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The Weighting Analysis of Influence Factor in Clinical Skin Physiology Assessment via Rough Set Method

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Abstract

The main purpose of this paper is to study the weighting analysis of clinical skin physiology assessment. First of all, we analyze skin's physiological factors, which include four factors: Cutometer, PH value, Sebumeter and Mx16. A detailed description of each influence factors is offered and based on the analysis of 61 experimental objects' testing numerical values. Then, using rough set method in soft computing theory and the weighting model, we derived the factors' weighting and relational of skin physical system from the skin characteristic analysis of diverse-aged research objects. This paper also applies Matlab to develop a complete human-machine interface type of toolbox in order to support the calculation and verification the huge data. Finally, some further suggestions are indicated for the research in the future.

Keywords: *Clinical skin physiology assessment, Weighting, Rough set, Matlab.*

1. Introduction

The condition of skin cannot be seen by naked eyes. It needs special equipment to test the physical properties of skin before determining its conditions. Clinically, there are various instruments for testing skin, though most simply analyze the general characteristics without diagnosing it in detail and further analyzing it according to age differences. As the largest human organ, besides protecting the human body, skin manifests human physical and mental conditions. This study attempts to analyze the weighting of factors in skin physiology assessment based on the physical conditions of various clinical cases, including the elasticity, pH value, sebum, color, moisture, and hydrating capacity of skin[1,2]. The significant analysis in rough set theory is applied to analyze the weighting of various factors in skin physiology assessment because this mathematical model fits the situation. The rough set is often used in applied to practical analysis, operated manually in analyses and calculations,

programmed with general languages even as a computer utility. For example, many Chinese version utilities and other software utility researches using the rough set are programmed with C^{++} and Visual Basic. As the rough set theory has been developed for over 20 years [3~5], applied to analyses in Taiwan for over a decade, and has become a popular research topic[6], this paper will integrate rough set method in software to develop corresponding and practical computer utilities with the Matlab[7~9]. Next, data will be collected from subjects of different skin quality selected clinically in order to develop a practical system based on the results of skin factor weighting analysis as a reference for cosmetology and related researches. Though there were some skin-related studies using the rough set theory, all are qualitative researches [10, 11].

Therefore, this is the first quantitative study on skin physiology assessment analyzing factor weight with the rough set theory in a software mathematical model. In this paper, first, in section 2, we list the whole mathematical foundation of rough set in detail. In section 3, the basic concept of clinical skin physiology assessment and its measurement method are presented. Section 4 consists of empirical analysis where actual data was substituted into the mathematical model to derive the needed data. The final section of this study consists of a conclusion and recommendations for future research.

2. Preview of rough sets

In this section, we only simply introduce the basic concept of rough set[6].

2.1. Basic relationship

2.1.1 Information system (IS)

$IS = (U, A)$ is called information system, where $U = \{x_1, x_2, x_3, ..., x_n\}$ is the universe finite set of object, and $A = \{a_1, a_2, ..., a_m\}$ is the set of attribute.

2.1.2 Information function

If exist a mapping $f_a : U \to V_a$, then V_a is the set of value of a, call the domain of attribute a.

2.1.3 Indiscernibility relation

An indiscernibility relation is defined as for any x_i and x_j, if x_i is identical to x_j, then x_i and x_j have all the same properties

2.2 Calculation method

2.2.1 Lower approximation and upper approximation

If $A \subseteq U$, then the lower approximation is defined as

$$\underline{R}(A) = \{x \in U \mid [x]_R \subseteq A\} = \bigcup \{[x]_R \in \frac{U}{R} \mid [x]_R \subseteq A\} \quad (1)$$

and upper approximation is defined as

$$\overline{R}(A) = \{x \in U \mid [x]_R \cap A \neq \phi\} = \bigcup \{[x]_R \in \frac{U}{R} \mid [x]_R \cap A \neq \phi\} \quad (2)$$

2.2.2 Positive, negative and boundary

Based on the mentioned above, the positive, negative and boundary are defined as

$$pos_R(X) = \underline{R}(X), neg_R(X) = U - \overline{R}(X), \; bn_R(A) = \underline{R}(A) - \overline{R}(A) \quad (3)$$

2.2.3 The dependents of attributes

$$\gamma_c(D) = \frac{|posc(D)|}{U} \quad (4)$$

Means under $a \in C$, the ratio in the whole set.

2.2.4 The significant value of attributes

In $S = (U, C \cup D, V, f)$ system, under $a \in C$, the significant value of attributes is defined as

$$\sigma_{(C,D)}(a) = \frac{\gamma_c(D) - \gamma_{c-\{a\}}(D)}{\gamma_c(D)} \quad (5)$$

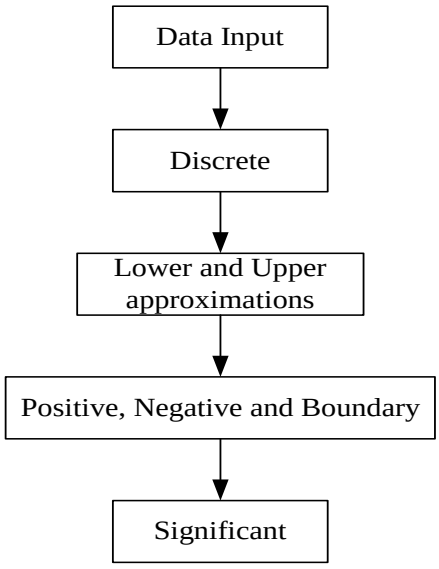

Figure 1. The operation of weighting in rough set method

3. Clinical skin physiology assessment

3.1 The clinical skin physiology assessment

The application and analysis of clinical skin physiology assessment are as follows

1. Testing conditions: 20±2°C and RH 45±5%. As the best results can be obtained in such conditions, it is necessary to create such an environment for running the test.
2. Subjects: 50-70 subjects will be selected, and the coverage of subjects and testing results will be the data for the statistical analysis.
3. Age and gender of subjects: over 18-52 years of age, females.
4. Part of skin test: As the keratin content, moisture content, sebum secretion, and skin pigment distribution vary at different parts of the skin, this study selects the cheeks as the location of testing conducted three times.
5. Cleaning of the part of test: Subjects will wash their cheeks with non-alcoholic lotion or cleansing lotion 3 hours before the test is conducted to let the skin recover its original condition.
6. Skin type: The subjects with dry and oily skin were selected on an equal basis after testing for three times. Those with skin irritation or allergy will be eliminated from the test.

3.2 The skin physiology analyzers

1. Cutometer: Using the ultrasonic theory, as the elastic fiber tissues crisscross, it needs to measure the same point of measurement from four different angles and calculate the mean elasticity of these four measurements.
2. PC Skin-pH-Meter 905: Improved from industrial pH testing rod, it judges the results with particular software or an LCD panel.
3. Sebumeter-810: It uses a special type of translucent papers that become transparent after contacting sebum, and the greater the amount of sebum, the more transparent the paper will become. Clean test papers will first be scanned once in the infrared sensing area before attaching them to the testing area for a particular time specified by the instrument. Then, the test papers absorbed the sebum will be scanned again to measure the amount of sebum.
4. Mexameter MX16: Using the spectral reflecting theory: It measures the LAB value with full spectrum or the melanin and hemoglobin counts at a particular wavelength.
5. Corneometer: Using the human conductivity theory: An electric current will be administered on the keratin. By calculating the impedance, the hydrating capacity of skin can be obtained.
6. Tewameter: This uses an ultrasensitive microchip to capture the water molecules diffused from the skin to measure the water loss speed of skin.

3.3 Evaluation factors

This study assesses human skin physiology in terms of five factors: skin elasticity, skin pH value, sebum secretion, skin pigment, and age as described in the mentioned above.

4. Results analysis

A total of 61 female subjects were selected from central Taiwan aged between 18 and 52 years of age. The weighting model was applied to convert skin physiological variables into factors for analysis in order to calculate the weighting of various factors.

The original data are shown in Table 1, and the discrete data are shown in Table 2, where cutometer takes large the better; PH value takes nominal better; sebumeter takes small the better; Mx16 takes large the better, and age takes large the better, the discrete are take five equal interval.

Table 1. The original measurement data

No.	Cutometer	PH	Sebumeter	Mx16	Age
1	0.94	4.55	120	166	19
2	0.53	5.42	50	320	52
3	0.62	5.13	90	326	48
4	0.71	5.22	130	250	40
5	0.95	5.33	257	168	20
6	0.92	4.89	220	188	21
7	0.91	5.31	256	367	19
8	0.92	5.43	187	245	20
9	0.9	4.80	290	260	21
10	0.93	5.44	210	157	24
⋮	⋮	⋮	⋮	⋮	⋮
53	0.76	5.88	140	217	25
54	0.78	5.95	114	142	24
55	0.82	6.15	227	192	22
56	0.66	5.78	120	152	25
57	0.72	5.72	89	160	23
58	0.62	5.90	129	160	24
59	0.83	5.68	256	227	28
60	0.62	5.79	124	232	23
61	0.75	5.45	156	142	24

Table 2. The measurement data after discrete

No.	Cutometer	PH	Sebumeter	Mx16	Age
1	5	1	4	1	1
2	1	3	5	4	3
3	2	2	5	4	3
4	3	2	4	2	2
5	5	3	1	1	2
6	5	2	2	1	2
7	5	3	1	5	1
8	5	3	3	2	1
9	5	1	1	3	2
10	5	3	2	1	1
⋮	⋮	⋮	⋮	⋮	⋮
53	3	2	4	2	1
54	3	2	4	1	5
55	4	2	2	1	2
56	2	2	4	1	1
57	3	3	5	1	2
58	2	2	4	1	1
59	4	3	1	2	2
60	2	2	4	2	1
61	3	3	3	1	1

Based on mathematical analysis, the significant of various factors on the skin of dispersed subjects at different ages was calculated from equation (1) to equation (5). The value is the

level of attribute significant that will affect the weighting of factor outcomes as shown in Table 3.

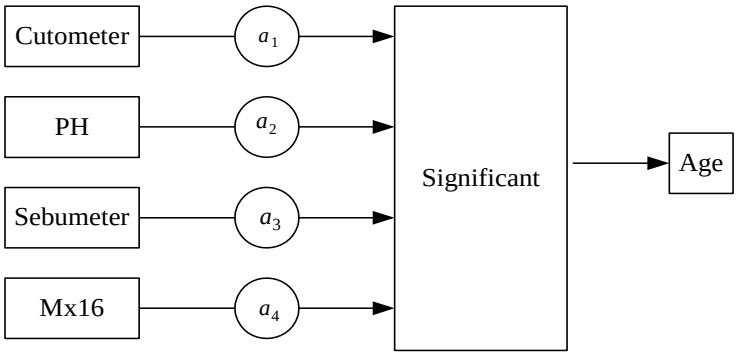

Figure 2. The analysis structure

Table 3. The analysis results

Factor	Cutometer	PH	Sebumeter	Mx16
Weighting	0.2830	0.1698	0.4151	0.3962
Rank	III	IV	I	II

Because of the amount of data are enormous, therefore, the computer toolbox is also used to analyze and verify [8], as shown in Figure 3.

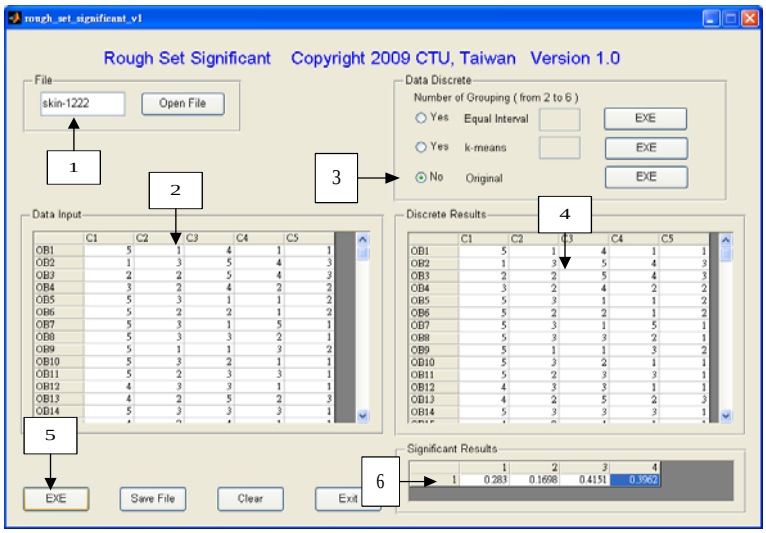

Figure 3. The screen of toolbox by using significant in rough set method

where:

1. Input the inspected data (Excel Type)
2. The original data is displayed
3. Choose discrete method (use original data)
4. The data after discrete

5. Press the EXE icon
6. The Significant is appeared

5. Conclusions and discussions

Conventional statistical analyses were applied to most studies on skin physiology assessment. As they need a large amount of data, it is clinically difficult to fulfill relevant requirements. As a result, results of these studies were unable to reflect the reality. The significant rough set method that used in this study can overcome these problems because the model developed in this study is a non-function serial model that is easy to use and does not need to conform to the typical distribution regularities. The practical measuring system developed with the rough set model in this study analyzes the weighting, and relational of skin physiological factors based on the skin characteristics of subjects at different ages, and delivers results that match the conventional concepts. Therefore, it can be a reliable reference for related researches. Besides, Matlab has been applied to develop a computer utility for this analysis model in order to develop an integrated computer analysis utility for processing a large amount of data.

To sum up, the rough set theory that used in this study is one of the software calculation methods. Therefore, in addition to including other related influence factors, further studies can increase the amount of data in order to enhance validity. Furthermore, other software calculations, such as the fuzzy, ANN, and grey system theory, can be integrated to the rough set theory to enhance the reliability of results.

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