Microcontroller Based Automated Water Level Sensing and Controlling: Design and Implementation Issue

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***Abstract*—**In this research, we provide a framework for managing and monitoring water levels based on the electrical conductivity of the water itself. Specifically, we look on microcontroller-based water level sensing and controlling in both wired and wireless settings. A method for controlling the water in a house's plumbing system might assist cut down on both the amount of energy needed to heat and cool the home and the amount of water wasted through overuse. Additional tank support for Global Water types such as cellular dataloggers and satellite data transmission devices for distant water monitoring is provided. In addition, lately, there has been an influx of cellular phones with comparatively powerful computing and high-quality graphical user interface. From the user's point of view, it is essential that such a valuable resource be reused in a mobile app. The last part of our proposal is a protocol for a worldwide, water-level-monitoring service that can be accessed through the internet and mobile devices.

***IndexTerms*—**Indicator, microchip, nozzle, and water level sensor.

INTRODUCTION

The availability of water and the capacity to preserve it for future generations has become a pressing global concern. Lack of proper and integrated water management, including wasteful water distribution and consumption, contributes discreetly to this issue. A wide variety of human activities rely on water, including farming, manufacturing, and home usage. As a result, a house or business's water management system may run into trouble if it isn't being used effectively or monitored. Several monitoring systems with built-in water-level sensors have gained widespread acceptance in recent decades. The process of measuring the height of a body of water is crucial from both a governmental and private standpoint. This would allow for a unified system of controls to monitor the progress of such projects as they are carried out. Therefore, there may be practical importance in installing water-control systems in residential settings. In this article, we will go through the current automated technique of level detection and how it may be utilized to turn a device on or off. The most frequent approach to level management in the house involves starting the feed pump at a low level and letting it run until a greater water level is achieved in the water tank. No reliable controlling system can function with this. As an additional use case, liquid level control systems are often installed in dams, silos, reservoirs, and other structures where liquid levels need to be monitored. Most often, these kinds of systems will display both many and continuous levels visually. This management system may be customized to incorporate audible and visual alerts at predetermined thresholds and the automated regulation of pumps according to the needs of the user. Water distribution coupled to sensing and automation requires proper monitoring to guarantee sustainability goals are met. As a part of such a programmed method, microcontroller-based automatic water level monitoring and regulating is implemented.

The following is the structure of this document. In the second chapter, we focused on the fundamentals of the system architecture. In Chapter 3, we walked over the specifics of what PIC16F84A is. Chapter 4 details the design and implementation phases. In Chapter 5, we outline the details of the control and monitoring system we want to implement. In the last chapter, we discuss the implications and directions for further research.

BASICCONCEPTS

Our suggested approach for monitoring and managing water levels is based on a few key components that are aggregated together gently. The following are brief overviews of a few key components.

The Water Level Gauge

We may utilize an LED light designed for use in water level indicators on the device that displays the water level. To turn the LED on or off, the user must contact the water level sensor at various depths (i.e. on: yes sensor senses water).

Water-Level Detection Device, Type B

We'd like to provide various practical materials, including Iron rod, nozzles, resistance, rubber, etc., that may be used to construct specialized water level sensors. To start, we need a grounding rod made of iron and steel, and then we need to connect at least four nozzles, each with their own ground, to +5v through a 1k resistance. To insulate each nozzle, we must link them together and insert a rubber at the spot where they meet. By virtue of the water's conductivity, an electric connection is made between the nozzles and the connecting rod as soon as the sensor comes into contact with water [3].

Control System for Pumps of Water, Letter C

Connecting the motor driver circuit to an output pin on the microcontroller enables us to regulate the flow of water. The microcontroller may turn the water pump on and off by sending a positive (5v) or negative (ground) signal to the motor driver circuit. In addition, we'd like to have a manual switch on the motor driver circuit that may be used to control the motor when the circuit is not in use. It improves the system's usability.

D. Microcontroller

A microcontroller, sometimes known as a "computer on a chip," may be instructed to carry out any operation requiring control, sequencing, monitoring, or display. The cheap price makes it the obvious option for the designer. The purpose of a microcontroller is to serve as all of these things. The fact that all of the peripherals required for its operation are already integrated inside it is perhaps one of its greatest advantages. As a result, we may avoid spending money on unnecessary materials and labor while making inexpensive gadgets [1].

E. Others

We require interface devices between the microcontroller pins and the high power devices like lights, heaters, solenoids, and motors in order to control them with a microcontroller. Switching currents from milliampere to several thousand amperes is possible using mechanical relays also known as contactors. The water pump in this setup needs a relay circuit in order to work with the high voltage ac current. The negative end of the motor's cord should be linked to the relay circuit's output. It is recommended that 220v ac current be supplied to the cable's positive end. It follows that electromagnetic relay may be used as a power amplifier.memory is used to store the program. The size of programmemory is 1024 locations with 14 bits width. Flash memorycan be rewritten large amount of times for updating purpose.EvenifpowerisswitchedoffthecontentsoftheflashmemorywillnotbelostbecauseofhavingEEPROM.Dataregisters aregenerallyusedtokeepnumericvaluessuchas integer andfloating-pointvalues.Itcanworkasaccumulatorofthememory.Datamemoryhasbeenpartitionedintogeneralpurposeregistersandspecialpurposeregisters which are used to store data address etc. and holdprogramsstate respectively.

DESIGNANDIMPLEMENTATION

The 8-bit microcontroller, inverter, reserve tank (res. tank), water tank, and water pump have all been used in our experimental design. A sensor that detects the level of the water has been used to activate the pump. In order to measure the water level, four improvised sensors are employed. The input of the microcontroller was previously skewed by inverted sensor data [6]. We programmed into the PIC 16F84A's memory using MPLAB [1].

Microcontroller, PIC 16F84A, Part I

After the success of the PIC1650, which was created by General Instrument's Microelectronics Division, Microchip Technology expanded the PIC family into its own line of RISC microcontrollers. The PIC integrated circuit was designed to offload some of the work from the central processing unit by managing other, less important devices. Humans have a central processing unit (CPU) in their brain and a peripheral input/output controller (PIC) that controls the rest of their body. This is why we recommend using a cheap 8-bit PIC 16F84A microcontroller as the brains of our system [1].

Block Description of the PIC16F84A

The PIC 16F84A is one of the PICmicro® microcontrollers, which fall somewhere in the middle of the product range. Data storage for software

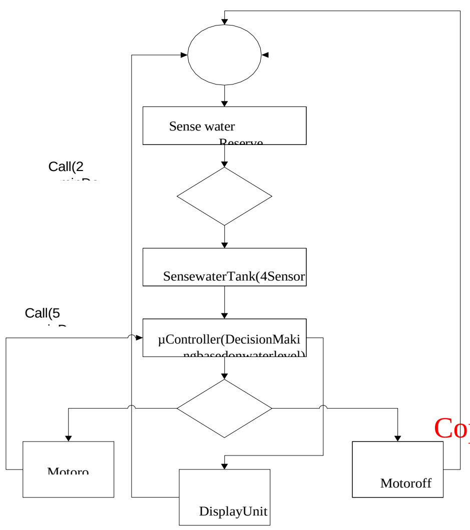

Figure1:

The System Design Process Flow Diagram

includes 1K words, which is equivalent to 1024 instructions given that the width of both program memory words and device instructions is 14 bits. In all, there are 68 bytes of data storage space in RAM [1]. A 64-byte data EEPROM is used. In addition, 13 I/O pins may be individually programmed by the user. It's possible that certain pins on the device are being used for more than one purpose.

Classification of Memories

The PIC 16F84A has separate storage areas for computer code and information [14]. Flash

Part A: The Framework

In the initial phase of development, a water level sensor is created to measure the height of a body of water. The use of a microcontroller to automate the system's controls simplifies the system's design and operation. The microcontroller learns the current water level via a sensor unit equipped with an inverter. The water pump's action (on/off) in response to the tank's present water status is determined by the resulting output from processing the input variables. Diagrammatic representation of the whole design process.

Assembled Sensing Device B

One portion of the water level sensor device is employed in the reserve tank, while the other four are installed inside the water storage containers themselves. Rod, nozzles, inducting rubber, etc., are also components of sensors. The rod's iron and steel construction provides a direct path to the earth. The nozzles are wired to a +5v source. Nozzles and iron rods are held together with rubber. Separating the nozzles from the iron rod's electrical connection is achieved using rubber. The resistance of 22k was chosen because of the high conductivity of water. The sensor works on the premise that when one of its nozzles is submerged in liquid, the conductivity of the water joins the nozzle to the rod. The inverter's input is then linked to ground (0v), and the nozzle receives power. As illustrated in Fig. 2, the inverter's output is wired into the input of a microcontroller, which turns the LEDs on and off and serves as the user interface.

System C: The Controls

The control unit's primary function is to operate the water pump in accordance with the parameters set out in a predetermined program stored on the microcontroller. The relay circuit is wired to a transistor, and the transistor is linked to an output pin on the microcontroller, where the water pump may be controlled. This transistor's emitter is grounded, and its collector is wired into the relay circuit. The relay circuit consists of a single diode used to convey a signal in one direction and a single inductor used to counteract the current flow direction shift. The wire attached to the pump's motor serves as a negative connection to the relay circuit's output. For the motor's positive connection, AC 220V is used.

The functions of the control unit are as follows:

The microprocessor turns the transistor off by shorting its base to ground, which causes its emitter and collector to become open. If this is the case, the relay circuit will not pick up any ground signal (0v). Therefore, a positive signal (+5v) is being sent to the negative end of the wire connecting the motor pumps. If the motor pump receives a positive signal (+5v) at one end and 220v ac at the other, it will turn off.
Transistor turns on when microcontroller gives positive signal (+5v), creating a short between the emitter and collector. The relay circuit and the motor pump will get a 0v ground signal, turning the pump on. The motor pump will also receive 220v ac on the positive terminal.

Further, the inductor is able to endure some resistance after being switched from positive signal (+5v) to ground or its reverse. A diode is the appropriate choice because of this same reason. The motor driver circuit may be manually activated and deactivated with the use of an on/off switch. Using a PIC16F84A microcontroller, the schematic for the control unit may be shown in Fig. 2.

D. Full Functioning Description and Circuit Schematic

To put up the system, we'll need things like a PIC 16F84A microcontroller, a Crystal Oscillator, two capacitors with values of 22 pF and 27 pF, an inverter, an LED, a water tank, a water level sensor, a water pump, a transistor, an inductor, and a few capacitors. Detailed circuit diagram graphically shown in Fig. The microcontroller's RA4 pin is used to check whether the backup tank is full. It provides a warning if there is no water nearby. enables or disables the whole circuit for a certain length of time. As soon as the timer turns on, it picks up on the presence of the backup supply once again. Get backwards data from the water supply by connecting to pins RA0, RA1, RA2, and RA3. A Crystal Oscillator is wired to the microcontroller's Pins 15 and 16. To execute the program's instructions, an external clock generator consisting of a crystal oscillator and two capacitors of 22 pF and 27 pF is linked to the ground.

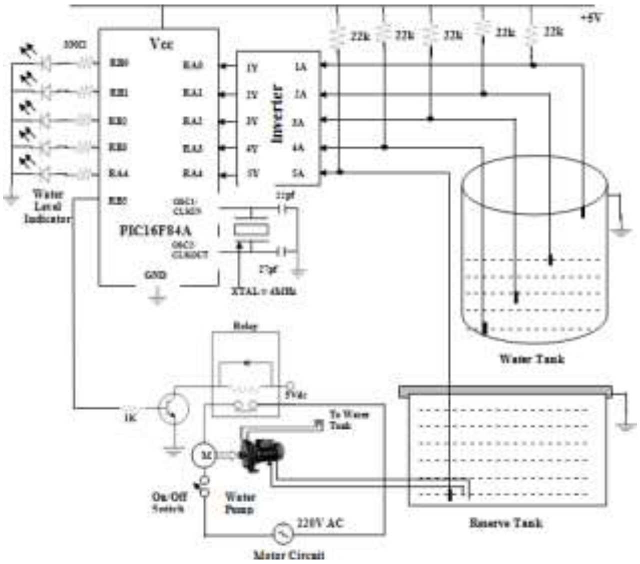

Figure2:Completecircuitdiagram

If the signals on pins RA0, RA1, RA2, and RA3 are all zero volts (ground), then the water tank is empty. All lights should be turned off then. We may also configure this problem in a smarter method, knowing for sure that there is no water in the tank if pin RA3 detects a ground signal. When the water tank is full, the signal at pin no. RA0 should be positive (+5v). Therefore, the water pump should turn on when the tank is empty, and the LED lights should be turned off. If only pin RA3 is receiving a 5v signal and the other three are receiving 0v, this indicates that the water level in the tank is one-fourth full. This is why the water pump is still running, and why the first LED is on but the other three are still off. Indicating when the water tank is full, a +5v signal appears on any of the four RA pins (RA0, RA1, RA2, and RA3). This means that the water pump should be turned off and all the LED lights should be activated. Please take note that we installed these LEDs for the purpose of visual and user home monitoring.

As the water level in the tank decreases due to domestic usage, the display LEDs should turn off successively from the top to the bottom. The tank is empty once again when all the lights go off, at which point the water pump should turn on automatically. These steps ought to repeat indefinitely automatically. Here we give the related experimental findings (see Table I).

An Explanation of the Code A.

The whole operation was controlled by an application developed in assembly language for a PIC16F84A microcontroller. The MPLAB development environment has been used to test and simulate all the programs.

A. Dataacquisitionandrepresentation

1) The first step is for the data collection server to connect the relevant

It is MICROCHIP's own software [1]. Our system uses a Crystal Oscillator (XTAL) 4MHZ as its external timer. Once the power was applied, the microcontroller received data from the inverter-connected water sensor. Microcontroller registers RA0, RA1, RA2, and RA3 are loaded with flipped inputs, and their permutations are tested. The following procedure was used to check the possible combos.

Initial, the microcontroller loads the signal into its register when it receives the first signal from a pin. After that, it inserts the data from the next pin signal into its register. In a similar fashion, the other pin signals are processed. At long last, the signal from all four necessary pins is loaded into the register. Each of the four possible outputs is determined by a combination of these signals and sent to the corresponding pin.

2) The process is cyclical or iterative with regard to the initial conditions.

PROPOSED NETWORK FOR MONITORING WATER LEVELS

One of the world's most valuable resources, water, has to be used effectively. However, a significant volume of water is lost every day owing to carelessness. Each day, our system is guaranteed to collect a substantial volume of useable water. The monitoring and management system relies on commonplace gadgets like laptops and smartphones. Because of the need for remote management, we developed a practical automated wireless control system. As shown visually in Fig. 3, the proposed web-based monitoring and controlling network is compatible with the current water management system. We recommend the following breakdown for the whole wireless network..

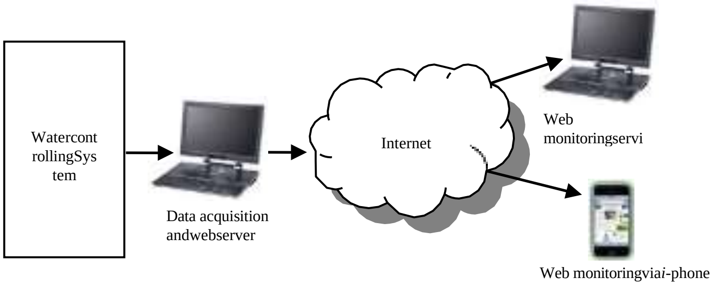

Figure3:Waterlevelmonitoringnetwork

port identified by the protocol used for exchanging digital information.

1) In Stage 2, you'll save the information you've gathered in a buffer and prepare it for use in a web app.

A third step involves converting data into XML format. The Simple Object Access Protocol (SOAP) might be used to transfer information between the server and client.

Third, a graphical user interface (GUI) should be used to display data for users, who should have protected access to the microcontroller that is used to operate the system. The XML file might also include a notice message in the event the water level is shown.

It is essential that the mechanism used to transmit data step 5 maintain the serializability of the interface. Additionally, the PC server should accommodate several clients and buffer obtained data so that the user may access the database and command the microcontroller. Further, from a security standpoint, here is where you'd bring in things like user authorisation.

Part B: Distant Interaction

The first step in integrating wireless water level monitoring is to create an interactive application program that can be accessed from a distant PC or mobile device.

The second step is to show both the local connections that are active and the distant connections that have been saved through the internet. Additionally, show data from the wireless automated controlling system in various ways (sensors/actuators in one node, all devices in a room, all devices in an apartment/factory, etc.).

3rd Step: Show the network architecture to the person in charge of upkeep.

CONCLUSION

One of the most fundamental need for life is access to clean water. However, a significant quantity of water is lost due to careless usage. There are a few additional automatic water level monitoring systems available, but they all fall short in one way or another when put into reality. To address these issues, we installed a sophisticated automatic system for monitoring and regulating water levels. The purpose of this study was to find a way to stop water from being wasted by creating a system that is both adaptable and inexpensive, as well as simple to configure. The low-cost PIC 16F84A microcontroller we've employed in our system is a major factor in the price cuts we were able to make.

cost. After conducting successful in-lab experiments, we presented a web-based water level monitoring and controlling network, giving us the freedom to manage the system remotely and across a variety of devices. This finding might have significant ramifications for effective water management.

REFERENCES

[1] Source: (2001) Microcontroller chip technology, PIC16F84A datasheet, www.microchip.com [1]

[2] Very Low-Cost Sensing and Communication Using Bidirectional LEDs, UbiComp 2003: Proceedings, vol. 2864, pp. 175-191, 2003, P. Dietz, W. Yerazunis, and D. Leigh.

[3] A Microcontroller-Based Monitoring System for a Batch Tea Dryer, by M. Javanmard, K.A. Abbas, and F. Arvin, published in the CCSE Journal of Agricultural Science, Volume 1, Issue 2, December 2009

[4]

[5] Low-Cost Surface Mount LED Gas Sensor, Roderick L. Shepherd, William S. Yerazunis, and Senior Member, IEEE King Tong Lau and Dermot Diamond, Sensors-00997, 2005.

[6] Microcontroller-Based Electric Expansion Valve Controller for Air Conditioning System, World Academy of Science, Engineering, and Technology, 2008. [5] T. S. Aye and Z. M. Lwin.

[7] Headspace total volatile basic nitrogen from selected fish species: monitoring by reflectance spectroscopic measurements of pH-sensitive filmsî, L. Byrne, K.T. Lau, and D. Diamond, The Analyst, vol. 127, pp. 1338-1341, 2002.

[8] An environment for real-time power monitoring of wireless sensor network systems, Proc. of SSST' 05, pp. 406-410, 2005 [7] Milenkovic A., Milenkovic M., Jovanov E., Hite D., and Raskovic D.

[9] Integrated chemical sensor array platform based on light emitting diode, xerogel-derived sensor components, and high-speed pin printing, by E.J. Cho and F.V. Bright, AnalyticaChimicaActa, vol. 470, pp. 101-110, 2002.

[10] An evaluation of chemical sensor array pattern identification algorithms: a comparative study, Anal. Chim. Acta 384 (1999) 305-317 [9].