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Design of Salinity Content (Salinometer) Tools Digital Based on Microcontroller ATmega328

I Made Satriya Wibawa[1], I Ketut Putra[2], Nyoman Wendri[3]

[1, 2, 3]Faculty of Mathematics and Natural Sciences, Udayana University

Abstract: ***A digital salinometer has been designed. This study aims to design a salinity level measuring instrument with an electrode sensor based on the ATmega 328 microcontroller. In addition to designing tools, this study also aims to find out the work system of measuring instruments and the accuracy of the measurement results of salinity measurement tools based on the ATmega 328 microcontroller. The salinity value obtained by measuring the voltage of the difference in resistance in the sample is then converted in salinity. The main processor of this tool uses the ATmega328 microcontroller which is programmed using Arduino IDE software and a detection sensor in the form of an electrode sensor. The results of the salinity values obtained will be displayed on the 16x2 LCD.***

Keywords: Salinometer, Microcontroller, Arduino IDE, Electrode Sensor

1. Introduction

Water is one of the main components in life that is very influential for the sustainability of the ecosystem. Aquatic ecosystems depend on the condition of the waters determined by the concentration value of several water quality parameters, both in physical, chemical and biological terms (Tirta et al., 2016). Observation of water quality can be done by observing several parameters, one of which is observing salinity. Salinity is one of the basic quantities in the field of marine science. Salinity is defined as the weight in grams of all solids dissolved in 1 kilo grams of seawater but salinity is often interpreted as the salt content of seawater. In observing salinity, it takes a tool both electronically (digitally) and analogously to monitor changes in the amount of salinity that occurs.

Very little domestic production in the field of developing measuring instruments for oceanographic parameters such as salinometers, has resulted in the price of these devices being relatively expensive because they have to be brought in from abroad (Yunus, 2003). The work system of the salinometer is still manual, so in this study a water salinity meter (salinometer) will be designed using an electrode sensor based on the ATmega328 microcontroller. ATmega328 microcontroller has a Harvard architecture, which separates memory for program code and memory for data so that it can work in parallel. The digital salinometer design can later be further developed and applied in the community, especially in the fisheries sector.

2. Research Methods

The implementation of this study will be divided into three parts, namely voltage data retrieval, hardware design and software development. Taking voltage data is done by measuring the voltage of some salinity values. Seawater salinity was measured using a salinometer in the Faculty of Marine and Fisheries, Udayana University, which later the salinometer will be used as a comparison tool. While the voltage is measured using a multimeter that is connected to the sensor as shown in Figure 1. This data collection aims to convert the voltage value to the amount of salinity. The block diagram of hardware design for measuring salinity (salinometer) using an electrode sensor based on the ATmega328 microcontroller is shown in Figure 2. The overall set of tools can be seen in Figure 3.

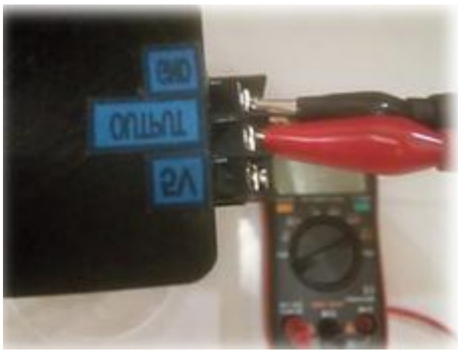

Figure 1: Sensor and multimetercircuit in voltage data collection

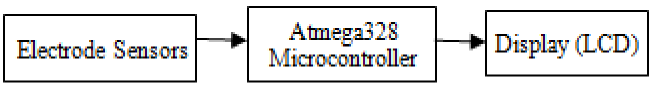

Figure 2: Block diagram of the salinity level gauge

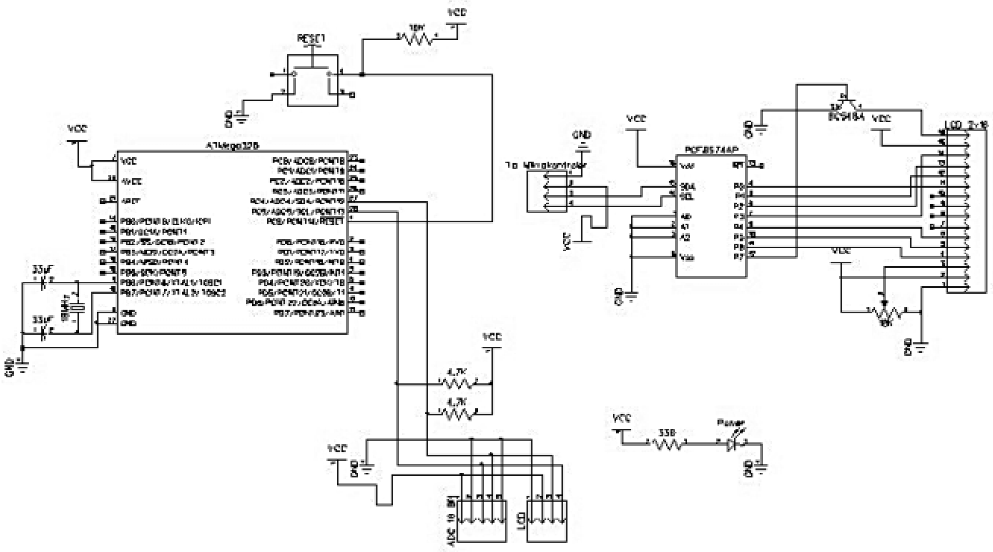

Figure 3: The whole set of circuits diagram

3. Result and Discussion

The work system of measuring salinity levels (salinometer) begins with measuring the voltage of the difference in resistance in the sample which is further converted into a salinity unit. The magnitude is obtained through electrode sensors which are dipped directly on the sample. The output signal from the sensor then goes to the internal ADC microcontroller ATmega328 to be converted into digital data so that it can be read by the microcontroller. At this stage, data processing is done by software (software) using a programming language that can be recognized by the microcontroller. In this case the software used is the Arduino IDE with a programming language that combines C ++ and Java. Data that has been successfully processed in the amount of salinity will then be displayed on the LCD.

In the calibration process, measurements are made by observing changes in the electrode sensor output voltage response to salinity measured by the reference device. Calibration data can be seen in Table 1. Then a stress graph is made against reference salinity and a regression with linear regression approach can be seen in Figure 4.

Table 1: The results of sensor voltage and salinity measurements from the reference device

Numb.	Voltage (V)	Salinity (ppt)
1	3.543	31
2	3.516	28
3	3.452	26
4	3.451	22
5	3.435	19
6	3.387	16
7	3.337	13
8	3.320	10
9	3.228	6
10	3.197	2

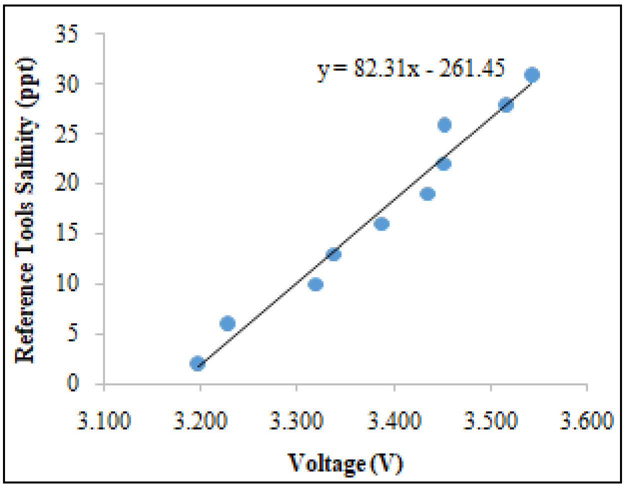

Figure 4: Graph of voltage conversion against salinity

Calculation of accuracy is done by comparing the results of salinity measurements using a design tool with the results of salinity measurements using a reference tool. There are 5 samples varied in such a way, then a graph of the average suitability of the measurement results between the design plan and the reference tool as seen in Figure 5. The graph in Figure 5 shows that the suitability of the measurement results between designed tools (orange bar) and reference tools (grey bar) relatively close. Accuracy calculations are shown in Table 2.

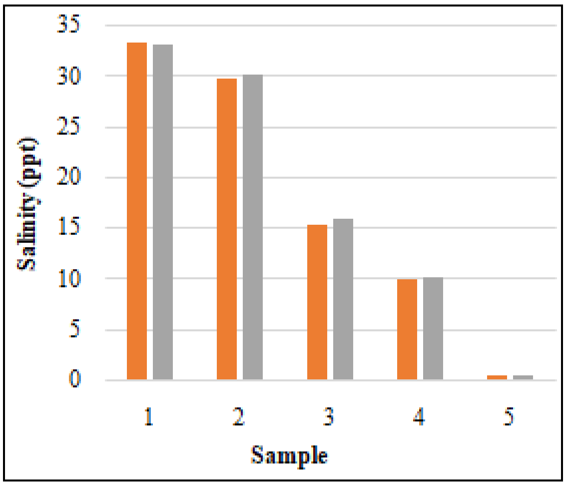

Figure 5. Suitability graph of design tool with reference tools

Table 2: Calculation results for the accuracy of the design tools

Sample Numb.	x (ppt)	y (ppt)	$\Delta x = \lvert x - y \rvert / y$ (%)	1-Δx (%)
Sample 1	33.22	33	0.67%	99.33%
Sample 2	29.73	30	0.90%	99.10%
Sample 3	15.27	15.8	3.35%	96.65%
Sample 4	9.94	10	0.60%	99.40%
Sample 5	0.41	0.4	2.50%	97.50%
Average			1.60%	98.40%

Which is:
x : Salinity average of designed tools
y : Salinity average of reference tools
Δx : The relative error of the design tool against references
1- Δx : accuracy of designed tools.

4. Conclusion

The work system of measuring the salinity level begins with measuring the voltage of the difference in resistance in the sample by the electrode sensor. The output signal from the sensor then goes to the internal ADC microcontroller ATmega328 to be converted into digital data so that it can be read by the microcontroller. Data that has been successfully processed in the amount of salinity is then displayed on the LCD, and the accuracy of the measurement results of the design tool for the reference tool is 98.40%. In order for a measuring instrument to be made more effective it is recommended to increase the resolution of the ADC used (above 10 bits) so that the data sampling process becomes more detailed which causes the measurement results to be more accurate.

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