

OBJECTIONABLE IMAGE DETECTION IN CLOUD COMPUTING PARADIGM-A REVIEW

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ABSTRACT

Obscenity detection from images and videos are now crucial due to social and ethical reasons. It has been two decades the research on this field started. Most of the works are based on skin color detection, which are not suitable for finding obscenity. The reason for this is that, there are many skins like objects such as beach photos, human skin like animal's fur, skin colored painting that enables false positive and negative rate. In addition all works performed well on some particular set of images or video data. In this research some aspects of obscenity detection is described delineating strength, weakness and possible extensions of prior works. Introducing some new features and incorporation of multiple classifiers and transfer learning will lead the work more robust. Moreover, traditional multimedia cloud computing has been investigated in this study and proposed some new research ideas.

Keywords: Content Based Pornography Detection (CBPD), Content Based Image Processing (CBIP), Transfer Learning (TL), Multimedia Cloud Computing (MCC)

1. INTRODUCTION

There is an enormous number of online resource monitoring cells all over the world due to rapid development of Information and Communication Technology (ICT). In spite of those security systems, it is not possible to check all content based image or video appropriately. This is a threat for the Internet users while using computers in office or in front of family members including children. Moreover objectionable content contradicts social and ethical issues. Hence content based image and video processing especially for identifying obscenity has now been a challenging research area Jaganathan and Vennila (2013) and Geetha and Narayanan (2008). It has been almost two decades when Fleek *et al.* (1996) published the first paper in this issue on "Finding Naked People". After that a large number of

works have been accomplished by different researchers all over the world. Text based protection system has been used in early 2000 for screening malicious contents from the Internet Kjeldsen and Kender (1996) and Yogarajah *et al.* (2010). Objectionable contents but non-objectionable web site names could not identify with these techniques. In support of this drawback, we can find millions of spaces that contain objectionable materials. Malicious contents can be categorized here as objectionable images. Most of the works are based on region based skin color detection which has low recognition rate whether an image contain obscenity in general sense. In this study we will focus on four subject matters following a new paradigm of using cloud computing in Content Based Pornography Detection (CBPD) Hadoop, 2013 Almeer (2012); Rossotti (1983); Kakumanu *et al.* (2007); Ramos-Pollan *et al.* (2012) and Pereira *et al.* (2010):

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- Skin detection
- Erotogenic body parts detection Usages of different machine learning tools (SVM and Adaboost)
- Usage of Cloud Computing for Obscenity detection

The remaining parts of this article can be organized according to the following ways: section 2 briefly describes literature review; different color space models related to skin detection will be elucidated in section 3 and 4. In section 5 a comparative evaluation of existing works has been evaluated, in section 6 some open research issues are proposed and finally a comprehensive discussion is presented in section 7.

2. LITERATURE REVIEW

There are extensive literatures on obscenity detection but in this paper some significant works have taken into consideration. Previous research mainly focused on large connected skin regions, erotogenic organs and feature descriptors applied with some different classifiers.

The following figure (**Fig. 1**) demonstrates number of significant works published since 1996 to till now. It has been observed that in 2010 most of the papers published due to significant improvement of machine learning tools.

3. SKIN DETECTION

Skin detection is a bit challenging task due to large variations in appearance, color and shape, occlusion, intensity, location of light source Kjeldsen and Kender (1996); Yogarajah *et al.* (2010); Yin *et al.* (2011); Abadpour and Ksaei (2005); Vezhnevets *et al.* (2003) and Kakumanu *et al.* (2007). Noise can appear as speckles of skin like color and many other objects for example wood, cooper and some clothes that are often confused as skin Wong *et al.* (2003) and Kakumanu *et al.* (2007). The noise can also be occurred by illumination that is the change of light source distribution and the illumination level (indoor, outdoor, highlights, shadows, non-white-lights) produces a change in the color. Illumination for the same person can be differed using different camera. Human skin color can be varied from person to person due to ethnicity. As for example skin color for the people of Asian differs with African, Caucasian and Hispanic groups. Some other factors such as age, sex, body parts, makeup, hairstyle, costumes, background colors, shadows, motion also affects the skin color appearance Kakumanu *et al.* (2007). In general, human skin is characterized by a combination of red and melanin (yellow and brown) and there is somewhat a range of hue for skin and saturation that represent skin-like pixels Taqa and Jalab (2010) and Rossotti (1983).

3.1. Color Based Skin Detection

When the skin is yellowish the saturation is more with much melanin Rossotti (1983). The main goal of skin detection and classification is to build a decision rule that discriminate between skin and non-skin pixels. Identifying skin color pixels involves finding a range of values for which most skin pixels would fall in a given color space Alshamasin *et al.* (2009); Brown *et al.* (2001) and Caetano and Barone (2001). The target is for a high detection rate and low false positive rate.

Fleek *et al.* (1996) demonstrates an automatic system for telling whether there are naked people present in the image. The strategy includes color and texture properties to obtain a mask for skin regions. It is effective for a wide range of shades and colors of skin. Skin regions are then fed to a specialized grouper, which attempts to group a human figure using geometric constraints on human structure. Using RGB color model and lack of machine learning tool are the main limitations.

Kjeldsen and Kender (1996) defined a color predicate in HSV color space for separating the hand from a cluttered background. The segmentation algorithm has also been applied to assist a user extract objects from the background in arbitrary color imagery. The method has shown its flexibility in a range of different office environments, segmenting users with many different skin-tones.

Yogarajah *et al.* (2010) proposed a skin segmentation algorithm, which calculates dynamic threshold values considering the color information of the detected face regions. In this approach fixed decision boundaries (or fixed threshold) classification approaches are successfully applied to segment human skin. These fixed thresholds mostly failed in two situations as they only search for a certain skin color range. (i) Any non-skin object may be classified as skin if non-skin object's color values belong to fixed threshold range. (ii) Any true skin may be mistakenly classified as non-skin if that skin color values do not belong to fixed threshold range. However, this method fails on varying illumination condition.

Yin *et al.* (2011) tried to detect adult images by considering color, texture and geometrical features of an image. The idea that was implemented in that research paper was color filtering the image to determine candidate skin regions, then the coarse degree of pixels of candidate skin regions was calculated for each pixel and lastly, fractal dimension of all the rest big enough skin regions was calculated and after a couple of iterations, a threshold was picked to use in decision making.

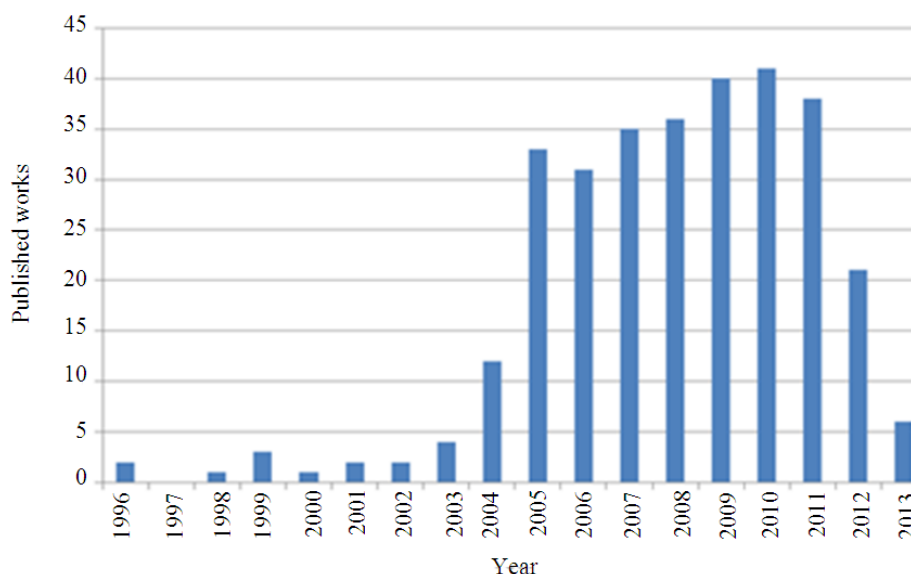


Fig. 1. Published works (1996-2013) on content based pornography detection

Jedynak *et al.* (2003) proposed a statistical model for skin detection. The maximum entropy model is used to infer the skin models from the data set. It has been shown that maximum entropy modeling can lead to an efficient algorithm for a supervised image segmentation problem. The Bethe Tree approximation and Belief Propagation algorithm are utilized in their work to approximate the probability for skin at pixel locations.

Zeng *et al.* (2004) proposed an intelligent adult image detector, called Image Guarder, which can automatically analyze the image content, efficiently recognize adult images. In order to speed up recognition, a two layers recognition framework is adopted. An adaptive statistical color model is developed to detect the skin pixel in variant illumination environment. Smooth character is used to test the skin texture feature after skin color detection.

Abadpour and Ksaei (2005) articulated a work on pixel-based skin detection for pornography filtering. In this work they investigated 21 color spaces in all of their possible representations for pixel-based skin detection in pornographic images. In connection of this work later Hedieh *et al.* (2007) proposed a similar work on a Boosted Skin Detection Method based on Pixel and Block information. In this work the authors implemented boosted pixel-based skin detector architecture.

It is to be noted that most of the works devoted to skin detection and color space model but there are lots of shortcomings. Presence of skin like objects and highly exposed skins without objectionable part may increase

false positive or negative ratio. Hence, now a day researchers are concentrating on both skin and erogenic body parts.

3.2. Region Based Skin Detection

Zheng *et al.* (2004) investigated adult image detection based on the shape features of skin regions using multi-Bayes classifier. The approach was to identify human shape feature and fed to a boosted classifier (C4.5) to decide whether or not the skin regions represent a nude. It has been demonstrated that using combination of different shape descriptors can enhance the performance of shape classification.

4. EROTOGENIC BODY PARTS DETECTION

4.1. Nipple Detection

Fuangkhon and Tanprasert (2005) presented an object detection using image processing and neural network entitled “nipple detection for obscene pictures”. The authors claimed that the detection rate was 65.4%. So far this paper was the only paper on nipple detection. In Wang *et al.* (2010) proposed another robust method entitled “Automatic Nipple Detection Using Shape and Statistical Skin Color Information”. In this study a new approach on nipple detection for adult content recognition presented and it combines the advantage of

Adaboost algorithm that is rapid speed in object detection and the robustness of nipple features for adaptive nipple detection. The detection rate of this approach was 75.6%.

4.2. Naked Body Detection

Wang *et al.* (2009) depicted a new method for identifying adult images based on naked body detection. In this work they considered navel and body features, which are composed by trunk, limb and face. The idea behind in this method was to consider the body as a combination of predefined key rectangles. The intersection of the key rectangles is the navel. Firstly, the algorithm recognizes the location of navel in an image. Then it constructs the feature vector of key rectangles. Finally, it classifies the features by Forward Propagation neural network to determine whether there is a naked body in the image or not. Experiments show that the algorithm can recognize nude images accurately and the recognizing speed can satisfy the requirement of practical systems.

4.3. Key Parts Detection

Pengyu and Jie (2013) presented a novel pornographic filtering method based on human key parts detection. It is published in 2013. In this study the authors described extraction of Haar-like features which depicts local grayscale distribution and then train the classifier with AdaBoost learning algorithm. Histogram of Oriented Gradient (HOG) and Gray level Co-occurrence Matrix (GLCM) features extracted from human key parts for performance.

4.4. Face and Trunk Detection

Shen *et al.* (2007) illustrated a method based on face and trunk detection. This paper compared with several deficiencies of the previous approaches, which detected by the features of skin-color only, the paper presents a novel algorithm based on the face and trunk detection and through the recognizing the erotogenic part in the image, they implemented the algorithm and construct a simple and fast pornographic image classifier system based on a decision tree. The detection rate is 80.31%.

5. COMPARATIVE EVALUATION

In this section some well-known and widely used image screening techniques will be evaluated following its limitations and possible extensions. It is to be noted that pornography detection has been carried out using

human skin likelihood ratio and erotogenic body parts (navel, nipple, pubic hair, breast, trunk, limb) detection. It has been observed that the detection rate would be higher by using hybrid model of skin ratios and erotogenic body parts. In addition usages of suitable classifiers (SVM and Adaboost) are also responsible for good performance. Different skin types such as white, pink, yellow, brown and dark can be classified by a good classifier in accordance with variety of illumination conditions on skins. The evaluation carried out in terms of True Positive Rate (TPR) and False Positive Rate (FPR). It is to be noted that all experiments carried out using different datasets. So, it is quiet impossible to obtain a proper evaluation of all methods since they are not evaluated on the same train and test datasets.

Every work tried to address certain problems to detect pornography, for example varying illumination condition Yin *et al.* (2011), increase detection rate using the same tools and datasets but different features, problems of close-up images and varying illumination conditions Yogarajah *et al.* (2010). If we consider erotogenic human body parts and Adaboost as a classifier then the work Pornographic Image Filtering Method Based on Human Key Parts (Haar like features) Pengyu and Jie (2013) showed the best performance (94.13 % detection rate).

Works in section 3 and 4 organized according to the following two principle detection techniques: (i) Skin segmentations and (ii) erotogenic body parts. Both features utilized some color space model, image segmentation and machine learning tools. Selection of appropriate color space is very important for human skin detection. As discussed in section 3 YCbCr color model is the best choice of skin detection for all types of ethnicity. For image segmentation, features are another important tool. Most scholars used skin color model as feature descriptor. Some well known features like HOG (Histogram of Oriented Gradient) for upright person detection, GLCM (Gray Level Co-occurrence Matrix and Gabor wavelet for texture based skin detection can also be applicable for better detection of pornography. All feature descriptor working in certain constraint. It is impossible to find a unique feature for all types of objectionable images.

6. OPEN RESEARCH ISSUES

In this section some emerging open research issues will be illustrated.

6.1. Choice of Classifiers and Feature Selection

The following would be considered as open research issue. Integrate a fast face detector and add some extra features such as face-skin divided by body-skin and biggest skin patch connected. Make use of skin adaptive models. Find a compact and more knowledgeable way to characterize the color information like incorporating color variance. Hybrid classifiers (SVM and Adaboost) can be used for better performance. Sometimes censored images may also be useful for education purposes or may be categorized according to age and culture. These things will be done perfectly by incorporation of knowledge base. Necessary steps could be done, training the stored and auto updateable database. In addition unsupervised transfer learning Pan and Yang (2010) can be applicable instead of traditional supervised classification because it is impossible to classify specific nude picture using a predefined set of dataset. Since there are more and more different kinds of objectionable pictures available, the traditional machine learning algorithm maybe inefficient to find new type of nude picture based on the old training datasets. In this situation transfer learning can be applicable to assist the discovery procedure.

6.2. Multimedia Cloud Computing for Obscenity Detection

Multimedia cloud computing is now a popular research topic due to wide spread information sharing and up gradation of network bandwidth. There are many works has been accomplished in cloud computing handling multimedia (Audio, video, image) but very little works in processing content based multimedia (image and video). Almeer (2012); Ramos-Pollan *et al.* (2012); Pereira *et al.* (2010); Zhu *et al.* (2004) and Chris *et al.* (2011). Still now there are only three methods introduced to process contents of images in cloud computing. (i) Hadoop Image Processing Interface (HIPI) Chris *et al.* (2011) (ii) Hadoop SEQUENCE files Hadoop, 2013 and (iii) BIGS Ramos-Pollan *et al.* (2012). Sequence files perform better than standard applications for small files, but must be read serially and take a very long time to generate Chris *et al.* (2011). HIPI Image Bundle have similar speeds to Sequence files, do not have to be read serially and can be generated with a MapReduce program Chris *et al.* (2011). Additionally, HIPI Image Bundles are more customizable and are mutable, unlike Sequence files. For instance, HIPI has the ability to only read the header of an image file using HIPI Image Bundles, which would be considerably more

difficult with other file types. Those three methods of handling images in Hadoop can process images based on some ground truth and image statistics. No work efficiently process images according to appropriate machine learning scenario. In SVM, 2013 the use of parallel SVM in Hadoop has been elucidated but still there in need rigorous analysis. In this perspective, scholars can think about how to fit machine learning strategies in Cloud Computing architecture.

7. CONCLUSION

Most of the existing works are based on skin color region detection which can't perfectly recognize whether an image contain obscenity in general sense. The reason for this is that, there are many skins like pixels such as beach photos, human skin like animal's fur, skin colored painting which enable false positive rate. In addition all existing works perform well on particular set of image dataset. It has been observed from table that, in spite of successfully applying skin color segmentation and geometrical structure of human body, eventually it was failed to detect naked body perfectly due to absence of machine learning tools Fleek *et al.* (1996). On the other hand, using skin color segmentation and machine learning tools improve detection rate significantly. Here choice of appropriate color models, skin detection algorithms and classifiers are the factors of performance. The performance of pornography detection has been dramatically changed using human body parts specifically erotogenic parts. In this case choice of proper color model, skin segmentation algorithms, classifiers and human erotogenic body parts are the factors.

In all cases a specific dataset has been applied for test images and hence the detection could not satisfy for all types of arbitrary nude images. Because there are huge amount of nude images available in their different pose, angle, illumination condition, partial occlusion, highly and partially exposed form. In this case unsupervised transfer learning could be a solution because it creates new data sets from already learned old datasets and thus would perform well on random unlabelled nude picture identification.

There are some common trends in every detection algorithms taking consideration of accuracy and performance. These two things are inversely proportional. To minimize this challenges parallel and distributed systems can be applicable. If we consider accuracy of obscenity detection then should pay attention for substantial improvement of existing image based

obscenity detection or if we consider a suitable existing method and want to improve the performance of the system then we should pay attention for applying parallel and distributed system. A cloud computing system can be utilized in this perspective. Content-based image processing in the cloud is still an open research issue. The reason for this is that in cloud computing paradigm only text-based data can be recognizable and there is no such built in tool to handle byte oriented image data Almeer (2012). Some scholars indicated to handle this problem using Hadoop SEQUENCE file Hadoop, 2013. But this technique also not had been proved yet. Recently there are two tools has been deployed to process large-scale image such as HIPI Chris *et al.* (2011) and BIGS Ramos-Pollan *et al.* (2012). These two techniques devoted to process some special images for example remote sensing and medical images. It is not sure whether it can work on objectionable images or not. There is another problem of processing images in distributed environment. Image can't be split during the processing phase because it affects the quality of the original image during merging Almeer (2012). If those issues could be resolved then performance of CBPD (Content based pornography detection) will increase significantly.

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