

Designing Comprehensive Independent Learning Interactive Multimedia and its Resources Demands

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Abstract

Generally, multimedia project refers to a combination of two or three types of media, such as texts, images, animations, applications, and videos, and is easily decompiled. This research produces interactive multimedia with five types of media using ActionScript. Using an external XML file as the connector between interface and contents, this interactive multimedia becomes reusable and developable. This multimedia project is flash based with the extensions *.swf and *.exe. To protect from decompiling, the project uses layered encryption combined with As3Crypto encryption. Based on test results, Sothink SWF Decompiler software cannot decompile and display all the properties of the project. In this research, the analysis highlights multiplatform, standalone, media types, content types, exercises system, responsive, reusability, developability, energy efficiency, layered encryption and independent learning. Based on test results, the project has been tested and participants declared that they can use all contents and navigations easily and it ran normally on the devices used.

Keywords: interactive multimedia, multimedia security, multiplatform, standalone, independent learning

1. Introduction

Generally, interactive multimedia consists of two or three types of media, i.e. texts, images, animations, applications, and videos [1]. In education, interactive multimedia is used to improve the effectiveness and efficiency of learning activities. In this research, the flash project is published in the Shockwave file format with the extension *.swf. The Shockwave file format is an open file format [2] which has security issues; for example, it is easy to decompile the source file using SWF decompiler software [3]. This research produces interactive multimedia by combining five types of media using ActionScript [4],[5] and examining how to protect the *.swf file projects from illegal decompiling using layered encryption combined with As3Crypto encryption [6]. This layered encryption is an effort to suppress decompiling issues and plagiarism of the flash platform multimedia project, because the unencrypted SWF file project can be decompiled easily using popular SWF decompiler software such as Sothink SWF Decompiler. If the multimedia file is decompiled, the output file will be converted to *.fla format, enabling modifications to be made to the project file and showing all properties and assets including ActionScript inside.

The kind of integration method where the interactive learning multimedia project is published in one file that consist of the interface and all contents will make it difficult to modify the contents and hard to develop the project. To solve this problem, the interactive multimedia product should be separated into the interface and contents using an external XML file [1]. With this technique, we can change and develop the interactive multimedia contents quickly and easily. In the implementation stage, an interactive learning multimedia about the antenna system was developed for vocational students who refer to the SKKD untuk SMK Teknik Telekomunikasi (Standard Curriculum for Vocational Students in Telecommunication Engineering Field) [7] and BSE SMK Teknik Telekomunikasi Jilid I (Telecommunication Engineering Text Book for Vocational Student, Volume I) [8]. This subject was chosen because for vocational education only a few interactive multimedia concerning the antenna system subjects exist. In this project, the subject is presented using five types of media, i.e. texts, pictures, animations, applications, and videos (for the tutorial and practical guide).

This interactive multimedia model will be useful, especially for vocational and engineering education and for many independent learning activities, which are generally

dominated by practical activities. Designed as comprehensive multimedia, there are ten highlights:

- a. Multiplatform Operating System. This interactive multimedia program can run on three types of operating systems i.e. Windows, MAC OS, and Linux, includes Mobile OS (Android).
- b. Standalone. This multimedia project is published in an executable format.
- c. Media Types. This interactive multimedia program includes five types of media, i.e. texts, images, animations, applications and videos.
- d. Content Types. This interactive multimedia covers all the basic stages of learning activities, consisting of introduction, main subject, motivational materials, questions and solutions, exercises, additional applications, videos [9] and email form (for communication between students and teacher).
- e. Encryption. This interactive multimedia program has been protected with layered encryption and combined with As3Crypto encryption.
- f. Responsive. This interactive multimedia program can run on various devices, such as desktops, tablets and smartphones, with various screen resolutions, aspect ratios and screen sizes.
- g. Reusable and Easily Developable. The contents can be changed or repaired quickly and developed easily in terms of overall contents [10].
- h. Energy Saving. By applying a dark/black theme, this interactive multimedia program is designed so that it can save on energy usage during the display process [11]. This is an effort to encourage the development of interactive multimedia that is environmentally friendly.
- i. Exercises System. There are some features, i.e. passing score, time limiter, multitype questions including essay questions, randomisation of questions, randomisation of answer choices, and the number of questions displayed from the question bank. After the exercises finish, the student can review the exercise process, so they will know which is the right and the wrong answer. Then, the test result can be printed out using the print feature. Besides this, the teacher will receive the student's test results automatically via email.

Independent Learning Concepts [12]. This interactive multimedia program is designed for independent learning activities. This project is bundled with complete contents, features and basic stages of learning, as well as hints.

2. Research Method

The research method here is a literature study [13],[14] and experiment. This research begins with collecting references, designing interface and contents, producing interface and contents, and associating interface and contents. To measure the performance of interactive multimedia program produced, the interactive multimedia is tested, which includes resource usage monitoring, device compatibility testing, operating system compatibility testing, multimedia security testing, and user response testing.

2.1 Research and Designing Flowchart

The flowchart in Figure 1 describes the steps in designing and producing this interactive multimedia project.

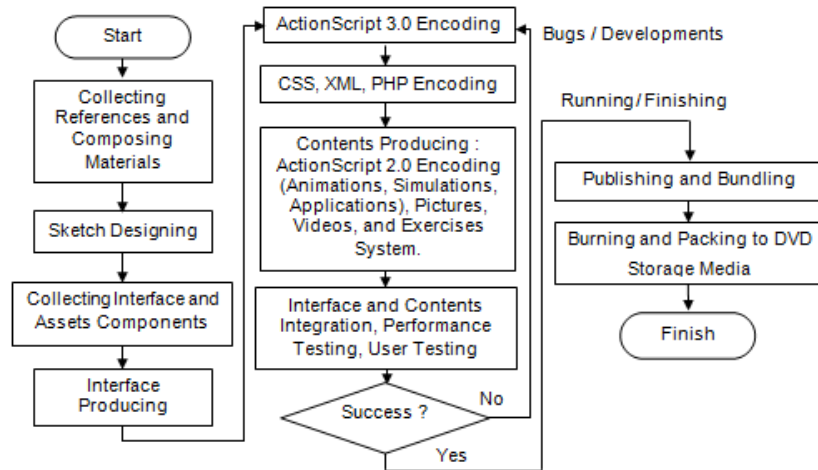


Figure 1. Research and Designing Flowchart

2.2 Interactive Multimedia System Flowchart

This flowchart describes how this multimedia works, multimedia structure and components included inside.

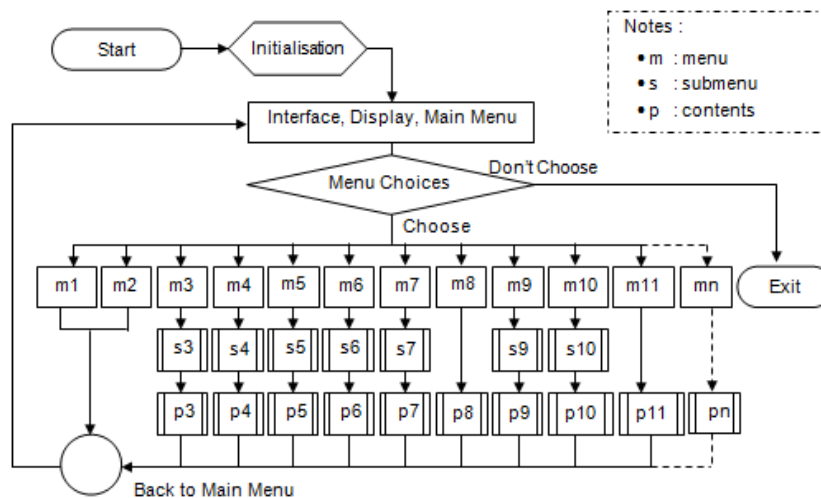


Figure 2. Interactive Multimedia System Flowchart

2.3 Content Execution Flowchart

This flowchart depicts a programming hierarchy and how these interactive multimedia components are executed through the program code created.

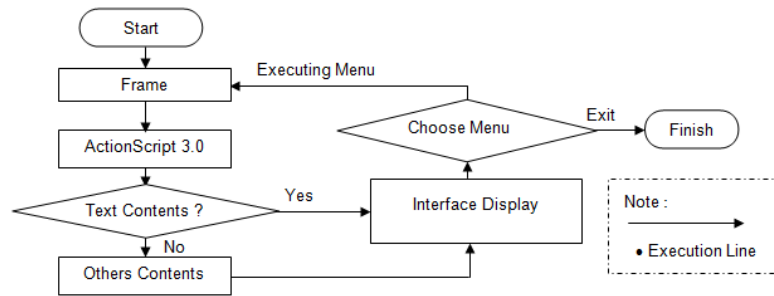


Figure 3. Content Execution Flowchart

2.4 Design Specifications

This project is designed to meet the following specifications:

- (1) The sample subject is restricted to the antenna system subject of Indonesia vocational students with reference to SKKD untuk SMK Teknik Telekomunikasi (Standard Curriculum for Vocational Students in Telecommunication Engineering Field) [7] and BSE SMK Teknik Telekomunikasi Jilid I (Telecommunication Engineering Text Book for Vocational Student, Volume I) [8];
- (2) standalone and multiplatform for 32 bit, 64 bit and mobile operating systems (Windows, Linux, Mac OS, and Android);
- (3) publish target to Flash Player 11.2;
- (4) 1 gigabyte storage harddisk capacity of target;
- (5) screen resolution standard: 1024 x 768 pixels;
- and (6) published in Shockwave file (*.swf) and Projector (*.exe) format.

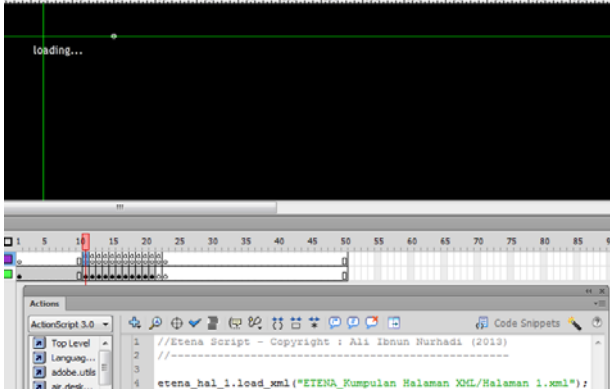
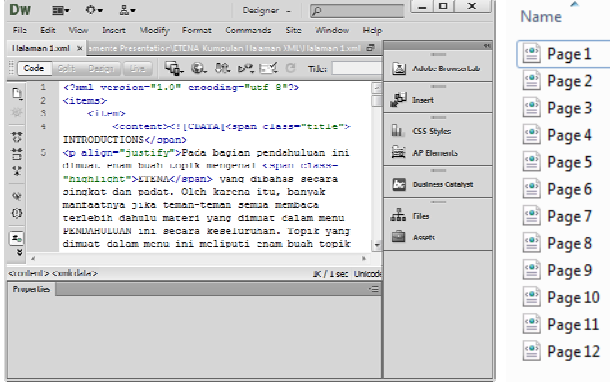
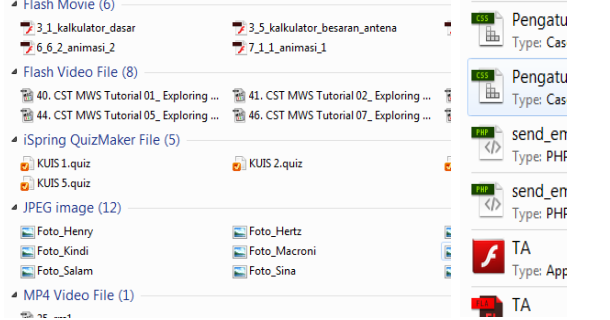
2.5 Flash Player 11.2 Minimum System Requirements

Table 1. Flash Player 11.2 Minimum System Requirements [15]

	Windows	Macintosh	Linux	Android
Processor	2.33 Ghz or faster x86-compatible processor, or Intel® Atom™ 1.6 GHz or faster processor for Netbook class devices	Intel® Core™ Duo 1.83 GHz or faster processor	2.33 Ghz or faster x86-compatible processor, or Intel Atom™ 1.6 GHz or faster processor for Netbook class devices	ARMv7 processor with Vector FPU, Minimum 550 MHz, OpenGL ES2.0, H.264 & AAC H/W Decoders
Operating System	Microsoft® Windows® XP (32-bit), Windows Server® 2003 (32-bit), Windows Server 2008 (32-bit), Windows Vista® (32-bit), Windows 7 (32-bit and 64-bit)	Mac OS® X 10.6 and Mac OS X 10.7	Red Hat® Enterprise Linux (RHEL) 5.6 or later (32-bit and 64-bit), openSUSE® 11.3 or later (32-bit and 64-bit), Ubuntu 10.04 or later (32-bit and 64-bit)	Android 2.2, 2.3, 3.0, 3.1, 3.2 and 4.0
Memory	128 MB of RAM (1GB RAM recommended for netbook class devices), 128 MB of graphics memory	256 MB of RAM, 128 MB of graphics memory	512 MB of RAM, 128 MB of graphics memory	256 RAM

2.6 Interface and Encoding Method

Table 2. Interface and Encoding

Captures	Function (As)	Representative Codes
	<p>Interface</p> <p>Interfaces > Scenes > Layers > Frames > Movie Clips Target > ActionScript 3.0</p>	<pre>etena_hal_1.load_xml ("ETENA_Kumpulan Halaman XML/Halaman 1.xml");</pre>
	<p>Connector</p> <p>External XML Files</p>	<pre><?xml version="1.0" encoding="utf-8"?> <item><content> <![CDATA[INTRODUCTIONS <p align="justify">Pada bagian pendahuluan ini <p align="center"></p> </content></item></pre>
	<p>Contents</p> <p>Pictures, Animations, Applications, Videos, Quiz, PHP Script, CSS.</p>	<pre><?php \$contact_name = \$_POST['name']; \$contact_email = \$_POST['email']; \$contact_message = \$_POST['message']; if(\$contact_name == true) { }?></pre>

2.7 Encryption Method

The encryption technique used is layered encryption technique combined with As3Crypto encryption (library). To encrypt the file project, two additional tools are used, i.e. Hexa Editor using Hex-Ed Software [16] and Flash Builder [17] for encoding requirements. The security and vulnerability of the encrypted file is tested using Sothink SWF Decompiler software version 7.4 [18]. To compare test results, commercial encryption software was used, namely Amayeta SWF Encrypt encryption software version 7.0 [19]. The steps of the layered encryption techniques are shown in the Table 3.

Table 3. Layered Encryption Steps

Step	Process	Descriptions	Example Captured	Layers	Decompiler Test
1	Load SWF at Runtime	Protect and embed SWF as binary data using the Embed tag.	<pre>1 [Embed (source = "etena.swf", 2 mimeType = "application/octet 3 private var content:Class;</pre>	1	The assets and the original code disappears
2	Decompressing the SWF File				
3	Creating Utility	Reading the uncompressed header and create compress function.			
4	Uncompressing the Loading SWF				
5	Analyzing Hex Code				
6	Adding as3crypto Encryption		<pre>1 var aes:AESEncrypt = new AESEncrypt(binKey); 2 var bytesToEncrypt:int = (data.length 3 for (var i:int = 0; i < bytesToEncrypt 4 aes.encrypt(data, i);</pre>	2	ActionScript was hidden in thousands lines of encryption code.
7	Encrypting Data	Adding as3crypto Encryption (library), modifying the loading SWF.			
8	Encryption Utility				
9	Modifying the Loader		<pre>/4 65 3E 3E ZW1W</dc:date>< 74 69 6F 6E /rdf:Description 44 10 E8 03 </rdf:RDF>.D... 00 06 00 00 <.C.....Z..... F0 9D 32 26 ..:.....2& 45 21 01 00 ..:.....?.. 6C A1 41 63 ..:.....1.Ac 06 64 E7 F8 *.q.&.....d.. F8 88 A2 8F T...h..R..... 88 28 A2 3E .n...Jn...(D7 01 70 CD ..Q....T.b....p.</pre>		
10	String Obfuscation : Renaming the Package, Classes, Functions and Variables.	Rename package, classes, functions and variables to unusual labels such as : This unusual labels will be matters to the decompiler but not to the Flash Player.		3	The Sothink SWF Decompiler Software cannot decompiling the encrypted SWF file.

2.8 Exercise Results Targeted [20]

The exercise results will be sent to the email server (use instructor’s email account) through an Internet connection. The system indicating works well if students can review exercise worked on and print the test results and if the teacher receives the summary of test results via email. Figure 5 describes the purposed process.

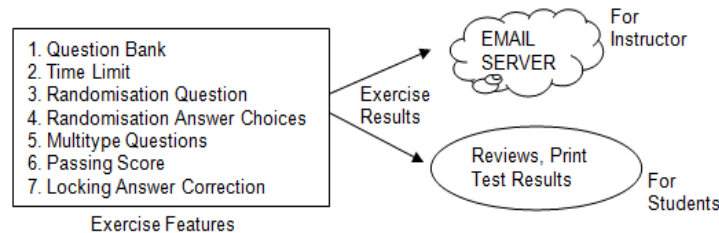


Figure 4. Exercise Results Process

2.9 Interactive Multimedia Testing

Before the system designed was tested, everything that was needed was prepared, for example: (1) The system to be tested, (2) software and hardware to be used for measurement/ testing, (3) the other additional requirements to accomplish every measurement/ test needed.

2.9.1 Resources Usage Monitoring

Resource usage monitoring will be conducted to find out the resource usage of the interactive multimedia. It is done using the Anvir Task Manager Pro 7.2 [21] with the following parameters [22]:

- a. Hardware: Intel Pentium i7 2720QM Processor 2200 MHz, 4 Gb DDR3 of Memory, Intel HD Graphics Family (Switchable) NVIDIA GeForce GT 540M 2 GB of Graphic Memory.
- b. The test is performed three times (three periods). Each period is done in a span of one hour, which is the total time needed to review all this interactive multimedia menu and contents.
- c. Monitoring is carried out on the usage of the processor, memory and harddisk.

2.9.2 Device Testing

The test is performed to examine directly the usage of interactive multimedia on a variety of devices with various screen width, screen resolution and aspect ratio. Testing was performed using four types of devices such as desktop, laptop, tablet, and smartphone.

2.9.3 Operating Systems Testing

Based on Flash Player data compatibility for various operating systems, the test is performed to find out directly how this interactive multimedia runs on various operating systems, including:

- a. Windows : XP SP2 32 bit, Vista 32 bit, Windows 7 Ultimate 64 bit, Windows 8 64 bit.
- b. Mac OS : Mac OS X 10.6 32 & 64 bit
- c. Linux : Ubuntu 10.4 32 bit, RHEL 5.6 32 bit, openSUSE 11.3 32 bit, Android 4.0 ICS.

2.9.4 Security Testing

The test is performed by using software Sothink SWF Decompiler version 7.4. This software is popular as decompiler software for the *.swf file format. The test is conducted to discover the vulnerability of the SWF file project without encryption, and test the robustness of layered encryption and Amayeta SWF Encrypt encryption.

2.9.5 User Testing

User testing is conducted with 30 participants who are vocational high-school students who are taking the antenna system subject. Participants were not conditioned before, used various devices, operating systems and each of the participants had a different way to explore the interactive multimedia product.

3. Results and Discussion

3.1 Interactive Multimedia Overviews (Main Interface, Content Types, Media Types)

Here are screen captures of the interactive multimedia product and interface, which consist of eleven menu buttons and an exit button. Besides this, also presented are screen captures of interactive multimedia contents that represent the content and media types of this interactive multimedia program.



Figure 5. Example Captures of Interactive Multimedia Product (Outer and Inner CD Product)

The following screen captures are some images displaying the product:

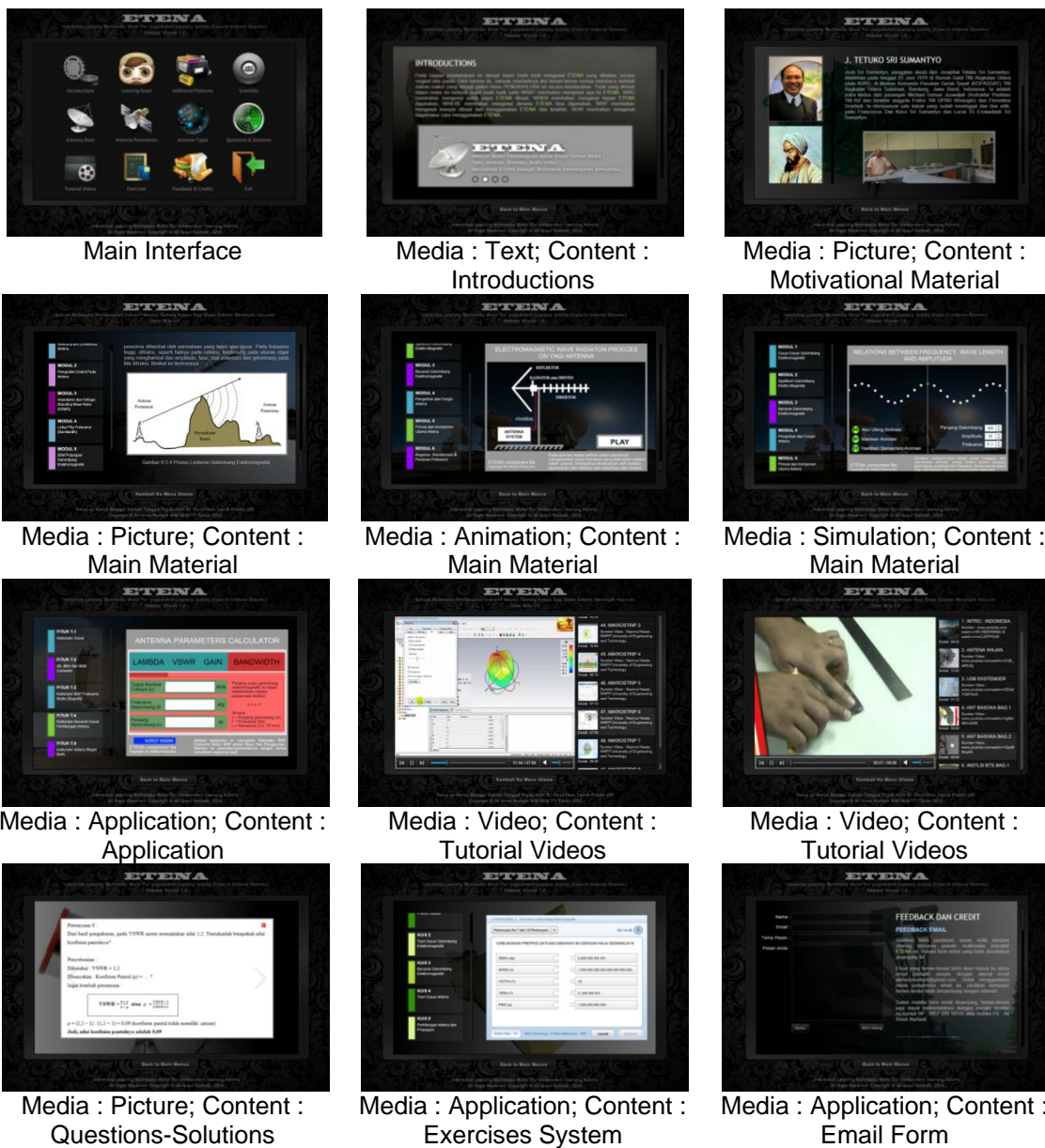


Figure 6. Interactive Multimedia Product: Screen Capture Overview

3.2 Resource Usage Monitoring Results

The following screen captures are of the resource usage monitoring of processor, memory and harddisk, which are performed in three sequential periods:

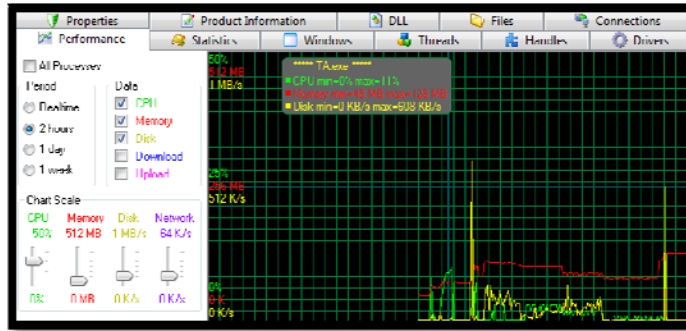


Figure 7. Measurement (1) Processor, Memory and Hard Disk Usage Graph

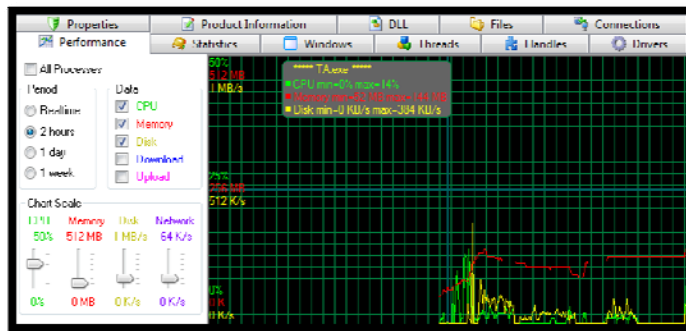


Figure 8. Measurement (2) Processor, Memory and Hard Disk Usage Graph

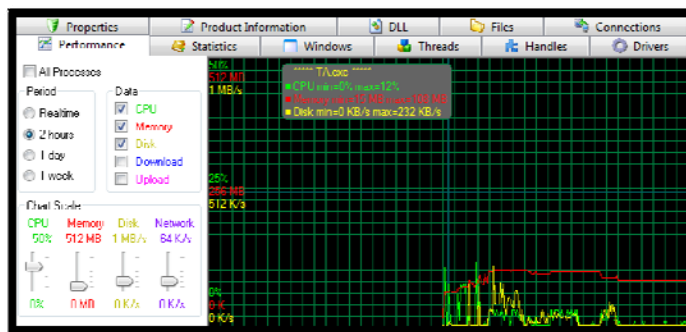


Figure 9. Measurement (3) Processor, Memory and Hard Disk Usage Graph
Here is the summary of the resource performance measurement results:

Table 4. Resource Performance Measurement Results

No	Parameter	Measurement 1 (Peak)	Measurement 2 (Peak)	Measurement 3 (Peak)
1.	Processor	966 MHz	1229 MHz	1054 MHz
2.	Memory	128 Mb	144 Mb	108 Mb
3.	Harddisk	608 KB/s	384 KB/s	232 KB/s

Based on the monitoring results above, this interactive multimedia does not require large resources. It is even below the value of the minimum system requirements of Flash Player 11.2 (Table 1). The monitoring results indicate that this interactive multimedia will be running normally and smoothly.

3.3 Device Testing Result

Table 5. Device Testing Result

Device	Processor	Memory	Graphic Memory	Screen Size	Graphic Standard	Pixel Resolution	Ratio	Result
Desktop	Intel Core i3 4130	2 GB	1 GB	18.5 inch	XGA	1028 x 768	4:3	OK
					HD/WXGA	1280 x 720	16:9	OK
					WXGA	1280 x 768	5:3	OK
					WXGA	1366 x 768	16:9	OK
Laptop	Intel Core i7 2670 QM	4 GB	2 GB	14 inch	XGA	1028 x 768	4:3	OK
					HD/WXGA	1280 x 720	16:9	OK
					WXGA	1280 x 768	5:3	OK
					WXGA	1366 x 768	16:9	OK
Tablet	Qualcomm Snapdragon 800	3 GB	Adreno 330	10.1 inch	WQXGA	2560 x 1600	16:10	OK
Smart Phone	ARM Cortex-A8	512 MB	Adreno 330	7 inch	WSVGA	1024 x 600	16:10	OK

Based on the test results on various devices, with its specifications as listed in the table 4, it was proven that this interactive multimedia can run normally and smoothly. This test data shows that this interactive multimedia is responsive.

3.4 Operating System Testing Results

Table 6. Operating System Testing Results

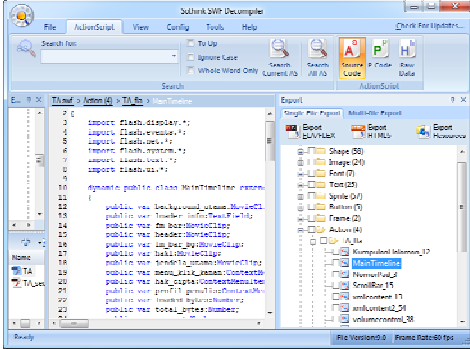
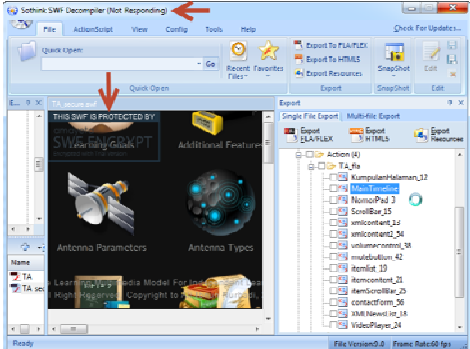
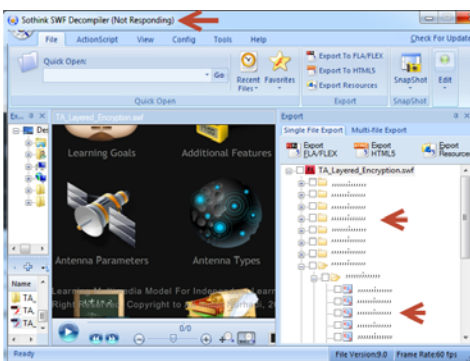
No.	Operating System	Version	Result
1.	Windows	XP SP2 32 bit	Running OK
		Vista 32 bit	Running OK
		7 Ultimate 64 bit	Running OK
		8 64 bit	Running OK
2.	Mac OS	X 10.6 32 & 64 bit	Running OK
		Ubuntu 10.4 32 bit	Running OK
3.	Linux	RHEL 5.6 32 bit	Running OK
		openSUSE 11.3 32 bit	Running OK
		Android 4.0 Ice Cream Sandwich	Running OK

Table 6 above describes the test results for various operating systems. Based on the test results, this interactive multimedia can run normally on Windows, Mac OS, and Linux in various versions that are listed in the table above. This is in accordance with the data of Flash Player system requirements. The flash platform project can run on various operating systems (Windows, Mac OS, Linux).

3.5 Security Testing Results

The following table (7) shows the screen captures of the decompiling test results and their encryption/ decryption explanation.

Table 7. Security Testing Results

Screen Captures	Encryptions	Descriptions
	Not encrypted	Sothink SWF Decompiler can decompile the SWF file project, and all assets including the ActionScript Code are visible clearly.
	Encrypted by Amayeta SWF Encrypt 7.0	Sothink SWF Decompiler is not responding (crashes) and cannot decompile the SWF file project. However, all properties labels are still visible.
	Manual Layered Encryption	Sothink SWF Decompiler is not responding (crashes) and cannot decompile the SWF file project. It happens when the compiler encounters unusual characters inside identifiers, it fails to parse them, and thus fails to decompile the project. On the other hand, the player does not have any problems with those unusual labels.

The screen captures in table 7 show that Sothink SWF Decompiler software cannot decompile (does not respond/ crashes) the encrypted SWF file and cannot define all property assets and ActionScript inside. This happens when the decompiler software encounters unusual characters inside identifiers, fails to parse them, and thus fails to decompile the program. When the Sothink SWF Decompiler failed to parse the encrypted project, then the software does not respond and crashes. Even if the software was successful at parsing the characters, it would face another two encryptions.

3.6 Users Testing Results

For this final test, 30 participants were involved. All participants explained that (1) they can use all the interactive multimedia contents and navigation systems easily, (2) this interactive multimedia can run normally on each device they are using, (3) they preferred to work with this interactive multimedia program for antenna system learning activities. In the other words, this system is robust and user friendly.

4. Conclusion

This interactive multimedia program is suitable for independent learning activities with examination highlighting aspects of its multiplatform operating system, standalone usage, media types, content types, exercises system testing, responsiveness, reusability, developability, energy saving (energy efficiency), layered encryption and independent learning concept. The layered encryption technique that was applied to this interactive multimedia program proved that this encryption is effective for protecting against SWF decompiler software, in this case Sothink SWF Decompiler. Interactive multimedia production by separating interface and contents by connecting an external XML file is the solution for interactive multimedia production that can be reused and developed easily. This interactive multimedia does not require high system specifications and can run on various devices including mobile devices. Besides this, this interactive multimedia program runs on Windows, Mac OS, Linux, and Android. This interactive multimedia is suitable for vocational and engineering education that is dominated by practical activities. Based on the test results, all participants declared that they can use all contents and navigations easily and it can run normally on the device they are using. In other words, this system is robust and user friendly.

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