ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 2, Issue 9, September 2014

Design & Implementation of Wireless Sensor Node for Measurement of Conducting Liquid

Mr. Amol Ashok Kshirsagar[1], Mr. Shashikant Hippargi[2]

Assistant Professor, Department of Electronics & Tele-communication Engineering, Nagesh Karajagi Orchid College of Engineering & Technology, Solapur, Maharashtra, India [1]

Assistant Professor, Department of Electronics & Tele-communications Engineering, S.P.S.P.M'S N.B. Navale Sinhgad College of Engineering, Solapur, Maharashtra, India [2]

Abstract: With abundance of water on the earth the fresh water sources are limited. So a need arises to precisely measure this resource in many industrial and commercial places wirelessly. Many measurement techniques for liquid such as float, pressure gauge, ultrasonic and radar are available. Floats and pressure gauge suffer from cumulative error which increases with time whereas ultrasonic and radar give very small measuring errors but are very costly. So, an immediate need is felt for measuring the level of conducting liquid with reasonable accuracy and low cost. The proposed sensor node is supposed to measure a considerable range with a minimum error. It will be environment friendly, low power consumption and high accuracy device. It can serve as a calibration gauge to other sensor such as pressure and float used in conjunction with it. A solar panel and battery backup will aid the gauge to be installed at remote places where supply is partially or not available at all, this scheme would make the unit self dependent. An additional feature added will be of wireless transmission of data from sensor node to the master unit. A smart self powered sensor node with wireless data transmission capability will be implemented and presented in this paper.

Keywords: Wireless, sensor node, conducting liquid.

I. INTRODUCTION

In this project is presented a novel idea to measure the conducting liquid column such as water. A need to measure the liquid level arises and is achieved by using floats, & pressure gauge, where accuracy is not of importance. Ultrasonic and radar transducers, are used where precision is the deciding factor. The floats and pressure gauge give a fair justice to the measurement of conducting liquid such as water but in long run gain cumulative errors. These errors can be so large that the gauge re-calibration is required at many instances, whereas in few cases the change in sensor may be required. Another problem faced by these sensors is that the minimum error varies with wide range of operation. This is because the minimum error is expressed in percentage of output, and if wide range of operation is desired then the minimum error may cross the maximum permissible limits of standard norms. The precision of ultrasonic gauges may be affected by the environment conditions such as the temperature, humidity, etc. The radar type of gauges does not have these problems and are the most accurate ones but are very expensive for applications such as water column measurement. The pressure type ones need data corrections of air pressure and water density. The recording of measured result becomes a difficult task if the gauge is at a considerable height, often leading to cluttered wiring. This not only makes the gauge immobile but leads to considerable increase in cost due to wiring & installation. The alternative to these problems is the design of a gauge to overcome above mentioned deficiencies and having the ability of wireless transmission. The design and implementation explored here will be intended to correct those deficiencies and aid wireless transmission of measured data, since water levels of reservoirs, lake and rivers are important factors involving water resources management and hydrological studies.

II. PREVIOUS WORK

A lot of work has been done in this regard with very useful papers aiding this topic are as follows:

Noncontact capacitance-type level sensor for a conducting liquid was designed and implemented [1] [2]. This is basically a non-inductively wound short-circuited coil taken as one electrode of a variable capacitor whereas the conducting liquid column is taken as other electrode. The sensor is connected with the metallic or non-metallic type liquid storage tank and with suitable instrumentation makes use of a variable capacitor principle [1].

Based on the characteristics of liquid resistance, a new transient liquid sensor has been designed by means of ratio measurement [4].

In a wide-range, long-time water-level measuring system, the absolute measurement error of gauges presently used increases with the increase of measurement range, which makes the gauges fail to satisfy the requirement of accuracy [5]. Meanwhile, the cumulative error also increases after the system has been in operation for certain period of time so that the gauges need to be manually calibrated periodically. A gauge is used which uses self calibration for wide measuring range [5]. This gauge serves its purpose by using mechanical and electronic arrangement to carry out its measurement using conductivity [3], [5]. Sensing of water by probes using

ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 2, Issue 9, September 2014

conductivity is of the most common techniques adopted [7].

A specific implementation plan of High-precision Low-power consumption wireless digital water level sensor transmitter which is based on WAP300C [6] was implemented.

III. PROBLEM STATEMENT

A design and implementation of water-level gauge with a wide range and high precision is desired by the self-calibration structure and active water surface perceiving approach [5]. In order to make the gauge a green device, a power dissipation control technique is to be carefully adopted and applied in every aspect of the gauge. Self power facility at the remote places through a solar panel, charge controller and battery backup with wireless transmission of the measured data is the additional feature proposed.

IV. PROPOSED WORK

This paper is organized as follows:

- The basic measurement principle and mechanical arrangement.
- The designing of the hardware.
- The operation sequence.
- The solar power and battery system for power supply management at remote places.
- Wireless transmission of data from sensor node to receiver terminal.

V. METHODOLOGY

A. Mechanical Setup

Suitable mechanical arrangement required for the project is fabricated. The arrangement is as shown in Fig. 1.The gauge uses electric motor driving the encoder and pulley, to perceive the water surface by hammer. The pulses from rotary encoder are used to measure distance [7]. With the self-calibration proposed, long-term cumulative errors are eliminated and a high-precision is guaranteed even with a wide measurement range [5]. It is required that we already know the height from bottom of the gauging well to the bench-mark. Here help of very accurate already calibrated laser can be taken to measure (L). The bench-mark can be detected by hammer passing through IR pair, where the microcontroller starts counting the pulses from rotary encoder.

The surface perceiving circuit consist of an isolated high voltage D.C. supply. The positive terminal connected to the winder bobbin through slip ring. The negative terminal is fixed at the bottom end of gauging well. By using instrumentation in surface perceiving circuit the detection of surface by hammer is given as an interrupt to micro-controller.

The power enable circuit can enable /disable the supply to other circuit, thus saving considerable power when unit is not measuring.

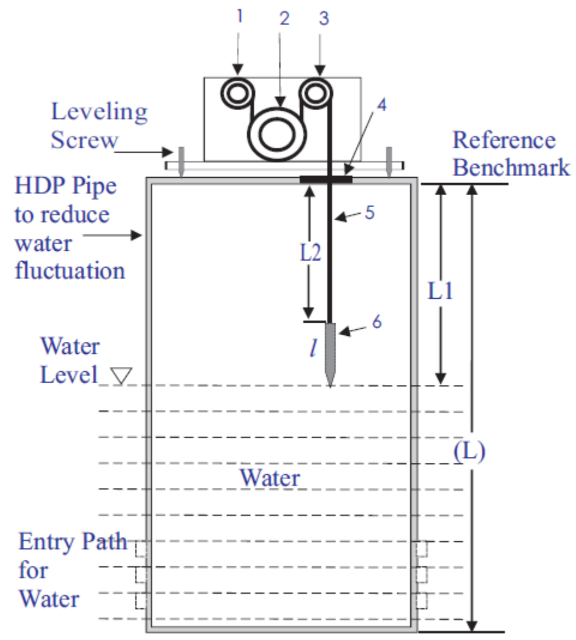

Fig. 1. Block Diagram of setup 1- d.c motor with winder bobbin, 2 - pulley connected to shaft of rotary encoder, 3- supporting pulley, 4 - benchmark detection system, 5 - conducting cable, 6- metal hammer.

B. Block Diagram of Measurement Principle

The block diagram for measurement principle is as shown in Fig. 2.

The microcontroller is used to count the pulses from rotary encoder. The measurement starts from bench-mark detection and ends when the hammer touches the water surface. The hammer can be moved up/down by controlling the direction of D.C. motor.

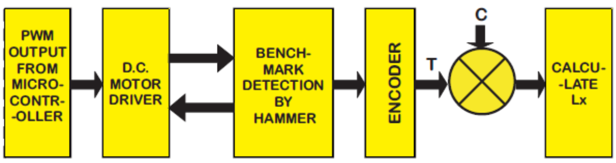

Fig. 2. Block Diagram showing Measurement Principle

C. Block Diagram of the Embedded Hardware

The block diagram of the embedded hardware is as shown in Fig. 3. A suitable power supply along with solar panel and battery, required charge controller are incorporated. A micro-controller with display does all the controlling, calculations and display the required parameters.

A micro-controller as shown in Fig. 3. has program loaded. This software takes care that proper sequence is followed. At start of measurement the hammer is pulled up to the benchmark. This is done by p.w.m output to motor driver, driving motor such that hammer reaches benchmark. The motor now drives the hammer towards the surface of conducting liquid. When the hammer passes the benchmark the micro-controller starts counting the pulses from encoder. The counting is stopped when the hammer touches the surface [5]. The calculations are done according to the formula:

Total distance travelled by cable (**L2**) = (Length covered per pulse of encoder (**C**)) * (Number of pulses counted by

micro-controller (**T**))
(1)

$$L1 = L2 + l \quad (2)$$

where, l = length of hammer

The unknown height of conducting liquid from the bottom is given by

$$L_X = L - L1 \quad (3)$$

This L_X is then displayed on l.c.d and also wirelessly transmitted to remote unit as shown in .. 4.

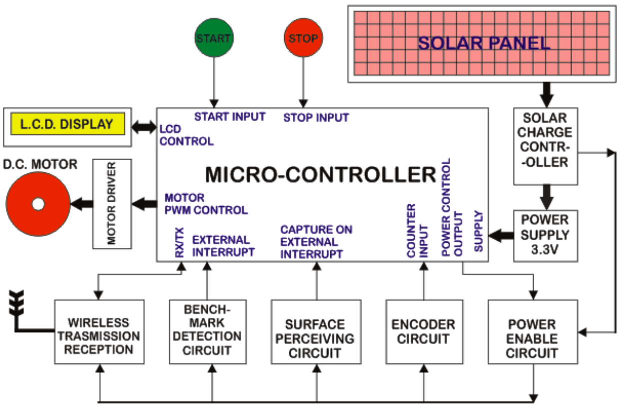

Fig. 3. Block Diagram of System Hardware

D. The Overall System Arrangement

Wireless transmitter module under the control of micro-controller is used to transmit the calculated and required data to the remote unit. The wireless transmission is particularly useful when the wiring is cumbersome and costly at difficult to reach locations and terrain. The system performance is considerably effective and efficient with the wireless technique adopted here. The overall system arrangement is as shown in Fig. 4.

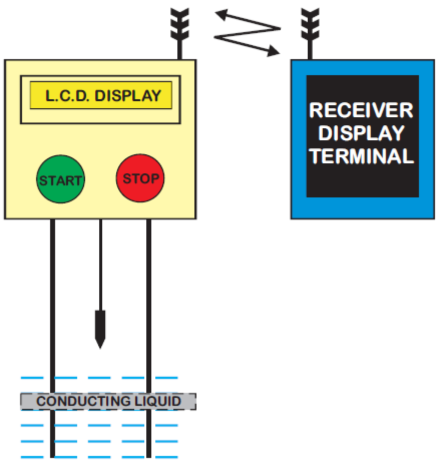

Fig. 4. Block Diagram of the System

VI. Conclusion

A sensor node with wireless transmission capability is thus implemented. Along with power saving and self calibration capacity the proposed gauge along with other gauge can be used for continuous operation and meet the requirement of wide range and accuracy, eliminate the cumulative errors and provide a effective solution for measurement of conducting liquid. The paper definitely aids in the measurement of conducting liquid wirelessly, removing the complications in wiring and installation and surely will be very useful in hydrographical studies.

Acknowledgement

Authors would like to thank the Department of Electronics and Tele-Communication Engineering and also those individuals who have motivated and helped in carrying this work successfully.

References

[1] S. C. Bera, J. K. Ray, and S. Chattopadhyay, "A low-cost noncontact capacitance-type level transducer for a conducting liquid", *IEEE Trans. Instrum. Meas.*, vol. 55, no. 3, pp. 778–786, Jun. 2006..

[2] W. Yin, A. J. Peyton, G. Zysko, and R. Denno, "Simultaneous noncontact measurement of water level and conductivity", in *Proc. IEEE Instrum. Meas. Technol. Conf. (IMTC'06)*, pp. 2144–2147, 2006.

[3] P. Xuange, L. Peipei, and H. Chunying, "One kind of water level monitor recording instrument", in *Proc. ICIEA*, pp. 24–25,Jun. 2008.

[4] Guilin Zheng , Hongyan Zong , Xiangtao Zhuan , Jianguo Luan, " Fast dynamic liquid level sensor based on liquid resistance", *IEEE Conference Publications AFRICON*,pp. 1 – 6, 2007.

[5] Guilin Zheng , Hongyan Zong , Xiangtao Zhuan , Lijuan Wang. "High-Accuracy Surface-Perceiving Water Level Gauge With Self-Calibration for Hydrography", IEEE Journals & Magazines, *IEEE Sensors Journal*, vol. 10, issue. 12, pp. 1893–1900, 2010.

[6] Li, Hui-ping , Liu, Hong-le , Ma, Fu-chang , Wang, Wei , Lv, Tao, "Wireless Digital Water Level Sensor Smart Transmitter Based on Wap300c" *IEEE Conference Publications. Digital Manufacturing and Automation (ICDMA)*, pp. 1647 – 1650, 2013.

[7] F. Lingang, W. Zhishui, C. Zezong, and Z. Chen, "A research on a new type of water level measurement system based on probe water-level sensor," *Chin. J. Sci. Instrum.*, vol. 30, pp. 130–134, Jun. 2009.

BIOGRAPHIES

Mr. Amol Ashok Kshirsagar is working as a Assistant Professor in Electronics & Tele-communication Department at N. K. Orchid College of Engineering and Technology, Solapur. He has a rich Industrial experience of six years and five years in teaching field. He has done B.E. (Electronics) and currently pursuing M.E. (E&TC). His special interest is in Micro-controllers, Instrumentation, prototyping new sensors.

Mr. S. S. Hippargi is working as a Assistant Professor in Electronics & Tele-communication Department at N. B. Navale Sinhgad College of Engineering, Solapur. He has a rich teaching experience of 14 years. He has done B.E. (E&TC), M.Tech. in Digital Communication and currently pursuing Ph.D. degree in Wireless Communication. His special interest is in the field of Wireless Communication and Image Processing.