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Recognition of Psychological Characteristics from Face

Ekaterina Kamenskaya[1], **Georgy Kukharev**[2]

[1] *Department of Computer Software Environment, St.-Petersburg Electrotechnical University*
[2] *Faculty of Computer Science and Information Technology, Szczecin University of Technology*

Abstract:

The nature of computer vision causes the fact that not only computer science researchers are interested in it, but neuroscientists and psychologists, too. One of the main interests for psychology is identification of person's psychological traits and personality types which can be accomplished by different means of psychological testing: questionnaires, interviews, direct observations, etc. Though that is a general tendency of people to read character into a person's physical form, especially face. In relation to psychological characteristics recognition, face provides researchers and psychologists with instrument of obtaining information about personality and psychological traits that would be much more objective than questionnaires and neuropsychological tests and could be obtained remotely using person's facial portrait, with no need for personal involvement. The paper describes approaches to psychological characteristics recognition from facial image such as physiognomy, phase facial portrait, ophthalmogeometry, and explains the need in automating it.

Keywords:

psychometrics, psychological characteristics, personality, Myers-Briggs typology, ophthalmogeometry, physiognomy, pattern recognition, face recognition, facial expression recognition

1. Introduction

A contemporary definition for personality is offered by Carver and Scheier: "Personality is a dynamic organization, inside the person, of psychophysical systems that create a person's characteristic patterns of behavior, thoughts, and feelings" [1]. In other words, personality is a complex combination of traits and characteristics that determines our expectations, self-perceptions, values and attitudes, and predicts our reactions to people, subjects and events.

According to the Diagnostic and Statistical Manual of the American Psychiatric Association [2], personality traits are "enduring patterns of perceiving, relating to, and thinking about the environment and oneself that are exhibited in a wide range of social and personal contexts." Traits and characteristics are the same

thing, as a trait is a distinguishing characteristic, feature or quality. Theorists generally assume that a) traits are relatively stable over time, b) traits differ among individuals, and c) traits influence behavior. Many psychologists have studied personality traits, and have attempted to identify or define all of the human traits. Some examples of personality traits identified and studied by psychologists are: warmth, emotional stability, independence, dominance, impulsivity, sensitivity, imagination, introversion-extroversion, suspiciousness, etc.

There is continuing debate about how many different personality traits exist. The most popular model of psychological traits is a five-dimension personality model named as the "Big Five" and proposed by Lewis Goldberg: Extraversion, Neuroticism, Agreeableness, Conscientiousness, Openness to experience.

The difference between personality type and personality trait should be considered. Personality types are distinguished from personality traits, which come in different levels or degrees. According to type theories, for example, there are two types of people, introverts and extraverts. According to trait theories, introversion and extraversion are part of a continuous dimension, with many people in the middle.

Identification of psychological characteristics is the task widely used in theoretical and practical psychological research, education, coaching, career guidance and hiring process, business and political affairs, psychotherapeutic diagnostics, self-exploration and awareness, etc. Teachers evaluate student's personality traits and cognitive abilities to know how to represent material better and how to establish communication and learning process in more efficient way. Lawyers are beginning to use personality testing for criminal behavior analysis, litigation profiling, witness examination and jury selection. Medical stuff analyses personality characteristics and observes patient's psychological state in regard of its influence on medical treatment process. Even websites design and software interfaces are now developed based on knowledge of user's personalities and their preferences.

It's hard to underestimate the role of identification of psychological characteristics in modern society, as everyone needs to know people's psychological traits to understand or predict their reactions to various subjects and situations.

2. Face analysis and other methods for psychological characteristics recognition

The question of methods and instruments which may be used for effective psychological characteristics identification exists. To measure human characteristics or identify personality types psychological researchers apply psychometrics which is the field of study including the theory and technique of psychological measurement primarily concerned with the study of differences between individuals. Psychometrics involves such research tasks as the construction of instruments and procedures for measurement; and the development of theoretical approaches to measurement. For instance, the study states that a useful psychological measure must be both valid (i.e., actually measures what it claims to measure) and reliable (i.e., internally consistent or give consistent results over time).

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The most accepted means of measuring personality using psychometrics study is psychological questionnaires and tasks. There are two major types of such personality tests. Projective tests assume that personality is primarily unconscious and assess an individual by how he or she responds to an ambiguous stimulus. The idea is that unconscious needs will come out in the person's response. Objective tests assume that personality is consciously accessible and measure it by self-report questionnaires. Research on psychological assessment has generally found that objective tests are more valid and reliable than projective tests. Examples of testing questionnaires and tasks are Holland Codes, Rorschach test, Minnesota Multiphasic Personality Inventory, Myers-Briggs Type Indicator, Enneagram Type Indicator, NEO PI-R, Thematic Apperception Test, Kelly's Repertory Grid, Online Depression Screening Test, Online Screening for Anxiety and so on [3].

Except psychological questionnaires and tasks, interviews and direct observation tests are applied. Interviews often contain some observation and questions about person's past, abilities and attitudes. Direct observation of people as they complete activities may be with clinical purpose, such as to observe the nature of a parent-child interaction in order to understand a relational disorder. The Parent-Child Interaction Assessment-II [4] is an example of a direct observation procedure that is used with school-age children and parents: the parents and children are videotaped playing at a make-believe zoo. Direct observation procedures are also used in research, for example to explore sequences of behavioral interaction.

There is a range of approaches to measuring personality and psychological characteristics which are based on human physical appearance. They are described below:

Evaluation based on face

The face plays a crucial role in human social cognition. Facial expressions are important signals of internal states – emotions and intentions. Humans also see in the face signals of internal qualities that are more stable over time, like attractiveness as a mate [5,6,7] or dominance [8,9,10], etc. According to Liggett [11], "There can be little doubt that the face plays a crucial part in our everyday assessment of our fellows. Not only does it enable us to identify transient emotions – flashes of pleasure and rage, disappointment and hatred – it can also help us to make useful judgments about more durable and lasting qualities of personality and character". Judging personality from face comes from ancient times [12,13] to nowadays. The belief that the face reveals information about underlying character cuts across national, cultural and geographical boundaries. Several classical Greek and Roman scholars, including Plato and Aristotle, argued that faces contain clues about people's underlying personalities and dispositions. For over 2500 years many notable philosophers, historians and physicians openly supported the idea that a person's disposition is reflected in their face. Widespread interest in physiognomy – the study of the face and its relationship to human ability, potential and character – peaked at the end of the eighteenth century when a physician and pastor named

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Johann Kaspar Lavater produced a formal classification system and set of rules specifying the relationship between the face and the mind [14]. Lavater believed that character is assessed just as well from the shape and size of the forehead, for example, as from observations of behavior. Indeed, eighteenth and nineteenth century courts commonly used physiognomy to assess immoral tendencies in suspected criminals.

Among contemporary applications of face analysis not only psychological interpretations are accomplished, but also medical results are obtained. For example, more than 700 genetic issues influencing facial structure and facial features are known, and special software for disease identification from face had been developed [15,16].

Body types

William Sheldon classified personality according to body type [17]. He called this a person's somatotype and identified three main somatotypes shown in Table 1.

Table 1. Sheldon's somatotypes and character interpretations

Sheldon's Somatotype	**Character**	**Shape**	**Picture**
Endomorph [viscerotonic]	Relaxed, sociable, tolerant, comfort-loving, peaceful	Plump, buxom, developed visceral structure	
Mesomorph [somatotonic]	Active, assertive, vigorous, combative	Muscular	
Ectomorph [cerebrotonic]	Quiet, fragile, restrained, non-assertive, sensitive	Lean, delicate, poor muscles	

Person is rated on each of these three dimensions using a scale from 1 (low) to 7 (high) with a mean of 4 (average). Therefore, for example, a person who is a pure mesomorph would have a score of 1-7-1.

In Ayurvedic medicine (used in India since ˜3000 BC) there are three main metabolic body types (doshas) – Vata, Pita, & Kapha – which in some way correspond to Sheldon's somatotypes. Body types have been criticized for very weak empirical methodology and are not generally used in Western psychology (they are used more often in alternative therapies and Eastern psychology and spirituality).

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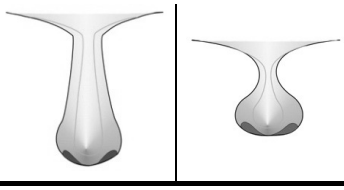
Complex physical appearance evaluation

This is approach of evaluation of face and body parts in complex, and it is considered to be physiognomy too. Physical appearance characteristics such as appearance of some facial features, of the skull, shoulders, hands, fingers, legs, type of mimics and voice may define personality traits. For example, it's used in socionics (see Table 2) that is a branch of psychology based on Carl Jung's work on Psychological Types. Moreover, many socionics experts use the visual method of personality characteristics identification as a main method for personality traits and types recognition.

Table 2. Example of some outer appearance characteristics and their interpretation

<table>
<tr><th colspan="6">OUTER APPEARANCE</th></tr>
<tr><th>No.</th><th>Physical character</th><th colspan="2">Sensoring</th><th colspan="2">Intuitive</th></tr>
<tr><td>01</td><td>The form of bones and muscles</td><td colspan="2">Short and thick, muscles are pronounced
  </td><td colspan="2">Lengthy and thin, muscles aren't pronounced
  </td></tr>
<tr><td rowspan="2">02</td><td rowspan="2">Form of the nose</td><td>Sensoring
+
Logical</td><td>Sensoring
+
Ethical</td><td>Intuitive
+
Ethical</td><td>Intuitive
+
Logical</td></tr>
<tr><td colspan="2">«triangle with peak on the top»
Horizontal line in the nose bridge.
  </td><td>«triangle with peak on the top»
  </td><td>«triangle with peak in the bottom»
  </td></tr>
</table>

Neuropsychological tests

Around the 1990s, neuroscience entered the domain of personality psychology. It introduced powerful brain analysis tools like Electroencephalography (EEG), Positron Emission Tomography (PET), Functional Magnetic Resonance Imaging (fMRI) and structural MRI including diffusion tensor imaging (DTI) to this study. One of the founders of this area of brain research is Richard Davidson of the University of Wisconsin-Madison [18]. Davidson's research lab has focused on the role of the prefrontal cortex and amygdala in manifesting human personality. In particular, this research has looked at hemispheric asymmetry of activity in these

regions. Neuropsychological studies have illustrated how hemispheric asymmetry can affect an individual's personality.

In contemporary psychological research there should be an instrument which would provide a maximum amount and type of objective/unbiassed information about personality in as short a time as possible, preferably with no participation of person whose characteristics are identified. Comparison of approaches to identification of psychological characteristics described above is represented in Table 3.

Table 3. Some comparison of approaches to identification of psychological characteristics

Criterion	**Approaches**			
	Psychological questionnaires	Interview, direct observation	Face, body evaluation	Neuropsychological tests
Easy and not time-consuming for person who is tested	–	–	+	–
Person may not participate in testing process	–	–	+	–
High validity and reliability	+ [19]	–	?	–
Practically no possibility for respondent faking	–	–	+	–
No need in expensive hi–tech hardware	+	+	+	–

In psychological testing there is considerable problem that respondents are often able to distort their responses. This is particularly problematic in employment contexts and other contexts where important decisions are being made and there is an incentive to present oneself in a favorable manner. Social desirability is a tendency to portray self in a positive light, and faking bad also happens, that is purposely saying 'no' or looking bad if there's a 'reward' (e.g. attention, compensation, social welfare, etc.). Work in experimental settings [20,21] has shown that when student samples have been asked to deliberately fake on a personality test, they demonstrated that they are capable of doing this.

Though several strategies have been adopted for reducing respondent faking, this is still a problem for such traditional psychological testing instruments like questionnaires, interviews, direct observations. Surprisingly, neuropsychological tests are prone to respondent faking, too [22,23]. Faking response styles include faking bad (malingering), faking good (defensiveness), attempts at invalidation, mixed responding (faking good and bad), and a fluctuating, changing style that occurs within one evaluation session. These response styles lead to getting incorrect results.

Concerning face and facial features, faking becomes much more complicated: it's impossible to change the shape of a nose or cheekbones just when person wants. Besides, it is often unknown to a holder what his/her face reveals exactly. Theoretically people can "fake" facial features intentionally changing their shape,

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color, texture, for instance, using plastic surgery, and identifying personal psychological characteristics becomes much harder in this case, though it may be also accomplished.

Face is the first subject that is unique for people and used for people recognition. Thus, face is the most available means of evaluation among other instruments based on questionnaires, interviews, neuropsychological tests. People in general may not participate in testing process, identification of personality characteristics may be done remotely, even by exterior parties.

Summarizing, face provides researchers and psychologists with instrument of obtaining information about personality and psychological traits that would be much more objective than questionnaires and neuropsychological tests (as we can's change facial features just when such desire appears) and could be obtained remotely using person's facial portrait, with no need for personal involvement.

If such instrument is working automatically (system gets facial portrait, processes it and in result gives out information about personality characteristics) and has straight-forward layout, then: 1) psychological testing becomes more accurate, fast, objective and available for different kinds of research and applications; 2) deep knowledge in interpretation of facial features, which is rather rare in modern society, isn't needed to administer and use the instrument. Methods and algorithms originally developed for face detection, face recognition and facial expression recognition research fields as well as contemporary trends (applying standard face images, multimodality, three-dimensionality) should be applied and adjusted to so-called Automatic Psychological Characteristics Recognition from Face. From its side, Automatic Recognition of Psychological Characteristics from Face is believed to bring scientific benefits to face recognition, facial expression recognition, face animation, face retrieval, etc., and finally contribute to development of human-computer interaction on higher level. Thus, the relations between such research areas as face recognition, facial expression recognition and psychological characteristics recognition are mutually beneficial.

3. Approaches to psychological characteristics recognition from face

There are three main approaches to psychological characteristics recognition from face: physiognomy, phase facial portrait and ophthalmogeometry, see Fig.1. The first originally interprets different facial features, the second works with angles of facial features and facial asymmetry, and the third extracts and interprets eye region parameters. Methods developed for these approaches are described below.

Physiognomy is a theory based upon the idea that the assessment of the person's outer appearance, primarily the face, facial features, skin texture and quality, may give insights into one's character or personality. Physiognomy has flourished since the time of the Greeks (Empedocles, Socrates, Hippocrates and Aristotle), amongst the Chinese and Indians, with the Romans (Polemon and Adamantius), in the Arab world (including Avicenna), and during the European renaissance (Gerolamo Cardano and Giovanni Battista della Porta). It faded in

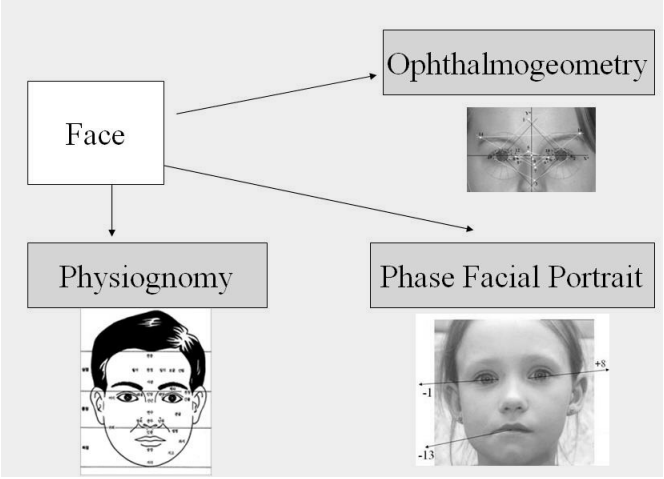

Figure 1. Approaches to psychological characteristics recognition from facial portrait

popularity during the 18th century, was eclipsed by phrenology in the 19th and has been refreshed by personologists in the 20th century.

During 20th century attempts had been made to perform scientific experiments concerning validity of different facial features interpretations and high accuracy results had been claimed [24], though they are mostly aren't accepted by official science [25]. At the same time, science step by steps proves some physiognomy beliefs. For instance, correlations have been established between IQ and cranial volume [26,27,28,29]. Testosterone levels, which are known to correlate with aggressiveness, are also strongly correlated with features such as finger-length ratios and square jaws [30,31].

Interpretation of facial features based on physiognomy has been implemented into psychological characteristics diagnosis tools such as "Visage" Project [32] developed by Dr. Paul Ekman and "Digital physiognomy" software [33] developed by Uniphiz Lab.

"Visage" is a project for collecting and organizing information about relatively permanent facial features. It includes methods for storing, retrieving, and inspecting the data. Visage is a unique database schema for representing physiognomy and the interpretation of physiognomic signs. The Visage demonstration application illustrates limited variations of some facial features in the following categories: forehead and eyebrows (see the Fig.2), eyes and eyelids, nose, mouth and jaw, cheeks, chin, ears. User should select features that are distinctive about the face that is going to be interpreted and then click the "Get..." button. The application retrieves information from the database relevant to description of physiognomy, including an estimation of the accuracy of the sources of information.

"Digital physiognomy" software determines a person's psychological characteristics based on temperament types, intellect, optimism – pessimism, conformism – adventurism, egoism – altruism, philanthropy – hostility, laziness, honesty, etc.,

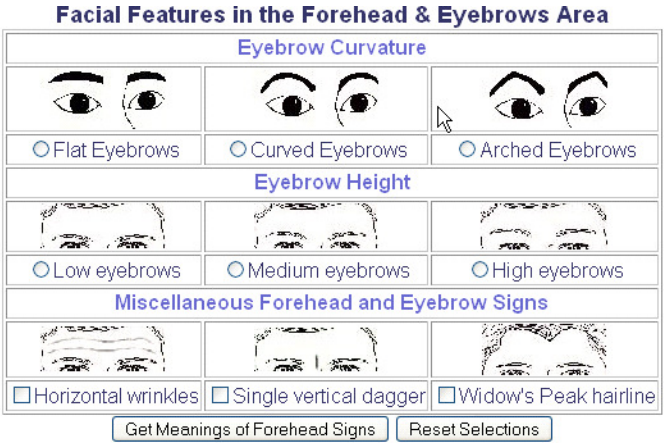

Figure 2. Example of the table and interface of Visage demonstration application: facial features in the forehead and eyebrow area [34]

and then presents a detailed person's character analysis in a graphic format. The tool works like a police sketch (photo robot), so user has to select different parts of the person's face, and doesn't need to have a person's photograph, see Fig. 3. It's claimed that only the facial features that can be interpreted with high accuracy were used, and the confidence factor is calculated for each interpretation by the tool. It should be noted that "Digital physiognomy" tool also uses visual systematic classification of 16 personality types based upon Myers-Briggs typology, see Fig. 4.

"Visage" and "Digital Physiognomy" projects are some of the first attempts to develop physiognomic database and use modern technology for physiognomic interpretations. In spite of having value for psychological diagnosis based on physiognomy, both projects use manual selection of facial features, and thus, can't be used extensively and applied in scientific research.

Phase facial portrait approach to psychological characteristics recognition from facial portrait is primarily based on calculating of angles of facial features lines directions, as shown on Fig.5. Video-computer psychological diagnosis and correction method [35] had been invented by professor Avtandil Anuashvili. It's remote method for personal psycho-type identification, method of one of the brain hemispheres dominance identification, method of psycho-diagnostics and psycho-correction. The method is based on the thesis that face is an informational background projecting in biological and psychological terms the results of joint brain hemispheres functioning. The system of 49 types of people in coordinates "left-side thinker – right-side thinker", "psychologically stable personality – instable personality" had been created and correlated to other personal typologies, see Fig. 6.

Software developed to apply video-computer psychological diagnosis and correction method accepts facial image and determines: 1) dominance of one of the brain hemispheres on the basis of a difference of amplitudes of oscillatory processes occurring in right and left hemispheres and 2) degrees of a coordination of

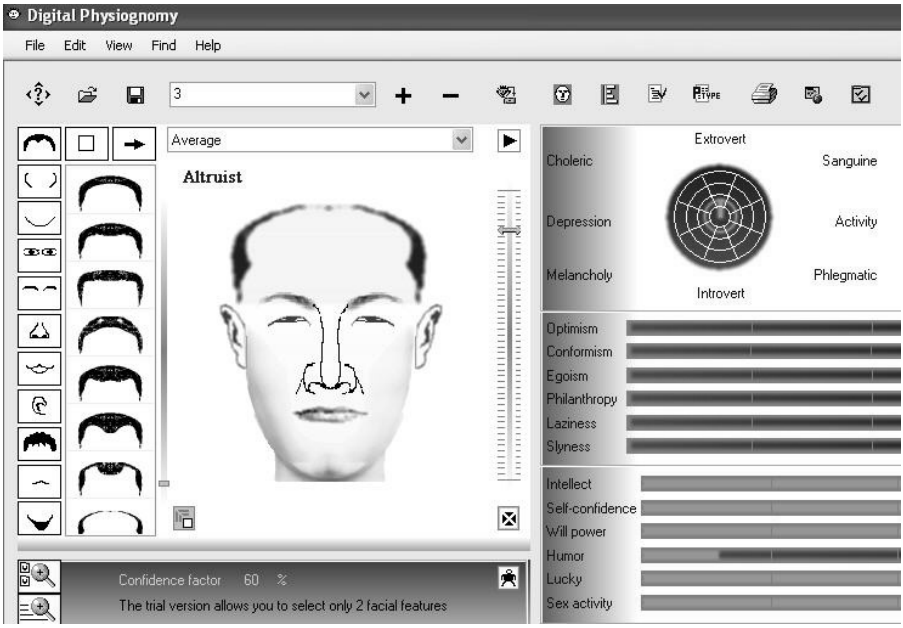

Figure 3. Fragment of "Digital physiognomy" software

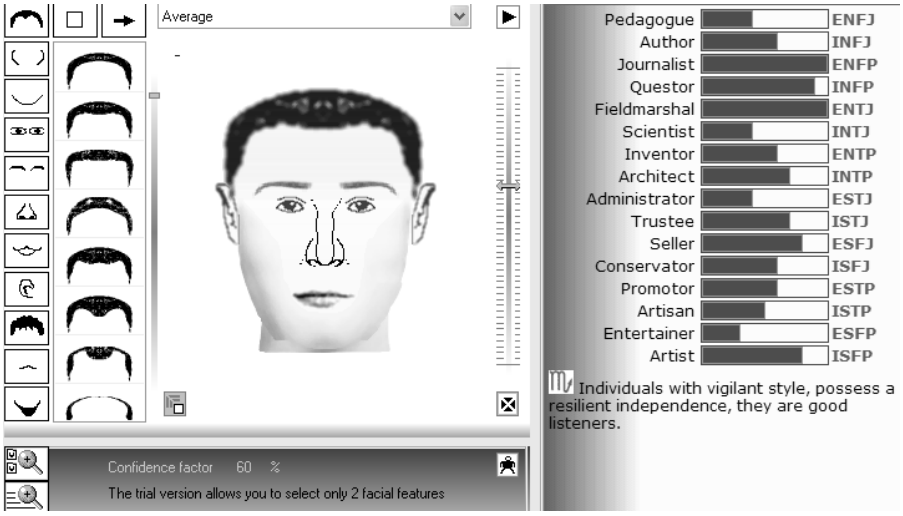

Figure 4. Socionics visual interpretation by "Digital physiognomy" based upon Myers-Briggs typology

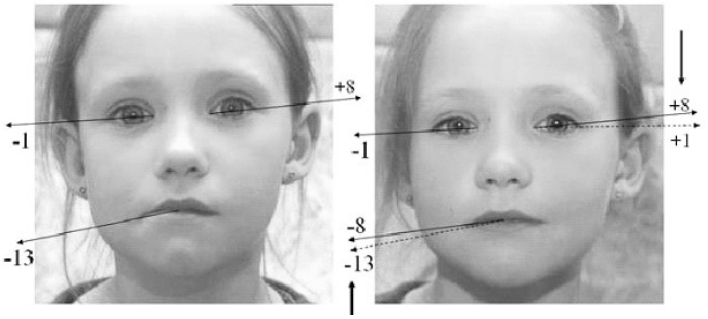

Figure 5. The representation of phase facial portrait concept [37]

these oscillatory processes among themselves [36]. Based on these meanings, the software classifies a given person to one of 49 psychological types and gives out complete personal characteristic, professional characteristic and recommendations on harmonization, effective interaction with other people and environment.

Video-computer psychological diagnosis and correction method is one of the primary instrumental psychological methods concerning examination and usage

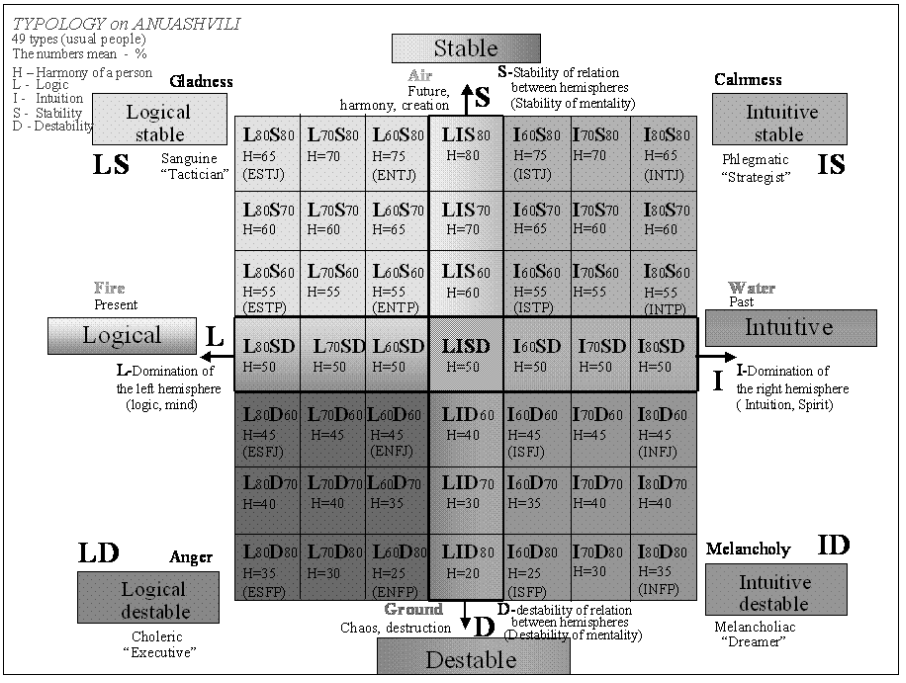

Figure 6. Table of 49 psychological types system invented used for video-computer psychological diagnosis and correction; here L – logic (practical mind), I – intuition (spirit, principles), S – stability, D – destability [38]

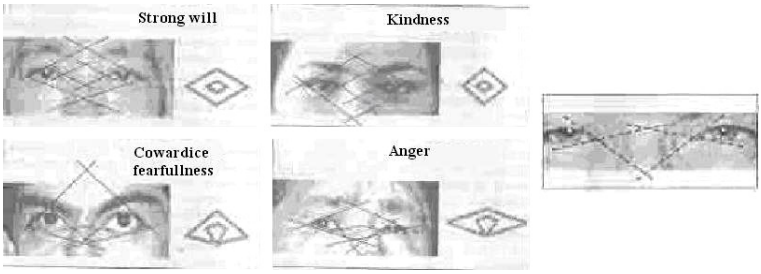

Figure 7. Translated picture from Muldashev's book [39]: here two parameters of facial eye region are used for recognition of some basic psychological traits, e.g. strong will and fearfulness, etc.

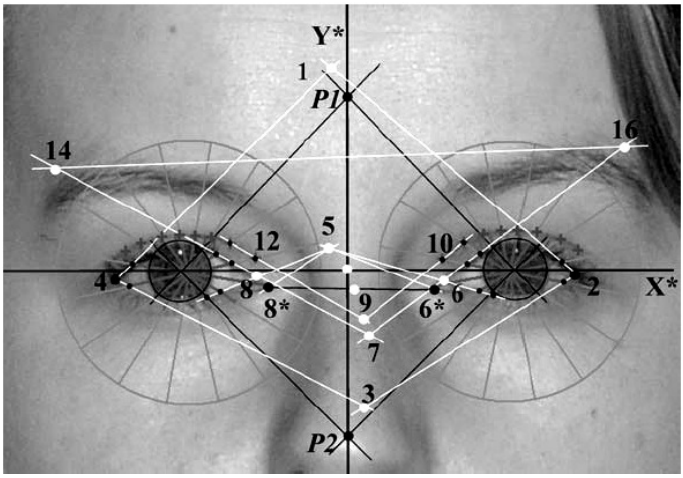

Figure 8. Ophthalmogeometrical pattern extraction [40]

of brain asymmetry phenomena and face asymmetry. Although Anuashvili claims that application developed for video-computer psychological diagnosis and correction method is entirely automated, practically it may be considered to be semi-automated as manual selection of facial points on image is required. This limits usage of such application for extensive research and other purposes.

Concerning ophthalmogeometry approach, it is based on idea that person's emotional, physical and psychological states can be recognized by 22 parameters of an eyes part of the face [39], see Fig. 7. Ophthalmogeometry phenomenon has been discovered by prof. Ernst Muldashev. Apart from other interesting facts, E. Muldashev has found that in 4-5 years after birth the only practically constant parameter of human body is the diameter of the transparent part of cornea which equals 10±0,56 mm. He also represented an idea that ophthalmogeometrical pattern is unique for people. The procedure of this pattern identification and calculation is described by Leonid Kompanets [40], see Fig. 8.

Ophthalmogeometry is based on interesting ideas and may be applied to psychological, medical research as well as to biometrics, though this is not very deeply investigated area of facial analysis which primarily needs automation of ophthalmogeometric pattern extraction and further investigation.

4. Conclusion

The paper represents general idea that face provides researchers and psychologists with objective instrument of obtaining information about personality and psychological traits. An up-to-date survey of approaches and methods in psychological characteristics recognition from facial image is provided.

In perspective new research task of automating procedures in applications of psychological characteristics recognition from face should be explored. Various approaches and methods developed within face recognition, facial expression recognition, face retrieval, face modeling and animation may be applied and adjusted for recognition of psychological characteristics from face. Undeniably, such automated system of psychological characteristics recognition from face will get countless psychological, educational, business applications. It may be used also as part of medical systems: 1) patient's psychological state and traits influence the process of medical treatment, and it should be taken into consideration and researched; 2) patient's psychological characteristics should be taken into account to reflect and construct the psychosomatic model of disease in the environment, which includes biological, psychological, and social factors.

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