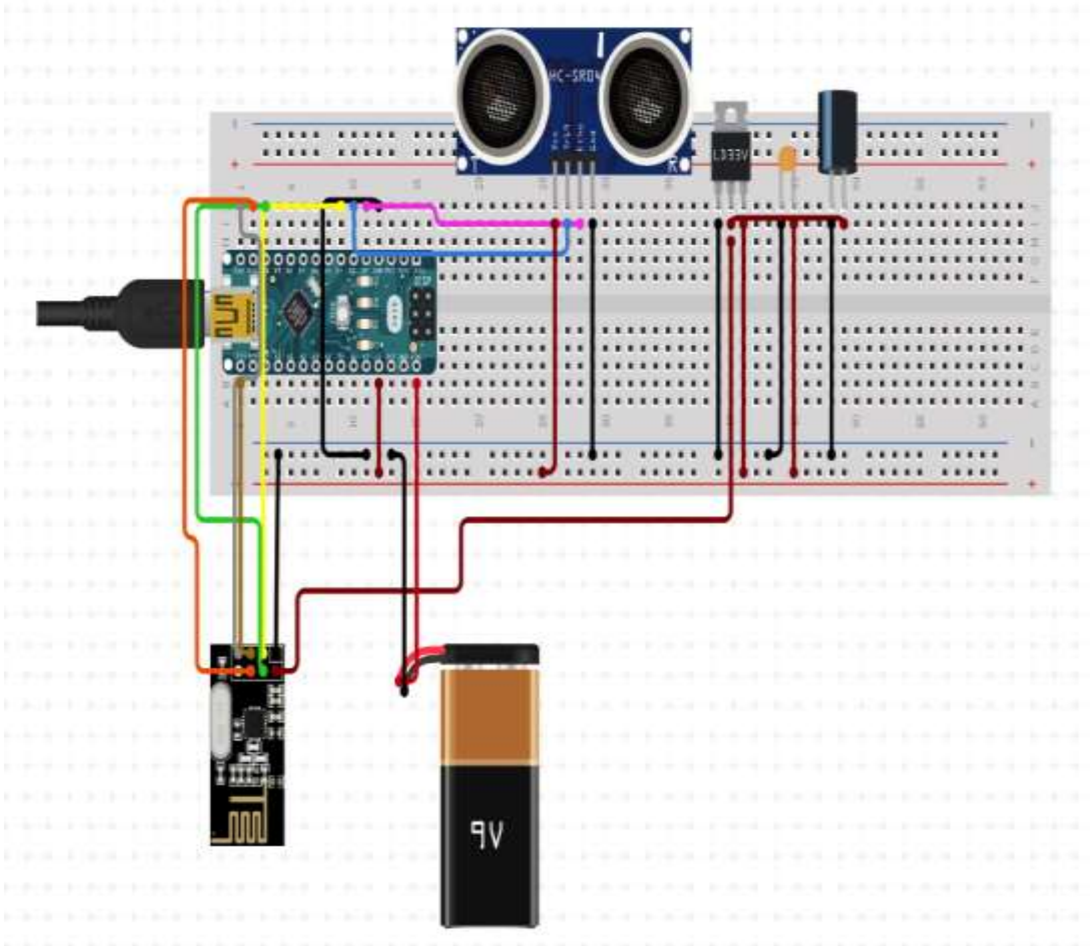

Figure 1: Circuit diagram of the transmitting circuit

Receiver Circuit – In the receiver Circuit, RF Receiver is used for receiving data from the transmitter. Data pin of RF Receiver is connected to D4 pin of Arduino. Water level is shown on LCD and LCD is connected to Arduino from pin D4 to D9. LCD is powered by Vcc and GND pin using the Arduino, the contrast of LCD is changed by moving the preset, which is connected to pin 3 of LCD. Receiver circuit is powered by a 9 Volt battery through a switch, which is connected between Vcc and GND pin of the Arduino. Circuit is shown in the figure below.

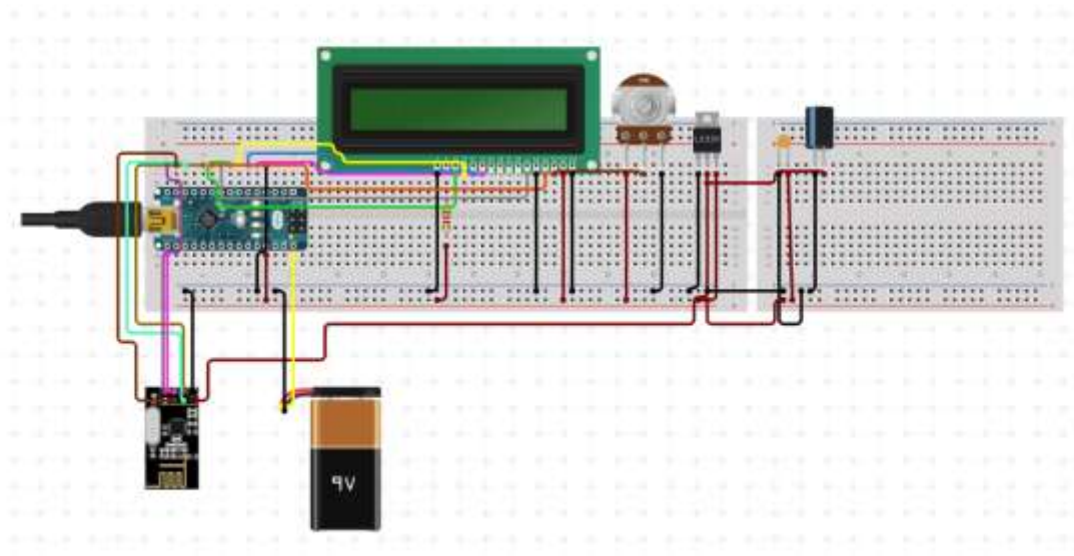

Figure 2: circuit diagram of the receiver circuit

Basic Concept

The technique of water level monitoring and controlling system concentrated with some basic parts which are softly aggregated together in our proposed method. Basic descriptions of some parts are described below.

List of Components

i. Arduino Nano
ii. Ultrasonic sensor Module
iii. RF transmitter
iv. Preset
v. 9 volt battery
vi. Connecting wires
vii. Switch
viii. Antenna

Materials and tools

i. Vero Board
ii. Breadboard
iii. Soldering iron
iv. Digital multimeter
v. Screw Drivers
vi. Plywood and woods screws
vii. Pieces of PVC rubbers

viii. Cutting plies
ix. Jumper wire

Construction procès

i. Circuit simulation using Proteus:

The circuit was first of all simulated using Proteus software in other to ensure the project is working.

ii. Programming the Arduino Nano board:

After simulation, the Arduino were programmed using the Arduino IDE and the codes were then uploaded to the Arduino Nano boards.

iii. Bread boarding the circuits:

The circuits were then transferred on a bread board for a test in order to ensure that errors were not made during programming the Arduino board.

iv. Constructing the circuits on a Vero board:

After all the above procedures, the circuits were then transferred on a Vero board for soldering.

Below are the pictures of the soldered circuits:

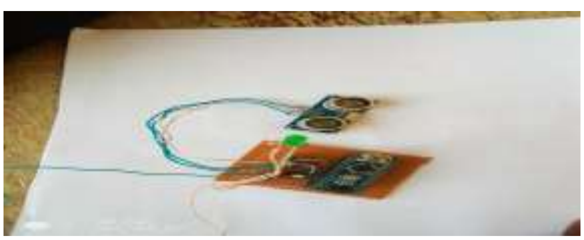

Figure 3: construction of transmitter circuit on Vero board

RESULTS AND DISCUSSION

The experiments conducted will help in assessing the accuracy of the system and also determine the range of transmission of the system.

An experiment is designed to test the functionality and workability of the project.

Experiment Design

This experiment was designed to test the workability of the project based on the aim of the project i.e. a water level indicator system that transmits wireless signal to a receiver section system whim displays the reading on LCD.

- The water container was filled with water i.e. up to 100% full
- The tap of the water container was then open to allow outflow of water, thereby making the water level to reduce
- The ultrasonic sensor (mounted on the inside of the water container cover) measures the instantaneous level of the water as it reduces.
- This is then transmitted to the transmitter section, received by the receiver, and displayed by the LCD.
- The result obtained were recorded as shown in Table 4.1

Experimental variables

- Distance between the transmitter and the receiver (X_{TR} %)
- Instantaneous water level as obtained from the calibrated scale on the tank (X_{CAL} %)

Table 1: Experimental result at (X_{TR} % =1 to 10 m)

S/N	*X_{CAL} (%)*	*Y (%)*	*Difference*
1	80	80	0
2	70	70	0
3	60	60	0
4	50	50	0
5	40	40	0
6	30	30	0
7	20	20	0
8	10	10	0

Table 2: Experimental result at (X_{TR} % =10 to 20 m)

S/N	*X_{CAL} (%)*	*Y (%)*	*Difference*
1	100	0	0
2	90	0	0
3	80	0	0
4	70	0	0
5	60	0	0
6	50	0	0
7	40	0	0
8	30	0	0
9	20	0	0
10	10	0	0

Table 3: Experimental result at (X_{TR} % =20 to 30 m)

S/N	X_{CAL} *(%)*	*Y (%)*	*Difference*
1	100	No reception	No reception
2	90	No reception	No reception
3	80	0	0
4	70	0	0
5	60	0	0
6	50	0	0
7	40	0	0
8	30	0	0
9	20	0	0
10	10	0	0

Table 1 to 3 shows the result of the experiment conducted to determine the effectiveness and workability of the system.

In table 1 and 2, the result were collected at X_{TR}=1 to 10m, and 10 to 20m, (i.e. the distance between the transmitter and the receiver).

The result shows that at X_{TR}=1 to 10m, and 10 to 20m, the readings collected at the receiver are the same with the calibrated readings on the water tank. Which shows that the system performs accurately at a distance of $X_{TR=}$1 to 20m.

When the X_{TR} distance is increased to 30m, there was little or no reception by the receiver, thus, no reading was recorded at $X_{TR=}$30m.

This shows that the system performs at X_{TR}=1m, i.e. the range of transmission of the system. Though theoretically, the RF module specification shows that with no antenna attached, the range is 3m. While if an antenna is attached, it can cover a range of about 100m.

CONCLUSION

A conclusion was drawn to this study in a such a way that after testing it on bread board and soldering it on vero board, a test was conducted on the system such that the result were recorded in table 2 and 3 above. Though there was a little or no reception between the receiver and the transmitter at X_{TR}=2m, and thus, no reading was recorded.

Automation of the various components around us has been widely increased to reduce human intervention and save time. It is known that improper water management can have harmful effects on both the system and the environment. The main objective of this project is not only to reduce manual labor but also help save water in an efficient manner. Finally, a conclusion can draw that this project can definitely be useful on a large scale basis due to its minimum requirement of man power and also the installation process being easier making it more compatible for everyone to use.

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