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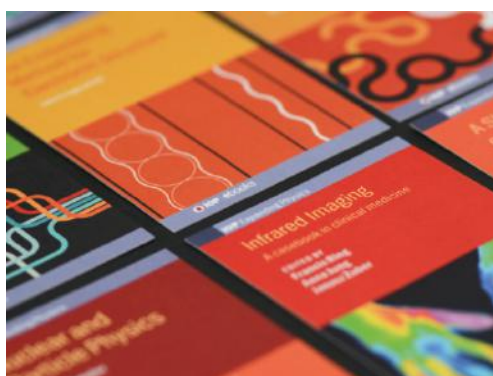# Seminar Nasional Fisika (SNF) 2017

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Preface
Seminar Nasional Fisika (SNF) 2017
Universitas Negeri Surabaya, Surabaya, Indonesia
November 25th , 2017

Nadi Suprapto, Abd. Kholiq, Utama Alan Deta and Nurita Apridiana Lestari

This conference, which is organized by the Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, is held at Auditorium Prof. Slamet Dajono, FMIPA, UNESA.

The theme of this conference is "Menghilirkan Penelitian-Penelitian Fisika dan Pembelajarannya". Two experts as keynote speakers in physics domain will share their experiences.
1. Prof. Dr. Bayong Tjasyono H.K., DEA., (Professor in physical meteorology, Institut Teknologi Bandung)
2. Dr. Ing. Setyawan Purnomo Sakti, M.Eng., (Expert in material instrumentation, Department of Physics, Universitas Brawijaya Malang)

This Conference on Physics and Physics Education is attended by more than 350 participants. There are about 110 papers is presented orally covering wide-variety subjects of physics (material physics, geophysics, theoretical and computation physics, instrumentation physics, and applied physics) and physics education (physics learning, assessment, innovative learning, and media). Totally, there are more than 35 institutions from Sumatra, Java, Madura, Borneo, Celebes, Maluku, and Papua participated in this conference. We thank you all for your participation.

We thank the Organizing Committee, Reviewers, and Steering Committee for having been working hard. Finally, we would also like to thank the Rector of Universitas Negeri Surabaya, Dean of Faculty of Mathematics and Natural Sciences, and Bank Tabungan Negara (BTN) for their support for this conference.

We hope you will enjoy our togetherness. Thank you.

Surabaya, November 25th , 2017
Best Regards,

SNF 2017 Committee

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Universitas Negeri Sutabaya, Surabaya, Indonesia

November 25th, 2017

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Table of contents

Volume 997

2018

◀ Previous issue   Next issue ▸

Seminar Nasional Fisika (SNF) 2017 25 November 2017, Surabaya, Indonesia

Accepted papers received: 19 March 2018
Published online: 12 April 2018

Open all abstracts

Preface

OPEN ACCESS   011001
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➕ Open abstract   🖹 View article   📄 PDF

OPEN ACCESS   011002
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➕ Open abstract   🖹 View article   📄 PDF

OPEN ACCESS   011003
Sponsor

➕ Open abstract   🖹 View article   📄 PDF

OPEN ACCESS   011004
Photograph

➕ Open abstract   🖹 View article   📄 PDF

OPEN ACCESS   011005
Peer review statement

➕ Open abstract   🖹 View article   📄 PDF

Papers

OPEN ACCESS

012008

The effectiveness of collaborative problem based physics learning (CPBPL) model to improve student's self-confidence on physics learning

B K Prahani, N Suprapto, Suliyanah, N A Lestari, M N R Jauhariyah, S Admoko and S Wahyuni

✚ Open abstract   📄 View article   📄 PDF

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012009

Synthesis of polyaniline/cellulose composite as humidity sensor

N P Putri, D H Kusumawati, N Widiyanti and Munasir

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS

012010

Analysis of mineral content of iron sand deposit in Bontokanang Village and Tanjung Bayang Beach, South Sulawesi, Indonesia

V A Tiwow, M Arsyad, P Palloan and M J Rampe

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS

012011

Exploring physics concepts among novice teachers through CMAP tools

N Suprapto, Suliyanah, B K Prahani, M N R Jauhariyah and S Admoko

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS

012012

Qualitative analysis of ionospheric disorders in Solok earthquake (March 6, 2007) viewed from anomalous critical frequency of layer F (f0F2) and genesis spread F

D Pujiastuti, S Daniati, E Taufiqurrahman, B Mustafa and Ednofri

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS

012013

The effectiveness of CPI model to improve positive attitude toward science (PATS) for pre-service physics teacher

T Sunarti, Wasis, Madlazim, Suyidno and B K Prahani

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS

012014

The D-dimensional non-relativistic particle in the Scarf Trigonometry plus Non-Central Rosen-Morse Potentials

U A Deta, N A Lestari, M Yantidewi, A Suparmi and C Cari

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS

012015

Spatial distribution of topsoil magnetic susceptibility in Sawahlunto City, West Sumatera

Afdal and E S Wahyuni

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012016

Analytical solution of Schrödinger equation in minimal length formalism for trigonometric potential using hypergeometry method

I Nurhidayati, A Suparmi and C Cari

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012017

Analysis of minimal length effect on the non-relativistic energy and wave function for the exponential type potential using Supersymmetric Quantum Mechanics

H Azizah, A Suparmi and C Cari

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012018

The design of a PC-based real-time system for monitoring Methane and Oxygen concentration in biogas production

M Yantidewi, M S Muntini, U A Deta and N A Lestari

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012019

Microseismicity of Blawan hydrothermal complex, Bondowoso, East Java, Indonesia

S Maryanto

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012020

Analysis of graphical representation among freshmen in undergraduate physics laboratory

A S Adam, S Anggrayni, A Kholiq, N P Putri and N Suprapto

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012021

Optimization of thermal conductivity lightweight brick type AAC (Autoclaved Aerated Concrete) effect of Si & Ca composition by using Artificial Neural Network (ANN)

Zulkifli and G P Wiryawan

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012022

The effectiveness of Concept Mapping Content Representation Lesson Study (ComCoReLS) model to improve skills of Creating Physics Lesson Plan (CPLP) for pre-service physics teacher

E Purwaningsih, Suyatno, Wasis and B K Prahani

+ Open abstract   ▤ View article   🗎 PDF

OPEN ACCESS   012023

The use of Papuan iron sand and river sand for fine aggregate in mortar for nuclear radiation shield application

K Dahlan, E Haryati and Y. S. Aninam

+ Open abstract   ▤ View article   🗎 PDF

OPEN ACCESS   012024

Correction factors in determining speed of sound among freshmen in undergraduate physics laboratory

A Lutfiyah, A S Adam, N Suprapto, A Kholiq and N P Putri

+ Open abstract   ▤ View article   🗎 PDF

OPEN ACCESS   012025

The scientific argumentation profile of physics teacher candidate in Surabaya

T N Ain, H A C Wibowo, A Rohman and U A Deta

+ Open abstract   ▤ View article   🗎 PDF

OPEN ACCESS   012026

The differences in analysing strategy of viscosity experiment between freshmen and laboratory assistant

S Anggrayni, H Mubarok, N P Putri, N Suprapto and A Kholiq

+ Open abstract   ▤ View article   🗎 PDF

OPEN ACCESS   012027

The estimation of occupational dose in 15 MV varian clinac iX room by Argon-41 as an activation product of photoneutron

R Latifah, Bunawas and J A E Noor

+ Open abstract   ▤ View article   🗎 PDF

OPEN ACCESS   012028

Horizontal Displacement Vector Analysis in Ujong Muloh GPS Station (UMLH) Sumatra Island on March 27 – April 25, 2012

S S Pamungkas, S Koesuma and Budi Legowo

+ Open abstract   ▤ View article   🗎 PDF

OPEN ACCESS   012029

Development of multimedia learning based inquiry on vibration and wave material

H Madeali and B K Prahani

+ Open abstract   ▤ View article   🗎 PDF

OPEN ACCESS   012030

Students' understanding of forces: Force diagrams on horizontal and inclined plane

J Sirait, Hamdani and S Mursyid

+ Open abstract   **▤** View article   **▧** PDF

OPEN ACCESS   012031

The Students' misconceptions profile on chapter gas kinetic theory

M N R Jauhariyah, N Suprapto, Suliyanah, S Admoko, W Setyarsih, Z Harizah and I Zulfa

+ Open abstract   **▤** View article   **▧** PDF

OPEN ACCESS   012032

The effectiveness of CCDSR learning model to improve skills of creating lesson plan and worksheet science process skill (SPS) for pre-service physics teacher

I Limatahu, Suyatno, Wasis and B K Prahani

+ Open abstract   **▤** View article   **▧** PDF

OPEN ACCESS   012033

The use of quizStar application for online examination in basic physics course

R Kustijono and H Budiningarti

+ Open abstract   **▤** View article   **▧** PDF

OPEN ACCESS   012034

Implementation of ECIRR model based on virtual simulation media to reduce students' misconception on kinetic theory of gases

A C Prastiwi, A Kholiq and W Setyarsih

+ Open abstract   **▤** View article   **▧** PDF

OPEN ACCESS   012035

Identification student's misconception of heat and temperature using three-tier diagnostic test

Suliyanah, H N P A Putri and L Rohmawati

+ Open abstract   **▤** View article   **▧** PDF

OPEN ACCESS   012036

Characterization of magnetite (Fe_3O_4) minerals from natural iron sand of Bonto Kanang Village Takalar for ink powder (toner) application

M R Fahlepy, V A Tiwow and Subaer

+ Open abstract   **▤** View article   **▧** PDF

OPEN ACCESS   012037

The effectiveness of flipped classroom learning model in secondary physics classroom setting

B D Prasetyo, N Suprapto and R N Pudyastomo

+ Open abstract　　📄 View article　　📄 PDF

OPEN ACCESS 　　　　　　　　　　　　　　　　　　　　　012038

Characterization of natural puya sand extract of Central Kalimantan by using X-Ray Diffraction

K G Suastika, K Karelius and I N Sudyana

+ Open abstract　　📄 View article　　📄 PDF

OPEN ACCESS 　　　　　　　　　　　　　　　　　　　　　012039

The performance assessment of undergraduate students in physics laboratory by using guided inquiry

H Mubarok, A Lutfiyah, A Kholiq, N Suprapto and N P Putri

+ Open abstract　　📄 View article　　📄 PDF

OPEN ACCESS 　　　　　　　　　　　　　　　　　　　　　012040

The use of physics practicum to train science process skills and its effect on scientific attitude of vocational high school students

E Wiwin and R Kustijono

+ Open abstract　　📄 View article　　📄 PDF

OPEN ACCESS 　　　　　　　　　　　　　　　　　　　　　012041

Designing laboratory activities in elementary school oriented to scientific approach for teachers SD-Kreatif Bojonegoro

Dwikoranto, W A Surasmi, A Suparto, S Tresnaningsih, D Sambada, T Setyowati, A Faqih and R Setiani

+ Open abstract　　📄 View article　　📄 PDF

OPEN ACCESS 　　　　　　　　　　　　　　　　　　　　　012042

The use of a four-tier wave diagnostic instrument to measure the scientific literacy among students in SMA Negeri 2 Karanganyar

A Krisdiana, N S Aminah and F Nurosyid

+ Open abstract　　📄 View article　　📄 PDF

OPEN ACCESS 　　　　　　　　　　　　　　　　　　　　　012043

Potential of iron sand from Betaf beach, Sarmi regency and river sand from Doyo, Jayapura regency, Papua as basic materials of mortar as nuclear radiation shielding

E Haryati and K Dahlan

+ Open abstract　　📄 View article　　📄 PDF

OPEN ACCESS 　　　　　　　　　　　　　　　　　　　　　012044

Developing physics learning media using 3D cartoon

M Wati, S Hartini, N Hikmah and S Mahtari

+ Open abstract 🗐 View article 📄 PDF

012045

The Stark Effect on the Wave Function of Tritium in Relativistic Condition

B Supriadi, S H B Prastowo, S Bahri, Z R Ridlo and T Prihandono

+ Open abstract 🗐 View article 📄 PDF

012046

A Low Cost Mobile Robot Based on Proportional Integral Derivative (PID) Control System and Odometer for Education

R Haq, H Prayitno, Dzulkiflih, I Sucahyo and E Rahmawati

+ Open abstract 🗐 View article 📄 PDF

012047

Socialization of Solar Energy Utilization in Ponpes Al Hidayah, Arjasa, Kangean Island, Sumenep

Y Cahyono, Y Setyaningrum, A Sarasechan, R G Nafsi, Setiyono, M D Salamah, N A Triyuliana, L Silvia,

B A Subagyo, M Zainuri, Triwikantoro, M A Baqiya, Endarko, M Z Asrori, S Pratapa, Suasmoro and Darminto

+ Open abstract 🗐 View article 📄 PDF

012048

Microstructure of Sinter Deposit Formed at Hot Springs in West Sumatera

A Putra, D Y Inanda, F Buspa and A F Salim

+ Open abstract 🗐 View article 📄 PDF

012049

Effectiveness of guided inquiry learning model to improve students' critical thinking skills at senior high school

E K Nisa, T Koestiari, M Habibbulloh and Budi Jatmiko

+ Open abstract 🗐 View article 📄 PDF

012050

Relative gravimeter prototype based on micro electro mechanical system

A S A Rozy, H A Nugroho and M Yusuf

+ Open abstract 🗐 View article 📄 PDF

012051

The solution of 4-dimensional Schrodinger equation for polynomial inverse potential and its partner potential by using ansatz wavefunction method

A Suparmi, C Cari, Wahyulianti and K N Wea

+ Open abstract 🗐 View article 📄 PDF

OPEN ACCESS   012052

Synthesis of PANi-SiO2 Nanocomposite with In-Situ Polymerization Method:
Nanoparticle Silica (NPS) Amorphous and Crystalline Phase

Munasir, N R D Luvita, D H Kusumawati, N P Putri, Triwikantoro and Z A I Supardi

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012053

Microstructure, thickness and sheet resistivity of Cu/Ni thin film produced by
electroplating technique on the variation of electrolyte temperature

M Toifur, Y Yuningsih and A Khusnani

+ Open abstract   📄 View article   📕 PDF

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Acquisition of electrical signals using commercial electronic components for detection system of Lead ion in distilled water

Pujiyanto[1], M Yasin[1] and F Rusydi[1]

[1] Department of Physics, Faculty of Science and Technology, Airlangga University

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Abstract. Development of lead ion detection systems is expected to have an advantage in terms of simplicity of the device and easy for concentration analysis of a lead ion with very high performance. One important part of lead ion detection systems are electrical signal acquisition parts. The electrical signal acquisition part uses the main electronic components: non inverting op-amplifier, instrumentation amplifier, multiplier circuit and logarithmic amplifier. Here will be shown the performance of lead ion detection systems when the existing electrical signal processors use commercial electronic components. The results that can be drawn from this experimental were the lead ion sensor that has been developed can be used to detect lead ions with a sensitivity of 10.48 mV/ppm with the linearity 97.11% and had a measurement range of 0.1 ppm to 80 ppm.

1. Introduction

Several measurement methods of the chemical concentration have been carried out using optical fiber sensors [1,2.3]. The optical method developed to measure the concentration of the material using a displacement phenomenon between the two ends of optical fibers. The phenomenon of displacement between the two ends of optical fibers has been successfully developed as a displacement sensor that can measure object displacement to micron-scale resolutions [4,5,6]. Furthermore, the displacement sensor may be used as an attractive approach to the measurement of non-contact hydroxyapatite thickness of the material [7,8,9]. The displacement sensor has been shown to be used as a good approach to measuring transparent plate thickness based on transmission and reflection phenomena [10]. Fiber optic sensors using tapered fiber optics can be used to detect potassium in distilled water [11]. Fiber optic displacement sensors using bundled probe can be used for medal detection [12].

The overall development of the method of measuring the concentration of a chemical by using fiber optic sensor that has been done still has not produced a direct reading of its concentration value. This work was attempted to develop optical fiber spectrophotometry technique that can measure the concentration of lead ions with direct concentration reading. To allow for a direct reading of the value of concentration, a signal acquisition system is required using commercial electronic components that available on the market. Conceptually the signal acquisition process can be shown through the block diagram as Figure 1. Each block is described by a transfer function (TF) which expresses the relationship between output and input. If the input is expressed with V_i and the output is expressed by V_k, the statement $TF = V_k / V_i$. After going through the entire of the acquisition process, it is expected output voltage V_o is proportional to concentration (c).

The sensor probe consist of a light source, directional coupler and silicon photo detector. A violet 405 nm light from Light Emitting Diode (LED) is launched into directional coupler and directed to a

region where the light interact with lead ion liquid. This interaction results in a modulation of optical intensity and modulated light is collected by the another optical fiber to be transmitted to the optical detector. By an optical detector, the received light intensity was converted into electrical voltage signal and then forwarded to acquisition system. The interaction of light with lead ions is an absorption phenomenon. Therefore, based on lambert-beer law, V_k / V_i is proportional to e^{-c}. At non-inverting operational amplifier, V_k / V_i is a gain of amplifier so that the output V_2 is proportional to e^{-c}. In amplifier intrumentation, one of the input voltages is given a certain reference voltage (V_r) which has greater value than V_2 so that V_k / V_i is proportional to (V_r-V_2). The output voltage V_3 of the amplifier intrumentation is proportional to e^c. The output voltage V_3 after multiplied by the number k (selected k = 100) and passed the amplifier logarithmic will be obtained output voltage V_o is proportional to c. This is because V_k / V_i for logarithmic amplifiers proportional to ln (V_4). Since the output voltage of V_o proportional to $c,$ it is possible to read the results of direct ion concentration detection directly.
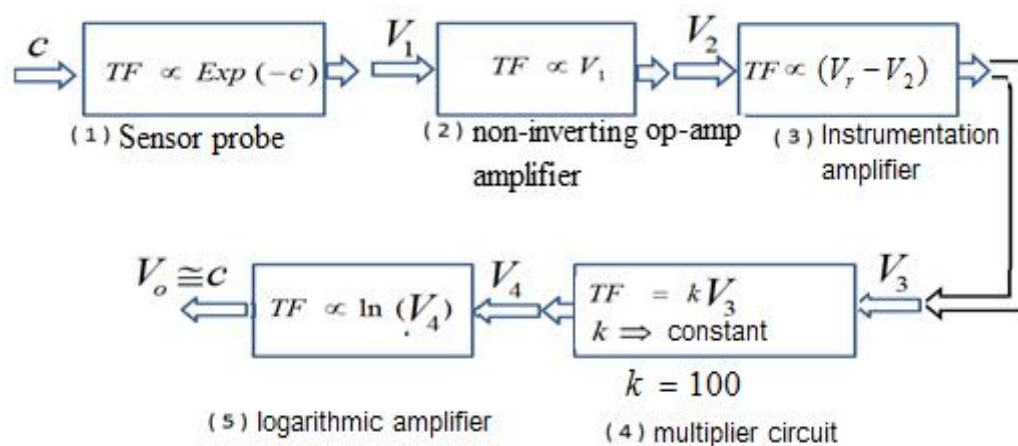

Figure 1. Block diagram of the electrical signal acquisition process.

2. Methods

This work was attempted to develop optical fiber spectrophotometry technique that can measure the concentration of lead ions with direct concentration reading. The main focus of this work was electric signal acquisition systems design using commercial electronic components and of optical probes. Probe sensor using asymmetric directional coupler *1 x 4* tree.

Procedures of this work focused on the design of electrical signal acquisition system devices using commercial electronic components for lead ion detection systems in distilled water were carried out through the following stages: 1) the design and manufacture of electric signal acquisition systems using commercial electronic components 2) the design and manufacture of optical probes 3) design of experiment setup for detection of concentrations of lead ions in distilled water, 4) sample preparation for testing, 5) data collection and data analysis. Conceptually the electrical signal processing in acquisition system was designed following the block diagram in Figure 1. The non-inverting amplifier output voltage (V_2), the output voltage of the multiplier circuit (V_4) and the output voltage of the logarithmic amplifier (V_o) were measured as the function of the lead ion concentration.
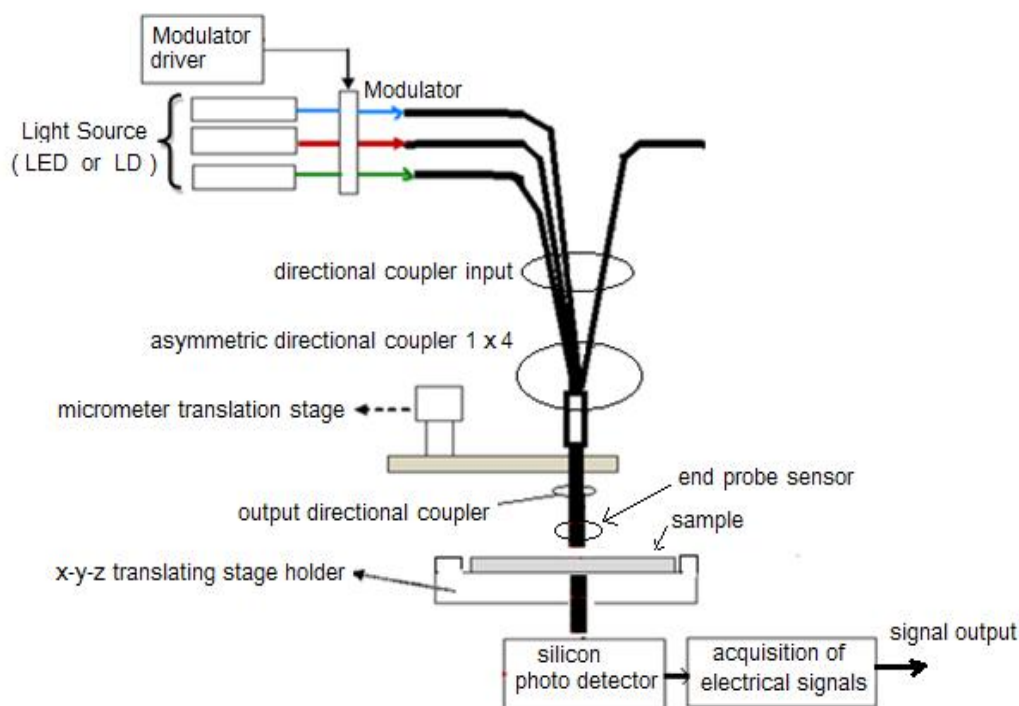
Figure 2. Experimental setup for concentration detection lead ions in water.

The design of the main optical system was the design of the probe sensor detecting the concentration in distilled water. Probe sensor concentration of several heavy metal ions were made from optical fiber displacement system using asymmetric directional coupler *1 x 4* tree. The directional coupler output was enabled to transmit light from the light source to the sample. The sensor probe integrated with the cuvette where the sample placed.

The experimental setup for the detection of concentrations of heavy metal ions in the water were shown in Figure 2. The main components of the experimental setup were light sources (violet LED) and concentration sensor probes.

In Figure 2, the light from a modulated LED light source (405 nm) through an electronic modulator with a certain frequency were fed into directional coupler input and transmitted to the sample through directional coupler output. The light passing through the sample guided through fiber optics to be transmitted to the optical detector. By an optical detector, the received light intensity was converted into electrical voltage signal. This voltage signal was amplified by a non-inverting OP-amplifier and then forwarded to the instrumentation and logaritmic amplifier. Output voltage non-inverting amplifier, output voltage of multiplier circuit and output voltage of logarithmic amplifier will be determined for the value as a function of the sample concentration.

The experiment was begun with the preparation of samples of lead ions. The lead sample of nitrate $Pb(NO_3)_2$, dissolved in water. Samples of $Pb(NO_3)_2$ were fed ethylene tetra acetate acid reagent (EDTA = $C_{10}H_{16}N_2O_8$). Each sample was made variation of concentration from 0.1 ppm to 80 ppm.

The data taken were the output voltage value of each part of the electrical signal acquisition system as its input function. The main data taken and to be analysed is the final output voltage value as a function of the concentration of lead ions in water.

Theoretically, the final output voltage as a function of concentration is linear. The result of the analysis gave the same data with a linear function.

3. Results and Discussion

Data obtained from this research were non-inverting amplifier output voltage, output line voltage multiplier and output voltage of logarithmic amplifier as a function of concentration of lead solution in water. The output voltage data as a function of lead ion concentration for Op-Amp amplifier, Multiplier Circuit and logarithmic amplifier presented in Table-1 and regression for each data presented in Figure 3. In Figure 3, it showed that the relationship between the output voltage Op-Amp amplifier (V_2) to the lead ion concentration can be approximated by function which decays exponentially with the equation $V_2 = 369.89\ e^{-0.0003\ c}$ with the coefficient of determination value 96.59 %. The relationship between the output voltage Multiplier Circuit (V_4) to the lead ion concentration can be approximated by function exponensial with the equation $V_4 = 157.13\ e^{0.0105\ c}$ with the value of coefficient of determination value 94.32%. The coefficient of determination value stated the level of data conformity with a particular function model. The form of voltage function V_2 and V_4 corresponded to the expected form of transfer function in the Op-amp amplifier and the multiplier circuit.

Table 1. Output voltage as a function of lead ion concentration (c) for Op-Amp amplifier, multiplier circuit and logarithmic amplifier.

(c) Concentrations of lead ions (ppm)	(V_2) Op-amplifier output voltage (x10 mV)	(V_4) Multiplier Circuit output voltage (x 0.01 mV)	(V_o) Logarithmic amplifier output voltage (x 0.1 mV)
0.1	371.0	136.2	309.0
1	369.4	164.5	497.7
10	368.7	178.7	580.8
20	367.3	206.9	727.4
40	365.2	253.3	929.3
60	363.1	306.8	1121.0
80	362.0	336.1	1212.0

In Figure 3, it showed that the relationship between the output voltage to the lead ion concentration can be approximated by linearity function with the value $R^2 = 0.9431$ (regression coefficient $R = 0.9711$) with the equation $V_o = (1.0483\ c + 45.205)$. In this case, V_o presented as the magnitude of the output voltage of the logarithmic amplifier, whereas c presented as the concentration of lead ions. Based on the value of R, it could be concluded that there were linearity correlation between the output voltages with lead ions. From the results of linear regression test can be known the sensors performance including sensitivity, linearity and measurement range. The performance of the lead ion sensor can be expressed in Table 2.

Table 2. Performance of lead ion sensor.

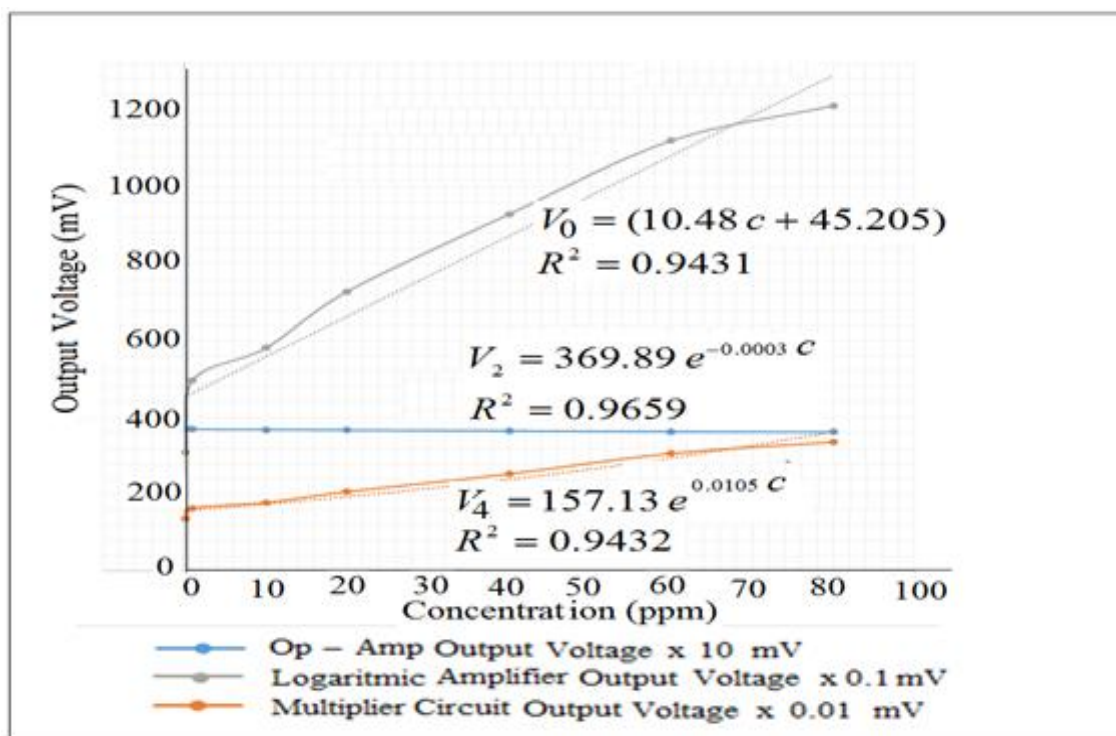| Parameter	Parameter Value for sample:
Sensitivity	10.48 mV/ppm
Measurement range	0.1 – 80 ppm
Linearity	> 97 %

Figure 3. Voltage output of Op-Amp, Instrumentation and Logarithmic Amplifier as a function of Lead ion concentration.

4. Conclusion

Development of lead ion detection systems for concentration analysis of a lead ion is presented and demonstrated. The output voltage of the detector shows a linear relationship to the change of lead concentration in distilled water. The 1 x 4 tree asymmetric directional coupler sensor probes were used and it enables to detect the concentration of several heavy metal ions simultaneously. The results that can be drawn from this experimental were the lead ion sensor that has been developed can be used to detect lead ions with a sensitivity of 10.48 mV/ppm with the linearity 97.11% and had a measurement range of 0.1 ppm to 80 ppm.

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