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System integration of medical practice activities with specific physiological processes in the human body

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***Abstract* – In this paper the author approaches the main domains of the medical practice and the interaction between them in terms of systems theory in order to evaluate the medical process from a perspective of engineering. It is also revealed the fact that medical practice processes are systemic similar to internal physiological processes of the human body. This approach is useful for both doctors and engineers especially in the development of specific medical engineering equipment.**

Keywords - control theory; medical practice; physiological processes; systemic approach.

I. INTRODUCTION

The human body is a highly complex system with capabilities still insufficiently known. Health, as general reference is quantified, among other things, in physiological parameters. For example, normal ranges of values presented in a medical tests bulletin are considered references.

Maintaining the current status of health in the reference values is ensured by a large number of existing biological automated systems in the human body. For example, maintaining the temperature of the human body at the reference value is ensured by a complex control system where the control function is fulfilled by the diencephalon [1].

When health problems occur they are related to dysfunction of one or more subsystems of the human body. In this case one or more of the three major medical practices analyzed from systemic perspective in Fig. 4 intervenes.

II. SYSTEM THEORY-BASED RELATIONSHIP BETWEEN MAJOR COMPONENTS OF MEDICAL PRACTICE

Three major components of medical practice based on the approaches to the health of the human body are identified. Starting from the definitions systemic approaches will follow.

Prophylaxis *means all medical measures applied to prevent the occurrence and spread of diseases* [2].

Diagnosis *means all clinical and laboratory investigations that aim to define pathological condition of a patient* [3].

Therapy *means all methods employed to fight the disease with the aim of healing* [4].

A summary systemic approach of the definitions above led to underline that:

1. Prophylaxis (prevention) can be approached as a control system based on preventive action (Fig. 1), depending on disturbances - meaning any form of external or internal aggression that could alter the health of the human body.

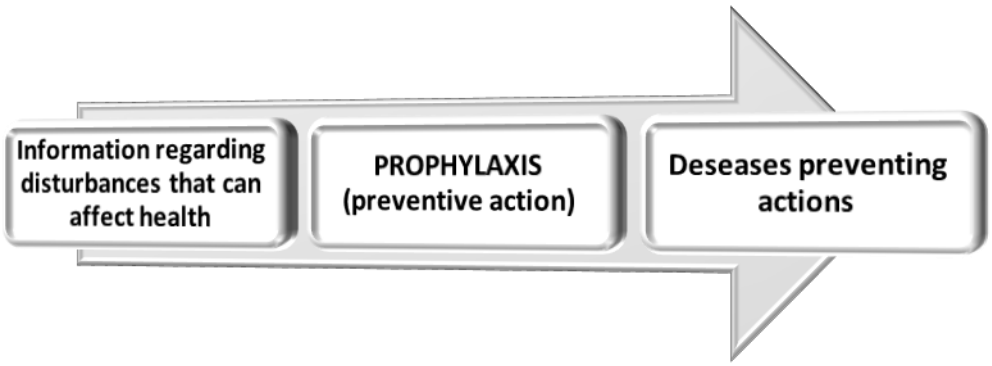

Figure 1. Prophylaxis - a systemic approach.

2. Diagnosis can be approached as a monitoring system for analyzing information related to the health of the human body (Fig. 2). The result can be a confirmation of health condition or can identify alterations of health and diagnose - that is to identify, with some degree of certainty, the disease.

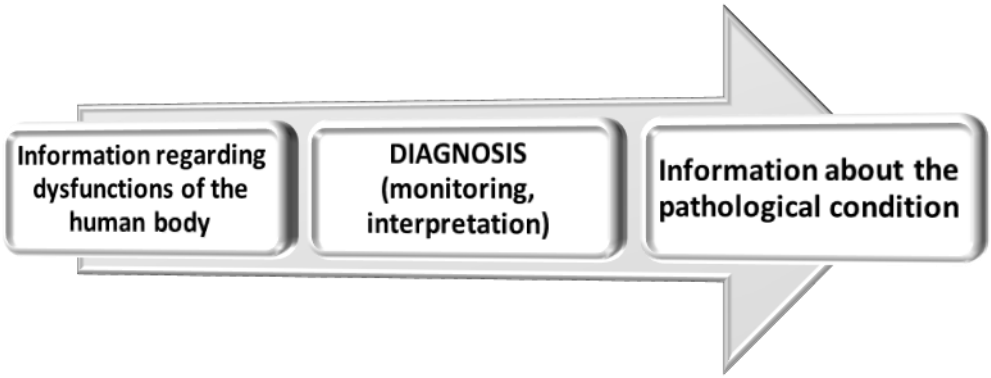

Figure 2. Diagnosis – a systemic approach.

3. Therapy can be approached as a control system based on corrective action (Fig. 3), based on deviations from the health condition of the body that should be corrected by the therapeutic process aimed to restore health and halting the progress of diseases that could have major implications both by the appearance of a high degree of disability or even death.

Figure 3. Therapy – a systemic approach.

Fig. 4 proposes a systemic relationship between medical practice and internal regulation processes of the body. It is observed that disturbances are affecting the control process but at the same time is a source of information for establishing procedures for disease prevention. The efficiency and fairness of the control processes are observed by diagnosis (i.e. the sub-component monitoring). The diagnosis provides information necessary for both therapeutic care methods and for ongoing evaluation of the effectiveness of the therapeutic process.

Regarding the time dimension of interaction, the degree of reaction and reaction type chosen, they are completely dependent on the type of malfunction and the extent to which it endangers the vital functions of the body. The reaction times depend on the imminence of danger (immediately or not).

Control associated to the internal processes of the body refers to the variety of ways in which the human body maintain a state of inner balance. Initiation of regulation processes occurs as a result of the stimuli that trigger reactions to them, either within the system or in its external environment. The control process involves the necessary mechanisms to monitor and control continuously certain conditions and variables, using various types of feedback.

Identifying disturbances represents an action of the body which indicates that there is an interruption in the process of self-regulation, generally caused by a change that occurs internally or externally. Answers appear unconscious by triggering mechanisms of self-regulation, actions aimed to manage problems caused by disturbance. Pollution, heat and cold are examples of disturbances from the environment, while changes occurring in the levels of electrolytes, in breathing or heart rate are examples of internal causes.

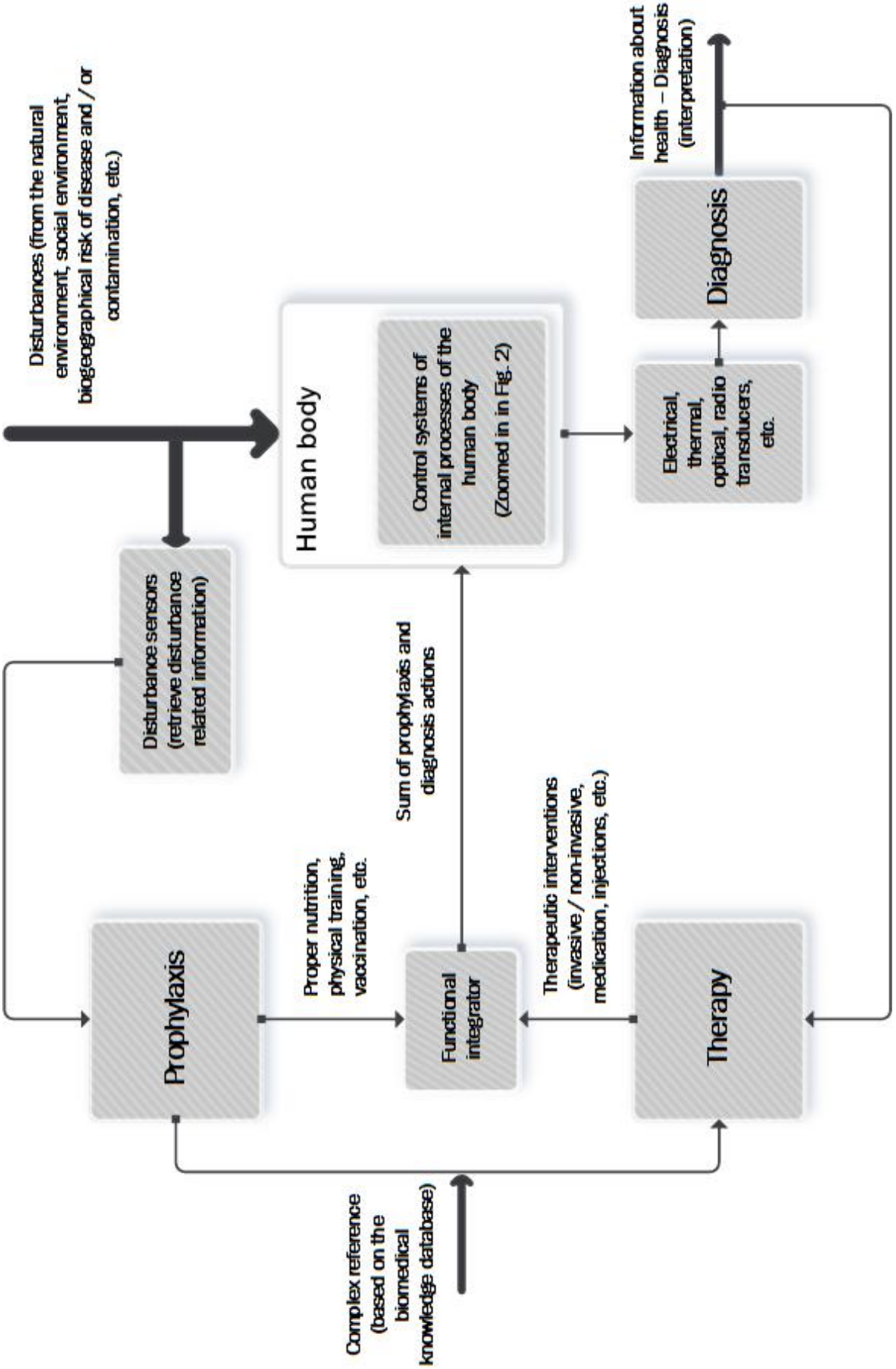

Figure 4. Systems theory – based relationship between major components of medical practice.

III. DESCRIPTION IN TERMS OF SYSTEMS THEORY OF HUMAN BODY'S INTERNAL PROCESSES VARIABLES CONTROL

Fig. 5 presents a systemic approach proposed by the author for the automatic adjustment processes taking place inside the human body. Internal processes are monitored through sensors that provide information about the status of these processes. Information provided by the sensors are transferred to the nervous system (via afferent nerve pathways) for electrical information, or the circulatory system (through blood vessels) for chemical information (such as hormones).

Information from the sensors are compared with the values (or intervals) of the human body's reference. If the value of process parameters offered by sensor's information differs from the reference or is outside the reference range, then stimulus arises. The stimulus is the warning given to the central nervous system about the internal process that is not carried out within normal parameters. Not infrequently the sensor, the comparator and the reference are part of a single physical structure and can be located where it can monitor the process - can be physically located anywhere, even in the brain.

Central nervous system (CNS) receives alarm information through stimuli. They get to the center of decision through afferent nerve or circulatory pathways connected to the nervous system's receptors. After receiving the stimulus, the control center will establish a procedure for rehabilitation of the abnormal process and generate a series of commands to correct deviations. Decision algorithm is part of the central nervous system and is mostly inherited. A part of the algorithm is the result of the life experience of the individual.

The control center commands cease when the stimulus disappears due to the state of normality of the monitored process restauration. The same process can be associated with more specialized sensors to monitor various process variables.

Commands are generated in the form of electrical or chemical information and are transported to the actuators associated with the process through efferent nerve pathways (electric information) or through the blood vessels of the circulatory system (chemical information). Effectors (actuators) are internal organs acting under central nervous system's command as a reaction to external or internal stimuli received through sensing organs [W8]. Sensing organs (receptors) may be, for example, muscles, endocrine glands, etc.

IV. CONCLUSIONS

Control theory approach of medical practice and internal physiological processes of the human body might be the answer to the need of use of an accessible language to transfer information between different scientific domains. The approach presented in this paper permitted the author to create an automated system for use in medical therapy. Keeping a scientific project at the systemic level as close as possible to the final specific design process enables a high availability of the information for several multidisciplinary users.

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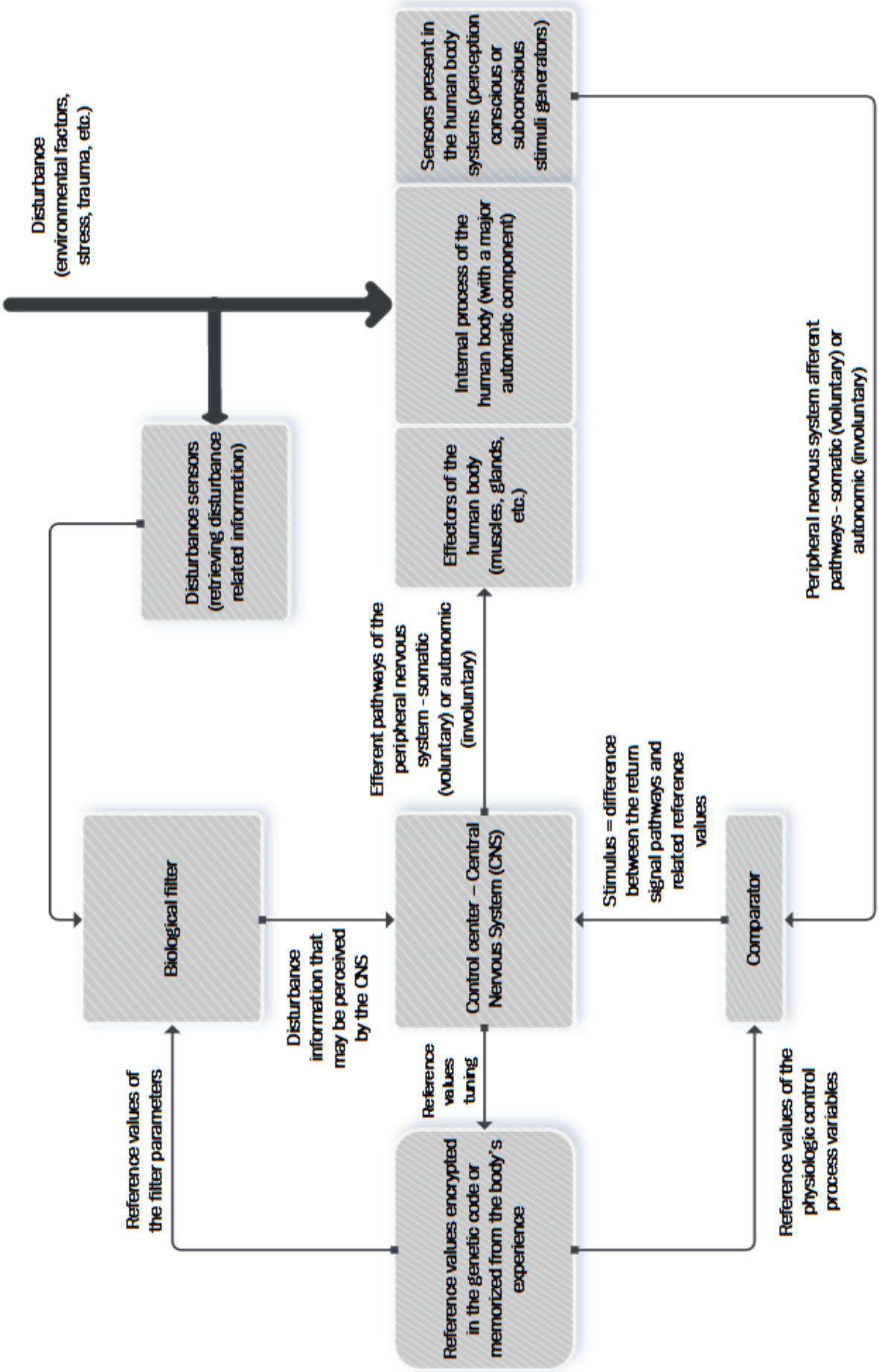

Figure 5. Description in terms of systems theory of human body's internal processes variables control (zoomed in from Fig. 1).