

Improving Knowledge Of Cadets Through The Development Of An Rtl-Sdr-Based Spectrum Analyzer

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ABSTRACT

The role of instructional media in the success of the learning process should not be underestimated. As a learning tool, this media has the ability to enrich students' understanding. The Spectrum Analyzer tool has the capability to display and analyze signal frequencies. In practical activities using this tool, the Spectrum Analyzer is relatively expensive, making it inaccessible to some parties. To address this, the researcher designed a tool with broad functions similar to a Spectrum Analyzer. This study employs the research and development method with the ADDIE development model. The aim of this design study is to determine whether there is an improvement in the cadets' abilities after being provided with the Spectrum Analyzer learning media. To assess the improvement in cadet knowledge regarding the Spectrum Analyzer, pretest and posttest were utilized. After conducting these tests, the N-Gain score was calculated, resulting in a percentage of 56.089% and an N-Gain value of 0.56. According to Hake, a percentage range of 56-75% falls into the interpretation category of being moderately effective. Therefore, based on the test scores conducted, it can be concluded that this instructional media application can assist in improving cadet abilities and is considered to be moderately effective and efficient.

INTRODUCTION

The advancement of technology, especially in electronics, encourages humans to create new innovations, including in the field of signal processing. One aspect discussed in the theory of signal processing is the analysis of a spectrum analyzer, which plays a crucial role in measuring the frequency of a signal. The process of creating a device generally includes planning, implementation, and testing (Sabur & Sinaga, 2020). Among these stages, the testing phase is crucial because it is through this stage that weaknesses in the performance of the designed system can be identified.

A spectrum analyzer is a measuring device used to detect the energy distribution within a certain frequency range of the measured electrical signal (Aerts et al., 2019; Tenbohlen et al., 2023). This tool is often used in laboratory activities in the telecommunications engineering program. In addition, a spectrum analyzer is also an essential equipment for companies in the telecommunications service sector (Wahyudi & Rahayu, 2015).

The importance of the role of instructional media in the success of the learning process should not be underestimated. As a learning resource, this media has the ability to enrich students' understanding. By utilizing various types of instructional media, teachers can convey knowledge to students more efficiently (Nurrita, 2018; Puspitarini & Hanif, 2019; Winarto et al., 2020).

RTL-SDR is a radio application that utilizes open-source hardware and software to convert signals into digital data that can be processed by a computer(Harianto et al., 2020; Stewart et al., n.d.). There are various variants of RTL-SDR, and one of them is an affordable type based on the USB DVB-T Receiver dongle with the 820T2 chip and SDR inside. This device functions to receive and convert radio signals into a digital format that can be processed by a computer(Pratama & Tresnawan, 2022).

Spectrum analyzers have a relatively high price, making it difficult for all relevant parties to afford one(Putri Anggraeni et al., 2021). Therefore, the author has innovated to address this challenge by creating software that, in essence, can provide similar functionality to the original spectrum analyzer. Additionally, it is expected that this software can serve as a learning tool and support educational activities, contributing to the improvement of knowledge and the quality of the cadets.

RESEARCH METHOD

In this study, the researcher utilizes the Research and Development (R&D) research method by applying the ADDIE development method, which consists of five steps: Analysis, Design, Development, Implementation, and Evaluation(Budoya et al., 2019; Rustandi, 2021; Stapa & Mohammad, 2019). This method was chosen to develop and test a beneficial product. The author opted for this method because the involved process aligns with the stages in ADDIE, starting from literature analysis, flowchart composition, design development, to evaluation

1. Analysis

The first step is to conduct an analysis of the product development needs, including the model, method, media, and learning materials. The preparation process involves gathering data from various relevant journals, conducting in-depth studies on related theories, and utilizing references from sources such as online forums or articles related to the program to be developed(Safitri & Moonlight Lady Silk, 2022). This research employs the Python programming language in its design process, with a laptop and a spectrum analyzer as the hardware to be used.

2. Design

The process starts with conceptualizing the idea for the product. Instructions regarding the application of design or product manufacturing are recorded clearly and in detail. At this stage, the product design is still in conceptual form and will serve as the foundation for development in the next phase.

3. Development

This step involves the implementation of the previously planned product design. In the previous phase, a conceptual framework was created to apply the new product. The conceptual framework that has been formulated is then realized into a ready-to-use product.

4. Implementation

To obtain feedback on the created product, an initial evaluation phase is conducted by inquiring about matters related to the product development objectives. The implementation is carried out with reference to the prepared product design. The creation of this product aims to streamline the learning process. Considering that Spectrum Analyzers fundamentally entail high costs, this project aims to provide a more efficient and economical solution.

5. Evaluation

The evaluation is conducted to obtain feedback from product users, allowing for

adjustments based on the evaluation results or any unmet needs of the product. Improvements are made to address potential errors that may arise during the production stage. The ultimate outcome of the evaluation is to assess the extent to which the set objectives have been achieved.

RESULTS AND DISCUSSION

1. Analysis

In this phase, an analysis of the necessary resources for this research has been conducted. For software needs, a software-defined radio with the Python programming language is required. As for hardware, a laptop and a spectrum analyzer will be used to validate the project. The initial step, as shown in Figure 1, involves configuring the software by installing the Python application. This Python application is utilized as the programming language for software development, data processing, artificial intelligence implementation, and web development(Saragih, 2018).

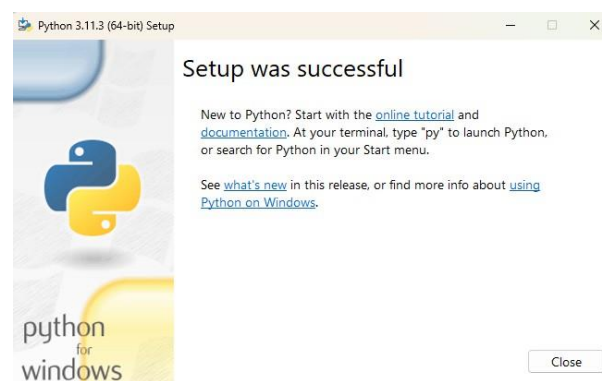


Figure 1. Installing The Python

In addition to installing Python, the installation of Visual Studio Code is also carried out. Visual Studio Code is a source code editor that can be used for various programming languages. This application supports a variety of programming languages, including JavaScript, Python, C++, Java, and PHP. As shown in figure 3 is install the driver using the Zadig application as the driver used to operate the Software-Defined Radio (SDR) in the project.

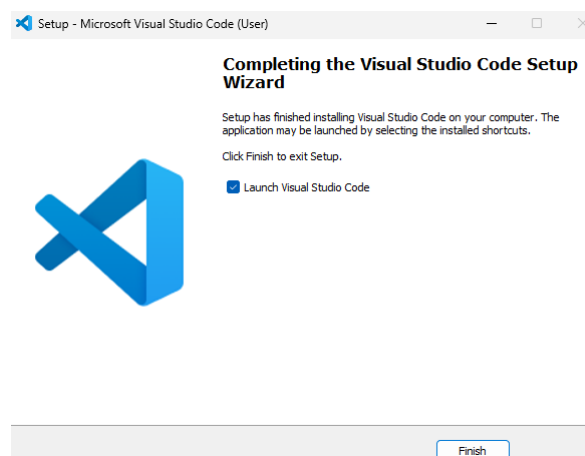


Figure 2. Installing Visual Studio Code

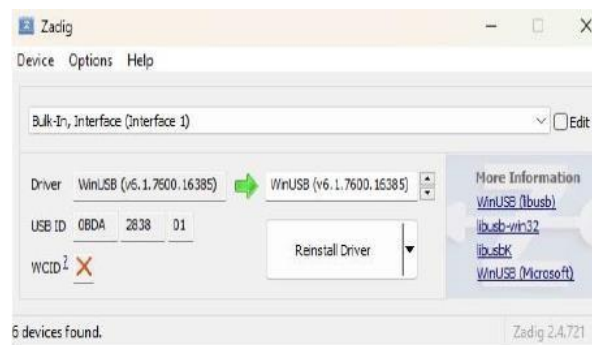


Figure 3. Installing Driver

2. Design

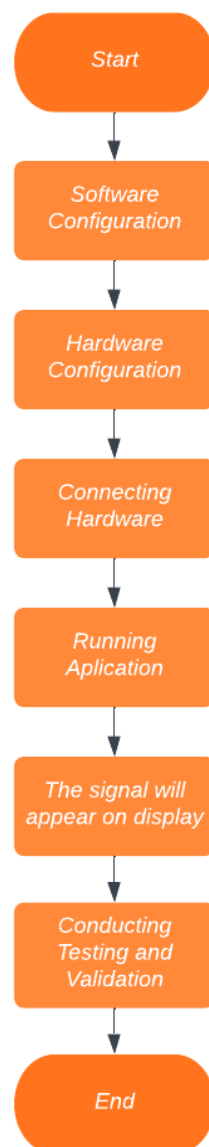


Figure 4. Design Flowchart

The following is an overview of a laptop that has been equipped with Python and connected to an RTL-SDR dongle via a USB port as the input, with a micro USB used as the cable. The antenna serves as the transmitter connected to the input port of the RTL-SDR.

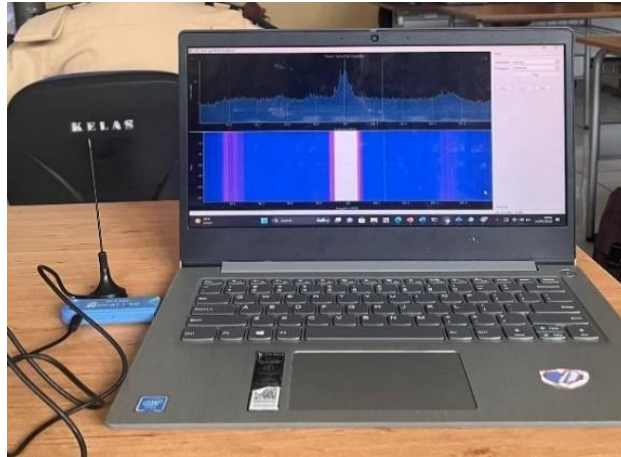


Figure 5. Equipment Design

3. Development

The development stage is a step to validate the success of the created project. The results of the validation testing will be revised until the tool meets the requirements for use as a more economical and efficient learning tool.

A. Testing with SDR Receiver

The initial step is to open the designed software application. This application contains features such as buttons to decrease or increase frequency. There are also features for setting the center frequency, connecting, and adjusting the bandwidth. In the image below, it is found that the experiment aligns with the settings made initially. The displayed signal shows a center frequency of 39.998 MHz, which corresponds to the setting on the frequency counter, namely 40 MHz.

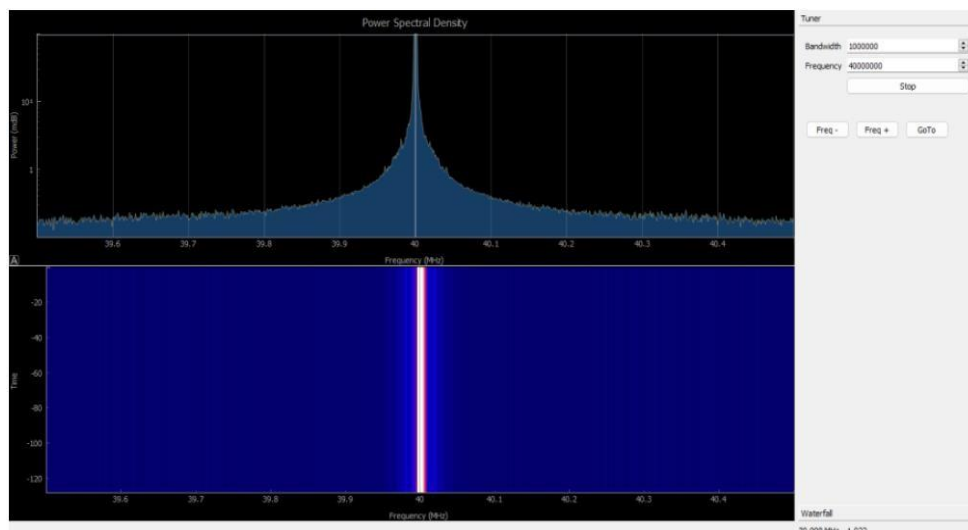


Figure 6. The frequency of 40 MHz set in the application.

B. Testing the Receiver with a Spectrum Analyzer

The center frequency is set to 40 MHz. The result is obtained as shown in figure 7. This display is used to compare the signal output from the spectrum analyzer with the designed application.

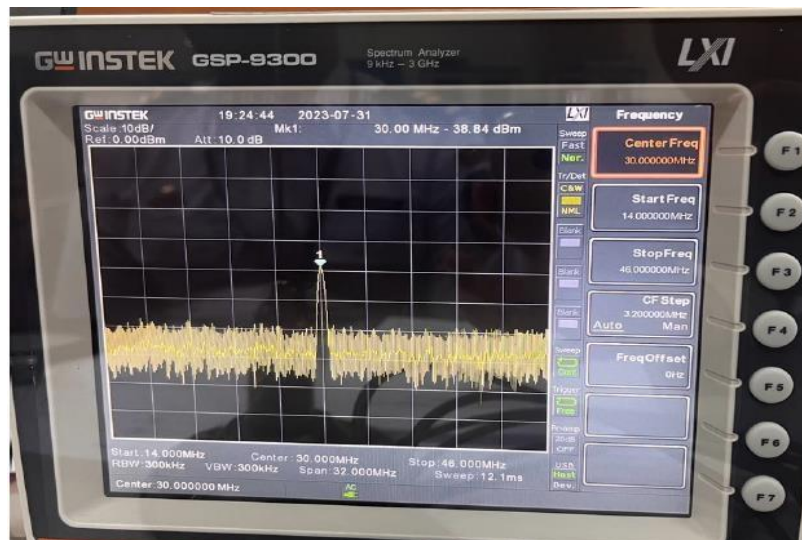


Figure 7. The frequency of 40 MHz set on the Spectrum Analyzer.

4. Implementation

Table 1. N-Gain Score.

NO	Posttest	Pretest	Post-Pre	Ideal score (100-Pre)	N Gain score	N gain score %
1.	70	50	20	50	0,4	40
2.	80	55	25	45	0,55555556	55,55555556
3.	80	50	30	50	0,6	60
4.	77	50	27	50	0,54	54
5.	85	58	27	42	0,64285714	64,28571429
6.	78	50	28	50	0,56	56
7.	80	50	30	50	0,6	60
8.	81	56	25	44	0,56818182	56,81818182
9.	82	56	26	44	0,59090909	59,09090909
10.	82	60	22	40	0,55	55
11.	72	48	24	52	0,46153846	46,15384615
12.	71	46	25	54	0,46296296	46,2962963
13.	80	52	28	48	0,58333333	58,33333333
14.	78	52	26	48	0,54166667	54,16666667
15.	74	50	24	50	0,48	48
16.	77	50	27	50	0,54	54
17.	79	50	29	50	0,58	58
18.	84	54	30	46	0,65217391	65,2173913
19.	84	58	26	42	0,61904762	61,9047619
20.	79	52	27	48	0,5625	56,25
21.	79	52	27	48	0,5625	56,25
22.	80	50	30	50	0,6	60
23.	85	55	30	45	0,66666667	66,66666667
24.	78	52	26	48	0,54166667	54,16666667
Mean	78,95833	52,33333	26,625	47,66666667	0,56089833	56,08983291

After meeting the requirements for use, this media will be applied in the learning process for cadets. Implementation is the fourth stage in the ADDIE development model. This media serves as a learning tool and can also be used to reinforce cadets' interest in further understanding programming. The testing of this learning media is proven through n-gain score testing via post-tests and pre-tests given to cadets at the Surabaya Aviation Polytechnic.

In the table above, it explains the calculation of n-gain score testing. The average n-gain score is found to be 56.089. According to Hake.R in (Yanti Dwi, 2018), testing Normality of Gain is a method that can provide an overall overview of the improvement in learning outcome scores before and after a treatment or intervention is applied, in the category of interpreting N-Gain effectiveness(Arif et al., 2023), a value of 56.089 falls into the category of being moderately effective. According to Meltzer and Syahfitri (2008: 33), the division of N-Gain score values consists of three categories: low, moderate, and high. With the value produced in this research, the score of 0.56 falls into the moderate category because 0.56 is greater than 0.3 and less than 0.7 ($0.3 \leq g \leq 0.7$).

5. Evaluation

Several trials have been conducted on the application design with the aim of facilitating cadets in their learning process. The results of these tests have revealed a number of criticisms and suggestions that can be used as feedback for improvement. The author then plans several steps to enhance the design based on the feedback provided. This application has the advantage of flexibility because it is lightweight and easy to carry to various locations. With the presence of this application, users can reduce the costs associated with conducting learning or using a spectrum analyzer, without the need to spend a significant amount on purchasing a factory-made Spectrum Analyzer. However, the application has a drawback, as it heavily depends on SDR, where the frequency generated is dependent on the frequency range supported by the SDR. If the frequency exceeds or falls short of what is specified in the SDR, it can lead to delays on the laptop or in the application.

CONCLUSION

The main objective of this research or project is to enhance cadet knowledge through the development of an RTL-SDR-based Spectrum Analyzer. By utilizing RTL-SDR technology, it is expected that cadets can gain deeper insights into the analysis and measurement of frequency signals. In this design, the tool operates effectively and according to its function. This can also be deemed as good and suitable for learning purposes because there is a significant change and improvement in cadet knowledge in studying the spectrum analyzer. This increase in knowledge is demonstrated through the N Gain score test with a percentage of 56.089%. And the N Gain value is 0.56.

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