Advanced Fluid Quality Monitoring System Using Wireless Sensor Network

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Abstract- *Underwater wireless sensor network is the simple and basic way to monitor the quality of water using wireless sensor network (WSN) technology powered by power supply unit. To monitor the quality of water over different sites as a real time application, a base station and distributed sensor nodes are suggested. A WSN technology like zigbee is used to connect the nodes and base station. To design and implement this model powered by solar cell and WSN technology is a challenging work. Through WSN various data collected by various sensors at the node side such as viscosity, level sensor, LDR are sent to base station. At the base station collected data is displayed as visual and is analyzed using different simulation tools. The advantage in this system is low power consumption, no carbon emission, more flexible to deploy at remote site and so on.*

I. INTRODUCTION

Present industry is increasingly shifting towards automation. Two principle components of today's industrial automations are programmable controllers and robots. In order to aid the tedious work and to serve the mankind, today there is a general tendency to develop an intelligent operation.

PIC Microcontroller is the heart of the device which handles all the sub devices connected across it. We have used as microcontroller. It has flash type reprogrammable memory. It has some peripheral devices to play this project perform.

It also provides sufficient power to inbuilt peripheral devices. We need not give individually to all devices. The peripheral devices also activates as low power operation mode. These are the advantages are appear here..

II. CURRENT PROBLEM FACED

Now-a-days, automation plays a major role. The wired networks and the monitoring systems are not automated enough. In this project, ZigBee technology and wireless sensor networks are used.

Hence, this development has changed the risk and disadvantages of previous projects. In future, solar panels can also e used for powering the circuits without using charged batteries.

III. SYSTEM SPECIFICATIONS

3.1 HARDWARE REQUIREMENTS:

- PIC
- LCD DISPLAY
- Viscosity sensor
- Level float sensor
- LDR sensor
- RS232
- ZIGBEE

3.2 SOFTWARE REQUIREMENTS

MPLAB- FOR PIC
LABVIEW

3.3 SOFTWARE DESCRIPTION:

MPLAB:

MPLAB IDE is an integrated development environment that provides development engineers with the flexibility to develop and debug firmware for various Microchip devices. MPLAB IDE is a Windows-based Integrated Development Environment for the Microchip Technology Incorporated PIC microcontroller (MCU) and dsPIC digital signal controller (DSC) families. In the MPLAB IDE, we can:

1. Create source code using the built-in editor.
2. Assemble, compile and link source code using various language tools. An assembler, linker and librarian come with MPLAB IDE. C compilers are available from Microchip and other third party vendors.
3. Debug the executable logic by watching program flow with a simulator, such as MPLAB SIM, or in real time with an emulator, such as MPLAB ICE. Third party emulators that work with MPLAB IDE are also available.
4. Make timing measurements.
5. View variables in Watch windows.
6. Program firmware into devices with programmers such as PICSTART Plus or PRO MATE II.
7. Find quick answers to questions from the MPLAB IDE

on-line Help.

3.4 MPLAB SIMULATOR:

MPLAB SIM is a discrete-event simulator for the PIC microcontroller (MCU) families. It is integrated into MPLAB IDE integrated development environment. The MPLAB SIM debugging tool is designed to model operation of Microchip Technology's PIC microcontrollers to assist users in debugging software for these devices

3.5 IC PROG:

The PRO MATE II is a Microchip microcontroller device programmer. Through interchangeable programming socket modules, PRO MATE II enables you to quickly and easily program the entire line of Microchip PIC micro microcontroller devices and many of the Microchip memory parts.PRO MATE II may be used with MPLAB IDE running under supported Windows OS's (see Read me for PRO MATE II.txt for support list), with the command-line controller PROCMD or as a stand-alone programmer

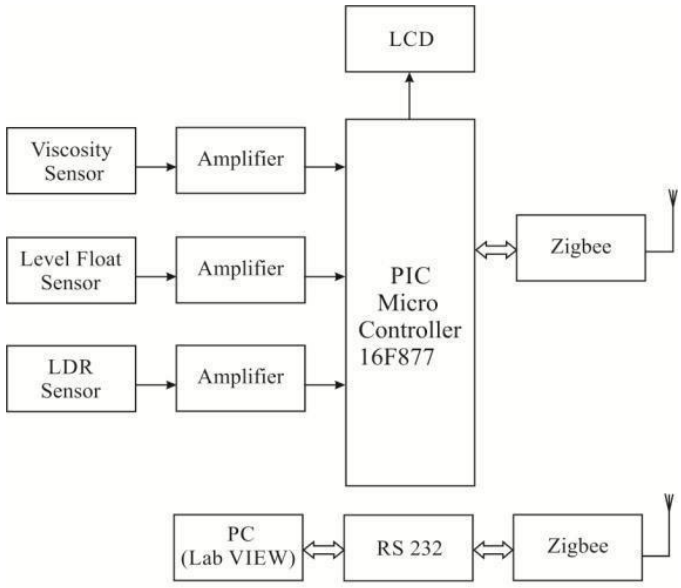
3.6 COMPILER-HIGH TECH C:

A program written in the high level language called C; which will be converted into PIC micro MCU machine code by a compiler. Machine code is suitable for use by a PIC micro MCU or Microchip development system product like MPLAB IDE.

3.7 PIC START PLUS PROGRAMMER:

The PIC start plus development system from microchip technology provides the product development engineer with a highly flexible low cost microcontroller design tool set for all microchip PIC micro devices. The PIC start plus development system includes PIC start plus development programmer and MPLAB IDE. The PIC start plus programmer gives the product developer ability to program user software in to any of the supported microcontrollers. The PIC start plus software running under MPLAB provides for full interactive control over the programmer.

IV. BLOCK DIAGRAM



4.1 BLOCK DIAGRAM DESCRIPTION

PIC CONCEPTS OF MICROCONTROLLER:

Microcontroller is a general purpose device, which integrates a number of the components of a microprocessor system on to single chip. It has inbuilt CPU, memory and peripherals to make it as a mini computer. A microcontroller combines on to the same microchip:

The CPU core Memory (both ROM and RAM) Some parallel digital i/o

Microcontrollers will combine other devices such as: A timer module to allow the microcontroller to perform tasks for certain time periods.

A serial I/O port to allow data to flow between the controller and other devices such as a PIC or another microcontroller.

An ADC to allow the microcontroller to accept analogue input data for processing. Microcontrollers are:

1. Smaller in size
2. Consumes less power
3. Inexpensive

Micro controller is a stand-alone unit, which can perform functions on its own without any requirement for additional hardware like I/O ports and external memory. The heart of the microcontroller is the CPU core. In the past, this has traditionally been based on a 8-bit microprocessor unit.

For example Motorola uses a basic 6800 microprocessor core in their 6805/6808 microcontroller devices. In the recent years, microcontrollers have been developed around specifically designed CPU cores, for example the microchip PIC range of microcontrollers.

4.2 AMPLIFIER

An ELECTRONIC AMPLIFIER is a device for increasing the (power of a (signal. It does this by taking energy from a power supply and controlling the output to match the input signal shape but with a larger amplitude. In this sense, an amplifier may be considered as modulating the output of the power supply. Here we use inverting amplifier as a gain amplifier. We can change the gain by adjusting the value of feedback resistance value. As the open loop DC gain of an operational amplifier is extremely high we can afford to lose some of this gain by connecting a suitable resistor across the amplifier from the output terminal back to the inverting input terminal to both reduce and control the overall gain of the amplifier. This then produces and effect known commonly as Negative Feedback, and thus produces a very stable Operational Amplifier system.

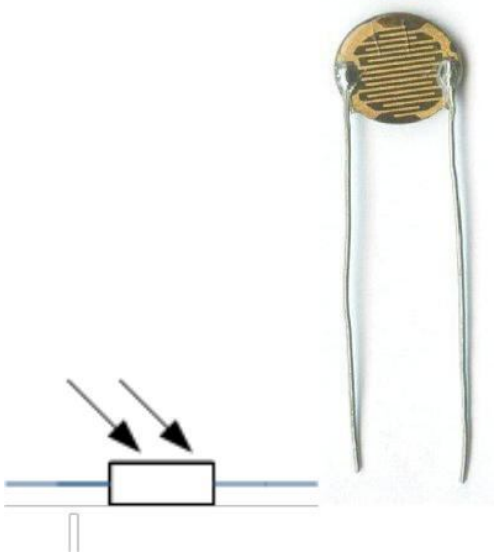
Negative Feedback is the process of "feeding back" some of the output signal back to the input, but to make the feedback negative we must feed it back to the "Negative input" terminal using an external Feedback Resistor called Rf. This feedback connection between the output and the inverting input terminal produces a closed loop circuit to the amplifier resulting in the gain of the amplifier now being called its Closed-loop Gain.

4.3 VISCOMETER

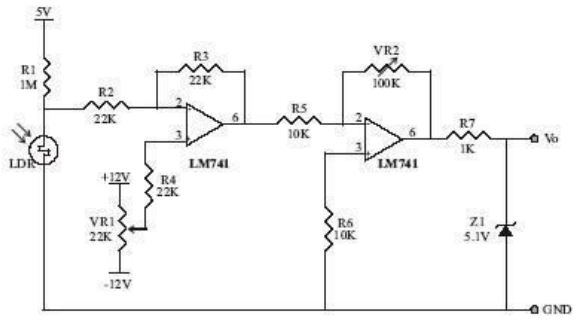
A viscometer (also called viscometer) is an instrument used to measure the viscosity of a fluid. For liquids with viscosities which vary with flow conditions, an instrument called a rheometer is used. Viscometers only measure under one flow condition. In general, either the fluid remains stationary and an object moves through it, or the object is stationary and the fluid moves past it. The drag caused by relative motion of the fluid and a surface is a measure of the viscosity. The flow conditions must have a sufficiently small value of Reynolds number for there to be laminar flow. At 20.00 degrees Celsius the dynamic viscosity (kinematic viscosity x density) of water is 1.0038 mPa•s and its kinematic viscosity (product of flow time x Factor) is 1.0022 mm2/s. These values are used for calibrating certain types of viscometers.

4.4 LIGHT DEPENDENT RESISTOR

A photoresistor is an electronic component whose resistance decreases with increasing incident light intensity. It can also be referred to as a light-dependent resistor (LDR), or photoconductor. A photoresistor is made of a high-resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance. A photoelectric device can be either intrinsic or extrinsic. In intrinsic devices, the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire band gap. Extrinsic devices have impurities added, which have a ground state energy closer to the conduction band — since the electrons don't have as far to jump, lower energy photons (i.e. longer wavelengths and lower frequencies) are sufficient to trigger the device.



INTENSITY MEASUREMENT USING LDR



Cadmium sulphide cells:

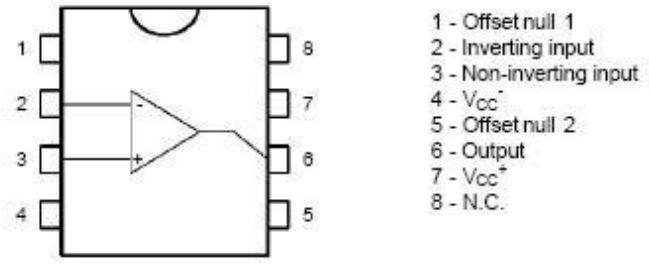
Cadmium sulphide or cadmium sulphide (CdS) cells rely on the material's ability to vary its resistance according to

the amount of light striking the cell. The more light that strikes the cell, the lower the resistance. Although not accurate, even a simple CdS cell can have a wide range of resistance from less than 100 Ω in bright light to in excess of 10 MΩ in darkness. The cells are also capable of reacting to a broad range of frequencies including infrared (IR), visible light, and ultraviolet (UV). They are often found on street lights as automatic on/off switches.

They were once even used in heat-seeking missiles to sense for targets.

Circuit working principle:

In this circuit the LDR is connected in series with resistor R1 formed as voltage divider network which is connected to inverting input terminal of comparator. The reference voltage is given to non inverting input terminal. The comparator is constructed by the operational amplifier LM741. The LM741 is a high performance monolithic operational amplifier on a single silicon chip.



When there is no light rays the output of the comparator is zero because we have set the reference voltage equal to inverting input voltage. When the light rays fallen on the LDR, it resistance value is decreased. The comparator delivered error voltage on the output terminal. Then the error voltage is given to next stage of the gain amplifier in which the variable resistor is connected in the feedback path. By adjusting the resistor we can get the variable gain voltage on the output terminal which is given to ADC or other related circuit in order to find the light intensity level.

Applications:

Photoresistors come in many different types. Inexpensive cadmium sulphide cells can be found in many consumer items such as camera light meters, clock radios, security alarms, street lights and outdoor clocks. At the other end of the scale, Ge:Cu photoconductors are among the best far-infrared detectors available, and are used for infrared astronomy and infrared spectroscopy.

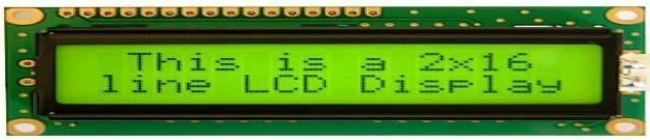
4.5 FLOW SENSOR:

A flow sensor is a device for sensing the rate of fluid flow. Typically a flow sensor is the sensing element used in a flow meter, or flow logger, to record the flow of fluids. As is true for all sensors, absolute accuracy of a measurement requires functionality for calibration. There are various kinds of flow sensors and flow meters, including some that have a vane that is pushed by the fluid, and can drive a rotary potentiometer, or similar device. Other flow sensors are based on sensors which measure the transfer of heat caused by the moving medium. This principle is common for micro sensors to measure flow. Flow meters are related to devices called velocimeters that measure velocity of fluids flowing through them. Laser-based interferometry is often used for air flow measurement, but for liquids, it is often easier to measure the flow. Another approach is Doppler-based methods for flow measurement. Hall Effect sensors may also be used, on a flapper valve, or vane, to sense the position of the vane, as displaced by fluid flow.

4.6 LCDDISPLAY:

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal. An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. One each polarisers are pasted outside the two glass panels. These polarisers would rotate the light rays passing through them to a definite angle, in a particular direction When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters. The

LCD's are lightweight with only a few millimeters thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD's don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly. The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications.



4.7 ZIGBEE:

The mission of the ZigBee Working Group is to bring about the existence of a broad range of interoperable consumer devices by establishing open industry specifications for unlicensed, untethered peripheral, control and entertainment devices requiring the lowest cost and lowest power consumption communications between compliant devices anywhere in and around the home.

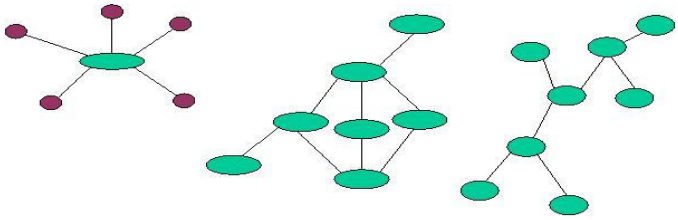
The ZigBee specification is a combination of HomeRF Lite and the 802.15.4 specification. The spec operates in the 2.4GHz (ISM) radio band - the same band as 802.11b standard, Bluetooth, microwaves and some other devices. It is capable of connecting 255 devices per network. The specification supports data transmission rates of up to 250 Kbps at a range of up to 30 meters. ZigBee's technology is slower than 802.11b (11 Mbps) and Bluetooth (1 Mbps) but it consumes significantly less power.

ZigBee is an established set of specifications for wireless personal area networking (WPAN), i.e. digital radio connections between computers and related devices.

WPAN Low Rate or ZigBee provides specifications for devices that have low data rates, consume very low power and are thus characterized by long battery life. ZigBee makes possible completely networked homes where all devices are able to communicate and be controlled by a single unit.

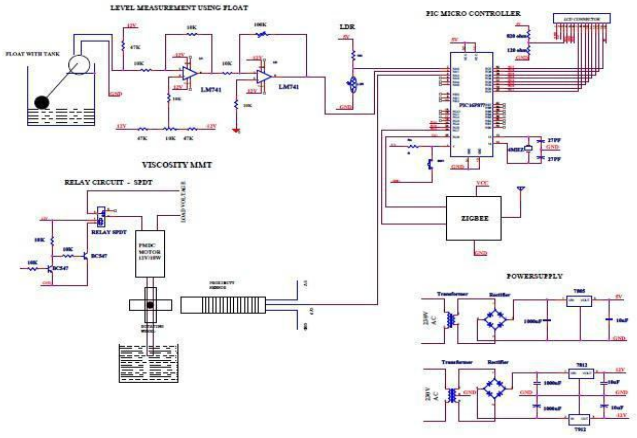
There are three different ZigBee device types that operate on these layers in any self-organizing application network. These devices have 64-bit IEEE addresses, with option to enable shorter addresses to reduce packet size, and work in either of two addressing modes – star and peer-to-peer.

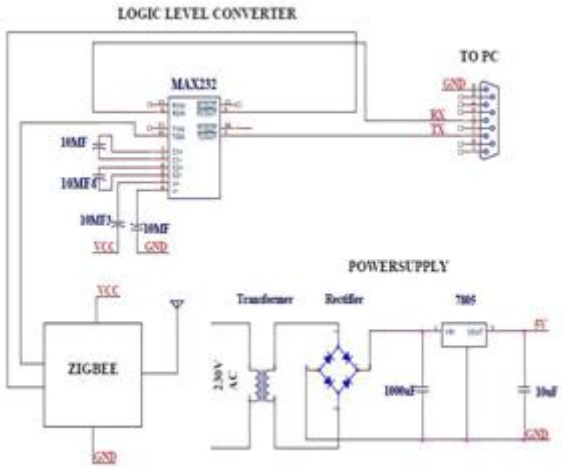
1. The ZigBee coordinator node: There is one, and only one, ZigBee coordinator in each network to act as the router to other networks, and can be likened to the root of a (network) tree. It is designed to store information about the network.
2. The full function device FFD: The FFD is an intermediary router transmitting data from other devices. It needs lesser memory than the ZigBee coordinator node, and entails lesser manufacturing costs. It can operate in all topologies and can act as a coordinator.
3. The reduced function device RFD: This device is just capable of talking in the network; it cannot relay data from other devices. Requiring even less memory, (no flash, very little ROM and RAM), an RFD will thus be cheaper than an FFD. This device talks only to a network coordinator and can be implemented very simply in star topology.



V. OVERALL CIRCUIT DIAGRAM

DESCRIPTION:





5.1 POWER SUPPLY:

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

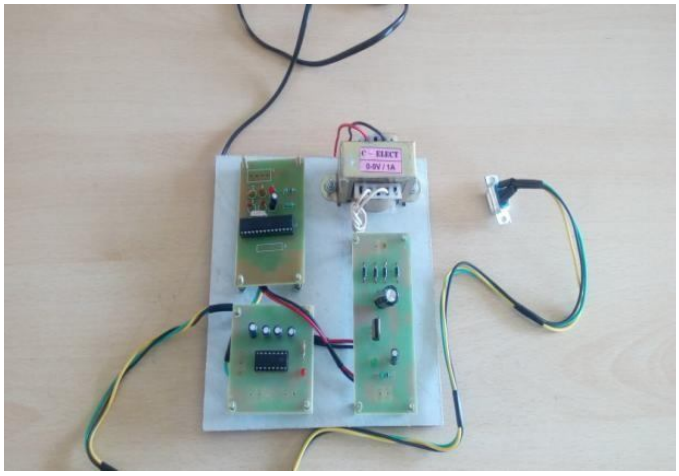
Working principle:

The project deals with the three analog inputs from level sensor, viscosity sensor, LDR. This is mainly to monitor the quality of the fluid which is to be determined. When the fluid in a tank to be monitored, three things are considered, they are nature of the fluid, density of the fluid and quantity of the fluid.

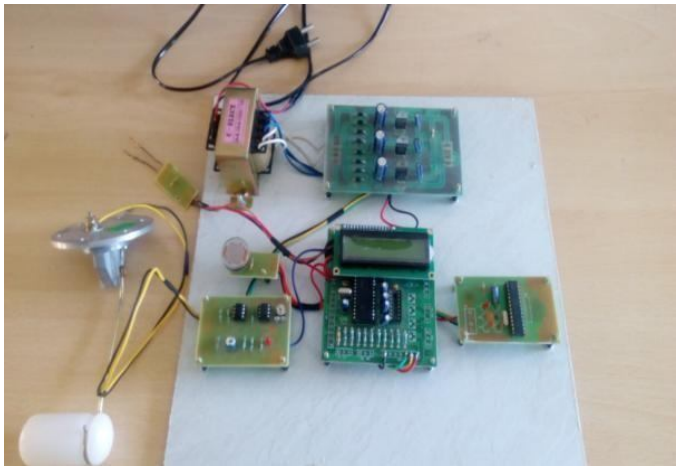
The level float sensor is made to float on the fluid. Based on the quantity of the fluid in tank the floating part moves and the corresponding changes is sensed by the sensor. The output of the sensor is given to the PIC microcontroller. The viscometer needle is dipped into the liquid, based on the viscosity of each fluid the nature of fluid is determined. The output of the sensor is given to the microcontroller. The LDR is mainly to detect the particles in the fluid. If the fluid is impure light can pass through so the LDR output will be high. If the fluid is pure the light cannot pass through, so the LDR output will be low. The output is given to the microcontroller. The microcontroller processes all the inputs and it displays the viscosity of the fluid in LCD. It displays the nature of the fluid. The microcontroller process the inputs and the output is given to the LAB view it process the output and plot it in graph. The graph maintains the viscosity, level and turbidity and plots it

5.2 HARDWARE IMAGES

1. Receiver Circuit



2. Transmitter Circuit



IC voltage regulators:

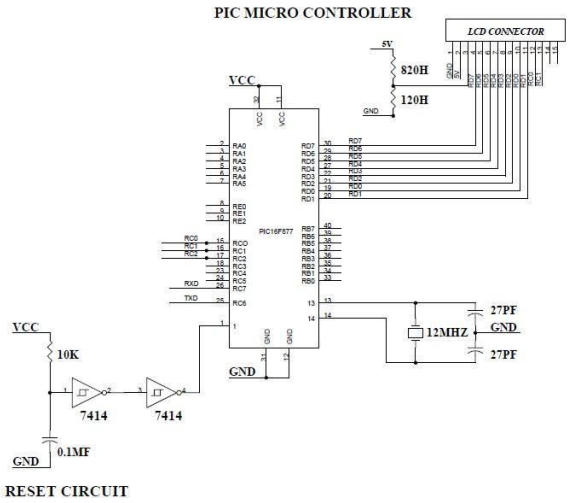
Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts.

Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

For ICs, microcontroller, LCD --------- 5 volts
For alarm circuit, op-amp, relay circuits --------- 12 volts.

5.3 LCD DISPLAY WITH PIC



We connect the LCD display with PIC through PORT D.

PORT D AND TRIS D REGISTER:

PORT D is an 8-bit wide bi-directional port. The corresponding data direction register is TRIS D. Setting a TRIS D bit (=1) will make the corresponding PORT D pin an input, i.e., put the corresponding output driver in a hi-impedance mode. Clearing a TRIS D bit (=0) will make the corresponding PORTD pin an output.

PORT D AND TRIS D REGISTERS:

This section is not applicable to the 28-pin devices. PORT D is an 8-bit port with Schmitt Trigger input buffers. Each pin is individually configurable as an input or output. PORT D can be configured as an 8-bit wide microprocessor Port (parallel slave port) by setting control bit PSPMODE (TRISE<4>). In this mode, the input buffers are TTL.

VI. CONCLUSION

Sequential follow up of fluid status in remote region can be archived by monitoring the quality of fluid& collecting comprehensive data. This system not only provides comprehensive evaluation of water environment but also can quickly discover urgent water pollution accidents or natural disasters, transferring the abnormal fluid quality information to monitoring center by quicker communication network and provides graphical references for the decision making department to comprehend the status of the disaster to establish the prevention and cure policy.

ACKNOWLEDGEMENT

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BIOGRAPHIES

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Bhuvaneshwari.S was born in Udumalpet, India on 22.06.1995 and completed her schooling from Government Higher Secondary School, Zamin Uthukuli in the year 2010.Currently pursuing the under graduate course, B.E (Electronics and Communication Engineering) in Sri Eshwar College of Engineering, Coimbatore, India. Her areas of interests include Digital Electronics and Embedded systems.