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RESEARCH ARTICLE

# Comparative Analysis of Hydroelectric Power Drainage Water Level Control Manually and Using by Microcontroller

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## Abstract

**Objective:** To compare water level drainage control manually and using a microcontroller for hydroelectric power. **Method:** To model water level drainage control using a microcontroller, data were gathered from a sample plant found in Ethiopia. The mathematical design was done as standard for all materials required since sampling was done at three pumps. When the water level reaches at 20 % then Arduino becomes 'on'. Thereafter that, LCD will show "level 20 %" and "pump1 on"; if the leakage is maximum and the level reaches 40%, Arduino turns pump2 'on'; if the level reaches 85%, Arduino turns pump3 'on', then the operator checks the status why the water level is at the maximum. **Findings:** This study designs a controlling system which is implemented for the existing plants directly, even though, the plant has a manual system, the key finding was to compare it with the microcontrolling system. The new controlling system can send messages to the operator when the water level advances to 85%. Although, manual data was recorded for 24 hours to take action. **Novelty:** The main outcome of this study is to upgrade the water level drainage control system for an existing Hydroelectric power system that is controlled by manually in a developing country, especially Ethiopia.

**Keywords:** Comparations; Hydroelectric Power Bludgeon; Ultrasonic; Microcontroller

## 1 Introduction

Nowadays, much research has been done on hydroelectric in different ways, but in the case of water level drainage system in a developing country, it is mostly unreliable because most hydroelectric power plants in developing countries have been developed before 30-40 years, not updated with new technology especially, in Ethiopia. These power plants with the water level drainage controlling system were developed manually. This manually controlled system can fail because of different reasons. For example, soil erosion. When soil erosion occurs at the dam, it reduces the performance of plants, which means the flow of water from the reservoir to the powerhouse through a penstock or canal.

The main problem of this manually controlled system, is in the generation capacity of the plant, is not constant, This study focuses on the development of water level drainage controlling systems using microcontrollers.

The study focuses on the design of a microcontroller-based level of water in the drainage system, with the design using all of the materials listed below as well as using Proteus software to simulate the result and compares the results with the present controlling system of the plant. This system can be installed at a powerhouse, then the signal can display the result on the LCD or the system. In case, it is above or below the standard, it sends the alarm for the concerning body in the microcontroller water controlling system, they simply wait for the messages.

The drainage and watering system is the most thought carefully part of the powerhouse when balanced with the attention given to the civil works and other electro-mechanical materials. The gathered information on Arduino and depending on the information taken, the Arduino board switches the pump[(1)]

Controlling water level is a controlled system in a reservoir. Monitoring water storage systems may not be a suitable exposure. In general, the study deploys a microcontroller-based system for monitoring water level drainage. A typical offline water level monitoring system may include sensors, actuators, and supportive electronic components. Sensor: It can perceive the change made in its surroundings and carry over the gathered information, Actuator: it is a device, which is capable of causing machines or devices to run.

The equipment requires when designing this microcontroller is digital electronics and controlling electronics is regularly used. Even though, additional peripheral input or output material was applied[(2)]. The control of water is starting from the reservoir since, the main input of power generation from hydropower is the water stored in a reservoir, The system can be designed in this water stored area and the all-controlling system can design. To sense different messages from the system an ultrasonic sensor is cared out[(3)].

## 2 Methodology

In this study, we focus on the hydroelectric power plants' water level drainage controlling system, The main novelty of this study is to replace the manpower water level drainage system to be automatic by using a microcontroller-based. And value-added in this research is to connect. The community, with the grid, since it increases the power generation from hydro. It compares with different works done before.

The method and material followed were as explained in the method first the problem of the plant can be identified since the controlling system was manual, after that in detail the literature review was done and also the novelty of the project that gives for the plant after this system can be applied.

The methodology raised in this study, all data is gathered from the plants which have these kinds of problems in Ethiopia, as the sample data to design water level drainage control system using a microcontroller. In general, the methodology follows the data gathered, system design, simulation, and implementation.

The method can address, all points which means it focuses directly on the hydroelectric power plant of a developing country. Which has a manually control water level drainage so, data was gathered from these plants. Which, have similar problems that can be controlled manually now they use this kind of controlling system. And increase their generation capacity with constant output power. This work is the design of a microcontroller-based hydroelectric power drainage water level control using an ultrasonic sensor. It gives a digital output that turns. On the water pumps, when the water in the tank(drainage hole) is at above expected or set value and turn off automatically if it is at below set value.

The system is done in different controlling systems, but in the case when compared with manual part or existing controlling system it is the most efficient for hydroelectric. Performance evaluation of the system from the test results shows that the system is highly efficient. Since it eliminates the unreliability of humans and also improves the workable lifespan of the pumping machines by controlling when to switch ON and switch OFF the pumping machines and making long use of the system since the project has a long life in Ethiopia in generating electric power. In the bludgeoning method, several errors occurred at the time of data record. However, in the microcontroller, the program is already arranged first by the standard of power plant water drainage capacity. So it is perfect.

The comparison is done between manpower and digital water level controlling systems. In manpower it is known that they control by human power by using bludgeon since this bludgeon has standard and numbering system and done by man and the data is recorded for one day to using or to cast the next day condition, so we focus on the microcontroller water level drainage control system, all of the materials, design parts standards is already taken from different research works done and compared with our plants' water level drainage system, we use software, Proteus software for simulation and this simulation results is compared with another research works done but finally, it focuses on the comparison between water level monitoring system using manually or using bludgeon and microcontroller depending water level drainage controlling system since the main objective is for this two system. As a material, the project requires the following.

### 2.1 Ultrasonic sensor (hc-sro4)

An ultrasonic detector determines the depth of water inside the tank. The information from the detector supplies the gathered information to Arduino and depending on the information taken, the Arduino board switches the pump. The microcontroller is a kind of microprocessor that can process data digitally [4]. The HC-SR04 Ultrasonic component has 4 pins, Earthing, VCC, Trig, and Echo. The time in which sound waves have traveled. Is around 341 m/s. via workout distance, we use the following equation. Distance = (time travel/2) * speed of sturdy, where the speed of sturdy is nearly 341 m/s.

### 2.2 Liquid crystal display

A liquid Crystal Display (LCD), is a kind of flat panel show which uses liquid crystals. A special organization is built to show the numerous water elevations using an LCD at the operator regulation panel, Liquid Crystal display is an electronic display [5] LCD is a judgment broad used in replacing LEDs (seven-segment LEDs or other multi-segment LEDs). This contrasts with LEDs, which are fixed with numbers and a few behaviors. The LCD is read to determine that the program and sensor are both working properly. The microcontroller, of course, does not require an LCD to read the sensor. It can read the numeric value held in the variable and ”interpret” the results LCD is used to observe the data locally [6].

### 2.3 Arduino Uno microcontroller

It is an open-source microcontroller. Communication in 900MHz band. Arduino is an open-source real platform for creating interactive systems that can stand alone or collaborate with the software on the computer for programming.

### 2.4 Arduino Hardware

Have two major parts: first Board of Arduino, which is the hardware part to work on to build the required objects; second, The Arduino Integrated Development Environment, or IDE, which is a software part to do programming, is used to create a sketch (a little computer program) that is uploaded to the Arduino board.

### 2.5 Digital I/O pins (pins 0–13)

Pins can be cast-off as input or output. The input is used to display the information that gets from the sensors, as well as output castoff to control the actuators. The ways (in or out) are specified in the sketch created in the IDE.

### 2.6 Analogue In pins that means (pins 0–5)

In analog, the input pins are used for reading voltage measurements from analog sensors and can also be cast off as digital inputs by setting them up through software. In comparing digital inputs, which can differentiate between two different levels (HIGH and LOW), analog inputs can measure 1,024 different ranges of voltage.6 Analogue output (pins three, five, six, nine, ten, and eleven) These are six pins that can achieve a third function: they provide the analog output.

### 2.7 Software for Arduino

To program the panel. The Arduino program is called a sketch which you need to unload into the board. It also introduces terms used in writing, editing, compiling, loading, and executing a program. Most microcontrollers are programmed with some variant of the computer-aided testing language. The computer-aided testing language provides a nice balance between the programmer's control of the microcontroller hardware and time efficiency in program writing. The first step is the compilation process. Here, the program source files are transformed into assembly code (filename.asm). If the program source files contain syntax errors, the compiler reports these to the user. The assembler transforms the assembly language source file (filename.asm) with machine code (filename .hex) suitable for loading on the Arduino processor.

### 2.8 Relays

Relays are shifts that open and close circuits electronically, A relay is also a switch that connects or disconnects two circuits. However, rather than manual operation, a relay is enforced on electrical characteristics, which in turn are attached or not attached to another circuit. Another pump can be used and used to supply water to the skyward energy source, issues can be addressed through the design of energy management and utilization of high capacity [7].

## 2.9 NPN Transistor (2N2222) and Generic Diode

In our circuit, we use the transistor and the diode to provide current amplification and an essential safety tool for our Arduino UNO, which is the diode, it protects from any fly-back current going back to the Arduino UNO.

## 2.10 12v dc motors

Unfeeling of the type, DC motors have a type of internal structure, which is electromechanical. To mitigate voltage, wave purified made of capacitors (sometimes in combination with inductors) are commonly extra to such a converter's output (load-side filter) and input (supply-side filter). The buck converter is applied when the direct current output voltage needs to be less than the DC input voltage [8].

The methodology we have followed in this project is summarized in the following flow chart Figure 1,

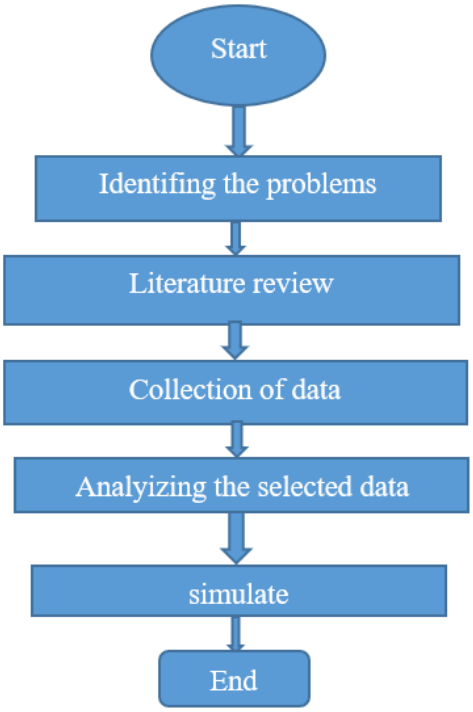


**Fig 1.** Flowchart

Simulation results using proteus software. Mainly used software is by an electronic design who can take part in the project work.

## 2.11 Circuit design

After listing, all the materials that were used for the project we have to arrange the circuit through Arduino. as shown in the figure below Figure 2.

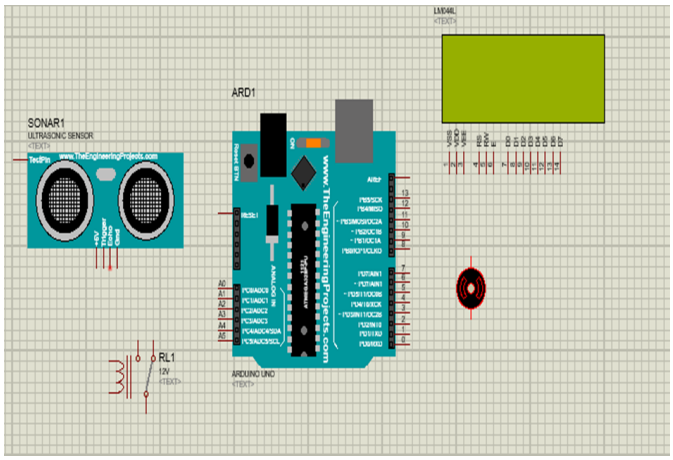


**Fig 2.** Designing the circuit of the proteus

We designed an Arduino sketch for LCD, so we placed the below code into Arduino

### 2.12 Liquid crystal LCD

The microcontroller controls all activities concerning the amount of water in the dam. Arduino UNO is preloved as a controller, it controls the level of Water[9] Then, we added a relay in which when we run the result, the relay will naturally get energized and after that will control the relay using logic.

## 3 Results and Discussion

Depending on the methodology, the results observed in this study focus on the controlling system of the hydroelectric water level drainage system of the mini-hydropower plants. In a developing country, like Ethiopia, this kind of plant can be controlled manually by manpower using a bludgeon which has several systems and is reported per day. Many pieces of research were done on microcontroller sited water flat control systems using different techniques. However, the main difference between this study from those researches done is that this focuses on the water level drainage controlling system for hydroelectric power which is done before by using the manual or bludgeon method. However, this is not effective in different ways in case of reliability, quality, cost-effective time wastage, and the performance of the plant in case of electric generation, Finally, the output of this study is that it compares the existing hydroelectric water level drainage control with the present one.

The study focuses on the design and implementation of a water level drainage control system using a microcontroller all data is gathered from the plant sample data for sample size the microcontroller is use three pumps depending on the capacity of the pump, and the design is done if the water level is below, optimum and also above the level it takes it own measurements since it designs mathematically for each equipment for controlling systems the methodology result is explained below in Figure 3 comparing with the simulation output. The main finding of this study is to design and implement water level control using a microcontroller that is controlled by manpower before. After design and implementation, the comparison is done in tabular form below.

This study, can improve the generation capacity of hydroelectric power from manual to automatic to increase the number of communities from off-grid to on-grid even though, it is the policy of using renewable energy, it also increases power reliability and quality after water level drainage is automatically controlled it has more advantages when compared with the existing techniques.

That means, that and microcontroller focuses on the water level drainage control system since the existing is not automatical or not digital, the output of this research is shown by simulation in Figure three with general results. The output of this research is indicated as follows. After analyzing, we connected all devices to get the desired simulation as displayed in the Figure 4.

The results of the simulation from the overall system diagram are that in the circuit, the ultrasonic sensor will get the distance. Then it will show the level on the liquid crystal display screen with the message “the level is in %”, At the time, the water level arrives 20 % then Arduino makes. On the water pump1 by driving the relay. After that, LCD will show “level 20 %” and “pump1 on “and if the leakage is maximum and the level reaches 40%, Arduino turns pump2 by driving a relay, and although if the level reaches 85% Arduino turns pump3 on by driving relay as well if the level is equal to 85% it turns on buzzer alert by driving a

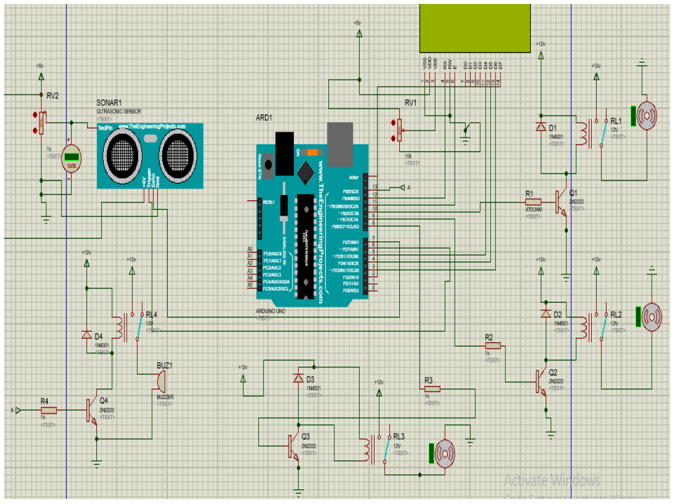

**Fig 3.** The overall system diagram of the circuit

relay to the operator to check the status why the water level is at the maximum. We place the code written on the Arduino IDE, which means copying the hex file to Proteus software run and getting the result.

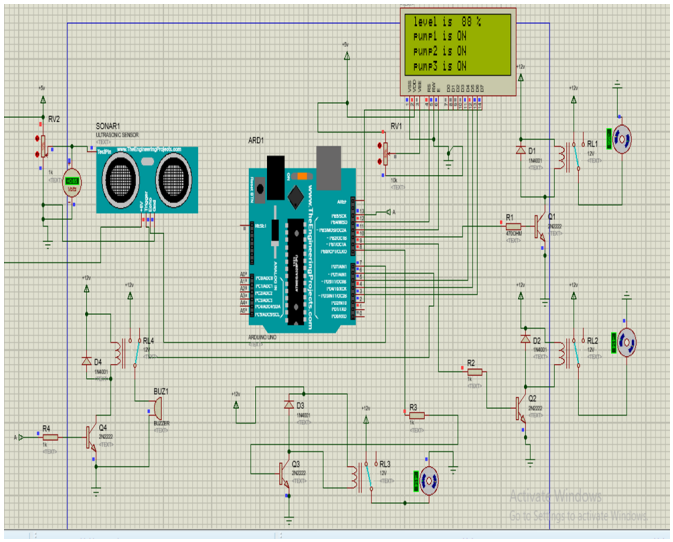


**Fig 4.** Overall simulation results

Finally, after all the above discussion, the results were done depending on the simulation results obtained from the simulation overall after all pumps opened, the water level drainage reported as well as the operators check the status by alarm, it can start to control the system all percents and the maximum and minimum of water levels can adjust using Arduino programming as standard.

The Table 1 below shows a comparison between water level control using manpower and using a microcontroller.

**Table 1.** Comparison between water level control using manpower and using a microcontroller

| Water level drainage control by manpower | Water level drainage control using a microcontroller |
|---|---|
| Manual | Automatic |
| Need manpower daily | Only for maintenance |
| Data recorded for 24 hours | Design is done and water by level is % send an only message. |
| Data is not constant because of fluctuation of water levels by different problems | Constant data, until the system, change the percent of water level |
| Affect the power quality or generation capacity of the plant | No affects the quality of power since it sends message first adjustments done on the generation capacity of the plant |
| The follow of water through a penstock to the ower house is not constant in needs data recorded within 24 hours | the flow of water to the turbine is constant. |
| Pumps are adjusted by manpower open and closed after 24 hours of data | Focus only on the message no need of waiting 24 hours to open and close the pumps. |
| Reliability and quality of power problems repeatedly occur within the grid-connected. | Reliable and quality power is connected to the grid. |
| Always error data is recorded because of seasonal focus power generation at the time of rain only | No error data send and constant no seasonal it focuses only on the generation capacity of the plant. |

## 4 Conclusion

Depending on the output found, the below suggestion was shaped. This work unveils the design of a microcontroller-based hydroelectric power drainage water level control using an ultrasonic sensor. It gives a digital output that makes on the pumps when the water in the tank(drainage hole) is at above expected or set value and turns OFF automatically, the pumps if it is at a below-set value. Performance evaluation of the system from the test results shows that the system is highly efficient since it eliminates the unreliability of humans and improves the workable lifespan of the pumping machines by controlling when to switch ON and switch OFF the pumping machines. If we compare this with the present controlling system by bludgeon, it has a big difference in the case of reliable quality and the management of the system in the plants.

Another main point this study contributes is that it reduces the manpower cost and the error occurred in the system because of water level drainage control in the plants. In this project, we control the drainage water level automatically using an Arduino microcontroller and ultrasonic sensor, and this project practically worked for the system.

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