DEVELOPMENT OF INTELLIGENT TECHNOLOGIES AND SYSTEMS IN AGRICULTURE

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Abstract. In article are discussed and reflected main results of theoretic analysis and experimental researches of new possibilities to development of intelligent sensors and measuring instruments for the use in agriculture, also classification of artificial intelligence (AI) and related intelligent systems and technologies (IST). Also theoretical substantiations and practically useful conclusions are submitted. The authors' sight on the basic achievement and ways of the further development of intelligent sensors is stated. The research contains the fundamental scientific problem of elaboration of expert and Artificial Intelligence (AI) system in the field of agriculture. On the basis of results of experimental researches has been developed the new intelligent concept, technologies and tools for application in agriculture also for the protection of consumers. Main results of research in article are reflected.

Keywords: intelligent technologies in agriculture, sensors, measuring, consumers' protection.

Introduction

The elaboration of intelligent technologies and systems (IST) becomes the main direction in development of agriculture. Intelligent sensors can essentially perfect the whole control system due to the increase of preciseness and a rational processing of signals received from the sensory element. Technological revolution in all the production spheres, especially in computing- and research-comprising technology branches determined the application of local (divided intellect) systems in the functioning structures and a further development of intelligent systems and technology in agriculture. Just in such way can be explained the world tendency towards the "intellectualization" of measuring devices and sensors for the quality and quantity control [1]. For years, engineers worldwide have been working to develop mechanical systems that can mimic the human senses of smell, sight, and taste.

Intelligent techniques for measuring human sensory response to food texture have been undertaken since 1980s by Boyar and Kilcast, Graham Bell, G. Moskvin [1], Shmulevich et al., Sakamoto et al., Kohyama, et al., to study relations between physiological and sensory testing of perception [2-3]. Since the half of the eighties the technological mimic of the main functions of human olfaction became possible. Since that, an increasing number of researchers have dedicated their efforts to improve the original idea pursuing the fabrication of electronic tongue. The research aim and task contains the creation and scientific substantiation of separate decisions and preliminary received results of experimental researches of a problem of elaboration IST by using of intelligent sensors.

Material and Methods

Research was focused on the development of quantity and quality automatic conformity control instruments, methods and algorithms at testing and accounting of the agricultural products. The basic contours of models technical realization are formed in a complete agreement of the existing notions, data, levels of knowledge about the investigation process or object with the exploration task and aim on the basis of the traditional visualization system (Fig. 1).

The electronic e-tongue or e-nose gives either a simple answer like recognized, "good", or "bad" or a more sophisticated response such as odor intensity or a molecule concentration. Sensors are immerged directly into the liquid or into others mediums. In the most generic sense, quality refers to the combination of characteristics that are critical in establishing a product's consumer acceptability. In the food industry, this is usually an integrated measure of taste, purity, flavor, texture, color, appearance and workmanship. In a highly competitive market, other criteria of quality can be "value" or a consumer's perception of the worth of the product based upon the funds available for consumers on all traceability stages of quality. Just in such way can be explained the world tendency towards the "intellectualization" of measuring devices and sensors.

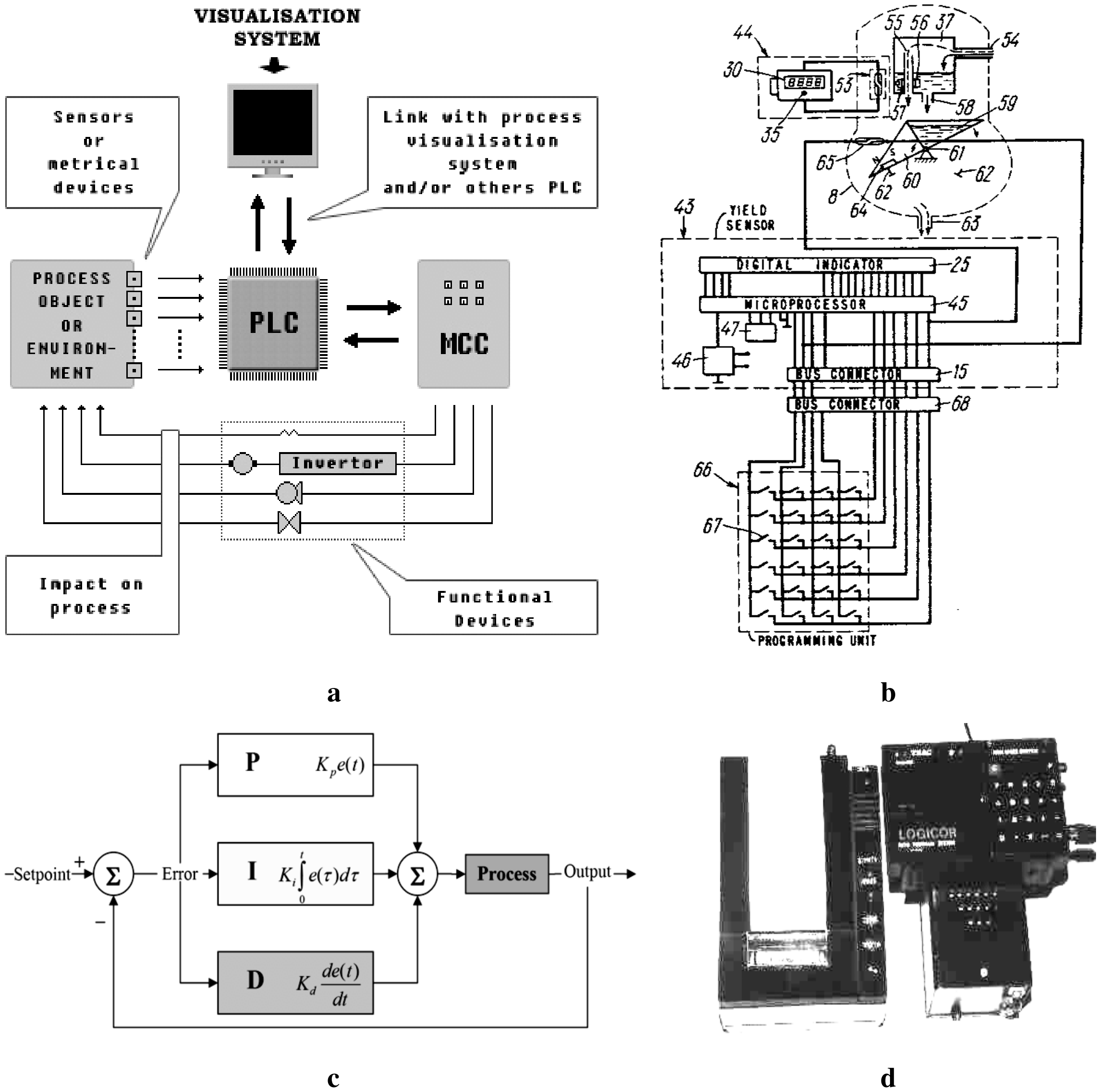


Fig. 1. **Modern sensory control, measuring and visualization system:**
(a) – MCC-motor control cabinet, PLC - programmable logic controller, (c) – PID control mathematical model, (b, d) – Patented [5-14] intelligent measuring device “Logicor SD“

Therefore we have developed many patented new technical decisions – view new measuring methods and algorithms, also measuring and error correction methods for quality conformity assessing of agricultural products, raw materials and goods. Also was developed “Chernoff faces” geometrical deviation analysis method for quality control of agricultural products. These standards “Chernoff faces” are referred as standards of identity [2, 3]. Intelligent measuring devices consist of two functional knots: primary sensing element (transducer) and registering device, elaborated with the possibility using of calculation, assessing and errors correction of measuring results on the bases of microprocessors. Sensing element has electric exit signal and further processing measuring information is completed by using different electrical schemes, mainly, of an analogous type.

In relation to functional opportunities, preciseness and signal stability, the processing of digital data has significant preferences [4]. The research of user, “consumer intellect” models, are carried out by means of synthesis of the non-traditional measuring also conformity assessment methods based on W. Ashby ‘black case” method, errors correction method, on principle of geometrical similarity of metrical images in different areas of identification, accounting, classification and conformity assessment of agricultural products by using of intelligent instruments.

a b c d

Fig. 2. **Modern intelligent technologies for the quality control in agriculture:** (a) – expert system for conformity assessment of the quality the wine, (Australia, 2007), (b) – electronic CD-catalog (MELDOK “Schadbildkatalog”, BMVEL, Germany, 2006), (c) – in LUA developed device “Logicor AT artificial tongue”, (d) – intelligent device “artificial nose” (Australia, 2007)

Successively, it can be assumed that registering co-operation results of the investigation object with different measuring devices, the object’s properties, which have to be fixed, can be so significantly different that there can be no "essence" at all in the indications of the measuring device because the exploration object is always connected with a definite "space-time" co-ordinate system.

IST perceptual modeling principle can also be used in mathematical biology and bionics, which now are rapidly developing. Relationship among such different biological prototype "features" of AI "reason" as "sensing", "perception", "understanding", "notion", "conception", "judgment", "deduction", etc. characterizes the whole of AI’s "reason and organism" as a systemic structure. This relationship remains the same invariant for all AI structures, "organisms" regardless the differences they may have in the technical-technological structure of their elements and component-parts.

Results and Discussion

Scientific basis of IST can be expressed by means of the mathematical concept "epimorphism", i.e., by unequivocal and ambiguous compliance of two group elements when one group reflects the other group. Then the structures of different "organisms" epimorphically reflect each other. Moreover, the basic relationship characterizing IST "cyber-organized organism" remains as a whole system.

"Intelligence" of any type of sensors refers to any object in such a way as it is required by its nature. Such methodological approach in the elaboration of IST very often in the measuring process does not provide a sufficiently complete idea about all the "inner" processes going on in the object under exploration because the functional structure of the synthesized device is aim fully oriented only towards the realization of in advance programmed functions.

Bionic approach in the modeling of IST measuring systems allows examining two types of IST models. For the elaboration of the first type models it is sufficient to study in isolation only "inner" parameters and processes of the object under exploration without taking into consideration the impact of outer medium factors and, in relation with it, "behaviour" changes of the structure intended for synthesis.

The further use of the model depends only on the success of the acquired model’s theoretic and technical continuation. "Behaviour" factor analysis of the object of interest has to be considered at the basis of the second type of IST models. Further on "reference" functions of the influence factors are determined and a feedback algorithm is synthesized in the form of mathematics programs through "self- learning". The basic contours of models technical realization are formed in a complete agreement of the existing notions, data, levels of knowledge about the investigation process or object with the exploration task and aim.

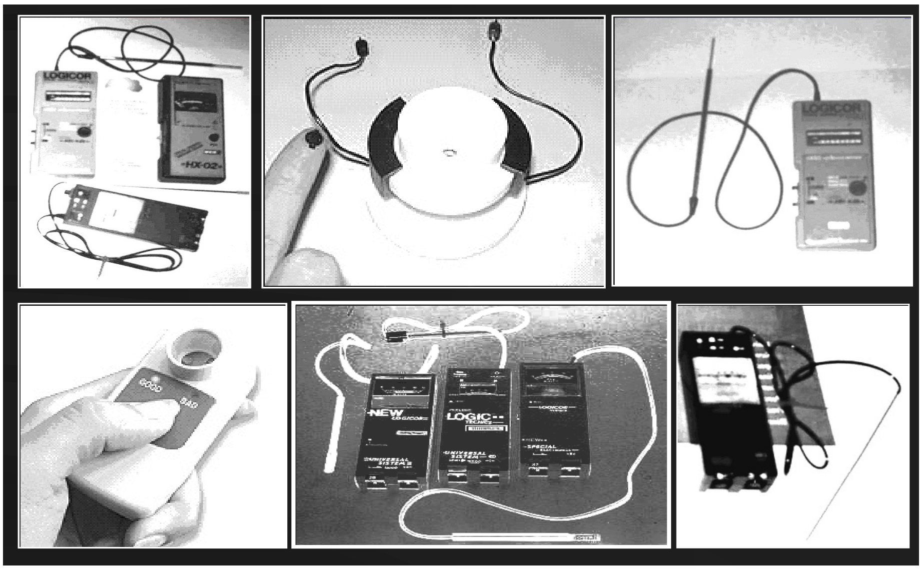


Fig. 3. **Results of experimental research. By LUA prof. G. Moskvin developed and patented new generation intelligent quality assessing devices “Logicor AT“for consumers’ protection**

Elaboration of optimal quality control IST in bionic (Fig. 3) is connected with the term "norm". Here the "norm" in its essence is a rather ambiguous concept, which can not be strongly used for the quality conformity assessment of agricultural products. [3, 4]. The offered “watch – fractal” information processing principle in IST expert systems (Fig. 5-6) will allow the operator (a person or apparatus substituting man’s control functions) to receive more complete, operative, "momentarily" knowledge for the monitoring, control and regulation of bionic processes and objects, and not a "bare", non-processed number information group which rather misinforms, disorientates than informs or takes away uncertainty about features, situation, peculiarities or quality control parameters of agricultural products, soil or raw materials.

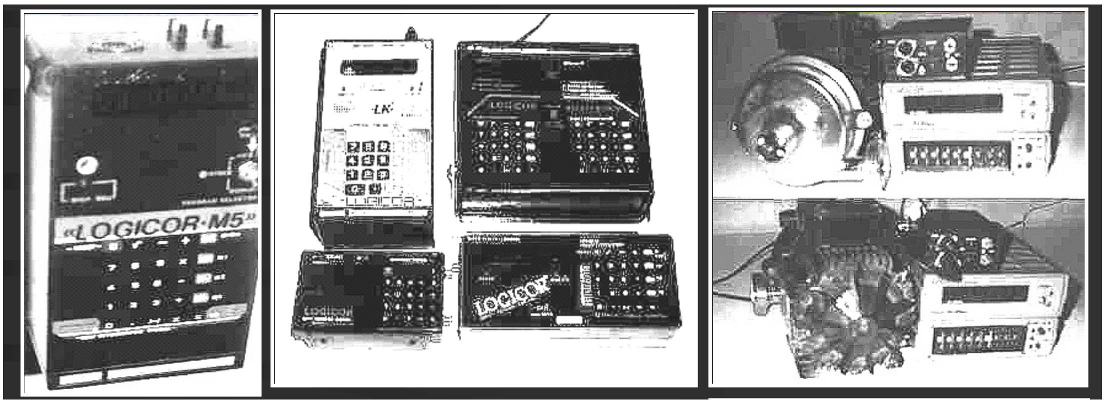
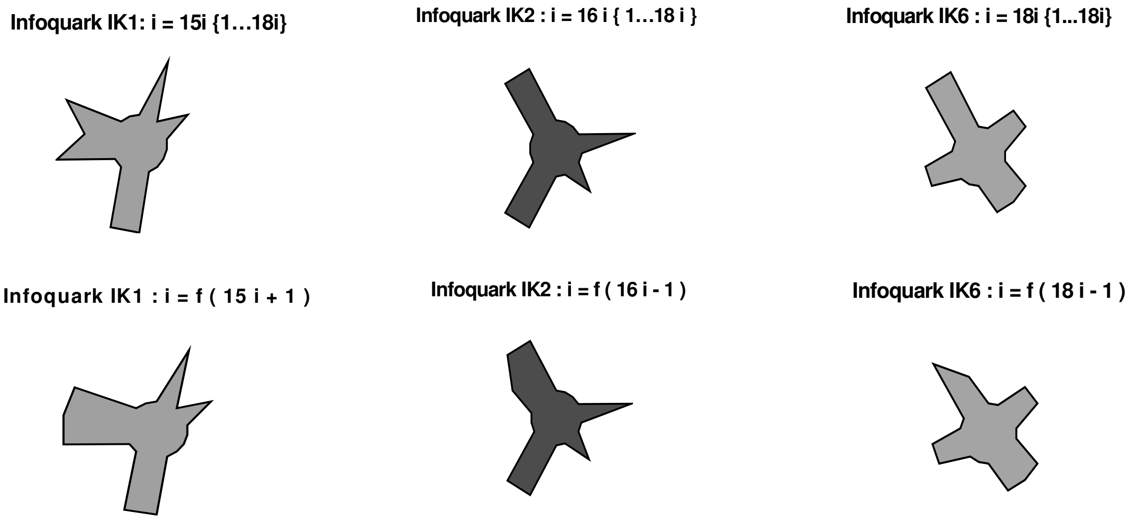


Fig. 4. **Results of experimental research. By LUA prof. G. Moskvin developed [5-14] new generation of intelligent quantity measuring devices “Logicor SD “(Europatents, PCT, USA, NZ, India, UK, Germany, Hungary, Sweden, Italy etc.)**

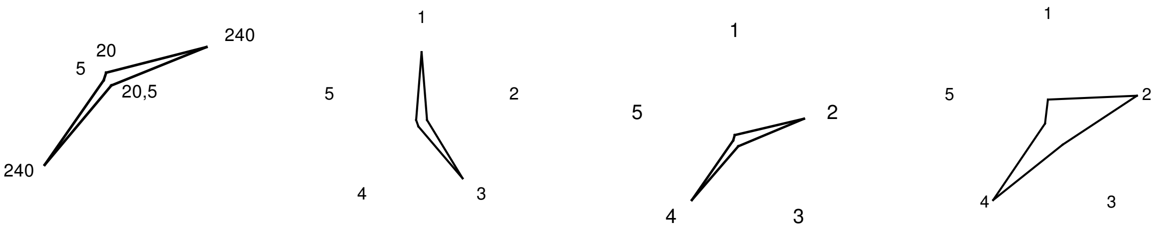
Fundamental research in the field of application of IST in agriculture allows creating abstract universal models which "improve" real processes and, in the result, the investigated situation becomes "transparent", accessible to theoretical analysis, generalizations and for the defining of new laws and the acquired new knowledge. Automatic measuring of quantity and quality, errors correction and quality conformity assessing of agricultural products, intellectual compatibility of measuring processes and functions of the "compensating stage" can be taken over by the cognition subject with its intellectual apparatus, which adds to the possibilities of applied investigation methods (Fig. 3 and Fig. 4).

The real properties of agricultural products can be expressed by means of the accepted conditioned standard of the perceptual model (expert’s knowledge). Besides, the most significant AI "biological" features remain. It can be said also in other way: real AI organisms are "the projections of the initial AI organism" designed by experts-theoreticians, models on in reality existing organic reason forms. The offered geometrical similarity principle using in expert systems for the consumers protection will allow the operator (a person or apparatus substituting man's control functions) to receive more complete, operative knowledge for the monitoring, control and regulation of bionic processes and objects, and not a "bare", non-processed number information group which rather misinforms, disorientates than informs or takes away uncertainty about features, situation, peculiarities or quality parameters of agricultural products. The results of previous experimental research prove that quality of agricultural products, soil and raw materials can be determined by using of new IST electronic instruments "Artificial Tongue-Logicor AT" (LUA) with application of new watch-fractal knowledge's imaging and non-traditional measuring and errors correction methods. The above said does not allow applying the traditional methods and measuring means in agriculture. Below are reflected some modeling results using of two types of geometrical similarity methods: "double-infoquarks" (Fig. 5) and "watch-fractals" (Fig. 6) for quality conformity control of agricultural products.



a **b** **c**

Fig. 5. **Example for conformity control of agricultural products**: double images (a), (b), (c) are elaborated for the visual conformity control by means of double - infoquarks IK1, IK2, IK6



a **b** **c** **d**

Fig. 6. **Watch-fractals for conformity assessing of agricultural products:** (a) – generalized watch-fractal (standard "watch-assembler" of quality), (b) – metrical image of fruit was not classified, (c) – fruit was classified as sort 1, (d) – fruit was classified as sort 2

The peculiarities, conditions and specifics of food production require elaborate simple, safe, inexpensive and precise electronic conformity control devices. The elaboration of such devices is control systems for the quality of food and other products - is the decisive factor in operation of the conformity. Too the quality conformity assessment and respectively the risks in the rapid alert system in the chain of agricultural production can be easy detected by method of fractal geometry.

Conclusions

1. Offered IST can be successfully using for the development of power saving technologies for increase of efficiency of agricultural energetics.
2. Quality refers to the combination of product characteristics that are critical for consumer acceptance. But risk can never be totally eliminated. Consumer science needs it own special methodology and own special intelligent instruments with AI elements.
3. The results of previous experimental research prove that quantity and quality of agricultural products can be determined by using of new patented IST intelligent instruments "Logicor SD" and "Logicor AT".
4. The real properties of agricultural products can be expressed by means of the accepted conditioned standard of the perceptual model (expert's knowledge). That essentially simplifies opportunities of creation of intelligent systems and technology for automatic quantity and quality surveillance of agricultural products.

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