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Potency of sensor displacement detection of cholesterol concentration using flat mirror as media for learning waves and optics

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Abstract. The use of instructional media needs to be implemented in one of the courses such as wave and optics to cover up the contents of material. To bring this advantage, one of the alternatives that can be used is to use fiber optic sensors for detecting cholesterol concentration. This device brings about the concepts of how the wave and optics behaves and operates. In doing so, the variation concentration of cholesterol solution is 0 ppm, 50 ppm, 100 ppm, 150 ppm, 200 ppm, 250 ppm, and 300 ppm. The work mechanism of cholesterol concentration detection is laser propagation of He-Ne wavelength 632.5 nm through fiber optic in cholesterol solution and reflected back by flat mirror then ray reflected through fiber optic bundle so detected by SL-818 silicon detector in the form of voltage Output. The detection results showed that the maximum output voltage showed a linear decrease in the concentration of cholesterol solution with a sensitivity of 0.21 mV/ppm and linearity of more than 95%. In terms of developed learning media, the use of optical fiber sensor learning media is compatible with optical wave learning in terms of basic competence of lectures, learning indicators, learning materials, student worksheets and science process skills. From the assessment of validation of learning media obtained an assessment of more than 95%. The results of this study indicate the parameters and performance of sensors that have accurate potential as a medium for learning wave and optics.

1. Introduction

The implementation of the lecture mainly focuses on efficiency and effectiveness to achieve learning goal. Therefore, each chosen lecture method, oriented to the general principle objectives used in the learning process by constructivist learning. Teaching and learning process required interaction between educator and learners. Interaction in teaching and learning process between lecturer and student where lecturer as facilitator with student is demanded to be more active in learning and supported by learning media [1].

One source of learning that can enrich the insights of students is a medium of learning. The role of the media will not be seen if its use is not in line with the contents and objectives of learning that have been formulated. Therefore, the purpose of learning should be used as a reference in using learning media, especially learning objectives that require experiments such as propagation and reflection properties.



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Learning media in science learning is a function that serves to convey learning information can make a positive contribution in interactive learning process, effective and cultivate students' curiosity to the concept of science shown by the media.

The use of instructional media is needed one of the courses of wave and optics. Where the description of this course includes one of the concept of vibration, wave phenomena, wave velocity in various mediums, electromagnetic waves, reflection and refraction of light, optical instrument, polarization, interference, diffraction and wave modulation and its integration with other sciences (biology and chemistry). One of the goals of the wave and optical course is to be able to apply the concept of propagation, absorption, and wave reflection properties, the problem-solving toolkit of the use of fiber optic sensors to determine the potential cholesterol concentration of media usage in accordance with the achievement of learning objectives.

The description of the researcher wanted to give one solution of the use of learning media on the lecture of wave and optics by using fiber optic sensor for the detection of cholesterol concentration. The use of sensor media is a practical application of the concept of propagation, absorption, and reflection of waves to solve problems in this case the determination of the concentration of cholesterol quickly and accurately. By determining the parameters generated by an accurate fiber optic sensor and the mechanism of media usage is easily set by guiding waves through optical fibers to the solution or material which is then reflected back through the optical fiber to detect the output voltage, it can be said the use of this sensor is easy And simple as well as potential as a wave and optical learning medium.

Cholesterol is a compound that has a nucleus of four cyclopentano - fenantren rings. Includes fat with very little solubility in water. Levels in blood plasma 150-200mg / ml, about 2x blood glucose levels. In the blood plasma 30% binds to lipoproteins that can increase the solubility in the blood. Another 70% of blood cholesterol is in the form of ester cholesterol. Cholesterol is not soluble in water but can be extracted from tissues with chloroform, ether, benzene and hot alcohols. The cholesterol in the circulating blood is not in a state free, but is in the particles of lipoproteins. Lipoproteins are complex compounds between fat and protein. In serum blood lipoprotein consists of 4 types, namely kilomikron, very low density lipoprotein (VLDL), low density lipoprotein (LDL), and high density lipoprotein (HDL). Kilomikrons contain 96% of triglycerides, 1.7% protein, 1.75% cholesterol, and 0.6% phospholipids. Kilomikron acts as a fat carrier from the intestine to places where it is needed. VLDL contains 60% triglycerides, 15% cholesterol, 10% protein, and 15% phospholipids. The VLDL serves as a carrier of endogenous triglycerides from its forming sites to where it is needed. LDL contains 10% of triglycerides; 45% cholesterol, 25% protein, and 20% phospholipids. LDL serves to transport cholesterol from one cell to another where it is necessary for the formation of steroids and steroids. HDL contains 3% triglycerides, 18% cholesterol, 50% protein, and 30% phospholipids. Cholesterol is not soluble in water but can be extracted from tissues with chloroform, ether, benzene and hot alcohols. Cholesterol includes a steroidal compound with the formula $C_{27}H_{45}OH$. Cholesterol is one of the important sterols and there are many in nature. From the cholesterol formula can be seen that the hydroxyl group contained in atom C number 3 has a beta position because it is connected by a full line [2].

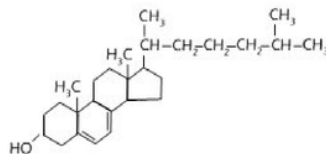


Figure 1. The compound cholesterol.

The detection of cholesterol concentrations has been done by many researchers such as sensitive electrochemical sensors and selectively using silver nanoparticles modified carbon glass electrodes for the determination of cholesterol in bovine serum [3]. Electrochemical sensors based on molecular film

molding on carbon nanoparticles are modified electrodes for the determination of cholesterol [4]. Nanotube layer of carbon nanotubes and gold biosensor-based biosensors for cholesterol detection [5]. Sensitive cholesterol detection by using positively charged gold nanoparticles [6]. The disadvantages of such sensors are sensor performance optimization such as sensitivity, linear range and detection limit is not maximal.

Another way to determine this cholesterol concentration can be determined through the character of a laser beam against the material through a fiber optic sensor. Optical fiber sensor method is more simple and cheaper to use to determine the concentration of a material [7]. One example of an optical fiber sensor to determine the salinity of a material is a simple instrument design, low price, and high sensitivity measurement results [8]. Based on this description will be developed research of fiber optic sensor as instrument model to determine cholesterol concentration by using fiber optic coupler sensor.

2. Experimental setup

The research method of determining cholesterol concentration is determined based on the character of laser beam on the material through optical fiber sensor by using Laser intensity modulation. The light beam that enters the optical fiber of the receiver and processed by the optical detector into an electrical signal to be displayed on the computer. Experimental results will be obtained linearity relationship between the peak voltage of sensor output as a function of variation of cholesterol concentration and will be measured parameter and sensor performance include sensitivity, linear range, and linearity.

The research device consisted of He-Ne lasers (632.5 nm, 5 mW), Fiber optic bundle, optical detector, chopper and chopper controller, Lock-in amplifier, flat mirrors, position micrometers (Newport), and PC.

The first step is to do the characterization of the shift sensor to know the shift of the fiber coupler sensing channel to the flat mirror. Next is to detect cholesterol concentration by making a set-up like the following picture:

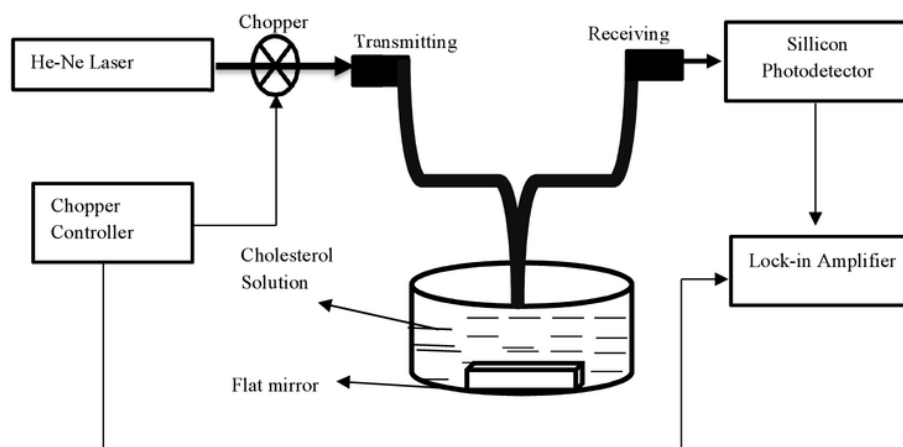


Figure 2. Experimental setup sensing the variation concentration of cholesterol using flat mirror.

The detection begins when the fiber bundle is placed close to the mirror that is shifted $z = 0$. The fiber bundle is placed on position micrometers shifted every $50 \mu\text{m}$. At each position of the shift the output voltage of the detector is measured to obtain the data in the form of output voltage of the detector as a function of the fiber coupler shift. The detection was performed on several variations of concentration including 0 ppm, 50 ppm, 100 ppm, 150 ppm, 200 ppm, 250 ppm, 300 ppm.

3. Results and discussions

Figure 3. shows a graph of the output voltage detector as a function of shifting fiber bundle for each concentration ranging 0 to 300 ppm. The figure shows the relationship changes in cholesterol concentration variations of the maximum output voltage at each concentration. The higher the Figure 3. shows the output voltage graph of the detector as a function of the fiber coupler shift for each concentration from 0 ppm to 300 ppm. The picture shows the relationship of variation of cholesterol concentration variation to maximum output voltage at each concentration. The higher the cholesterol concentration the lower the measured output voltage of the detector.

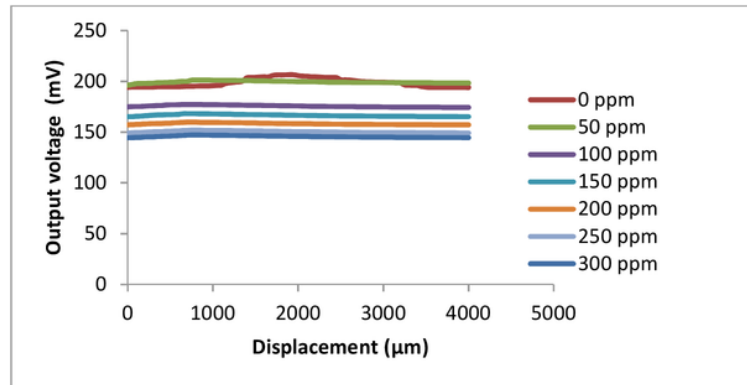


Figure 3. Output voltage against displacement for various concentration of cholesterol.

Detection data of the output voltage of the detector begins when the coupler is placed with the mirror at the shift $z = 0$. Fiber bundle placed on the micrometer position is shifted every $50 \mu\text{m}$. At each position the output voltage shift of the detector is measured. So that the data obtained in the form of output voltage of the detector as a function of the fiber coupler shift, so as to obtain the maximum output voltage from each variation of cholesterol concentration. The maximum output voltage value of cholesterol concentration variation as in table 1.

Table 1. The maximum output voltage value of cholesterol concentration variation.

Data	Concentration (ppm)	Maximum Output Voltage(mV)
1	0	206.4
2	50	201.3
3	100	177.2
4	150	168.1
5	200	159.7
6	250	151.8
7	300	147.1

Figure 4 shows that the maximum output voltage shows a linear decrease in the concentration of cholesterol solution with a sensitivity of $0.21 \text{ mV} / \text{ppm}$ and linearity of 95.09% .

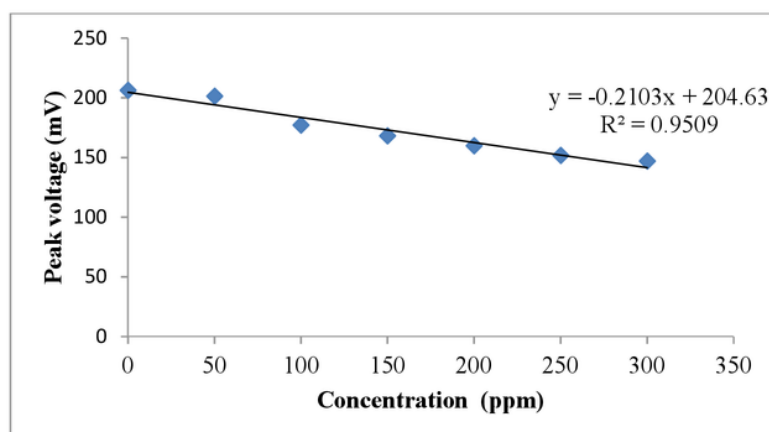


Figure 4. Peak voltage versus concentration of cholesterol.

Validation analysis of optical fiber sensor learning media to determine cholesterol concentration in optical wave learning validated by lecturer as education expert. Validation results are shown in table 2.

Table 2. The validation result of fiber optic sensor learning media by lecturer as education expert.

Rated aspect	Percentage of assessment (%)
Selection of instructional media Optical fiber sensor according to the basic competence of optical wave learning	96
Media learning Optical fiber sensor in accordance with indicators and learning objectives	96
Media learning Optical fiber sensor according to the material of optical wave properties	98
Media Optical fiber sensor in accordance with the practicum contained in the student worksheet	98
Optical fiber sensors can train students' process skills	98

Table 2 above shows that the use of optical fiber sensor learning media is compatible with optical wave learning in terms of basic competence of lectures, learning indicators, learning materials, student worksheets, and students' process skills. From the assessment of validation of learning media obtained an assessment of more than 95%.

4. Conclusion

Fiber optic sensors based on intensity modulation can detect cholesterol concentration. The results of the detection analysis showed that the maximum output voltage showed a linear decrease in the concentration of cholesterol solution with a sensitivity of 0.2103 mV / ppm and a linearity of 95.09%. the result of validation analysis of learning media of fiber optic sensor showed percentage more than 95%. With experiment result parameter and validation result of sensor learning media, fiber optic sensor can be potential as learning media to support wave and optical program learning.

Acknowledgement

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