Design an automatic fresh water distribution system with microcontroller for community sanitation needs

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Abstract. Limitations and shortages of fresh water often occur problems especially for coastal communities, port areas and other areas with minimal water supply. The need and limitations of fresh water can cause distribution which is hampered due to lack of monitoring and distribution in the field, so that the distribution and distribution are evenly distributed. The purpose of this study is to overcome the problems that occur by designing and simulating tools that regulate the distribution of fresh water. The system works when the water flow sensor calculates the flow of water that passes through it and after reaching the maximum capacity previously set, the solenoid valve will automatically stop the distribution of water, so that every citizen who has the right to receive fresh water will get according to his daily allowance. In designing the simulation design there are several obstacles to the unavailability of several sensors needed, such as water flow sensors and solenoids for which we make alternative solutions by making logic C ++ algorithm in Arduino Uno R3.

1. Introduction
Water needs for daily needs are very important, not least in coastal villages and around ports, the quality of the water in the coastal shore doesn’t support the needs of the people even if there is a dry season it becomes increasingly difficult to get fresh water. Some cases such as in India with increasing population are one additional factor besides the problem of inefficient water management [1]. Many previous studies have been conducted regarding the issue of fresh water as conducted by Verdaguer et al. [2] which discusses changes in urban fresh water structure, the problem of fresh water distribution is also done by Babah [3] and some water savings by doing water recycle for agricultural needs by upholding [4].

The solution to some problems in terms of inefficient water management is to regulate the distribution of fresh water distribution with a microcontroller, with previously we tried designing and simulating a water distribution system with the concept of the Internet of Things (IoT). IoT is a concept or scenario where an object has the ability to transfer data over a network without requiring human-to-human or human interaction to a computer. One of the devices that can be used to make the IoT system is Arduino, our research is the system will be using a solenoid valve which functions as a valve to open and close the flow of water flowing in the pipe and water flow sensor which functions to calculate the amount of flowing water flow connected to Arduino. The simulation is done using the proteus professional 8 application, and the water limitation settings are done through the C ++ program because several components in the proteus software aren’t available.
2. System description
Kevin Ashton, a technology pioneer who also created a global standard system for RFID and other sensors, said that almost all the data circulating on the internet comes from the results of input or results of capture made by humans into the system [5]. From a system point of view, humans are slow, error-prone objects, introducing data that is inefficient and has limitations in terms of quality and quantity, sometimes even trying to translate and change the data. As an alternative, it will be more efficient if the system can be connected with sensors that can translate real-world events directly. So, in the future, the system does not require human intermediaries and is connected directly to sensors and the internet to record data taken from the real world. So it can be said that the Internet of Things (IoT) is a powerful integration of radio frequency identification (RFID), sensors and wireless devices, which makes various devices intelligent and it is hoped that millions of physical objects are connected to form systems that create a wide distribution network [6].

![Diagram](image_url)

**Figure 1.** Automated system monitoring & water distribution.

Figure 1 describes the architecture of the monitoring system and the automation of water distribution. Use begins with setting the water usage limit value to be used. The water monitoring system consists of Arduino as a data processing center by requesting maximum data on the use of water to the database, a water flow sensor that functions to calculate the flow of flowing water, solenoid as a valve to open and close the flow of water. Solenoid will close if it has exceeded the predetermined limitation, even though later the tap at home is open but the water will still not flow because it is blocked by solenoid.

3. Project methodology
The methodology carried out begins with a research literature search which includes cases of problems with fresh water distribution, searching for data and theories based on literature and the internet as supporting media. Next, make a simulation design and variation of input data for simulation and draw conclusions from the simulation results. Following is the flow of research conducted:
3.1. Study literature

3.1.1. Microcontroller Arduino. Arduino is defined as an open source electronic platform, based on flexible and easy-to-use software and hardware, aimed at artists, designers, hobbies and anyone interested in creating an interactive object or environment that Arduino is an electronic kit or electronic circuit board in which there are main components, namely a microcontroller chip with AVR type from Atmel company and programming software that is open source licensed [5].

3.1.2. Waterflow sensor. Water flow sensor is one of the transducers used to measure the flow of water flowing in a pipe. Water flow sensor consists of a plastic valve (valve body), waterway and a sensor hall effect. When water flows through the sidewalk, the sidewalk will rotate and the speed of the sidewalk will be in accordance with the flow of water entering through the sidewalk. Hall effect occurs when the conductor carrying current is held in a magnetic field, the field gives a sideways force to the charges flowing in the conductor, any changes in the magnetic field that occur will be detected by the hall effect, where changes in the north and south poles will provide input to the hall effect and produce output [6].

3.1.3. Solenoid valve. Solenoid is a device used to convert electrical signals or electric currents into mechanical linear motion. Solenoid is made from movable coil and iron core. The pulling and pushing strength is determined by the number of turns on the coil. The jolt of solenoid is very important. A small jolt will result in a high level of operation, and less power is needed. Pipe valves, such as taps for hot and cold tap water are the most visible types of valves. Other valves found on a daily basis include gas control valves on the stove, small valves installed into washing machines and dishwashers, and security devices installed for hot water systems.

3.1.4. LCD. Electronic display is one of the electronic components that functions as a display of data, both characters, letters or graphics. LCD (Liquid Cristal Display) is one type of electronic display made with CMOS logic technology that works by not producing light but reflecting the light around it against front-lit or transmitting light from back-lit.
4. Results and discussion

4.1. Design simulation

The mechanism for running the automatic water distribution simulation is shown in the following figure:

![Design of an automatic water distribution tool simulation](image)

**Figure 3.** Design of an automatic water distribution tool simulation.

The input sensor is responsible for detecting and sending signals to the microcontroller where the water flow sensor is one of the transducers used to measure the flow of water flowing in the pipe. Water flow sensor consists of a plastic valve (valve body), water rotor and a hall effect and waterflow sensor which is a trigger for solenoid. All information will be displayed by the LCD, information on water discharge will appear as long as it has not met the maximum limit of daily water, if it is already there is a notification exceeding the limit. At the end of the simulation using a solenoid as an opening and closing valve flow, this device will validate the maximum number of limits per day specified 500 ml. The next step after the design simulation design is carried out the process of making the system flow in the form of activity diagrams, the system scheme will be created and adjusted to the objectives of the study, the flow chart diagram is shown in the following image:

![Work flow diagram of an automatic water distribution system](image)

**Figure 4.** Work flow diagram of an automatic water distribution system.
Activity diagram that has been created will be the logic documentation that will be applied to the proteus simulation application. Proteus is a combination of ISIS and ARES programs, by combining these two programs the schematic of electronic circuits can be designed and simulated and made into PCB layouts. In ISIS also included a ProSPICE program that is useful for simulating schematic circuits, so that ISIS can be an interactive electronic circuit simulator program. In proteus we use plugins to use Arduino Uno R3 microcontroller devices to process inputs from waterflow and solenoid valve sensors. The microcontroller in its programming uses the C++ language, making this program from Arduino using Arduino Genuino IDE version 1.8.5 to write programming languages on the microcontroller. Process of making electronic circuits with proteus has limited plugins, some devices especially related to sensors are still rare so some of our tools are done via programs, here are some tools that we use in designing using proteus software.

Table 1. Devices used in software simulations.

| DEVICES      | DESCRIPTIONS                          |
|--------------|---------------------------------------|
| ARDUINO R3   | Arduino uno R3                        |
| TRANSISTOR   | NPN bipolar transistor primitive       |
| RELAY        | Animate relay model                    |
| LCD          | 16x2 alphanumeric LCD                  |
| RESISTOR     | Digital primitive model of a pull-up resistor |
| DIODE        | Generic diode valve                    |
| VSINE        | Sine wave AC voltage source            |

After the series has been successfully made, a simulation will be carried out through the program created, some conditions are adjusted to activity diagrams including the condition of the LCD showing the initial condition of the water discharge and the maximum limit that has been flowed to the homes of residents. In this system the LCD is installed on port B Arduino. There are 2 conditions before the limit and after exceeding the daily limit:

Table 2. LCD script before and after limit.

| Before Limit                                | After Daily Limit                                |
|---------------------------------------------|--------------------------------------------------|
| lcd.begin(16, 2);                           | lcd.setCursor(0, 0);                             |
| // Print a message to the LCD.              | lcd.print("Sudah Melebihi "); //$over the limit|
| lcd.print("Solenoid - ON");                | lcd.setCursor(0, 1);                             |
| lcd.setCursor(0, 0);                        | lcd.print("Batas Pemakaian "); //$usage limit   |
| lcd.print("Soleno"");                      | flow = 0;                                        |
| lcd.setCursor(0, 1);                        | // print the number of seconds since reset:      |
| lcd.print(totalMilliLitres);                | lcd.print("Solenoid - OFF ");                    |
| lcd.print(" ml ");                         | digitalWrite(7, LOW);                           |
| digitalWrite(7, HIGH);                      |                                                                            |

Calibration of the waterflow input sensor is done so that the similarity limit between virtual data in the microcontroller and the actual data has a limit of similarity in the amount of discharge, the logic used
for checking each water flowing through the water flow sensor will be recorded and the data will be validated to the solenoid valve, where the pseudocode The script used is as follows:

**Table 3. Water calibration method.**

| Pseudocode Calibration |
|-------------------------|
| if flow equal to 1      |
| digitalWrite(7, LOW);   |
| flowRate = ((1000.0 / (millis() – oldTime)) * pulseCount) / calibrationFactor; |

// Note the time this processing pass was executed. Note that because we’ve
// disabled interrupts the millis() function won’t actually be incrementing right
// at this point, but it will still return the value it was set to just before
// interrupts went away.
// int maxLitres = 500;
// set first value for variable oldTime, flowrate, flowmillilitres, totalmillilitres == 0
oldTime = millis();

// Divide the flow rate in litres/minute by 60 to determine how many litres have
// passed through the sensor in this 1 second interval, then multiply by 1000 to
// convert to millilitres.
flowMilliLitres = (flowRate / 60) * 1000;

// Add the millilitres passed in this second to the cumulative total
totalMilliLitres += flowMilliLitres;
end if

4.2. Simulation processing
The process of running the simulation:

4.2.1. Simulation conditions when started will be carried out. This condition will show the usage limit is still full with the number 500 ml listed, according to the condition of the maxLitres variable that we set with a value of 500 ml.

![Figure 5. Conditions for starting a program.](image-url)
4.2.2. *Simulation starts.* When the program starts, when we press the on button, the water starts flowing and there is information indicating that the solenoid sensor is open and 86 ml of water has been flowed. Every addition of water flow that passes through the sensor waterflow will be recorded in the virtual terminal, as shown in the picture below:

![Solenoid - OK 86 ml](image)

*Figure 6. The condition of the program simulation starts.*

4.2.3. *The condition of the waterflow stops when the solenoid is closed.* The condition where the solenoid is closed is indicated that the flow of water will stop and the remaining residual information will appear as much as 302 ml. In this process people are called to close the water taps in their homes so that the system still records the remaining fresh water they can still get.

![Sisal Penakalan 302 ml](image)

*Figure 7. Condition of program stop simulation.*
4.2.4. Simulations have reached the limit. Conditions after reaching the limit, in this program the maximum limit of 500 ml of water will continue to stop with the closing of the solenoid valve and information will be displayed via the LCD screen, the tap will not drain when it reaches the daily limit shown in the picture below:

![Figure 8. Condition of water supply when it reaches the limit.](image)

5. Conclusion

Based on the results of the study it can be concluded that the simulation of the fresh water distribution system runs well even though there are several plug-in tools that are not yet available in proteus software such as solenoid valve and waterflow sensor, but that can be handle with replaced by engineering software through C++ where the logic can be stop and resume counting the water flow. This simulation can be a support system in helping various parties in the process or mechanism of distributing fresh water evenly and automatically. Based on the characteristics of the sensor running, the solenoid will close the water flow when the usage conditions have exceeded the maximum limit that passes through the waterflow sensor. The next study will begin with the prototype of an automatic water distribution tool with Arduino and the web to support the simulation theory that was made in this study.

References

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