Intelligent Water pH Indication System

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Abstract— In order to maintain the water purity, certain water quality parameters must be monitored and controlled. Some of these parameters that most directly affect the purity of water are the pH, alkalinity, hardness, temperature, dissolved oxygen and nutrients. Among all the mentioned parameters , the pH value of water needs to be ascertained to know whether the water is acidic or basic and hence if its potable This paper presents a microcontroller based sensor circuit which ascertains the pH level of water. In this project, a pH sensor, TL-42 electrode is used to sense the pH level in the drinking water. The data collected by the sensor is processed by the Microcontroller system. Tedious conventional chemical methods can be replaced by the above method. Hence, an efficient system is proposed for monitoring and analysis of the pH of water.

Key words: The pH sensor, Microcontroller

I. INTRODUCTION

Water is vital for survival of all living beings. The chemical, physical, biological, and radiological characteristic of water determines the water quality. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. The pH value is a good indicator of whether water is hard or soft. The pH of pure water is 7. In general, water with the pH lower than 7 is considered acidic, and with the pH greater than 7 is considered basic. While the ideal pH level of drinking water should be between 6-8.5.An efficient water purity level indicating monitoring and system is developed. Our intension of this project was to develop a flexible, economical and easy configurable system which can solve the water impurity problem. Currently our project aims at indication of the pH level, the same method can be implemented for indication of different basic water parameters and water purity at greater extent can be assessed.

II. PROPOSED SYSTEM

The proposed system is an embedded system which closely monitors the pH level in water sample. The sensor senses the pH level of the water and the microcontroller reads the data from the input port. An in-built ADC converter is used to convert the analog signal to digital signal. Based on the reading, the microcontroller will indicate the pH level on the display unit. Since a microcontroller is used as the heart of the system, it makes the setup low-cost and effective.

III. SYSTEM ARCHITECTURE

The pH sensor components are usually combined into one de-vice. This combinational device is called pH electrode. The measuring electrode is usually made of glass and it is quite frag-ile. In the recent developments the glass is replaced with the more durable solid-state sensors. The signal conditioning circuit amplifies the weak analog voltages from the pH sensor. The amplified signals are given as input to the microcontroller. The 8051µC processes the input signal and displays the purity level on the LCD.

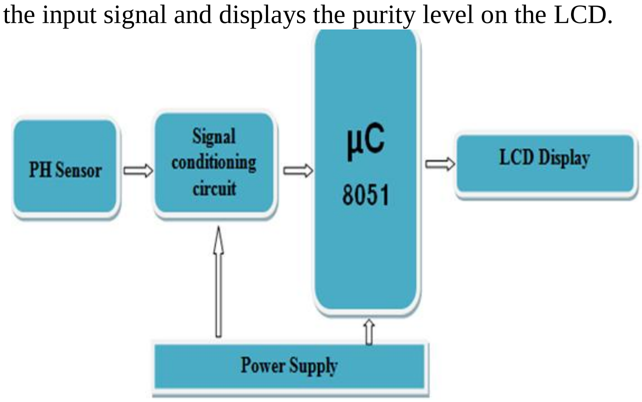

Fig. 1: Block Diagram of Water Purity Indicator

IV. HARDWARE DESCRIPTION

The block diagram of the system is as shown in the figure above. The system consists of

- Power Circuit
- The pH sensor
- Signal conditioning Circuit
- Microcontroller -P89V51RD2
- All in one interfacing board.

A. Power Circuit:

The supply voltage that is 220 V is given to a step down trans-former for obtaining lower voltages and is later rectified by the bridge rectifier circuit. The output of the bridge rectifier is given to the voltage regulator IC 7805, IC 7905, IC 7812, IC 7912 which gives +5V,-5V, +12v and -12V respectively.

B. TL-42 the pH Electrode:

The pH refers to the exponent or power of hydrogen where 'H' is the symbol of the element Hydrogen and 'p' stands for power. The pH is defined as the negative logarithm of the molar concentration of the active hydrogen ions, the pH = -log H+.

At the given temperature the relative acidity or alkalinity of the sample is conveniently compared using pH. For example, pure water has a neutral pH of 7, where the activities of hydrogen and hydroxide ions are equal. The sample is described as acidic, if the pH is below 7. The pH decreases with increasing hydrogen ion activity.

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Fig. 2: TL-42 Electrode

C. Signal Conditioning Circuits:

The output potential from the pH electrode is applied as an input to the signal conditioning circuit. The direct signals from the electrode are highly fluctuating. Hence, the circuit is used to stabilize the output. By adding capacitors for the input supply, the fluctuating signals were grounded so that it should not interfere with the incoming signal. Low pass filter was connected to the non-inverting terminal to filter out noise and other distortions. Unity gain was maintained by adding negative feedback so that the input directly appears at the output. The output is a voltage signal that varies from -413mV to +413mV.

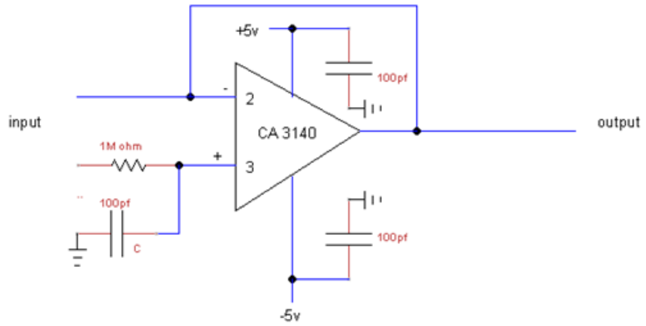

Fig. 3: Signal conditioning circuit 1

The output voltages from -413mV to +413mV are amplified to 0-5V by the circuit. Variable resistors were used to set the appro-priate gain. IC LM324N was used which acts as an instrumenta-tion amplifier and faithfully amplified the input signals to the required range. The amplified signals are then given to the mi-crocontroller.

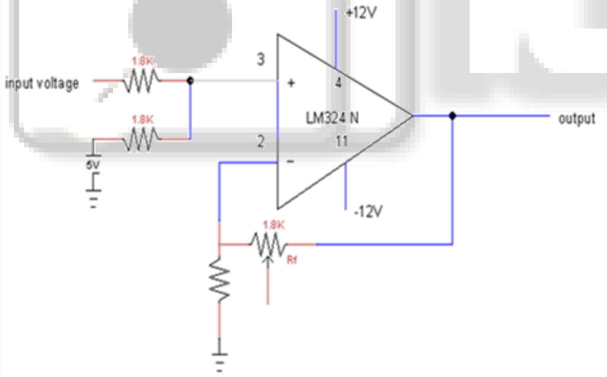

Fig. 4: Signal Conditioning Circuit 2

D. Microcontroller:

A microprocessor with RAM, ROM and other peripherals chips together on a single chip is called a microcontroller. In the project we make use of one microcontroller P89V51RD2 (of CSE), manufactured by the Philips.

The P89V51RD2 with 64 KB Flash and 1024 bytes of data RAM is an 8051 microcontroller. Parallel programming mode offers gang-programming at high speed, reducing programming costs and time.

E. All in One Interfacing Board:

An interfacing board was used to interface the conditioned ana-log signals from the circuits to the microcontroller. This board consists of ports such as temperature sensor port, LCD display, HEX keypad, stepper motor port, industrial sensor port. We used port P0, which has an inbuilt ADC for conversion of analog volt-ages to required digital form. Programming was done for these digital signals.

V. SOFTWARE DESCRIPTION

A. Keil Micro Vision Integrated Development Environment:

Every level of developer from the professional applications engineer to the student can use the Keil Software development tools for the 8051 micro controller family.

The industry-standard Keil C Compilers, Macro Assemblers, Debuggers, Real-time Kernels, and Single-board computers support all 8051- compatible derivatives and help to get the projects completed.

The source code is written in assembly language. It is saved as .ASM file. The .ASM file is converted into hex file using Keil software. Hex file is dumped into micro controller using LABTOOL software (flash magic).

B. Embedded C:

For different embedded systems Embedded C is a set of language extensions by the C Standards commit-tee to address commonality issues that exist between C extensions for the C Programming language. In order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations, the Embedded C programming requires nonstandard extensions to the C language [9].

VI. FLOW CHART

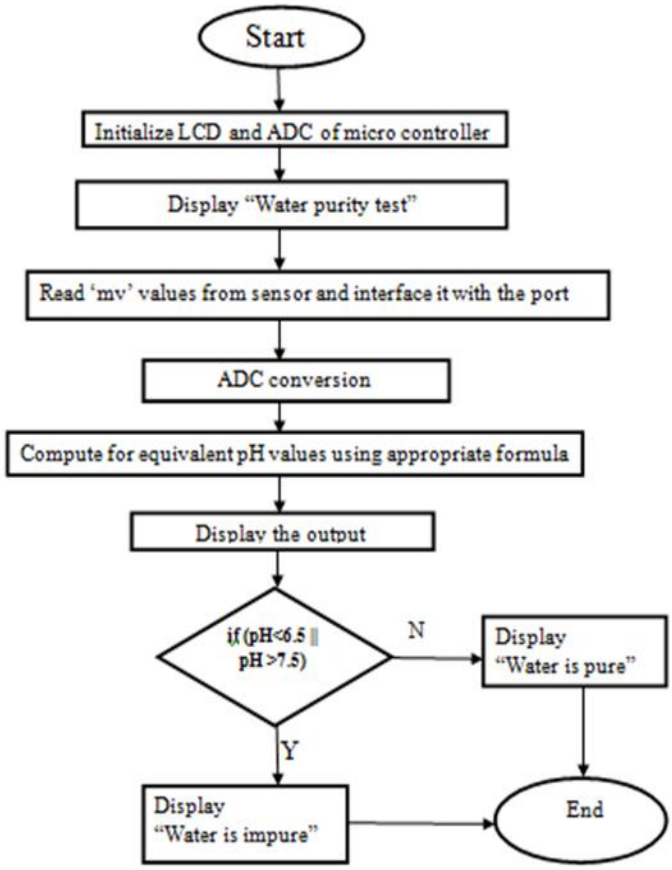

Fig. 5: Flow Chart

VII. EXPERIMENTAL RESULTS

Water purity test was conducted for various water samples collected from different sources such as tank and drinking water of R.V.C.E. The outputs obtained are tabulated below.

Sl. no	Source of test sample	pH obtained	Remark
1	Std test sample I (4 pH)	4.0	***Calibrated*** result obtained (acidic).
2	Std test sample II (7 pH)	7.0	***Calibrated*** result obtained (neutral).
3	Tank Water	8.0	Water is ***basic.***
4	Campus Drinking water	6.0-7.0	Water is ***slightly acidic.***
5	Residential drinking water	7.0	Water is **potable**.
6	Std test sample III (9 pH)	9.0	***Calibrated*** result obtained (basic).

Table 1: Experimental Results

VIII. SIMULATION OUTPUT

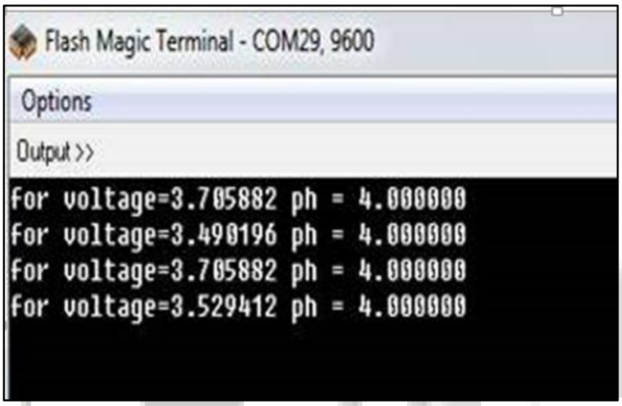

Fig. 6: Result Display of Test Sample I

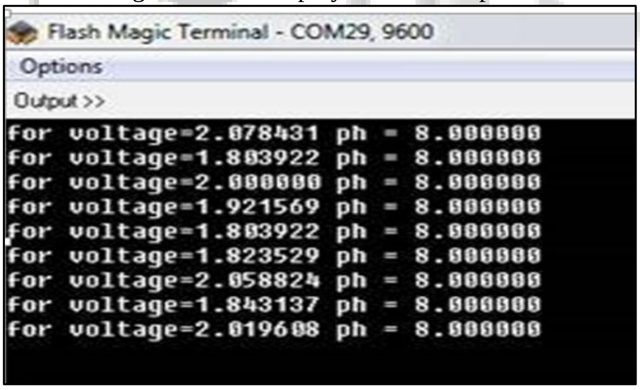

Fig. 7: Result Display of Tank Water Sample

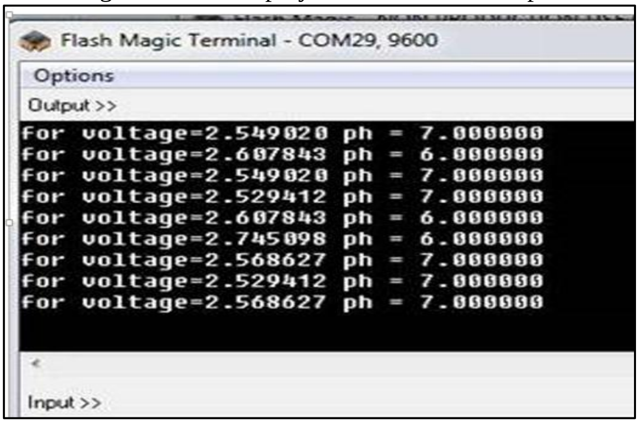

Fig. 8: Result Display of Campus Drinking Water Sample

IX. CONCLUSIONS

The project “INTELLIGENT WATER pH INDICATION SYSTEM” is successfully designed and tested. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Modern pH sensor with direct mV output helped in further processing. The intelligence added to this project was by means of programmable 8051 micro-controller which was programmed using embedded C. The pH of water can be easily measured and displayed economically. The pH measurement done in this project is accurate, precise, and the pH electrode, TL- 42, does not require any calibration against a buffer solution as it is required for a conventional pH electrode.

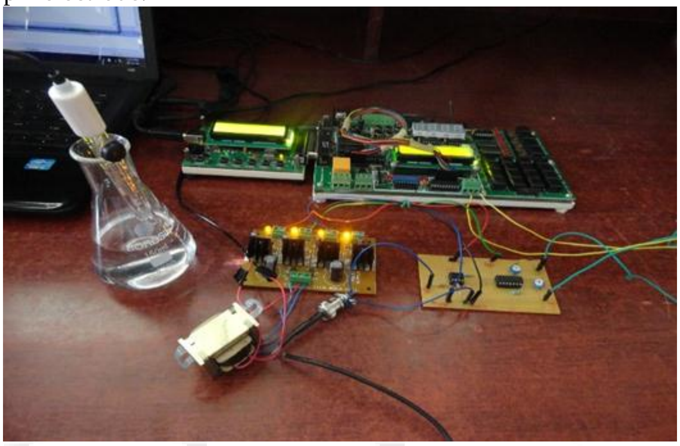

Fig. 9: Project Prototype

X. FUTURE ENHANCEMENTS

The same prototype can be implemented for testing other basic parameters of water such as hardness, conductivity, and dissolved oxygen. It can be designed using a microprocessor which indicates the presence of impurities using few specific inputs. Using a microprocessor for this purpose fetches the advantages like simple and compact structure, easy usage, controlled mechanism, etc. This new model will be effective in reducing the problem of water impurities as it is periodically detected and respective precautions can be taken. The system has widespread application value and can be extended and transplanted to other fields of automatic monitoring wherever needed.

XI. ACKNOWLEDGEMENT

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