

A review of human skin detection applications based on image processing

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Article Info

Article history:

Received Apr 29, 2020

Revised Jun 1, 2020

Accepted Jul 18, 2020

Keywords:

Applications of human skin

Dataset

Skin color modeling

Skin detection

ABSTRACT

In computer science, virtual image processing is the use of a digital computer to manipulate digital images through an algorithm for many applications. To begin with a new research topic, the must trend application that gets many requests to develop should know. Therefore, many applications based on human skin and human life are reviewed in this article, such as detection, classification, blocking, cryptography, identification, localization, steganography, segmentation, tracking, and recognition. In this article, the published articles with the topic of human skin-based image processing are investigated. The international publishers, such as Springer, IEEE, arXiv, and Elsevier are selected. The searching is implemented with the duration criteria of 2015-2019. It noted that human skin detection and recognition are the most repetitive articles with 43% and 28.5%, respectively of the total number of the investigated articles. The usage of human skin models is being widely used in the image processing of various applications.

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1. INTRODUCTION

Skin detection plays an important role in a wide range of image processing applications ranging from recognition, detection, tracking, classification, segmentation, identification, blocking, localization, cryptography, steganography, and content-based image retrieval (CBIR) systems. Nowadays, the image pressing for human skin detection based on skin color recognition has demonstrated an attractive, efficient, powerful technique and partial occlusions. For this application, the skin color recognition can be work simultaneously with other methods such as; shape, boundary, geometry, and other features are used to improve the accuracy of the system. An accurate system of detection; it has seven regions (feature points, skin tone, face, diseases, pornographic, hand, and adult). For recognition, it has pornography, disease, face, gender and hand. Tracking application has face, diseases, and hand. Segmentation application has face, diseases and hand. Steganography has skin tone and diseases. Localization application has hand region only. Identification also has for adult only. Cryptography application has diseases. Blocking application has adult. Classification has face, hand, diseases and age [1-9].

The skin detection based on color information is the technique to identify the skin and non-skin regain of the tested image. The skin regains means any part of the human skin that noted in the image under the test of the human skin detection system, such as the face, legs, and hands. Therefore, the skin detection is the first process of any recognition system such as face recognition [10-15]. This study aims to investigate

the up to date researches of human skin detection applications. This article tried to sum up the differences between these applications, their strengths, and limitations.

This article is organized as follows: section 2 illustrates the human skin detection process such as recognition, detection, tracking, classification, segmentation, identification, blocking, localization, and cryptography. Section 3 demonstrates the desiccation and future work of this application. Finally, section 4 concludes the presented techniques and recommended the futures of human skin detection using image processing.

2. HUMAN SKIN APPLICATION

The detection of the skin plays an important role in a wide range of image processing applications, from facial recognition to face tracking and various digital communication domains. There are ten types of human skin applications, which are detection, classification, blocking, cryptography, identification, localization, steganography, segmentation, tracking and recognition, as shown in Figure 1. For the next section, we explain each application and its correlated datasets.



Figure 1. Types of human skin applications

2.1. Recognition

Hand gesture recognition helps us to contact people with disabilities by using sign language alphabet and controlling some robots and appliances without a controller. In human computer interface (HCI), gesture recognition is an important topic which needs to have a breakthrough. It has been used in combination with skin detection in more than 17 research like [1-3]. DATA: ECHO, personal data, NITS hand gesture, VGG16, collected from a project supported by the polish ministry of science & higher education. The test data are collected from videos captured by web-camera, collected a dataset of twenty-four. New dataset is created in which the signs from www.indiansignlanguage.org are replicated, Indian sign language (ISL) gestures.

Face recognition is an important problem when the photo of a suspect is not available or is captured with very poor quality. It has been used in combination with skin detection in more than 14 research studies like deep convolutional neural networks (DCNN) [4], deep neural network [5], recognition of skin from hyperspectral face [6]. DATA: (facial spectral, CMU, VidTIMIT, AT&T & ORL, ORL, LCPTS Facial &

Caltech, LFW, from internet, FEI, LFW, Caltech & FERET, IIITD Viewed, CUFS, e-PRIP & MGDB Unviewed, pictures captured by laptop web camera, FERET, CASIA-WebFace&FaceScrub).

Subsequent work has commenced to analyze the feasibility of the state-of-the-art to the recognition of image within the domains of dermascopy and dermatology. There are seven research studies available on skin diseases recognition for cancer, Psoriasis Skin, Skin Lesion, and Skin Lesion as [7, 8, 16, 17].

An overview of the dataset containing all points to present an identification challenge for melanoma was selected at the international symposium on biomedical imaging (ISBI 2016). In order to carry out the trace and evaluation, we used the data set published by the international collaboration on skin imaging (ISIC) to challenge the international symposium on biomedical imaging 2016 (ISBI 2016) entitled "Skin Lesion Analysis toward Melanoma Detection".

In recent years it has been suggested that people's demographic characteristics, such as age and gender orientation have been considered in the past decade [18]. Automated images face recognition is implemented by using three supervised learning machines, which are adobos, neural network, and SVM. Recognizing demography characteristics of individuals, for example, age and gender using automatic image recognition taken much consideration in last few years [18]. DATA: (FERET). In order to identify obscene images on the Web, the two key points are the accuracy and speed of identification. At present, many techniques are recommended to recognize the obscene images. One of the functions of skin detection is the identification of obscene images and pornography such as; multimedia files pre-processed, to analyze skin-colored pixels [19], Oriented FAST and Rotated BRIEF (ORB) [20], and combination of global and local features [21]. DATA: (From internet, NPDI).

2.2. Detection

Skin cancer is a major medical problem in general. If it can be detected timely then it can save life costs. Melanoma skin cancer is one of the most fatal skin cancer forms but can be easily cured if detected early enough. More than 23 researches had presented a solution for detecting early-stage melanoma skin cancer and detection of skin lesions like automated classification using deep neural networks [22], algorithms for automated diagnosis of melanoma [23], selection of a classifier [24], deep convolutional neural networks [25]. DATA: (PH2, ISIC, ISBI, Personal data, Edinburgh, Synthesis, from internet, DermIs, DermQuest).

Face detection is used in many fields, such as: intelligent video surveillance, face recognition, mobile photography equipment, etc. These applications require skin detection to achieve face detection quickly. These have been used in combination with skin detection in around 33 studies like color matching [26], three dimensional model of the human face using optimization-based reconstruction algorithms [27], swarm of particles in a kernel [28], k-nearest neighbors (KNN) algorithm and high boost filter [29]. DATA: (Personal data, FEI, Pointing'04, Bao Face, Group, Utrecht, MIT, AFW, Wider Face, ATM, PIE, FERET, LFW, Caltech, CMU, HHI, VidTIMIT, AT&T, ORL, M2VTS, XM2VTS, VALID, Helen, Faces in the, Wild, Microsoft hand gesture, Padua Hand gesture, Padua Face Dec., FEI, images of the same person, from the video, from internet, from the video dataset ChokePoint, Paratheepan, FDDB, Pascal Faces, Custom, pictures captured by laptop web camera, MIT-CBCL, Georgia Tech, University of Oulu Physics-based face, CMUPIE, IMM).

A powerful detection of the hand signals and gestures remained challenging test for the basic computer, which was under real conditions. It may be useful to identify some of the applications in the images, such as communication that was recorded through a sign language analysis. Hand detection is mandatory for some hand-related functions, such as understanding hand gesture and pose, which is very useful for mechanical technology like robotics and interaction between humans and computers. The hand detection of CNN [30], CNN [31], multiple scale region-based fully convolutional networks [32], CNN [33], multi-feature CNN [34] are based on detecting skin pixels. DATA: (Oxford, Egohands, Personal dataset, 5-signer, VIV, Egohands, HGR).

The scale of adult content on the Internet is increasing every day. Many of the obscene and pornographic stuff is unlimited and open to all customers and users. The Adult based Page detection plays an important role in preventing sexual entertainment and pornography. In the area of adult image detection, noteworthy articles have been written on the detection of porn images with skin color CNN and RNN [28] forward an approach [29]. DATA: (From internet, NPDI).

With the growing amount of inappropriate content on the Internet like pornography the need to detect and filter such material has arisen. They [35], color-saliency preserved mixture deformable part model [36], deep convolutional neural networks [37], key-frame extraction algorithm [38], local feature with Bag-of-Words models (BoW) [39], deep learning [40], deep learning [41], optimized nudity recognition [19] are proposed pornographic detection methods based on low level features of skin regions. DATA: (Video data, Pornography-800 & Pornography-2k, APPA-Real, from Internet, NPDI)

2.3. Tracking

An important area of research in computer vision is target tracking. It is usually applied in the area of artificial intelligence (AI), for example, reorganization, surveillance, intelligent traffic, automatic control, and human-computer communication, etc. [42]. The tracking of face is an important research in the area of analysis of image and computer Vision framework. As a result of face tracking help security forces to investigate the wrongdoing and crimes. Analysts developed a technique for facial tracking based on autonomy-oriented entities (AOEs), and deep learning concepts [43], SDN algorithm [44-47] to highlight skin color, and extraction. DATA: (APIDIS, from video, Personal data, Visual Tracker Benchmark, images of the same person).

Hand gesture recognition system can be used for human-computer interaction (HCI). Depending on the skin's detection, some researchers used Hand gesture recognition [48-50]. DATA: (Grabbing hand gesture, Face zoom out, Occluded hands, Personal data, ECHO).

2.4. Classification

Skin disease is one of the most common illnesses in human daily life when people want their first assessment, there is no doubt that the VRS visual recognition system is helpful even if not perfect. For example, if a detailed section of skin disease has been performed, the user can bring up a recent picture of skin disease for diagnosis. Surprisingly, most research has been conducted using artificial vision technology to identify common skin diseases using common sense. There are many applications for skin disease, skin cancer, Skin Lesions, and skin pigmentation disorders [51-54]. DATA: (Edinburgh & MED-NODE, Personal data, ISBI, PH2, ISIC, the ISIC Archives, the Edinburgh Dermofit, Image Library).

Hand gestures and motions are commonly used in major applications such as human machine interface design, sign languages, virtual reality, and animation, etc. The accuracy of a consistent gesture sequence is based on the technology used to extract the tasks used in the system. From the classification of the skin, it was observed that the area was used to determine the hand boundary [32, 55]. DATA: (Oxford, Sebastien Marcel, Cambridge Hand Gesture, NUS Hand Posture).

Facial skin assessment is crucial for a number of fields including the make-up industry, dermatology and plastic surgery [56]. DATA: DermNet. With the rapid development of the internet, obscene and pornographic images/videos can more easily spread and cause greater harm to the social stability and teenagers' mental health [57]. DATA: from Internet. Human age classification via face images is not only difficult for human beings but also challenging for a machine. Facial skin ageing features consist of facial skin textural features and wrinkle analysis [58]. DATA: FG-NET ageing.

2.5. Segmentation

The segmentation components of the system are used to identify the lesion areas and Melanoma (cancer) for skin on the medical images [53,59-63]. DATA: FG-NET ageing. Hand segmentation for hand-object interaction is a necessary pre-processing step in many applications such as augmented reality, medical application, and human-robot interaction [64-67]. DATA: (ECHO, Microsoft Kinect v2, HGR and NUS-II, Personal data, EgoHands, EYTH, GTEA, HOF & EgoHands+). The face Semantic segmentation (FASSEG) repository contains more than 500 original face images. There are six classes that are based on segmentation masks, namely mouth, nose, eyes, hair, skin, and background [68]. DATA: (MIT-CBCL, FEI, POINTING'04, SIBLINGS HQ-f).

2.6. Identification

Many research studies have already been done on adult image identification. Authors [69] used adult image identification depends on skin color detection. DATA: from internet.

2.7. Blocking

This work aims at the detection of adult images that appears on the Internet. Skin detection is of the paramount importance in detecting adult images; [70] used blocking adult images based on statistical skin detection. DATA: Compaq & Poesia.

2.8. Localization

One amongst the vital pre-processing operation in every face recognition system is face localization. [28, 71] here proposed an algorithm which performs skin detection using particle swarm optimization for face localization. DATA: (FEI, LFW, Caltech & FERET). In [72], this paper outlines another strategy for detecting the manual landmarks in 2D color images. The Handheld Destination Area is an important source of information for the detection of hand gestures. In order to properly evaluate the algorithms for hand landmark localization HGR set of hand images was used (available at <http://sun.aei.polsl.pl/~mkawulok/gestures>).

2.9. Steganography & Cryptography

Steganography is the art of hiding information in another medium to make mysterious correspondence. The currently used steganography technology depends on biometrics. In addition, the biometric enhancement used to update steganography is the positioning of skin tones in images [73].

In the proposed procedure [74], the biometric coverage used to make steganography is to make a skin tone region of the images. The mysterious and secret data information is embedded in ROI and not in the whole video. In [75], this article recommends a blind videotape steganography algorithm that focuses on high sensitivity and compression of MPEG-4. The proposed algorithm adds large secret pictures with video recordings. Human skin areas are selected as an ROI for the data embedding process.

Authors [76] presented an interesting strategy in which secret information can be embedded in the skin because it is not a very basic for HVS (human visual system). From the beginning, an image is taken then skin tone detection is performed based on HSV MODEL. LSB based on encoding method has been proposed in [77] that utilized DCT and pixel flipping technique to form the stego-image. Stego-key generation method is also implemented to validate the authorized receiver during retrieval. The image of the skin disease is considered to be both, cover image and stego-image. The receiver can retrieve the original image using key-based decryption algorithm, LSB, and pixel flipping method. DATA: (From internet, videos and image).

3. RESULTS AND DISCUSSION

There is varied amount of journals research publishers, such as Springer, IEEE, arXiv and Elsevier, that studied human skin application. We reviewed major applications of human skin from 2015-2019. Figure 2 illustrates the number of the published article based on the publisher of each human skin detection application. It can see that the Detection application has the highest number of published articles. In addition, the IEEE and Springer publisher demonstrates the highest number 23 and 20 of published articles, respectively. A large number of researches that have been published in the publishers with high reputation have found this figure. As you can see, each application has the highest amount of papers in the journal. For detection, recognition, tracking, classification and segmentation applications, IEEE is the highest number of journals with 23, 11, 4, 4, and 4 respectively. On the other hand, steganography application has the high amount of papers in Springer journal. Human skin detection is one of the most captivating topics in the eyes of researchers, where through Figure 2 has been found a large number of studies that have been published in the journals with high reputation.

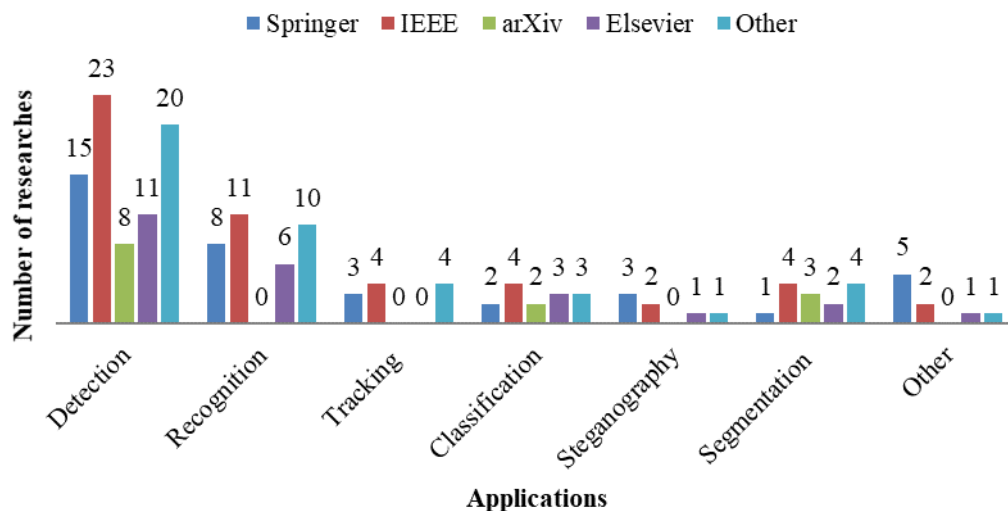


Figure 2. The number of researches in journal for human skin applications

Figure 3 has summarized the number of studies in human skin applications in 2015-2019. With a total of 149 papers, we can conclude that the applications are in the form of pie chart statistics. As we can see, the majority of researches are in detection and recognition with 43% and 28.5%, respectively. However, a few studies were published for the applications of identification, blocking, and cryptography. It is noted that the detection is one of the hottest topics last five years for human skin detection.

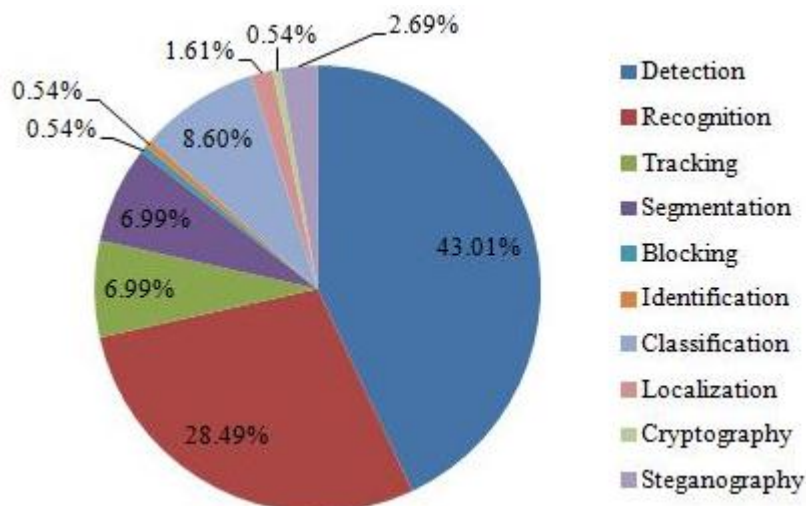


Figure 3. The number of researches in journal for human skin applications

4. CONCLUSION

This article has investigated many important applications for humans and human's life (such as detection, classification, blocking, cryptography, identification, localization, steganography, segmentation, tracking, and recognition) based image processing. The investigation is implemented by searching for the human skin application within several international academic search engines, such as Springer, IEEE, arXiv and Elsevier from duration criteria of 2015-2019. Among these different applications, the skin detection is the most repetitive application published last five years in international journals. The result shows that 43% of the published articles are developed algorithms for skin detection applications. Human skin detection is very important and has many applications for society, which are important and effective for human needs and fulfil many tasks. On the other hand, each application contains many scientific fields, as every field uses a database of images that varies according to the type and need. It is worth mentioning that the studies on the human skin detection and its applications are very important where the studies have been published in international journals and publishers; such as Springer, IEEE, arXiv, and Elsevier. The investigation of this article guides the researchers for the hottest application and research scope. In short, more development is recommended on the image processing for human skin detection in recent years

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