International Journal of Engineering Research and Technology. ISSN 0974-3154 Volume 10, Number 1 (2017)

Low Cost Automatic Water Level Control for Domestic Applications with Digital Display

M. R. Latte[1]
[1]*Assistant Professor, Department of Production*
D.Y.Patil College of Engineering and Technology, Kolhapur, Maharashtra.

Prasad Done[2]
[2]*PG Student,*
University of Windsor, Canada

Abstract
The drinking water crisis in India is reaching alarming proportions. It might very soon attain the nature of global crisis. Hence, it is of utmost importance to preserve water. In many houses there is unnecessary wastage of water due to overflow in Overhead Tanks. Automatic Water Level Controller can provide a solution to this problem. The operation of water level controller works upon the fact that water conducts electricity. So water can be used to open or close a circuit. As the water level rises or falls, different circuits in the controller send different signals. These signals are used to switch ON or switch OFF the motor pump as per our requirements. Controller itself provides with a LCD display to show the water level inside the tank or water container.

Keywords- Crisis, automatic water controller, open or close

1.0 Introduction

Water scarcity is a problem that is gripping the major metro cities of the world; the main culprit is not availability but undue wastage. Most of the people who have easy access to resources like water, have careless attitude toward this kind of issues but people who face this problem knows the worth of clean drinkable water. [5] Some even say third world war will neither be fought for oil nor boundaries but water, many would not believe it but it's the truth, it's already a polling agenda in developing countries like India.

Today, there are several names of manufacturers to take, which provide the devices to control the water level, inside the tank. Many of them are KVB Instruments Pvt. Ltd. (Chennai), Leelavati Automation Pvt. Ltd. (Mumbai), Dynamic Engineers (Mumbai), BVK Fibrotek Engineers (Chennai).[5] Since there costs ranges in decades of thousands, are not suitable for domestic purpose. Thus an economical & portable system is to be designed to control the water level inside the tank.

Figure 1: Controller Unit

This paper is a sincere effort for developing an economical and portable water level controller. In this the water level controller depends on two detection points in the tank. The water level must be controlled at these two points (made standardized). To facilitate this, we have used sensors and these sensors are metallic contacts with space between them present at each detection point. [6] When water reaches a sensor, a proper circuit must be present such that the presence of water is detected and a signal is produced. This signal must pass through logic circuits to give the correct actuator output. Also it must be strong enough to activate the actuator. A similar action must take place when water reaches another sensor. Circuit essentially uses the high and low states of a NAND gate to activate or deactivate the actuator. [3] Simply put, we rely on the ON and OFF states of the actuator. We have used simple microcontroller for the actuation.

2. NEED

2.1 Motivation

The total amount of water available on Earth has been estimated at 1.4 billion cubic kilometers, enough to cover the planet with a layer of about 3 km. About 95% of the Earth's water is in the oceans, which is unfit for human consumption. About 4% is locked in the polar ice caps, and the rest 1% constitutes all fresh water found in rivers, streams and lakes which is suitable for our consumption.[6] A study estimated that a person in India consumes an average of 135 liters per day. This consumption would rise by 40% by the year 2025. [6] This signifies the need to preserve our fresh water resources

2.2 Need

In order to save water in ample quantity, it is essential to use a water level controller, while filling the water tank. But to reduce the waste of excessive water, when the water tank is overloaded, a device must be assembled or inbuilt in a tank to start the water supply when the water level reduces to pre-set value. Also, to stop the water supply when the water tank is overloaded with water reached to a specific preset level.

This will reduce the manual efforts to start or stop the system or motor, whenever necessary.

3. DESCRIPTION & SALIENT FEATURES

3.1 Description

Figure 2 shows a micro controller based circuit which indicates the level of water in a tank. This circuit produces alarm when water level is below the lowest level L1 and also controls the pump (on and off) when water just touches the highest-level L8. The circuit is designed to display 8 different levels on LCD display. However, these display levels can be increased or decreased depending upon the level resolution required. This can be done by increasing or decreasing the number of level detector metal strips (L1 to L8) and their associated components. [6]

3.2 Salient Features

- Micro controller based interface using 8051 MCU (AT89C51, 52, S51, S52)
- 16x2 Line LCD module to display eight different water level
- Display the eight level
- Buzzer for Alarm
- Relay Outputs to control the pump (on and off)
- Contact rating - See text
- Operating voltage -12V AC / DC (nominal)
- Operating current - 100mA with no relays operated mA with relays operated
- On board power, and relay on / off LEDs [6]

4. FEATURES IN DETAIL

4.1 Water Level Sensing

The actual circuit of the level sensor is extremely simple. The circuit around N1 forms an oscillator. If the two sensors are immersed in a conductive solution. C4 will be charged up via the AC coupling capacitors (C2 and C3) and the diodes. So that after a short time, the output of N2 is taken low and the MCU port is pulled in. [6] The MCU port can be used to display water level on LCD and control a pump,

4.2 Microcontroller Interface

The water level controller built around an AT89S51 micro controller. The combination of resistor R1 and capacitor C1 provides the necessary slow-rising power-on-reset signal to the micro controller's reset input pin 9. The eight inputs (water level) to be scanned are connected to the eight input pins (P0.0 through P0.7) of port 0 of the micro controller via eight CMOS NAND gate (CD4093). Two additional output (P3.3 through P3.5) for buzzer and relay. [14]

4.3 Power Supply

Two supply voltages are required for the circuit. A DC AC 12 V mains adaptor is connected to bridge rectifier (D1 - D4) via DC jack. U1, U3, and U5 are supplied with a regulated 5 V from a 7805 (U2) fixed voltage Regulator. [10] The unregulated voltage of approximately 12 V is required for the relay.

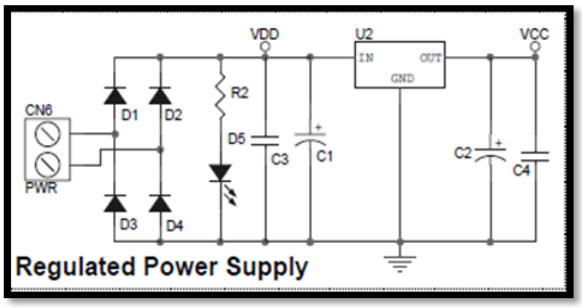

Figure 2: Power supply

4.4 Relay

A single pole double throw (SPDT) relay to control the AC water pump. It's connected to pin 5 of the micro controller through a driver transistor. The relay requires 12 volts at a current of around 50 mA,, which cannot provided by the micro controller. So the driver transistor is added. The relay is used to operate the external electrical device. [7] Normally the relay remains off. As soon as pin of the micro controller goes high, the relay operates.

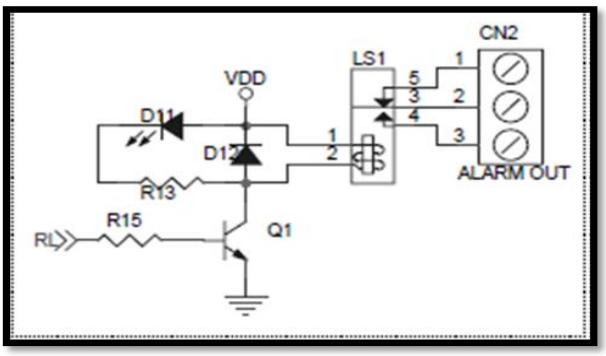

Figure 2: Relay Circuit

4.5 AT89xxx *Micro Controller*

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM).[14] The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. [14] By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer, which provides a highly flexible and cost effective solution to many embedded control applications.

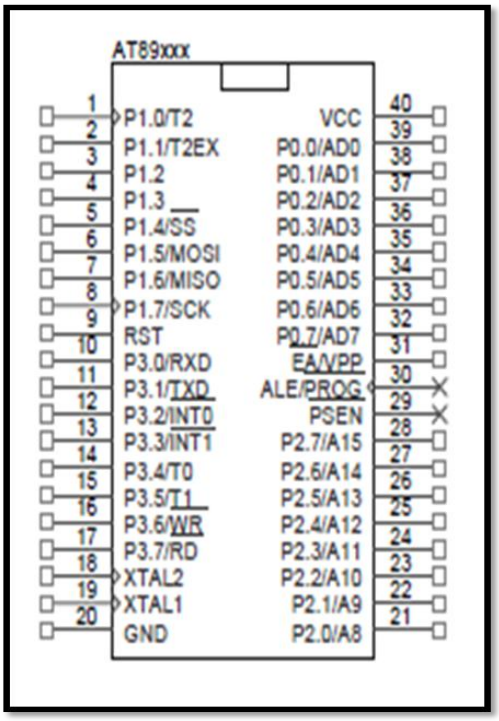

Figure 4: Pin Configurations

Features

• Compatible with MCS-51™ Products

•4K Bytes of In-System Reprogrammable Flash Memory

• Fully Static Operation: 0 Hz to 24 MHz

•Three-level Program Memory Lock

• 128 x 8-bit Internal RAM

• 32 Programmable I/O Lines

• Two 16-bit Timer/Counters

• Six Interrupt Sources

• Programmable Serial Channel

• Low-power Idle and Power-down Modes

• 8-bit [14]

4.6 LM7805 (Voltage Regulator)

Three terminal Positive Voltage regulator. This is used to make the stable voltage of +5V for micro controller. The LM7805 is three terminal positive regulators are available in the TO-220/D package and with several fixed output voltages, making them useful in a wide range of applications. [10] Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators.

4.7 CD4093 - (Trigger Circuit)

The CD4093B consists of four Schmitt-trigger circuits. Each circuit functions as a 2-input NAND gate with Schmitt-trigger action on both inputs. The gate switches at different points for positive and negative-going signals. The difference between the positive (VT +) and the negative voltage (VT -) is defined as hysteresis voltage (VH). All outputs have equal source and sink currents and conform to standard B-series output drive. [13]

4.8 Buzzer, LCD & Relay

4.8.1Buzzer

The buzzer for generating the audible alarm is connected to P3.0 (pin 10) of MCU through resistor. [10]

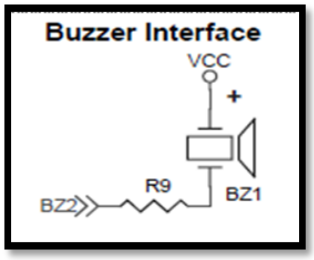

Figure 5: Buzzer

4.8.2 LCD Interface

A 16x2 Line LCD module to display the Status and Error Message micro controller send the data signals through Pin 26 through 29 (D4 – D7) and control signal through 23, 24 and 25 of the micro controller. Pin no 3 of the LCD is used to control the contrast by using preset VR1. [8]

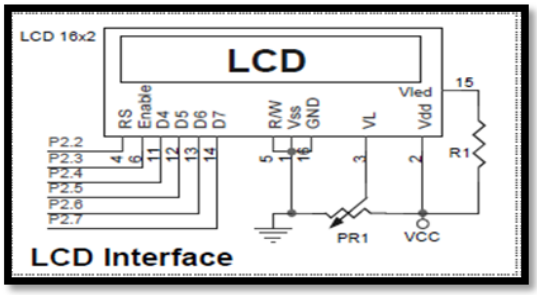

Figure 6: LCD interface

4.8.3 SPDT Relay – 12V

It closes the voltage less point of contact while the remote control works to control the equipment outside. The relay takes advantage of the fact that when electricity flows through a coil, it becomes an electromagnet. The electromagnetic coil attracts a steel plate, which is attached to a switch. So the switch's motion (ON and OFF) is controlled by the current flowing to the coil, or not, respectively. [7] A very useful feature of a relay is that it can be used to electrically isolate different parts of a circuit. It will allow a low voltage circuit (e.g. 5VDC) to switch the power in a high voltage circuit (e.g.

100 VAC or more). The relay operates mechanically, so it cannot operate at high speed.

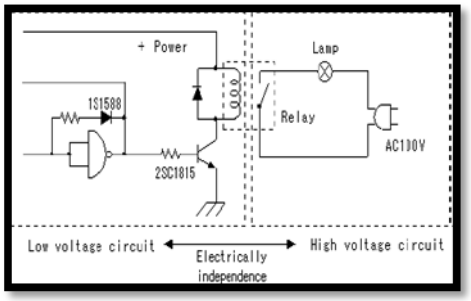

Figure 7: SPDT relay

5. ASSEMBLY & TESTING

5.1 Assembly Instructions

Use the component overlay on the PCB to place the components starting with the lowest height components first. Make sure that the diode, LED and electrolytic capacitors are inserted the right way around.

1. Resistors and diodes

2. IC sockets

3. Preset

4. Ceramic capacitors.

5. LM7805 regulators.. It does not require a heat sink.

6. Transistors (Q1) and bridge rectifiers

7. Electrolytic capacitors. Make sure you insert them the correct way around.

8. Relays and crystal, LCD display

NOTE – The Main Micro Controller PCB & the LCD display Connect with the help of Ribbon Wire. [3]

5.2 TESTING

When the power is applied to the board, the RED power LED should be on and the relay released. Use a multi meter to measure the voltage across pins 40 (+) and 20(-) of the U1 socket – it should read 5 volts. Use a short Length of wire to connect U1 socket pins 10 and 11. The relay should operate. Make sure no IC leads are 'bent under' as they are inserted. Switch on power again and then adjust PR1 (20K Preset) until the LCD screen contrast is satisfactory. [3]

If It Does Not Work

Poor soldering (dry joints) is the most common reason for the circuit not working. Check all soldered joints carefully under a good light. Re-solder any that look suspicious. Are all the components in their correct position on the PCB? Are the electrolytic capacitors and diode?

6. PRINCIPLE & WORKING

The operation is based on low voltage AC single sensing of levels. Level Sensors with the rise and fall of liquid level and actuates the sensors. The signals from the sensors are received by the Main Control Unit. This unit indicates Liquid Levels and provides necessary outputs of Automation. [3]

The triggering circuit with NAND gate ICs provides the signal sensed by the electric probes inside the water tank. In this case the water is assumed to be the conducting medium. This signal is provided at the input ports of pre-programmed microcontroller; the crystal controls the internal oscillation frequency of signal to 11.0592 MHz. [6] The capacitor at the extra feature port reset the microcontroller, when discharged. The NPN transistors at the buzzer & relay circuit, acts as a closed switch, when forward biased & vice versa.

Thus, when the water level reaches to the high level (L8), the controller gives the signal as per the program fed, to stop the motor. This is the due result of reverse biased transistor, forming an open switch at the relay, where the motor or pump connection can be given. [11] At the same time, transistor at the buzzer circuit is forward biased, forming a closed switch. In the inverse manner, at low water level (L1), relay is switched ON, due to reverse biased transistor to start the motor. Thus, the NPN transistor, essentially acts as switch.

7. ADVANTAGES

7.1 Maintenance

It is an economical system that requires very less maintenance as compared to conventional system as it has no complicated circuits and delicate mechanisms. [3] This saves the additional maintenance cost.

7.2 Cost

The main advantage of the water level controller is it has very low cost than the conventional one available in markets. [5] For example, some commercial controllers use microcontrollers which alone costs around Rs.800. Some controllers even have a price range of Rs.2000-Rs. 4000. But for our system, the components used are less in number and easily available. Hence losses will be less leading to a better efficiency.

8. CONCLUSION AND FUTURE WORKS

8.1 Conclusion

- This system is very beneficial in rural as well as urban areas.
- It helps in the efficient utilization of available water sources. It can provide a major contribution in the conservation of water, if used on large scale.

8.2 Future Work

There is no way of knowing whether the source of water, which in this case is the UGT, actually has water or not. If no water source is present, then the submersible pump would start running unnecessarily and overheat itself. This could be taken care by implementing another sensor. Also, the rate of water input must always be equal to or greater than the rate of

water output. To make this happen we could use a speed regulator. [3] If these issues are taken care of then a more efficient and reliable performance can be achieved.

9.References

[1] Bolton W., Mechatronics Electronic Control System In Mechanical & Electrical Engineering, 3rd Edition, Pearson Education System, 2003.

[2] Er. R. K. Rajput, 2007, A Textbook Of Mechtronics For Engineering Students Of B. Tech/B.E. Course, 3rd Edition, S. Chand & Company Pvt. Ltd. , New Delhi.

[3] Harish Chandra Murmu, Laloo Kumar Yadav, "Water Level Controller For Domestics Application", 2014 Fourth International Conference On Emerging Trends In Engineering & Technology.

[4] Hmt Limited, Mechatronics, Tata Mcgraw Hill Education Pvt. Ltd., New Delhi.

[5] http://dir.indiamart.com/impcat/water-level-controller.html

[6] Joydeep Kumar Chakraborty, "Water Level Controller", 2014 Fourth International Conference on Emerging Trends in Engineering & Technology.

[7] Kevin R. Sullivan, "Understanding Relays", Professor of Automotive Technology, Skyline College.

[8] M. D. Singh, J. G. Joshi, 2006, Mechatronics, PHI Learning Pvt. Ltd. New Delhi.

[9] Nitaigour Premchand Mahalik, 2003, Mechatronics Principles, Concepts & Applications, Tata Mcgraw Hill Publishing Company Limited.

[10] R. K. Rajput, Basic Electrical Engineering, 2nd Edition, Laxmi Publications (P) Ltd., New Delhi.

[11] Vardakas, John, Twists And Turns In The Development Of Transistor, IEEE-USA Today's Engineer, May 2003.

[12] Ward, Jack (2004), The 555timer IC, ©Atmel Corporation.

[13] 74f00 Quad 2-Input Nand Gate Datasheet, 2003 Philips-Corporation.

[14] 8-bit Microcontroller with 4K Bytes In-System Programmable Flash AT89S51, © Atmel Corporation 2001.