

Human Skin Texture Analysis Using NGLDM

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Abstract: There are various types of skin diseases like skin dryness, fungus, and allergies. The objective of this paper is to analyze the skin disease using texture analysis of skin image and by comparing the test image to a defined images. When image processing is concerned in the skin analysis, it is important to evaluate different texture features.

Skin texture analysis is one of the feature in Digital image processing used to analyze the images that captured by the imaging devices on human skin.

A new method for color texture characterization and color texture region detection is presented. This method, which we will name NCDM (Neighbouring Color Dependence Matrices), is the extension to color textures of the NGLDM (Neighbouring Gray Level Dependence Matrices) introduced by Sun et al. [1] and completed by Berry et al.[2].This approach consists in estimating the dependences of colors between a pixel and its neighbours. We propose two steps: a color areas classification in two classes followed by the characterization of the detected areas. In A new method for color texture characterization and color texture region detection is presented. This method, which we will name NCDM (Neighbouring Color Dependence Matrices), is the extension to color textures of the NGLDM (Neighbouring Gray Level Dependence Matrices) introduced by Sun et al. [1] and completed by Berry et al.[2].This approach consists in estimating the dependences of colors between a pixel and its neighbours. We propose two steps: a color areas classification in two classes followed by the characterization of the detected areas. In A new method for color texture characterization and color texture region detection is presented. This method, which we will name NCDM (Neighbouring Color Dependence Matrices), is the extension to color textures of the NGLDM (Neighbouring Gray Level Dependence Matrices) introduced by Sun et al. [1] and completed by Berry et al.[2].This approach consists in estimating the dependences of colors between a pixel and its neighbours.

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A new method for color texture characterization and color texture region detection is presented. The method NGLDM (Neighboring Gray Level Dependence Matrices) introduced by Sun et al. and completed by Berry et al. This approach consists in estimating the dependences of colors between a pixel and its neighbours. The texture analysis method that allows best prediction of smoothness for our tumor domain is the NGLDM method. The Neighbouring Gray Level Dependence Matrices (NGLDM, Sun & Wee in 1983 [1] and Berry & Goutsias in 1991 [2]) to color images.

Keywords

- Digital Image Processing.
- Neighboring gray level matrices

- Skin Texture Analysis.
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1. Introduction

Texture analysis is one of the feature in image processing used to analyze the images that captured by the imaging devices on human skin. Normally human skin texture having different types like smooth, dryness which is happened based on individual human food habits, living environment, genetic and etc. The skin texture varied depending on their age as well. The major properties of skin are rough, smooth, random and regular. The following are some of common skin diseases:

a. Allergic Skin Disorders: Most people are bothered by skin irritations at some point in time. This irritations are common and varied that they are called by different names, which can lead to confusion. When an allergen is responsible for triggering an immune system response, the irritation is an allergic skin condition. There are different types of Allergic Skin Disorders like:

- **Atopic Dermatitis:** Atopic Dermatitis is a chronic skin condition that usually begins in infancy or early childhood and is often associated with food allergy, allergic rhinitis and asthma.
- **Contact Dermatitis:** When certain substances come into contact with our skin, they may cause a rash called Contact Dermatitis.
- **Hives and Angioedema:** Urticaria is the medical term for hives, which are red, itchy, areas of the skin. They can range in size and appear anywhere on our body. Angioedema is a swelling that affects the deeper layer of the skin. It is usually not red or itchy. Angioedema commonly occurs with hives on its own. Insect sting reactions are a common cause of hives and Angioedema.
- **Dermatitis:** An inflammation of the skin that produces a red, itchy rash is known as dermatitis. The most common types are atopic dermatitis and contact dermatitis.



Fig: Allergic Skin Disorders.

b. Viral Skin Diseases: In the vast world of skin diseases, viral skin disorders account for a significant percentage. Most viral skin diseases present with an exanthema (skin rash) and, accompanying anathema (lesions involving the mucosal membrane). There are different types of Viral Skin Diseases like:

- **Shingles:** Shingles causes uncomfortable and painful symptoms due to the inflammation of the sensory nerves.
- **Chickenpox (varicella):** A viral illness characterized by a very itchy red rash, is one of the most common infectious diseases of childhood, This is known as Chickenpox.
- **Rubella:** Rubella is caused by the rubella virus, in the Ruby virus genus. Rubella spreads from person to person through direct contact with nasal or throat secretions of infected individuals. Signs or symptoms of rubella are slight fever, sore throat, runny nose and malaise.
- **Roseola:** Roseola is caused by human herpes virus type 6B (HHV-6B) and possibly type 7 (HHV-7). Roseola signs are high fever lasting for 3–5 days, runny nose, irritability and tiredness. As the fever subsides rashes may appear on the face and body. Roseola is also known as roseola infant and exanthema subatomic.
- **Later thoracic Exanthema:** Later thoracic exanthema is an uncommon rash affecting young children, which is suspected by a viral infection. Later thoracic exanthema is also known as Asymmetric Per flexural Exanthema.
- **Yellow Fever:** Yellow fever is a viral disease found in tropical regions of Africa and the America. The yellow fever virus belongs to the flavi virus group, which is spread by the bite of Aedes and Haemogonus mosquitoes. Infection causes the disease, from mild symptoms to severe illness. The name of this disease is derived from the jaundice that affects some patients.



Figure 1: Viral Skin Diseases.

c. Bacterial Skin Diseases: A bacterial infection is a proliferation of a harmful strain of bacteria on or inside the body. An infection can take many different forms depending on the location, bacteria type, and even the age of the affected patient. Many bacterial infections can be treated by a general physician. More complex one may need specialist dermatologist or even a rheumatologist. There are different types of Bacterial Skin Diseases like:

- **Cellulites:** Cellulites causes a painful, red infection that is usually warm to the touch. Cellulites is a bacterial infection affecting the two deep layers of the skin: the dermis, and the subcutaneous tissue. Cellulites is associated with both Staphylococcus and Streptococcus, although many other type of bacteria can cause the condition. Cellulites typically develops in areas where the skin has broken, such as ulcer or surgical wounds.
- **Erysipelas:** Erysipelas is a bacterial infection that occurs in the top two layers of skin. It is also commonly referred to as St. Anthony's Fire because it is very painful and causes an intense burning sensation.
- **Folliculate:** Folliculate is a common infection of hair follicles. It may be caused by bacteria and fungus and the symptoms are tiny, red bumps that are filled with pus. Folliculate is more common among people with acne. Shaving can further increase the risk.
- **Hot Tub Folliculate:** Hot tub folliculate is an infection of the hair follicles which is caused by the bacteria Pseudomonas aeruginosa. The bacteria is commonly found in contaminated whirlpools, hot tubs, water slides, physiotherapy pools, or even local sponges. Children tend to get it more than adults.
- **Furuncles:** While folliculitis involves the infection of a hair follicle, a furuncle is an infection of the entire pilosebaceous unit. Pilosebaceous units are made up of shaft, follicle, sebaceous and are located throughout the body with the exception of the palms, soles of the feet, and lower lip. A furuncle is most commonly found on the face, chest, and upper neck.
- **Carbuncles:** A carbuncle is a cluster of several furuncles densely packed together. It is a serious infection than a furuncle typically requiring medical attention. Carbuncles occur in the same areas as a furuncle but also can develop on the buttocks, thighs, groin, or armpits.



Figure 2: Bacterial Skin Diseases.

d. Fungal Skin Diseases: Fungal infections are common throughout much of the natural world. In humans, fungal infections occur when a fungus takes over an area of the body and is too much for the immune system to handle. Fungal skin infections are caused by different types of fungi and can be a common sign of itchy skin. There are different types of Fungal Skin Diseases like:

- **Athlete's foot:** Athlete's foot is commonly associated with sports and athletes because the fungus grows perfectly in warm, moist environments, such as socks and shoes, sports equipment, and locker rooms. Anyone can be affected by athlete's foot. It is most commonly occurred in warmer climates and summer months, where it can quickly multiply.

- **Yeast Infection:** Yeast infections are a common form of Candida overgrowth in women, usually caused by Candida albicans. An overgrowth of Candida disrupts the balance of the bacteria in the vagina. The imbalance of bacteria may be due to antibiotics, stress, and hormone imbalances.
- **Jock Itch:** Jock itch is another common fungal skin infection. These fungi occurs in warm environments and thrive in moist areas of the body, such as the buttocks, and inner thighs. Jock itch may be more commonly occur in summer or in warm, humid areas of the world.
- **Ringworm:** Ringworm is a skin infection that lives on dead tissues, such as the skin, hair, and nails. Ringworm is the fungus that causes jock itch and athlete's foot. It can appear anywhere on the body.



Figure 2: Fungal Skin Diseases.

2. Texture Analysis

Texture and color of human skin has proven to be the most important aspect of several imaging systems. Human texture reproduction has been very beneficial in medical diagnosis, cosmetic analysis etc. The basis on which the human is able to discriminate between surfaces and objects is texture analysis. The skin texture has a close relation with the individual's diet, hormones, hydration and any allergic symptoms.

Texture analysis approaches are categorized into 4 methods. They are:

1. Structural
2. Statistical
3. Model-based and
4. Transform

1. Structural: This approach depicts texture by well-defined primitives and arrangements of those primitives. Defining the primitives describes the texture very well. A tool for structural texture analysis is provided by mathematical morphology. It may be useful for bone image analysis, e.g. for the detection of changes in bone microstructure.

2. Statistical: This approach do not attempt to understand the ordered structure of the texture. Rather, they represent the texture indirectly by the non-deterministic properties that control the distributions and relationships between the gray levels of an image. Methods based on second-order statistics have been shown to achieve higher discrimination rates than the power spectrum and structural methods.

3. Model based: Texture analysis using fractal and stochastic models, attempt to interpret an image texture by use of respectively generative image model and stochastic model. The parameters of this model are estimated and then used for image analysis. In practice, the primary problem is the computational complexity arising in the estimation of stochastic model parameters. The fractal model is useful for modeling some textures.

4. Transform: In this method of texture analysis, such as Fourier, Gabor and wavelet transforms represent an image in a space whose co-ordinate system has an interpretation that is closely related to the characteristics of a texture. Due to its lack of spatial localization methods based on the Fourier transform perform poorly in practice.

Models of texture: Models used for image segmentation are:

- AR model
- Gaussian-Markov RMF and
- Gibbs RMF

3. Texture Analysis Techniques

A new technology, Neighboring Gray Level Dependence Matrix (NGLDM), for texture classification is presented. The major properties of this technology are as follows:

- (a) Texture features can be easily computed.
- (b) They are essentially invariant under spatial rotation.

Definition of the NGLDM

In order to simplify the notations, the NGLDM will be noted as Q. The general term of Q is given by the expression:

$$Q_{d,a}(g, s) = \# \{ (\ell, c) \mid G(\ell, c) = g \text{ and } \# [(i, j) \in V_d \mid |G(\ell, c) - G(i, j)| \leq a] = s \}$$

Hence the NGLDM is a matrix of size $N_G \times (N_d + 1)$ and $Q_{d,a}(g, s)$ is the number of pixels in an image with gray level that have exactly s neighbours with gray level in the interval $[g-a, g+a]$. The matrix Q allows us to calculate the estimated joint distribution of the random variables G and S , as shown below:

$$\hat{P}_{d,a} [G = g, S = s] = \frac{Q_{d,a}(g, s)}{\sum_{u=0}^{N_G-1} \sum_{v=0}^{N_d} Q_{d,a}(u, v)}$$

Example of NGLDM Algorithm

This matrix takes a two-dimensional array Q, where $Q(i, j)$ can be considered as frequency counts of grayness variation of a processed image. This array is $N_g \times N_r$ where N_g is the no. of possible gray levels and N_r is the no. of possible neighbours to a pixel in an image.

If the image function $f(i, j)$ is discrete, then it is easy to compute the Q matrix by counting the number of times. The difference between each element in $f(i, j)$ and its neighbours is equal or less than a at certain distance d .

Here is the example ($d = 1, a = 0$):

Input matrix and output matrix Q:

		NGLDM numbers (N_r)									
		0 1 2 3 4 5 6 7 8									

$\begin{bmatrix} 1 & 1 & 2 & 3 & 1 \\ 0 & 1 & 1 & 2 & 2 \\ 0 & 0 & 2 & 2 & 1 \\ 3 & 3 & 2 & 2 & 1 \\ 0 & 0 & 2 & 0 & 1 \end{bmatrix}$	gray levels	0	0	0	1	0	0	0	0	0	
		1	0	0	1	1	0	0	0	0	0
		2	0	0	0	0	4	1	0	0	0
		3	0	1	0	0	0	0	0	0	0
	(N_g)										

In the above example that you have provided, $d=1$ and $a=0$. When $d=1$, When $a=0$, this means we look for pixels that have the same value as the centre of the neighbourhood.

The basic algorithm is the following:

1. Initialize our NGLDM matrix to all zeroes. The total number of rows corresponds to the total number of values in your image. The total number of columns corresponds to how many pixels are there in our neighbourhood plus 1. For $d=1$, we have an 8-pixel neighbourhood, so $8 + 1 = 9$. Because there are four possible values in $(0,1,2,3)$, thus we have 4×9 matrix. Let's call this matrix as 'M'.
2. For each pixel in your matrix, take note of this pixel. This goes in the N_g row.
3. Write out how many valid neighbours there are that surround this pixel.
4. Count how many times you see the neighboring pixels matching that pixel in Step #1. This is your N_r column.
5. Once you figure out the numbers in Step #1 and Step #2, increment this location by 1.

4. Conclusion

This paper describes some techniques and models that have been used till now for the feature extraction of the image. These methods produced great results in the field of skin diseases diagnosis. When the extraction is to be done in the field of medical it has to be very accurate so that the proper treatment can be given to the concerned patient. We have used different texture analysis techniques like NGLDM (Neighboring Gray Level Dependence Matrices). A case study regarding various techniques for texture analysis are being analyzed and the most suitable and more efficient statistical method for texture analysis was determined.

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