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Data Mining Based Skin Pixel Detection Applied On Human Images: A Study Paper

Gagandeep Kaur*, Seema Pahwa**, Kushagra Sharma***
*(Department of IT, Sri Sukhmani College of Engineering, & Technology, Derabassi- Punjab Technical University)
** (Department of IT, Sri Sukhmani College of Engineering, & Technology, Derabassi - Punjab Technical University)
*** (Department of Computer Science and Engineering, Sri Sukhmani College of Engineering, & Technology, Derabassi - Punjab Technical University)

ABSTRACT
Skin segmentation is the process of the identifying the skin pixels in a image in a particular color model and dividing the images into skin and non-skin pixels. It is the process of find the particular skin of the image or video in a color model. Finding the regions of the images in human images to say these pixel regions are part of the image or videos is typically a preprocessing step in skin detection in computer vision, face detection or multi-view face detection. Skin pixel detection model converts the images into appropriate format in a color space and then classification process is being used for labeling of the skin and non-skin pixels. A skin classifier identifies the boundary of the skin image in a skin color model based on the training dataset. Here in this paper, we present the survey of the skin pixel segmentation using the learning algorithms.
Keywords-Skin segmentation, Data mining and machine learning, Computer Vision, Color Models, WEKA

I. INTRODUCTION

In terms of computer science research, skin segmentation is one of the active research area which attract the researchers from the historical days of computers Culture related aspects of the human images can be determined based on the skin color and textures of the images which plays the significant roles and one of the important parts to identify cultural aspects of the humans. By looking at the skin features, one can easily determine the various parameters of the human images such as race, health, age, wealth, beauty, etc.[1]. However these kind of assumptions vary as per the cultures, regions, and geographical locations. In images and videos, skin color is an indication of the existence of humans in such media. In the last many years, research has been done on human images in terms of skin detection. Skin segmentations means detecting the skin and non-skin pixels in human images. Based on the skin color models and representations, the skin segmentations is the process of dividing the skin and non-skin pixels. In the past most the research in this area has focused on detecting skin pixels and regions based on their color. Very few approaches attempt to also use texture and other features to classify skin pixels [2].

Skin segmentation is one of the greedy research area and most of the important task which is used in different applications such as face [3] and adult content filtering [4]. In the past, many skin detection methods have been proposed which we will discuss in the background study section [4-6]

In terms of skin color modelling and detection, a good amount of work has been done in the past on skin color modelling by several authors. Recently tremendous amount of effort has been spent on skin colour modeling and detection methods by several authors. Kakumanu et al.[7,8] have reviewed the articles on skin colour modeling and detection methods and mentioned that the skin colour detection plays an important role in a wide variety of applications ranging from face detection, face tracking, gesture analysis and content based image retrievals to various human computer interaction domains. Skin segmentation deals with detecting human skin areas in an image. It is considered as an important process for face detection, face tracking and CBIR [9]. Skin colour can also be used as complementary information to other features and can be used to build accurate face detection system [10, 11, 12, 13]

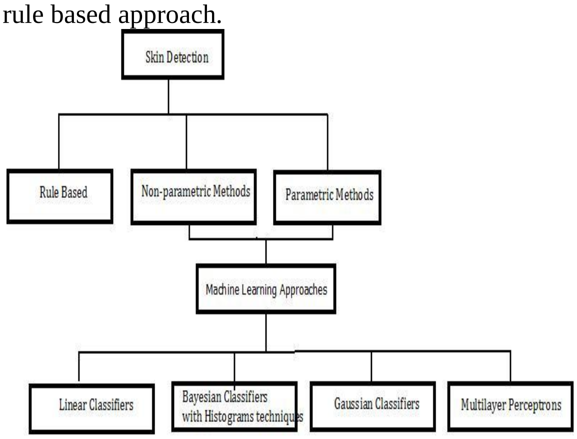
In the paper[4], the feature for the detection of skin region is by skin colour so the colour spaces provide the basic framework for feature vector extraction in skin colour detection or segmentation [14,15,16]. Different colour spaces like RGB, Normalized RGB, HSV, YCbCr and CIE L*a*b etc., are used for developing the skin colour detections [17, 18, 19]. Choice of colour space is the main aspect of skin colour feature extraction. It is mentioned in the literature that model based skin segmentation are more efficient than edge-based or histogram based techniques. Here in this paper, we compare the performance evaluation of classifier models based on various learning algorithms which are applied on human image or stack of human images. The features of the human image are being selected manually through rectangular selection of pixels of the image.

The format of the remaining paper is: section 2, defines and explains the background study and various methods discussed in the literatures as well as different classifications of skin colors that have been employed. Section 3 deliberates the framework design and discusses our detailed design of the implemented system. Section 4 discusses conclusion and future work of the research problem.

II. BACKGROUND STUDY

In the past research, several methods have been proposed and discussed. We can divide these methods majorly into three categories: explicitly defined skin regions, non-parametric methods and parametric methods.

In explicitly defined skin detection methods, such as [3] and [5], a series of rules have been defined and based on these rule sets, the pixels of the image is identified. When pixels of the skin matches one these defined rules, it will marked as skin pixel. In spite of their poor performance, these methods are good in their speed of detection as they are following rule based approach.



The other two categories are machine learning approaches. In these methods, the skin detection problem is defined as a learning problem and the skin detector is trained by a training set. The goal of these methods is usually to calculate p(skin|RGB), which is the probability that a pixel with color RGB be a skin pixel. After learning the p(skin|RGB), these values are used to create a skin probability map for image, such as Figure 1(b). In skin probability map, the probability that each pixel be a skin pixel is shown. This probability map is used to create the skin map which shows skin and non-skin pixels, such as Figure 1(c). The common and simple way to create skin map from skin probability map is using a threshold. The pixels with value greater than threshold are considered as skin pixels and other pixels are considered as non-skin pixels. The threshold can be constant [5] or calculated adaptively for each image [3].

In non-parametric methods, such as [3] and one of the methods proposed in [5], the p (skin|RGB) is estimated base on training data set without considering any model for probability model. The most common way to do this is using Bayesian classifiers. More details are explained in section 2, where we describe our skin detection method which is a non-parametric method. These methods usually have high true positive and low false positive rates. The main drawback of these methods is that storing p (skin|RGB) table (also known as Look Up Table (LUT)) requires high memory. A solution to this problem is using a smaller space color, such as a color space with 323 colors instead of 2563 colors [5].

Classifications Approaches:

There are various classification approached which can be classified into discriminative approaches such as Support Vector Machines, and generative ones such as graphical models.

2.2.1 Discriminative Approaches

Support Vector Machine (SVM) as a classifier based on the machine learning technique is becoming popular because of their automatically ability to select the relevant features from larger set of feature set. They are also popular in terms of performance and their ease of use.

Classifiers based on Support Vector Machine

Support vector machine is been widely applied in the field of pattern recognition. In this there is a separation in terms of hyperplane that determine and maximize the gaps between the object and non-object class. Papageorgiou et al. [1998], Mohan et al. [2001], SVM are used as classifiers over parts-based descriptors. Mohan et al. [2001] created a two stage cascade of SVM classifiers. The first stage creates part (head, left arm, etc) detectors from Haar wavelets. The second combines the part detections to obtain the final object detector. SVMs are also used as an intermediate stage in Ronfard et al. [2002], Dork´o and Schmid [2003]. In Ronfard et al. [2002], 15 SVM and Relevance Vector Machine (RVM) based limb detectors are created based on first and second order image gradients, but the final classifier is based on dynamic programming over assemblies of limb detections as in Ioffe and Forsyth [2001b,a]. Dork´o and Schmid [2003] use SVM based classifiers over interest points as intermediate part detectors for general object recognition, and test two types of final classifiers: (a) likelihood ratios for detecting parts P(part=1|object=1)/ P(part=1|object=0) , and (b) mutual information between detected parts and object classes.

Cascaded AdaBoost

AdaBoost combines a collection of weak classifiers to form a stronger one. In vision, it is used particularly to build cascades of pattern rejecters, with at each level of the cascade choosing the features most relevant for its rejection task. Although AdaBoost cascades are slow to train, owing to their selective feature encoding they offer significant improvement (compared to SVMs) in the run-time of the final detectors. Viola and Jones [2001], Viola et al. [2003] use AdaBoost to train cascades of weak classifiers for face and pedestrian detection, using spatial and temporal difference-of-rectangle based descriptors. Opelt et al. [2004] use a similar AdaBoost framework for their interest point based weak classifiers. Schneiderman and Kanade [2000, 2004] propose a more elaborate classification model. They define parts as functions of specific groups of wavelet coefficients, represented with respect to a common coordinate frame. This implicitly captures the geometric relationships between parts. Independent ("naive Bayes") combinations of likelihood ratios P(part|object=1)/P(part|ob ject=0) are combined to form the final classifier. The original detector did not use AdaBoost, but in Schneiderman and Kanade [2004], conditional probability scores are estimated using a modification of AdaBoost. Mikolajczyk et al. [2004] also use likelihood ratios P(descriptor|ob ject=1) P(descriptor|ob ject=0) as weak classifiers, but relax the independence assumption by using likelihoods over pairs of descriptors as weak classifiers. They again use AdaBoost to combine weak classifiers linearly to create strong ones. Finally, a coarse-to-fine strategy is used for fast detection.

Recently Zhu et al. [2006] used histograms of oriented gradient features proposed in this thesis with a cascade of rejecters based approach. They use an integral array representation [Viola and Jones 2001] and AdaBoost to achieve a significant improvement in run time compared to our approach while maintaining similar performance levels.

Other Methods

Agarwal and Roth [2002] use the perceptron-like method Winnow as the underlying learning algorithm for car recognition. The images are represented as binary feature vectors and classification is done by using a learned linear function over the feature space.

2.2.2 Bayesian and Graphical Models

Ullman et al. [2001] and Vidal-Naquet and Ullman [2003] show that image fragments selected by maximising the mutual information between the fragment and the class label provide an informative and independent representation. They use Naıve Bayes classification and show that using tree based Bayesian networks over the same fragment set does not give a noticeable improvement in classification results.

III. Skin Segmentation Classifier Model

A. Processes to build the classifier model:

Here we discuss the processes of building and development of the classifier model based on the learning algorithms. Basically there are two phases for building of any classifier models, training a model based on the labeled data set and testing of the model on the test data.

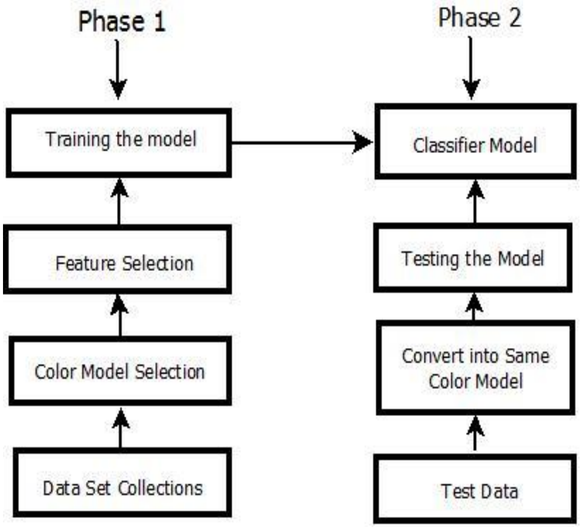


Figure 1: Framework for Classifier Model

In any given color space, skin color occupies a part of such a space, which might be a compact or large region in the space. Such region is usually called the skin color cluster. A skin classifier is a one-class or two-class classification problem. A given pixel is classified and labeled whether itis a skin or a non-skin given a model of the skin color cluster in a given color space. In the context of skin classification, true positives are skin pixels that the classifier correctly labels as skin. True negatives are non-skin pixels that the classifier correctly labels as non-skin. Any classifier makes errors: it can wrongly label a non-skin pixel as skin or a skin pixel as a non-skin. The former type of errors is referred to as false positives (false detections) while the later is false negatives. A good classifier should have low false positive and false negative rates. As in any classification problem, there is a tradeoff between false positives and false negatives. The more loose the class boundary, the less the false negatives and the more the false positives. The tighter the class boundary, the more the false negatives and the less the false positives.

Phase 1: Training the Classifier Model

In this phase of the model, the data set is being collected from Image databases and selection of image data from historical images. The training features are selected to learn the classifier model.

Phase 2: Testing the Classifier Model

In this phase of the model creation, the model is being tested and validated through the tested data. The tested data is converted into the same color model as the training data and then validation of the classifier model has been performed.

Feature Extractions (with trainable Weka segmentation)

Feature extraction from the image or stack of image: First step is feature selection; we select the features that we want to use in the building of classifier model for classification of skin pixels. Selection of features of the image with the help of ImageJ open source tool:

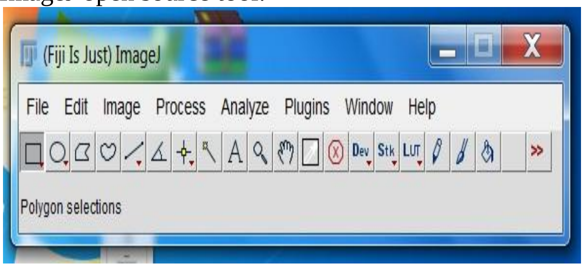


Figure 2: ImageJ snapshot

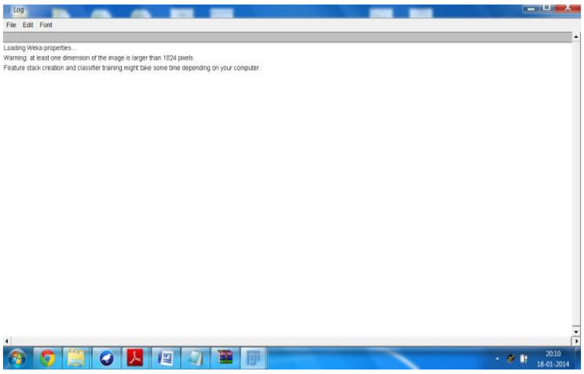


Figure 3: Trainable Weka Plugin

Algorithms used in building models and performance evaluations:

1. Naive Bayes Classifier: A naive **Bayes classifier** is a simple probabilistic classifier based on applying Bayes' theorem with strong (naive) independence assumptions.
2. Decision Tree: **Decision tree learning** uses a decision tree as a predictive model which maps observations about an item to conclusions about the item's target value. It is one of the predictive modelling approaches used in statistics, data mining and machine learning. More descriptive names for such tree models are **classification trees** or **regression trees**. In these tree structures, leaves represent class labels and branches represent conjunctions of features that lead to those class labels.
3. SMO: **Sequential minimal optimization** (**SMO**) is an algorithm for solving the optimization problem which arises during the training of support vector machines. It was invented by John Platt in 1998 at Microsoft Research. SMO is widely used for training support vector machines and is implemented by the popularLIBSVM tool. The publication of the SMO algorithm in 1998 has generated a lot of excitement in the SVM community, as previously available methods for SVM training were much more complex and required expensive third-party QP solvers.
4. Random Forest: **Random forests** are an ensemble learning method for classification (and regression) that operate by constructing a multitude of decision trees at training time and outputting the class that is the mode of the classes output by individual trees. The algorithm for inducing a random forest was developed by Leo Breiman and Adele Cutler, and "Random Forests" is their trademark. The term came from **random decision forests** that were first proposed by Tin Kam Ho of Bell Labs in 1995. The method combines Breiman's "bagging" idea and the random selection of features, introduced independently by Ho and Amit and Geman in order to construct a collection of decision trees with controlled variation.
5. J48: **C4.5** is an algorithm used to generate a decision tree developed by Ross Quinlan. C4.5 is an extension of Quinlan's earlier ID3 algorithm. The decision trees generated by C4.5 can be used for classification, and for this reason, C4.5 is often referred to as a statistical classifier.
6. ZeroR: ZeroR is the simplest classification method which relies on the target and ignores all predictors. ZeroR classifier simply predicts the majority category (class). Although there is no predictability power in ZeroR, it is useful for determining a baseline performance as a benchmark for other classification methods.

Tools and Techniques Used:

Weka machine learning tool is used during the building of classifier as well as for feature selection of the human image based on trainable weka plug-in.

IV. CONCLUSION

Here in this paper, we try to present the skin segmentation as research problem and solution for skin segmented presented in various academic and research level. Basically there are three categories of algorithms for skin detection known as rule based non-parametric and parametric methods. Rule based method are depend on the templates or patterns matched whereas other two methods are based on the machine learning techniques such Gaussian mixture model, linear classifiers etc. Then we identified that there is not perfect model for skin detection as it depend upon the training features of the images. We also observed that there is no standard process for image feature selection for classification process. Therefore we try to solve the problem by proposing features selection of the human images. In next level of research, we are trying to build a classifier model based on the optimal features of the image.

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