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Biological Purpose Electronic Systems Improvement Motives

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Introduction

With the increasing capabilities and popularity of electronic calculating devices and decreasing costs and overall dimensions as well with the software improving there is an allurement rising to use them in various human activity fields, including the engineering of biological processes, for example in plants and in handling processes in their surrounding.

The necessity of many electronic systems (ES) does not raise doubts anymore. Examples could be electronic phytotron temperature, humidity, illumination and other systems. There are allowable margins of environment parameters values variation entered to the systems and they ensure it. But there is no control how the mentioned values variations affect the states of biological object (BO) and its systems. Besides, ES is handling only a few factors' parameters. Because of it BO is often affected by casual circumstances that influence the efficiency of biological systems (BS). There is a task to handle as many factors' values as possible and to relate their $\{ES_i\}$ among them as well as with $\{BS_j\}$. The necessity of such measures is validated by the sample analyzed below.

Influence of $\{ES_i\}$ correlations

We put the case that handled BS_j, which aim parameter (loses, costs and noxious effect) is Y; there is an influence of BS_j so the values of this parameter are determined by the set $\{F_V\}$ of factors and here F_V is closely associated with ES_i parameter X_i, the allowable X_i handling verge (x_i-$\Delta x_i \div x_i+\Delta x_i$; $\Delta x_i << x_i$; Δx_i – size does not create) are narrow and do not make the essential influence to Y parameter. The dynamic of such handling can be imaged in the graphs given in the Fig. 1.

We put the case that it is known that the value of v-th factor is usually F_{V1}, with it the minimal value of parameter Y is assured by ES_i X_i parameter's value x_{i1}. Because of it ES_i is matched in such way that X_i parameter value (x_i) stays in these verges:

$$x_{i1} - \Delta x_i \le x_i \le x_{i1} + \Delta x_i\,. \tag{1}$$

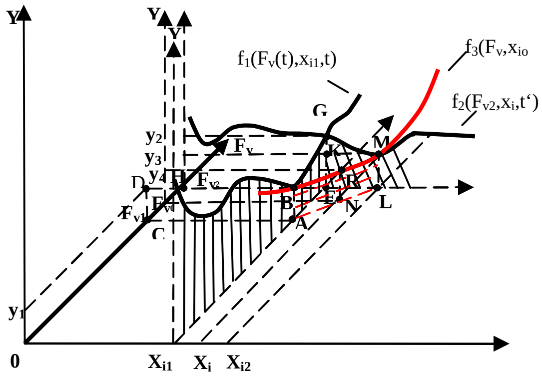

Fig. 1. Graphs of handling dynamic

Because F_V values are uncontrolled, they are shifting in such way deciding the shift of Y –

$$Y(t) = f_1(F_V(t), x_{i1}, t)\,. \tag{2}$$

Therefore in some moment (for example t^I)

$$f_1(F_V(t^I), x_{i1}, t^I) = y_2\,. \tag{3}$$

It is obvious that $y_2 > y_1$. If there were a possibility to change X_i values at that particular moment, we would get different dependence -

$$Y(t^I) = f_2(F_{V2}, x_i, t^I)\,. \tag{4}$$

When X_i value is equal to x_{i2}, then

$$Y(t^I) = f_2(F_{V2}, x_{i2}, t^I) = y_3\,. \tag{5}$$

Y aim parameter value reduces by the size of

$$\Delta y = y_2 - y_3 \tag{6}$$

With shifting F_V, the optimal X_i value x_{i0} shifts as well. In such way we can construct

$$Y(F_V) = f_3(F_V, x_{i0})\,. \tag{7}$$

Or (relatively) graph (Fig. 1). Frequently it is nonlinear function (as plant growing slowdown dependency on surrounding temperature) Therefore even if we choose average F_V value – F_{V0} and select a rational X_i value – x_{iv}, which are corresponded by a minimal (in that particular field) Y value – y_4, we get the dependency $Y(F_V, x_{iv})$ Presented in the Fig. 2.

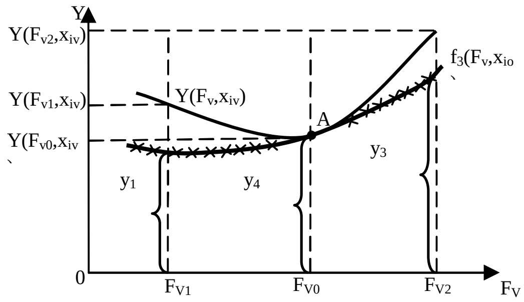

Fig 2. Graphs of $Y(F_V, x_{iv})$ and $f_3(F_V, x_{i0})$ functions

In the graph of the Fig. 2 it is possible to see that by selecting a X_i parameter value (x_{iv}), which is going to be rational then F_V value is equal to F_{V0}, $Y(F_V, x_{iv})$ and $f_3(F_V, x_{i0})$ functions has only one joint point- A. By selecting X_i parameter value and considering the average F_V value, there is a depravation of aim parameter obtained, which can be determined by

$$\Delta Y_{\Sigma}(F_V) = \int_{F_{V2}}^{F_{V2}} Y(F_V, x_{iv}) dF_V - \int_{F_{V1}}^{F_{V2}} f_3(F_V, x_{i0}) dF_V , \quad (8)$$

either (relatively)

$$\Delta Y_{\Sigma}(F_V) = \frac{\int_{F_{V1}}^{F_{Vy2}} Y(F_V, x_{iv}) dF_V}{\int_{F_{V1}}^{F_{V2}} f_3(F_V, x_{i0})} - 1 . \quad (9)$$

Besides ES_i , which ensure the given X_i value, another ES is necessary, for example ES_{i+1}, which would handle normative X_i values when F_V shifts. In such way an integrated *ES* (*IES*) (Fig. 3) is constructed.

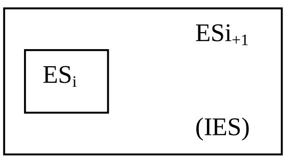

Fig. 3. *ES* integration version

By choosing a variation of biotronic systems when *ES* and *BS* are associated and *BS* aims priority is constructed, we get an integrated biotronic [1] system (*IBTS*) of given structure, which is presented in the Fig. 4.

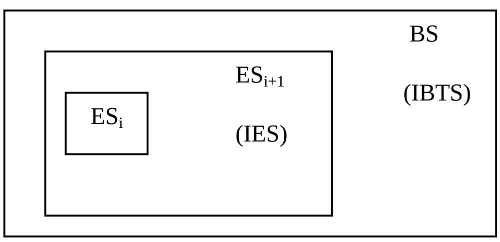

Fig. 4. *IBTS* structure

With the handling being improved the number of integrated systems increase, their internecine actions coordination is used, etc. The demand of artificial intelligence emerges. But is it really necessary? Is computer obligatory when you cultivate cucumbers?

IBTS appliance motives

In those activity fields where handling systems are necessary but not exists a human partly replace them. But with the prices of calculation techniques, software going down and calculating and handling programmes improving, with the overall dimensions of these devices reducing and correlations developing there are more and more reasons to use them in phytotronic as well. How purposive it is we will try to answer by analyzing one (not the most complex one) *IBTS* – electronic plant leave testing system (EPLTS) let's say that the purpose of this *IBTS* is to forecast the condition of the plant from the chromatic and other peculiarities of the leaf. A person (specialist) could do it in a visual way, but EPLTS can be used as well. We are analyzing the advantages and disadvantages of both below.

In the first case the following advantages exist:

There is no need for any electronic devices; less time is necessary to detect the condition; an experienced specialist can consider to other symptoms, and the EPLTS can not do it in the early stage; experience of specialist can be used with expedition in different places (territories); easier training, etc.

But there are a lot of disadvantages in this case as well: specialist is not able to evaluate promptly the influence of integrated dynamic and multiple environment, continuous plant conditions dynamic and many data from the sources that are not accessed in a visual way; it is not possible to grant a high accuracy of the prognosis; it is not possible to forecast the combinations of a few diseases and probabilities; it is not possible to process the information from various sources with different reliability with expedition and sufficient accuracy; it is not possible to detect the correlations among external factors, their intensity and plant condition; it is not possible to keep history dynamic for the future researches; it is not possible to forecast the condition development and to handle it; specialist is not able to calculate the optimal one time effect and dynamic handling variation; there is no possibility to organize a united (centralized), automatic handling of all factors and processes (illumination, irrigation, temperature handling, nourishment, etc.); centralized handling expedition reduces; there is no possibility to ensure the optimal combination of all handling procedures; operative handling of accidental incidents (non-planned, sudden flowing processes) becomes more difficult or sometimes even impossible; continuous participation of experienced specialist is necessary in order to perform the tasks.

In the second case the following advantages exist: it is possible to avoid many disadvantages mentioned in the first case; it is possible to establish *IBTS* centers [2] in such way spreading the experience; the cost of purchasing technologies for every consumer would reduce; biology specialists with lower qualification than in the first case could handle the systems; projection of centralized automated systems would be easier; databases would grow and improve permanently in such way ensuring the higher accuracy and reliability of prognosis; gaining the experience new BO and IBTS features could be discovered; there is a possibility to solve BS and BTS problems in a complex way; it is possible to optimize (minimize) vegetation costs.

It is necessary to mention some disadvantages of the second case as well: it is necessary to persuade agriculture and electronic specialists that it is necessary and perspective to develop biotronic (BT); it is necessary to create the methodology of many BT courses including the vision of EPLTS; it is necessary to project a few original EPLTS measures, including:plant leaf chromatic features detection (receptorics) tools; raster matrix projection measures; database organization and system training measures; *BO* condition forecasting measures, etc. there are some other BT development directions given [3], including phytotronic cybernetics [4]. The motivation of these works is presented as well. General systems reliability assurance methods are researched [5]. Let's discuss, for example, the principles of third measure projection.

EPLTS phytotronic information usage

General *BTS* phytotronic information peculiarities are discussed [4], so let's try to motivate the possibilities of EPLTS usage.

Let's say that in this case the research object (Fig. 5) – BO (plant, including the leaf). Information about it and environments is accumulated in the system. The main information part is formed of it. This information comes from many sources; one of them (for example the first one) is plant leaf chromatic detector. Raster matrix of many leafs (M_1) are constructed. When the color spectrum is fragmented, chromatic fragments probability of i-th leaf in the raster is determined (Fig. 6) and density graph is constructed.

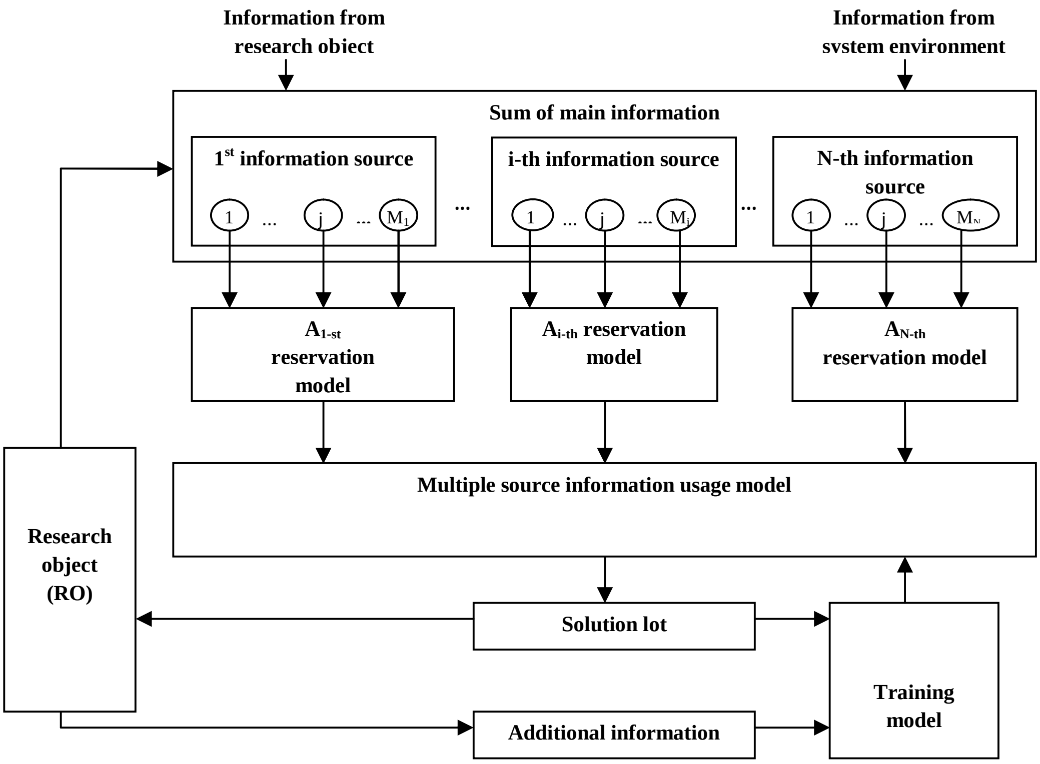

Fig. 5. Phytotronic information usage schema

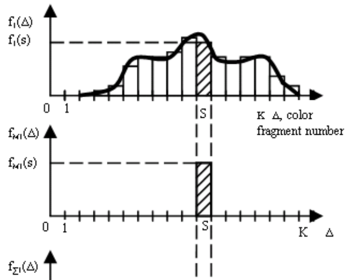

Fig. 6. Leaf color information summary

Color fragment probability densities of the first leaf are $f_1(\Delta)$, *j-th* – $f_j(\Delta)$, and M_1-*th* – $f_{M1}(\Delta)$. Summarizing information about all (M_1) leaves, every s-th fragmentation probability in the leaf

$$f_{\sum 1}(s) = \frac{\sum_{j=1}^{M_1} f_j(s)}{M_1}; \quad (10)$$

here $f_j(s)$ – *s-th* fragment color probability in the j-th leaf. In such way the first source leaves colors fragments probability distribution density $f_{\sum 1}(\Delta\ )$is formed. If in the first source every leaf raster propriety probability

$$P_1 = P_2 ... = P_j = ... = P_{M1} = P\ , \quad (11)$$

so it could be in such case when all leaves are scanned with the same devices and summarized (reserved) information reliability can be counted in such way:

$$P_{1\sum} = 1-(1-P)^{M_1} . \quad (12)$$

When (11) condition is not valid, then

$$P_{1\sum} = 1-\prod_{j=1}^{M_1}(1-P_j) \quad (13)$$

In such way (10) formula changes as well:

$$f_{\sum 1}^{I}(s) = \sum_{j=1}^{M_1} \frac{P_j}{\sum_{l=1}^{M_1} P_l} f_j(s) \ ; \quad (14)$$

where P_l – *l-th* leaf matrix propriety probability; $l = \overline{1, M_1}$.

Projecting a multi-source information model it is possible to use analogous evaluation principles. Realizing multi- source information usage model, forecasted $f_{\sum 1}(s)$, or $f^{I}_{\sum 1}(s)$ are compared with plant leaf color fragments distribution densities with various diseases given in paid normative databases. During such comparison diseases or BO conditions in general, the probabilities of their combinations are forecasted. The decisions are made and according to the effects on RO are handled. Knowledge and prognosis validated and by additional information channels they are sent to the training model which functions using a model projected for it. Training can consist of a few components, but it is essential when multi-source information usage model is being improved.

Conclusions

The presented information shows that it is necessary to improve biologic purpose ES, to implement it in the activity. That would increase research possibilities, prognosis accuracies and construct probabilities to forecast BO conditions dynamic.

The most effective in this field would be integrated systems, which functions using BS aims priority. That would make the possibilities to unite most of the BO conditions handling measures, to automate process handling and to save the resources.

When the computer technologies are used for BS handling there is a possibility to reserve multi-source information, to create prognosis lots, to calculate the reliability of these prognoses and to improve multi-source information usage processes.

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Biologic purpose (mainly used in the horticulture) electronic systems (ES) usage peculiarities are discussed. It was discovered that recently autonomous, on the biologic object (BO) nondependent ES are the most frequent. The motives that stimulate to improve such purpose electronic devices, to integrate and handle them using biologic system (BS) aim priorities, to realize biotronic schemas are enumerated. Using electronic plan leaf research system's information processing schema there were the advantages of ES and BS, reserve information and its reliability evaluation peculiarities demonstrated, as well as the ways how to improve the reliability of BO condition prognosis. Ill. 6, bibl. 5 (in English; summaries in English, Russian and Lithuanian).

П. Балайшис, А. Валинявичюс, Д. Эйдукас, Е. Керас, Н. Дзингус. Мотивы усовершенствования электронных систем биологического предназначения // Электроника и электротехника. – Каунас: Технология, 2009. – № 2(90). – С. 39–42.

Рассмотрены особенности применения электронных систем (ЭС), предназначенных для управления биологическими процессами (особенно в растениеводстве). Показано, что в настоящее время чаще всего применяются автономные, независящие от состояний биологических объектов ЭС. Изложены мотивы, стимулирующие усовершенствовать электронные средства данного назначения, их интегрировать и управлять, примениая приоритеты целей биологических систем (БС) – реализуя системы биотроники. Применяя схему обработки информации электронной системы исследования листа растения, показаны преимущества: взаимосвязанности ЭС и БС; применения резервной информации; оценки её надежности и др. Приведены способы как увеличить надежность прогнозов состояний БО. Ил. 6, библ. 5 (на английском языке, рефераты на английском, русском и литовском яз.).

P. Balaišis, A. Valinevičius, D. Eidukas, E. Keras, N. Dzingus. Biologinės paskirties elektroninių sistemų tobulinimo motyvai // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2009. – Nr. 2(90). – P. 39–42.

Aptarti biologinės paskirties (daugiausia naudojamų augalininkystėje) elektroninių sistemų (ES) naudojimo ypatumai. Parodyta, kad šiuo metu dažniausiai veikia autonomiškos, nuo biologinio objekto (BO) būsenų nepriklausančios ES. Išdėstyti motyvai, skatinantys tobulinti šios paskirties elektronines, priemones, jas integruoti ir valdyti, naudojant biologinės sistemos (BS) tikslų prioritetus, realizuoti biotronikos sistemas. Naudojant elektroninės augalo lapo tyrimo sistemos informacijos apdorojimo schemą, parodyti ES ir BS sąsajų privalumai, rezervinės informacijos ir jos patikimumo vertinimo ypatumai, taip pat būdai, kaip padidinti BO būsenų prognozių patikimumą. Il. 6, bibl. 5 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).

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