RAMS
Reliability, Availability,
Maintainability, and Safety

This is the Title of my Thesis

Your Name

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PROJECT THESIS

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Contents

Chapter 1

Introduction

File recovery from digital data storage devices has been a hot topic among the Digital Forensics field. Traditional data storage devices make use of a file system, in order to manage contained data, their available space and to maintain location of files. When the storage device and their file system are intact, it is quite simple to recover data from them. This is mainly because file systems make use of meta-data in order to track information for their files. Meta-data can contain information such as creation date, data struc- ture (e.g directory or regular file), file type, file owner, size, last modified date etc. In a real life forensic case it is highly unlikely that file meta-data will be present, or they might be corrupted or deleted. It became clear for the digital forensic community that an alternative, more realistic approach must be used.

1.1 Background

File carving is a forensics technique that recovers files based on their content, without relying on their meta-data. File carving process involves two steps. File validation and file reconstruction.[1]. During the recovery procedure, we must first validate the type of the file and then apply the appropriate reconstruction technique. In this thesis, only the validation techniques are of our interest. By examining the content (the actual byte-code) and/or the structure of a file [22], file validation techniques are used to classify its type. Several file types contain common structures like headers, footers (named Magic Number Matching) [7][3], fields that specify file attributes like color or size etc.(Data Dependency Resolving [3]), that can be used to identify the type of the file. Additionally, another approach is to apply statistical analysis techniques and algorithms, which use the complete byte code of a file, creating a fileprint for every file type. Some examples are the n-Gram Analysis [9], the Byte fre- quency analysis (BFA) algorithm and the Byte frequency cross-correlation (BFC)[4]. The aforementioned techniques have some profound weaknesses. The Magic Number Matching and the Data Dependency Resolving approaches make general type classification infeasible. This is due to the fact that not every 2file type contains such structures. Furthermore, n-Gram Analysis and both BFA and BFC were designed to be applied in a complete file or a pre-defined part of it, which retains all of its content. Hence, they depend on files inter- nal structure and characteristics.

Problem Formulation

So why this is a problem? The answer lies in file systems behaviour and file fragmentation. When we delete a file from a media storage, the data are not actually removed. The clusters in which the file was stored still contain the same data, although the file system mark them as unallocated [2]. Which means that the next time a new file is created, the file system is free to use these clusters, which are marked as unallocated, to store the new file. But if the new file is bigger than the old one, and the file system tries to store it starting from the same cluster entry as the deleted one, it wont have enough space to store it. So the file system will allocate all the clusters of the previ- ous deleted file, while the remaining data which do not fit, will be stored to other unallocated clusters. This results to file fragmentation. In a forensic file recovery case, it is more probable that the files that must be recovered are fragmented. Validation techniques which use the complete file content are high unlikely to provide aid to forensic examiners. Hence, an alternative approach to file type validation must be taken. File fragment classification is a technique that uses only a small fragment of a file, in order to determine its type. Ergo, file fragmentation is not a problem any more as this approach is independent from files overall struc- ture. Although in theory file fragment classification looks like an ideal so- lution, in practice current solutions that use this approach could not yield good results[6][22]. One reason that file fragment classification is difficult, is due to the complex container files. Complex container files like TAR, ZIP, RAR, PDF etc. contain other primitive file types, making general fragment classification difficult. Moreover, a fragment might contain more data which are strongly related to the files content than the files structure

1.2 Objectives

Although general fragment classification is difficult (due to lots of file formats containing large blocks of highly compressed data that look similar to a classifier), a large amount of file types consist of or at least contain, (plain) text data. In this project our main objectives are

1. This is the first objective

2. This is the second objective

3. This is the third objective

4. More objectives

1.3 Approach

It has been observed that BFA, although extremely inaccurate, classifies a big amount of fragments that belong to a document file as text. We will make use of the classic BFA among with some variations of it and try to enhance its accuracy on classifying document-file fragments as text. Then we will isolate all the fragments classified as text and analyse them in order to find patterns which will help us to design our algorithm. The BFA that we are going to use is the same as [McDaniled] with the only difference that we wont train our fingerprints with the complete byte set of the fragments. Due to the fact that many file types contain partially plain text, in this project we will analyse the byte set that corresponds to printable ASCII characters (32 b 126) of every fragment. Additionally, some more bytes that could reveal a documents nature as the newline (10), tab (9), carriage re- turn (13) characters are being used. Until now, almost every approach, for both file and fragment classification, analyses the complete ASCII byte set (0..255). We will try to discover if by ignoring almost half of the ASCII byte set, we can acquire more reliable results and create an algorithm which will be able to classify document-type files. Moreover, we are going to use the same corpus as Shahi did in [XX] in order to test effectively the accuracy of our algorithm.

1.4 Structure of the Report

The rest of the report is structured as follows. Chapter 2 gives an introduction to …

Remark: Notice that chapter and section headings shall be written in lowercase, but that all main words should start with a capital letter.

The report should be no longer than 60 pages in this format (+ the CV).

Chapter 2

Equations, Figures, and Tables

The content of this chapter will vary with the topic of your thesis.

Remark: If you want a shorter chapter or section title to appear in the Table of Contents and in the headings of the chapter, you just include the short title in square brackets before the title of the chapter/section.

2.1 Simple Equations

This is how a simple equation is included:

$$F(t) = \int_0^t \exp(-\lambda x)\, dx \tag{2.1}$$

The equations are automatically given equation numbers – here (2.1) since this is the first equation in Chapter 2. Note that you can refer to the equation by referring to the "label" you specified as part of the equation environment.

You can also include equations without numbers:

$$F(t) = \sum_{i=1}^{n} \binom{n}{i} \sin(i \cdot t)$$

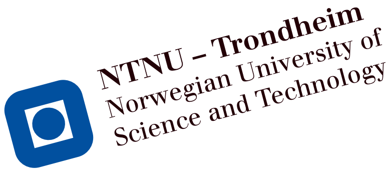

Figure 2.1: This is the logo of NTNU (rotated 15 degrees).

More Advanced Formulas

Please consult the LaTeX documentation.

If you want to include a definition of a term/concept in the text, I have made the following macro (see in `ramsstyle.sty`):

☞ **Reliability**: The ability of an item to perform a required function under stated environmental and operational conditions and for a stated period of time.

2.2 Including Figures

If you use pdfLaTeX (as recommended), all the figures must be in pdf, png, or jpg format. We recommend you to use the pdf format. Please place the figure files in the directory **fig**. Figures are included by the command shown for Figure 2.1. Please notice the "path" to the figure file written by a *forward* slash (`/`). You should not include the format of the figure file (pdg, png, or jpg) – just write the "name" of the figure.

Each figure should include a unique *label* as shown in the command for Figure 2.1. You can then refer to the figure by the *ref* command. Notice that you can scale the size of the figure by the option `scale=k`. You may also define a specific width or height of the figure by replacing the `scale` options by `width=k` or `height=k`. The factor `k` can here be specified in mm, cm, pc, and many other length measures. You may also give `k` as a fraction of the width of the text or of the height of the text, for example, `width=0.45\textwidth`. If you later change the margins of the text, the figure width will change accordingly. As illustrated in Figure 2.1, you may also rotate the figure – and also do many other things (please check the documentation of the package `graphicx` – it is available on your computer, or you may find it on the Internet).

Table 2.1: The degree of newness of technology.

	Level of technology maturity		
Experience with the operating condition	Proven	Limited field history or not used by company/user	New or unproven
Previous experience	1	2	3
No experience by company/user	2	3	4
No industry experience	3	4	4

In LaTeX all figures are floating objects and will normally be placed at the top of a page. This is the standard option in all scientific reports. If you insist on placing the figure exactly where you declare the figure, you may include the command `[h]` (here) immediately after `\begin{figure}`. If you will force the figure to be located either at the top or bottom of the page, you may alternatively use `[t]` or `[b]`. For more options, check the documentation.

Large figures may be included as a *sidewaysfigure* as shown in Figure 2.2:[1]

2.3 Including Tables

LaTeX has a lot of different options to include tables. Only one of them is illustrated here.

Remark: Notice that figure captions (Figure text) shall be located *below* the figure – and that the caption of tables shall be *above* the table. This is done by placing the `\caption` command beneath the command `\includegraphics` for figures, and above the command `\begin{tabular*}` for tables.

2.4 Copying Figures and Tables

In some cases, it may be relevant to include figures and tables from from other publications in your report. This can be a direct copy or that you retype the table or redraw the figure. In both cases, you should include a reference to the source in the figure or table caption. The caption might then be written as: *Figure/Table xx: The caption text is coming here (Rausand and Høyland, 2004).*

[1] You can use a similar command for large tables.

Figure 2.2: This is the logo of NTNU.

In other cases, you get the idea from a figure or table in a publication, but modify the figure/table to fit your purpose. If the change is significant, your caption should have the following format: *Figure/Table xx: The caption text is coming here (adapted from Rausand and Høyland, 2004).*

2.5 References to Figures and Tables

Remember that all figures and tables shall be referred to and explained/discussed in the text. If a figure/table is not referred to in the text, it shall be deleted from the report.

2.6 A Word About Font-encoding

When you press a button (or a combination of buttons) on your keyboard, this is represented in your computer according to the *font-encoding* that has been set up. A wide range of font-encodings are available and it may be difficult to choose the "best" one. In the template, I have set up a font-encoding called UTF-8 which is a modern and very comprehensive encoding and is expected to be the standard encoding in the future. Before you start using this template, you should open the Preferences ->Editor dialogue in TeXworks (or TeXShop if you use a Mac) and check that encoding UTF-8 has been specified.

If you use only numbers and letters used in standard English text, it is not very important which encoding you are using, but if you write the Norwegian letters æ, ø, å and accented letters, such as é and ä, you may run into problems if you use different encodings. Please be careful if you cut and paste text from other word-processors or editors into your LaTeX file!

Warning

If you (accidentally) open your file in another editor and this editor is set up with another font-encoding, your non-standard letters will likely come out wrong. If you do this, and detect the error, be sure *not* to save your file in this editor!!

This is not a specific LaTeX problem. You will run into the same problem with all editors and word-processors – and it is of special importance if you use computers with different platforms

(Windows, OSX, Linux).

2.7 Plagiarism

Plagiarism is defined as “use, without giving reasonable and appropriate credit to or acknowledging the author or source, of another person’s original work, whether such work is made up of code, formulas, ideas, language, research, strategies, writing or other form”, and is a very serious issue in all academic work. You should adhere to the following rules:

- Give proper references to all the sources you are using as a basis for your work. The references should be give to the original work and not to newer sources that mention the original sources.
- You may copy paragraphs up to 50 words when you include a proper reference. In doing so, you should place the copied text in inverted commas (i.e., “Copied text follows …”). Another option is to write the copied text as a quotation, for example:

  > Birnbaum’s measure of reliability importance of component i at time t is equal to the probability that the system is in such a state at time t that component i is critical for the system.
  >
  > Rausand and Høyland (2004)

Chapter 3

Summary and Recommendations for Further Work

In this final chapter you should sum up what you have done and which results you have got. You should also discuss your findings, and give recommendations for further work.

3.1 Summary and Conclusions

Here, you present a brief summary of your work and list the main results you have got. You should give comments to each of the objectives in Chapter 1 and state whether or not you have met the objective. If you have not met the objective, you should explain why (e.g., data not available, too difficult).

This section is similar to the Summary and Conclusions in the beginning of your report, but more detailed—referring to the the various sections in the report.

3.2 Discussion

Here, you may discuss your findings, their strengths and limitations.

3.3 Recommendations for Further Work

You should give recommendations to possible extensions to your work. The recommendations should be as specific as possible, preferably with an objective and an indication of a possible approach.

The recommendations may be classified as:

- Short-term
- Medium-term
- Long-term

Appendix A

Acronyms

FTA Fault tree analysis

MTTF Mean time to failure

RAMS Reliability, availability, maintainability, and safety

Appendix B

Additional Information

This is an example of an Appendix. You can write an Appendix in the same way as a chapter, with sections, subsections, and so on.

B.1 Introduction

B.1.1 More Details

Bibliography

Lundteigen, M. A. and Rausand, M. (2008). Spurious activation of safety instrumented systems in the oil and gas industry: Basic concepts and formulas. *Reliability Engineering and System Safety*, 93:1208–1217.

Rausand, M. and Høyland, A. (2004). *System Reliability Theory: Models, Statistical Methods, and Applications*. Wiley, Hoboken, NJ, 2nd edition.

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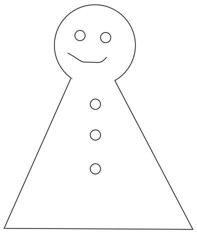

Your picture

Language Skills

Describe which languages you speak and/or write. Specify your skills in each language.

Education

- School 1
- School 2
- School 3

Computer Skills

- Program 1

- Program 2
- Program 3

Experience

- Job 1
- Job 2
- Job 3

Hobbies and Other Activities