Chapter 1

Introduction

This chapter serves as an introduction to this dissertation. A quick background on the importance of video fingerprinting and the problems associated with it, followed by the research objectives and methodology. The chapter is then concluded with a brief look at the organization of the dissertation.

1.1 Background

In 1892, Sir Francis Galton proved that no two person's fingerprints are the same [6]. These days law enforcement uses this knowledge to automatically match unknown fingerprints, found at a crime scene, to a database of fingerprints to find suspects. Over the past few years people started to realize the power of fingerprinting systems in multimedia and Content Based Information Retrieval (CBIR) came into being. Following the recent burst in video usage over the internet, video fingerprinting has become a very popular research subject.

Videos don't naturally have fingerprints like humans do, so to create a system that can

detect unknown videos by using fingerprints, one first has to design an algorithm that can extract fingerprints from videos. These fingerprints will have to compactly characterize the videos based on the content of those videos, all the while creating unique fingerprints for videos that have different content. The fingerprints will also have to be robust to common video manipulations so detection is still possible.

One could ask the question: "Why not just compare the raw video data to a database of videos?" Well, to answer that question, one can probably make use of cross-correlation to match videos, but the chances of mismatches are very high because of all the different formats, distortions and manipulations that can be applied to videos. Also, it would take a very long time to compare such large amounts of data to determine if a valid match is found. Thus, the need for an algorithm to create fingerprints that characterise videos is of utmost importance so the detection can be robust and fast. The use of an algorithm also allows one to focus on different aspects of video fingerprinting as needed by the application.

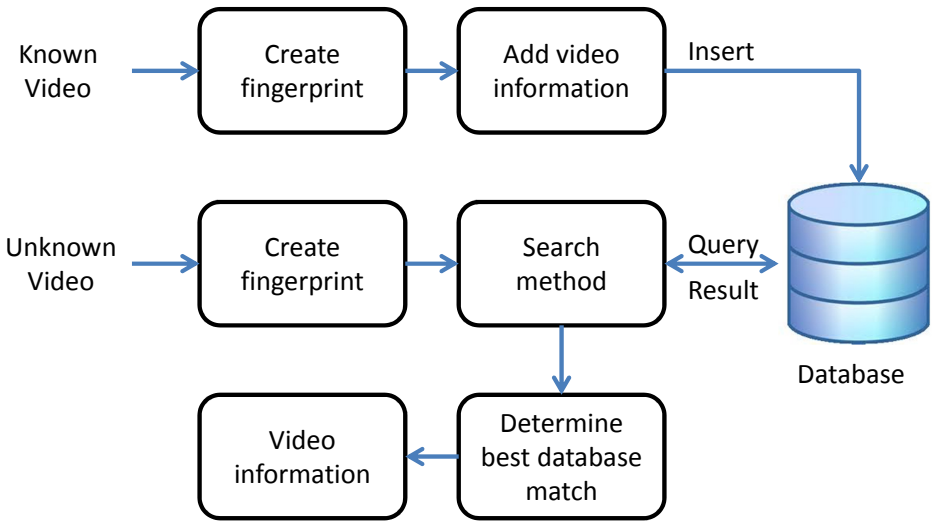

Figure 1.1: Diagram of basic video fingerprinting system.

A basic representation of a video fingerprinting system is shown in Figure 1.1. Fingerprints are extracted from known videos, using the fingerprinting algorithm. Once the fingerprint is calculated, meta data is added to it and the fingerprint is saved to a database. Once the necessary video's fingerprints are added to the database, it can be used to detect unknown videos. To detect an unknown video, the video is also fingerprinted and the fingerprint is compared to the fingerprints in the database using a searching method. Once the search is completed the results of the search is analysed and the most promising match is found. The match's meta data is extracted from the database and the results are displayed to the user.

1.2 Research Question

As the amount of multimedia increases, the amount of effort needed to keep track of all the information increases with it. Video fingerprinting tries to solve this problem, by automatically monitoring media sources so people can easily manage videos. One industry that can benefit from this technology is the television broadcast industry, where video fingerprinting can be used to detect if and when advertisements are shown. Advertisement tracking or broadcast monitoring can be a lucrative business, as prices for advertising are very high (see Table 1.1) and businesses lose a lot of money if their advertisements are shown at the wrong time or not shown at all. The fingerprinting system will also replace any human job that may be in place to monitor the broadcasts, relieving them from a repetitive and unfulfilling job.

Channel	Early Morning	Evening Prime Time
SABC 1	R2500	R85000
SABC 2	R8000	R142000
SABC 3	R2000	R71000
ETV	R7000	R54000
DSTV	R3000	R24000
M-Net	R4000	R59000

Table 1.1: Cost (excluding VAT) of 30 second advertisements on South African television stations [5].

Although video fingerprinting is a relatively new research topic, a lot of implementations already exist in literature and some of them will be mentioned later on in the dissertation. All of these systems use different techniques to characterize videos and they achieve different levels of success, but they are mostly designed for a specific application or they focus on being very robust. This means that there is no implementation specifically designed for real-time advertisement tracking.

With the above mentioned problems in mind the following research question is posed: **Can a robust, real-time video fingerprinting system be developed and tested to be used for advertisement identification in a video signal?**

1.3 Objectives

The objectives of this research are to understand video fingerprinting techniques and the theory it is based on, including image processing, video encoding and wrapping and database structures. The knowledge that was gathered through the background research will then be used to design a novel video fingerprinting system that can be used for broadcast monitoring.

The novel technique must be able to detect advertisements in real-time, and mustn't need a lengthy amount of footage to detect a match. The video stream that will be used during detections will be a television broadcast, so the level of distortion won't be excessively high. This allows for an algorithm that is fast and robust, but not too computationally intensive that a current-day laptop can't run it in real-time.

After the implementation, the system will be run through a series of tests to determine its limits and to point out areas where the system can be improved upon. The results gained from the testing will then be used to alter the system to improve it and to draw conclusion from the work that was done.

1.4 Research Methodology

In this section the steps that were executed to complete this dissertation are discussed.

1.4.1 Plan of action for dissertation

At the beginning of the research period, the research topic was chosen and rough planning was done to complete this dissertation.

1.4.2 Study video fingerprinting and related work

To get an understanding of the field of study, research about video fingerprinting and related topics were read and studied. This was an important stage to understand the current state of research in the field.

1.4.3 Design a novel video fingerprinting system

At this stage the information that was gathered in the background study was used to design a novel video fingerprinting technique that is suited for the intended application of broadcast monitoring.

1.4.4 Select development environment

Once the technique was designed and tested briefly in Matlab, a development environment had to be chosen to implement the video fingerprinting system, so thorough testing could be done. The environment that was chosen, was Visual Basic and the video and image processing library that was used, was EmguCV. EmguCV is a C#/VB wrapper for the C library, OpenCV.

1.4.5 Experimental set-up

Once the system was fully implemented in Visual Basic, experiments were set up to optimize and test the effectiveness of the new video fingerprinting system.

1.4.6 Acquire results from tests

The results that were acquired from the tests were saved and used to understand the limits and strengths of the system in more detail.

1.4.7 Draw a conclusion

With al the work and testing done on the system, conclusions can be drawn and future work can be proposed to further the field of video fingerprinting.

1.5 Dissertation Outline

This dissertation consists of 6 chapters:

- **1. Introduction**: It is the current chapter and it consists of a quick background of video fingerprinting and the research objectives of this dissertation. The research methodology and planning overview was also given.

- **2. Background: Video Fingerprinting**: The important aspects and uses of video fingerprinting are discussed in this chapter. Afterwards a few existing video fingerprinting techniques will be summarized and their strengths and weaknesses mentioned.

- **3. Techniques**: The techniques used to create the fingerprinting system are discussed. These techniques include the Scale Invariant Feature Transform (SIFT), Speeded Up Robust Features (SURF), Shazam and Key Frame Detectors (KFDs).

- **4. Implementation**: In depth look at the novel technique developed for advertisement tracking. First, the steps for fingerprinting a frame will be shown, followed by video fingerprinting using key frames.

- **5. Tests and Results**: Tests are done to show the characteristics and effectiveness of the system. The first set of tests are done to optimise the detection process, then a test is done to decide on the best key point detector between SIFT and SURF. After that, the database is tested to find its limits, and finally the test that confirms advertisement detection is done. Verification and validation of the system is done at the end of the chapter.

- **6. Conclusion**: In the last chapter an overview of the dissertation is given along with the objectives that were achieved and a summary of the results in the previous chapter. Future work and ideas to further the research are also given at the very end for anybody that would like to continue with this type of work.