ATUWA VIDEO REDUNDANCY MANAGER SOFTWARE

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ABSTRACT

In storage technology, de-duplication refers to the elimination redundant data. When specializing the video de-duplication, it refers to the elimination of redundancy in videos. In video de-duplication, a video is divided into a number of segments and duplicate video segments are deleted, leaving only one copy of each video segment to be stored replacing the deleted segment with a pointer to the unique copy.
Traditionally, two data items are considered redundant if their underlying bit-streams are identical. However, the notion of redundancy is too strict when considering video. Even though two videos are considered unique at system level, if they are similar in content, then they are considered as redundant videos. ATUWA is a Video Redundancy Manager Software which helps to use storage capacity efficiently when storing videos by eliminating the redundancy.

Key words: de-duplication, video redundancy, content level similarity, signature, video segmentation, hierarchical structure of signatures

1. INTRODUCTION

Storage capacity in any computer is a limited resource. So every user tries to store only the important documents, files and video clips. If this limited capacity is filled with redundant data then it is a significant waste. In storage technology, elimination of this redundancy in data is referred as de-duplication.

When storing videos in a computer, if it is attempted to store an existing video with a different name, even in the same folder, the new one is also stored, since the computer cannot understand the content level similarity of the videos which have different names. So in order to overcome this difficulty, the user has to remember all the videos already stored in his machine, which is not a practical solution. So there should be an efficient mechanism to eliminate the redundancy in videos and use the storage capacity efficiently.

2. PROPOSED SYSTEM

The proposed system, ATUWA Video Redundancy Manager Software gives a solution to this video redundancy problem. Once user saves the video through this software, it checks the video with the existing videos in the machine and compares the similarity between them in the content level.

The Figure 1 shows the overall modular architecture of ATUWA.

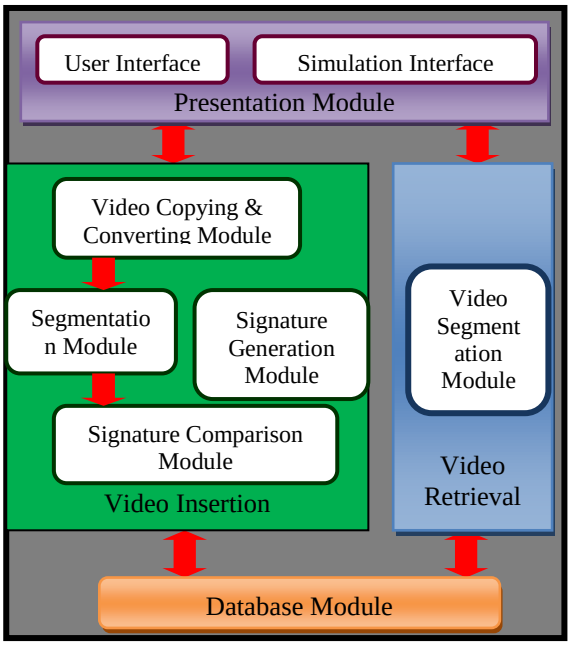

Figure 1: Modular architecture of ATUWA video redundancy manager software

2.1. Presentation Module

This is responsible for creating an interaction with the user with the software. Mainly this

provides user interfaces where the user will be able to give the path of the video clip which he wants to store and to retrieve a video clip by giving the name which he used to store it. Other than to these two user interfaces, there is a simulation interface which gives the details of the back end process of software.

2.2. Segmentation Module

This module is responsible for segmenting the video clip based on scenes. First this module identifies the scene changing points of the video clip. The motion level value and the centroid position of the brightest and darkest pixels of the frame [1], generated by the signature generation module for each frame, is used to identify the segmentation positions. Then the time relevant to that position is added to a vector. Finally the video clip is segmented according to those points.

2.3. Signature Generation Module

This module develops signatures for each video segment based on various parameters like colour level [3], [4], [6], centroid [1], [2] and motion level which is an unique and compact representation of the video segment [4].

In each signature generation method, signatures are first created per each frame [3] and each signature generation class holds those values in an array. Once the segmentation module identifies the segmentation location based on the signature values of those frames, those values are structured in a hierarchical manner with three levels.

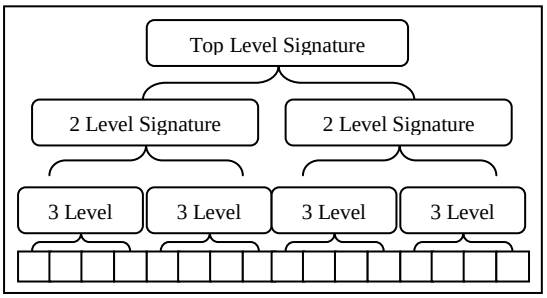

Figure 2: Hierarchical structure of the signature values

In the first step four values are calculated by dividing the array of values into four subsets and getting the average of each set. This becomes the third level signature. Again by averaging the third level values, the second level signature is calculated. Finally the top level signature is calculated as shown in Figure 2.

2.3.1. Signature Based on the Colour Distribution

This signature is calculated based on the RGB values of the segment. A 4×4 grid is applied to each frame [3] and for each square the average colour level is calculated separately for R, G and B. Now there are 16 values for one colour and 48 values for one frame. These values are stored in a three dimensional array of size 4×4×3. Finally those values are structured in a hierarchical manner with three levels as shown in the Figure 2.

2.3.2. Signature Based on the Centroid of the Brightest and Darkest Pixel Positions

Here two signatures are calculated based on the centroid position of the darkest pixels and brightest pixels of the frame [1]. The process of creating the signature can be described as follows.

If the frame belongs to the first ten frames of the segment,

Brightness values of all the pixels of the frame are added to a list and the values fall at the boundary of the 10% darkest and 10% brightest pixels of that list and added into two other lists.

If the frame is the 11^{th} frame of the segment,

The average brightness value for the list is calculated and it is used as the predefined brightness threshold value for the next frames until the next segmentation location is identified.

After doing the above check, all pixel positions which have a higher and lower brightness value than the predefined brightness threshold values are added to another list. Similarly pixel positions which have a lower brightness value than the predefined darkest threshold value are also added to another list.

2.3.3. Signature based on the Motion Level

When calculating the motion level signature, bit level difference between the current frame and the previous frame is taken. This method gives an average motion level of a frame as the output.

2.4. Signature Comparison Module

This module is responsible for finding the existing similar video segments for newly generated and comprises of algorithms to compare the signatures of the newly created and existing segments in order to identify the similarity

First it loads the segments which are similar in length. Then it compares the segments based on the signature values in three levels. When doing the search in three levels, the system does not try to retrieve the segments which have the exact signature value at each level. It performs a kind of fuzzy search. At each level the system retrieves the segments which have signature values belonging to some range with the exact signature values of the segment and tries to compare several signatures from the eight signatures the system generates for one segment.

2.4.1. Defining the Range for Signature Values at each Level

In each level, the system retrieves segments with signature values which are less than or greater than the actual value of the corresponding signature by some amount. The system uses different ranges in different levels. In order to maintain the accuracy the range should be small in deeper levels. When defining a range, the comparison module should be able to satisfy the following conditions as much as possible.

- Identify the similar segments as identical
- Minimize the error rate

The error rate is considered as the percentage of different segments identified as identical segments.

2.4.2. Defining the Number of Signatures to be matched at Each Level

When comparing the signatures, the system tries to match the maximum possible number of signatures which is able to give the maximum result at the end. With the defined number of signatures, the segment comparison module should be able to,

- Identify the similar segments as identical
- Minimize the error rate

When considering the results shown in Figure 3, we could see the rate of identifying similar segments becomes when increasing the range value at each level. Even though the exact identification rate increased, the error rate also increases with the increase of range. After considering all the test results, we decided to take 30 as the top level range, 20 as the second level and 15 as the third level range values. This was because that range value category gives the maximum identification rate while minimizing the error rate. With those ranges, two segments are identified as identical when at least 5 signatures are matched out of eight signatures.

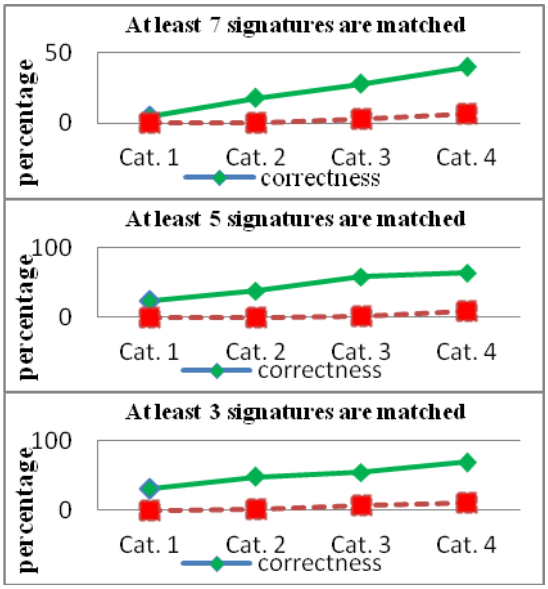

Figure 3: Test analysis of the range check

2.5. Video Segment Linking Module

This module is responsible for giving the requested video as one video clip. Since this software stores the video clip as segments, when the user wants to retrieve it again, the software has to find all the relevant segments and link them together to play it as single video. The required segment index pattern is retrieved from the database and the relevant segments are retrieved from the stored places. Then they are linked together and the whole video is played.

3. TEST ANALYSIS

3.1. Performance Analysis

The overall performance of the ATUWA is measured by considering the time spent by the system to produce results. This period covers the total insertion time of a video through the system. The total insertion time consists of time taken for similarity search in the DB and the time to write to the disc.

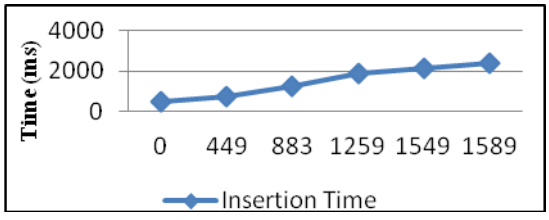

Figure 4: Performance analysis graph

This graph shows when the number of segments already in the database is increased, the time consumed for the insertion processes has increased with it. Here the insertion is done after

removing the redundancy in videos in the content level. So each new segment is matched with the existing segments in the database. This can be explained by the obvious reason that when there are more segments in the system the number segments to be compared is increased.

3.2. Accuracy Analysis

3.2.1. Accuracy with the Increase of Database Size

This shows the increase of the accuracy with DB size. Obviously when the database contains more segments, the probability of having a similar segment in the database also increases. So the probability of matching also increases with the increase in the size of the DB.

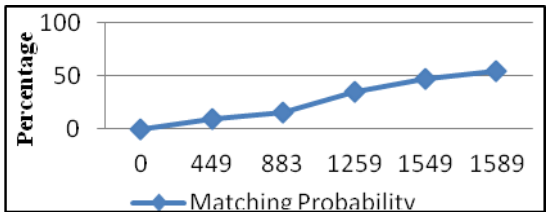

Figure 5: Accuracy analysis graph

3.2.2. Accuracy Analysis for the Various Types of Videos

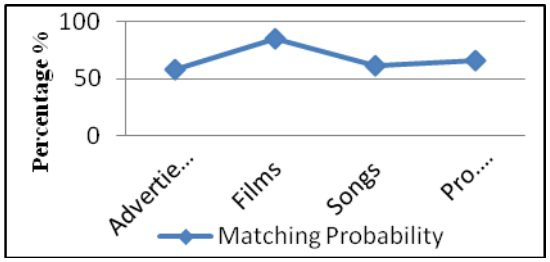

Figure 6: Accuracy analysis graph for various types of videos

4. FUTURE WORKS

ATUWA is a good and efficient solution to the video redundancy problem. ATUWA has a real potential of becoming a great product in the real word with the following remarkable improvements which we would like to carry out or see being done in the future.

- In this initial version we focus only on a limited number of signature generation methods. In the future versions, those methods can be improved and some more signature generation methods can be included to improve the accuracy of the software [1, 2, 3, 4, 5].
- In this version of the software, we will be focusing on using one content base video segmentation method. In the future versions, we can integrate several methods which can be used to segment a video clip based on scenes such as audio [1, 2]. By doing so we can improve the accuracy of segmentation.

5. CONCLUSION

With the comprehensive contribution of all group members the project ATUWA has achieved almost all the objectives it set out to do. The objective of the project was to come up with an efficient solution to the video redundancy problem. Even though there were some researches based on this topic, still there was no solution which was implemented. So ATUWA gives a solution to the video redundancy problem by eliminating the redundancy in videos at the content level.

6. REFERENCES

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