Two-Stage Correlation Approach for Detection of Video Steganography

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Abstract **– Video steganography is an emerging sub field of digital steganography. Video provide fairly high bandwidth for data embedding and are frequently posted and transferred online. The goal of steganalysis is to reduce the effective bit rate of data embedding in video by reliably detecting the higher embedding rates. Moreover, the information hiding process changes the statistical properties of the cover, which is a steganalyst attempts to detect. The aims of the study is to investigate a video steganalysis method to detect the presence of hidden messages. In this paper, we adopt two stage correlation cost for traditional approach: feature selection performs a Pearson correlation in the first stage and detects the correlation values in second stage. Two types of statistical features, co-occurrence matrices and grey level histogram which are used to identify and classify in the proposed system.**

Keywords – **steganalysis, steganography, MSU stego, correlation, feature extraction**

I. INTRODUCTION

The development of IT industry brings much convenience but many information security problems as well. Video steganography is becoming an important research area in various data hiding technologies. Video Steganography algorithm should be transparent in order to achieve highly secret transmission. The aim of discovering the hidden data in cover objects, which mean that steganalysis has gained attention in the fields of computer forensics to reduce the serious consequences of covert communications. Mostly, steganalysis research is mature in the area of image and audio not be successful in video steganography.

Difference type of video steganography approach which are developed in this day. On one hand, video steganography and steganalysis require research backgrounds on video compression and its complex system; on the other hand, few well-developed video steganographic softwares appear in public. According to this reason, a large number of video information hiding algorithms was accomplished in the compressed domain [1-4] recently; which can be used as video steganography method with slightly modification. On the other hand, there are less of research area in the analysis of compress video stream. Because the video can be treated as one sequence of still images, the video steganalysis can be enlightened by the image ones.

This system proposed to analyze the difference between stego video and without stego video (cover video). The objective of the study is combined to use the image feature extraction with two stage correlation approach for detection video steganography.

The rest of this paper is organized as follows. In Section 2, proposed system are explained. Section 3 describe the related methodology of proposed system and explain about the type of steganalysis approach.

II. PROPOSED FRAMEWORK

The proposed system architecture is shown in Fig.1. Firstly visual feature is extracted from video file for feature calculation and each clip is divided into frames.

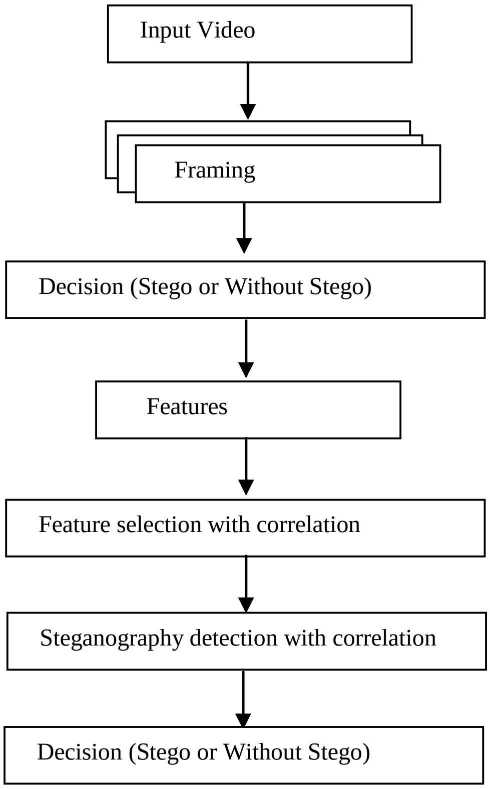

Fig.1. Proposed architecture

Features are analyzed and extracted by using visual features histogram moments, Co-occurrence matrices: contrast, energy, entropy, homogeneity, and variance. Extracted feature are used to select most relevance features by using Pearson correlation. Moreover, the selected features are investigate for detecting video steganography based on correlation analysis.

III. METHODOLOGY

A. Type of Steganalysis

. There are two type of steganalysis; active and passive steganalysis [8]. Passive steganalysis is to investigate whether a given object is a steganogram or not. The goal of active steganalysis is to estimate the secret message itself. Estimating the embedded message is to find the length or location of the embedded message or the parameters used to create a steganogram. Mostly, steganalysis research is mature in the area of image and audio not be successful in video steganography.

Steganalysis means to discover the image's information and estimate the procedure of embedding algorithm, the length of the message, the content of the message or the secret key used. There are three type of less theoretical and more practical steganalysis algorithm which are shown in below:

i) Targeted Steganalysis: to attack the works for that specific algorithm.

ii) Blind Steganalysis: to attack that can be appropriate on all steganographic algorithms

iii) Semi Blind Steganalysis: to attack that can apply on a selected set of steganographic algorithms

This study aims to attack on the target steganalysis approach, MSU Stego video tool and algorithm is used to analyze for detecting video steganography.

B. Feature Extraction methods

Texture analysis is the detection of textured images. Texture defect detection is the process of estimating the place and/or extend of various defects using textural properties of the given image. The following section describe the difference types of texture features which are used to detect the video steganography.

Co-occurrence Matrices

Statistical features of grey levels were one of the earliest methods used to classify textures. Haralick [1] suggested the use of grey level co-occurrence matrices (GLCM) to extract second order statistics from an image. GLCMs have been used very successfully for texture classification in evaluations [5].

Table.1. Features calculated from the normalized co-occurrence matrix P (*i* , *j*)

Texture Feature	*Formula*
Energy	$\sum_i \sum_j P^2(i,j)$
Entropy	$\sum_i \sum_j P(i,j) log P(i,j)$
Contrast	$\sum_i \sum_j (i-j)^2 P(i,j)$
Homogeneity	$\sum_i \sum_j \frac{P(i,j)}{1+\lvert i-j \rvert}$

Where *P* =co-occurrence matrix

μ=mean of the co-occurrence matrix *P*

σ=standard variation of co-occurrence matrix *P*

Gray level histogram

The statistical approach is more useful than structural approach to texture analysis. There are five aspects which will be analyzed for these features. Those aspects are mean, entropy, variance, skewness, and kurtosis of the image histogram. Thus,

$$\mu = \frac{1}{N}\sum_{i=1}^{K} x_i\, h(x_i) \qquad (1)$$

$$N = \sum_{i=1}^{K} h(x_i) \qquad (2)$$

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{K}(x_i - \mu)^2 h(x_i) \qquad (3)$$

where N = n1 n2 is the image dimension, and K is the number of grey levels.

C. Correlation Analysis

As mentioned above major objective of this study is to ascertain the detection of hidden message in video steganography. Since this study mainly on deriving the relationships between variables, it has conducted correlation analysis on the variables under concern.

Through correlation analysis, it measures the strength of the relationship between two variables. In stream of correlation analysis, in order to ascertain correlation coefficient two tests are widely applied,

- Pearson Correlation analysis
- Spearman Rank Correlation

In order to conduct Pearson correlation analysis following assumptions should met,

- Interval or ratio variable
- Linear relationship
- Normal Distribution

If, either one of the breached it is recommended to use Spearman Rank Correlation. For the purpose of the study it has used Pearson correlation analysis where the variables under consideration is meeting the above assumptions. In the issue on the distribution of the variables, it has presumed as normally distributed based on the central limit assumptions.

Pearson correlation analysis conducted based on the following formula (Cowan, 1998):

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Where,

x = extracted features and y = stego video or not

The Pearson correlation means to indicate the strength of the relationship between the two variables of independent variable x and dependent variable Y. The sign of the correlation coefficient is positive if the variables are directly related and negative if they are inversely related.

If the correlation result is 0, then x and y are said to be uncorrelated. The closer the value is to1, which means that strong correlation.

In order to make inferences on the population based on the sample, it has conducted a hypothesis testing procedure on the ascertained correlation coefficients.

IV. EXPERIMENTAL STUDY

All experiment based on different video sequences from different sources including the movies and on-line videos from CNN and YouTube. The secret text message is embedded using MSU stego video tool. It takes an avi file as a cover and text as the secret message

The number of samples is at least 50 video clips for each video during 10 second with the frame rate of 25fps. In this sample contains fast motion sequences (soccer). 40 video samples are used as the training data containing classes such as original and stego video and sixty videos are used for testing for the experiment evaluation. The data was divided into training (40 %) and testing (60 %) sets. For cross validation, the frames for training and testing classifier are randomly chosen and the reported results are the average of 100 experiments. According to the system, detecting the video stego or not which are classified based on the proposed method. In the performance analysis, the following section will describe the detecting accuracy based on various situations such as: without feature ranking, different bit numbers, and fast motion movies.

A. Detection of MSU Stego Video without Feature Selection

Figure 2 describes the correct rate for different type of movie and detection accuracy is varied by noise levels. Experimental results show that in this case the correct rates are more accurate at noise level 30.

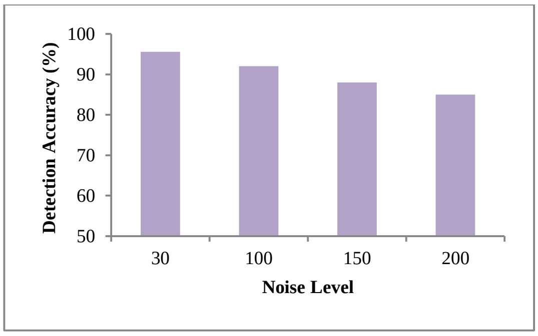

Fig 2. Detection Accuracy for Fast Movie over Different Noise Level

Noise level is hiding parameter for MSU Stego video tool. This can be selected in embedding process of MSU stego. It can be seen that noise level 30 is lowest level for parameter of MSU stego tool. In this video steganalysis system, detection accuracy is slightly decreased at noise level is higher than 100.

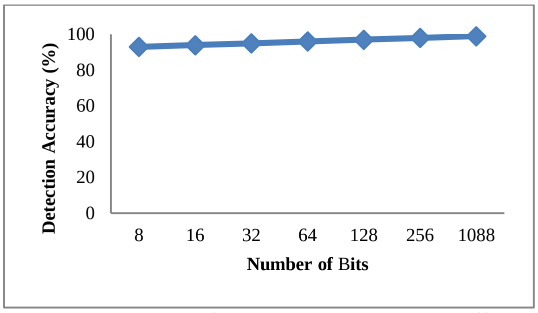

Fig 3. Detection Accuracy for Fast Motion Movie over Different Bit Numbers

Figure 3 describes the detection accuracy for tested in different number of bits. It can be seen that detection accuracy is varied by bit rates.

B. *Detection of MSU Stego Video with Feature Selection*

The second approach with feature selection is described in Figure 4. The extracted features are the valuable on each analysis but some have the redundant information for video analysis. Therefore, this study aim to select the most related feature for detection of video steganography which have most significance relationship with proposed steganalysis approach.

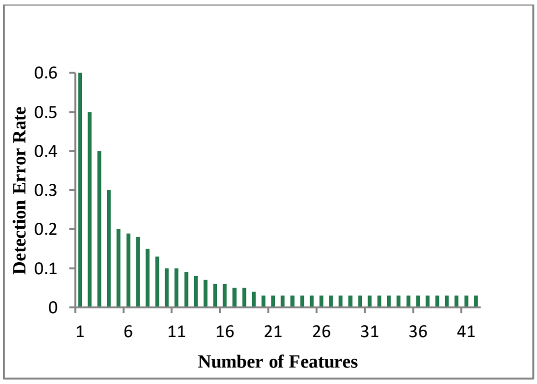

Fig 4. Detection Error Rate for all Feature

This may be done by selecting a subset of relevant features from the total number of features, or by ranking methods based on Pearson Correlation. Correlation tries to select a subset of best features from 41 features (Histogram and Texture), in an incremental manner.

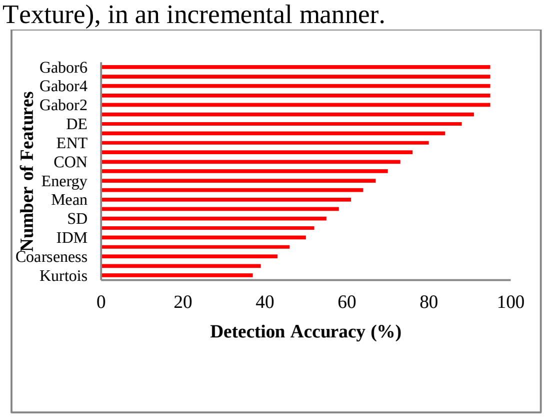

Fig 5 Detection Accuracy for Fast Motion Movies

Figure 5 describe the detection accuracy for the best twenty features of Fast Motion movies.

In this experiment, all features are detected with 97.6 % for stego video and selected of fifteen features is discriminated from stego with the accuracy of 75.27%. In this steganalysis system, the best features are selected by using Pearson Correlation. By using features ranking method is to improve the execution time.

C. *Performance results*

In our experiments, receiver operating characteristic (ROC) curve has been used to verify the effectiveness of the proposed method. Forward feature selection is used in this proposed system. Detection accuracy is not varied in feature 30, 25, and 20 but features are less than 20, detection accuracy is slightly decreased. Figure 6 shows the performance analysis for features selection with correlation. Therefore, at least total number of 20 features is needed to discriminate stego and cover video files.

Figure 7 describes the comparison of execution time for two approaches. Video steganalysis with feature ranking approach is less time complexity than without ranking approach. Numbers of 41 features are used to analyze with correlation in feature selection.

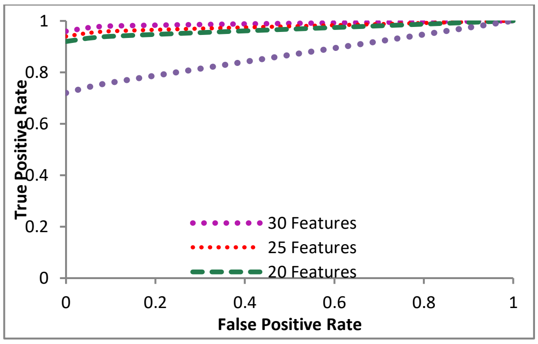

Fig 6. ROC curve for Feature Ranking

However, the best 20 features are selected by Correlation and that are trained in with ranking approach.

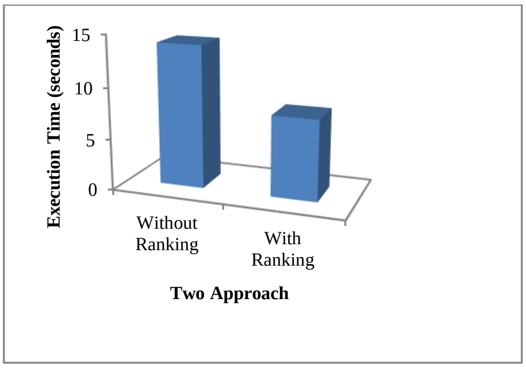

Fig 7. Comparison of Execution Time with Feature Ranking and without Feature Ranking

V. CONCLUSION

The main objective of the study is to investigate a video steganalysis method to detect the presence of hidden messages. In this analysis, we used to apply two stage correlation cost for traditional approach: feature selection performs a Pearson correlation in the first stage and detects the correlation values in second stage. In order to identify and classify the two types of statistic texture feature are used. Pearson Correlation is used in machine learning approach for relevance and redundancy analysis which applied in steganography detection and feature selection for this proposed system. The result revealed that the combination to use with feature selection and detection with Pearson Correlation have the highest accuracy for detecting the stego video. The proposed approach can be implemented efficiently and that it leads to a substantial improvement of the performance for detection of video steganography. According to the analysis, this system suggested to the MSU stego tool to improve to get the better robustness for video steganalysis by using the combination of image feature with two stage correlation approach.

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