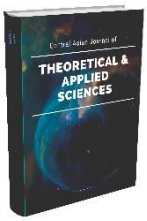

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Algorithms for the Selection of Relevance Functions of the Intelligent Measurement System

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Abstract: *Algorithms for initializing the values of relevance functions of the intelligent measurement system and its component software package are considered in this paper. On the basis of the proposed algorithms, a classical multilayer network with correct connections was developed to solve the problem of signal filtering.*

Keywords: *Intelligent measurement system, algorithm, relevance functions.*

Introduction

The intelligent measurement system (IMS) component software package includes: listing component, CUSTOMADCard analog-to-digital conversion board base class listing, RSL 818L series Analog digital converter (ADC) multi-function board class, I/O port reference module, DataContainer, GraphStoree, NspGenerator, TimerManager components, data types and structures, statistical functions, instructions for using the components, instructions for using the demonstration program. A multi-layer neural network with proper connectivity is convenient to solve the signal filtering problem. We use adaptive digital filtering algorithms designed for signals with different spectrums.

Development of digital filtering software of IMS. MATLAB software package can be used to create models of digital filters of IMS [1, 6, 7].

Main part

We consider a model of a digital low-pass filter (LPF) with adaptive relevance functions. The order of the filter is eight (N = 8), and the count that evaluates the signal is x_{n-8}. We call the set of relevance functions “knowledge base” (Fig. 1). We store three knowledge bases of membership functions in the memory of the digital filter. Depending on the characteristics of the signal, the digital filter selects one of the above knowledge bases. Each of the knowledge bases can be trained in separate training algorithms. We separate the direction to the knowledge base by indicating its number or capital Latin letter: A - knowledge base #1, B - knowledge base #2, C - knowledge base #3.

Each relevance function is divided into a stepwise approximation, i.e. eight steps (K=8). Thus, we can store 8·4·3=96 values of the membership function in the memory of a fully trained digital filter.

All models are made in the form of a set of functional subsystems. The Simulink base library, as well as standard modules of the DSP Blocksets and SimulinkExtras libraries were used to build the models [1]. Approximated values of processed signals and relevance functions are stored in the working space of the environment.

Before running the models for the first time, it is necessary to run the workspace selection program.

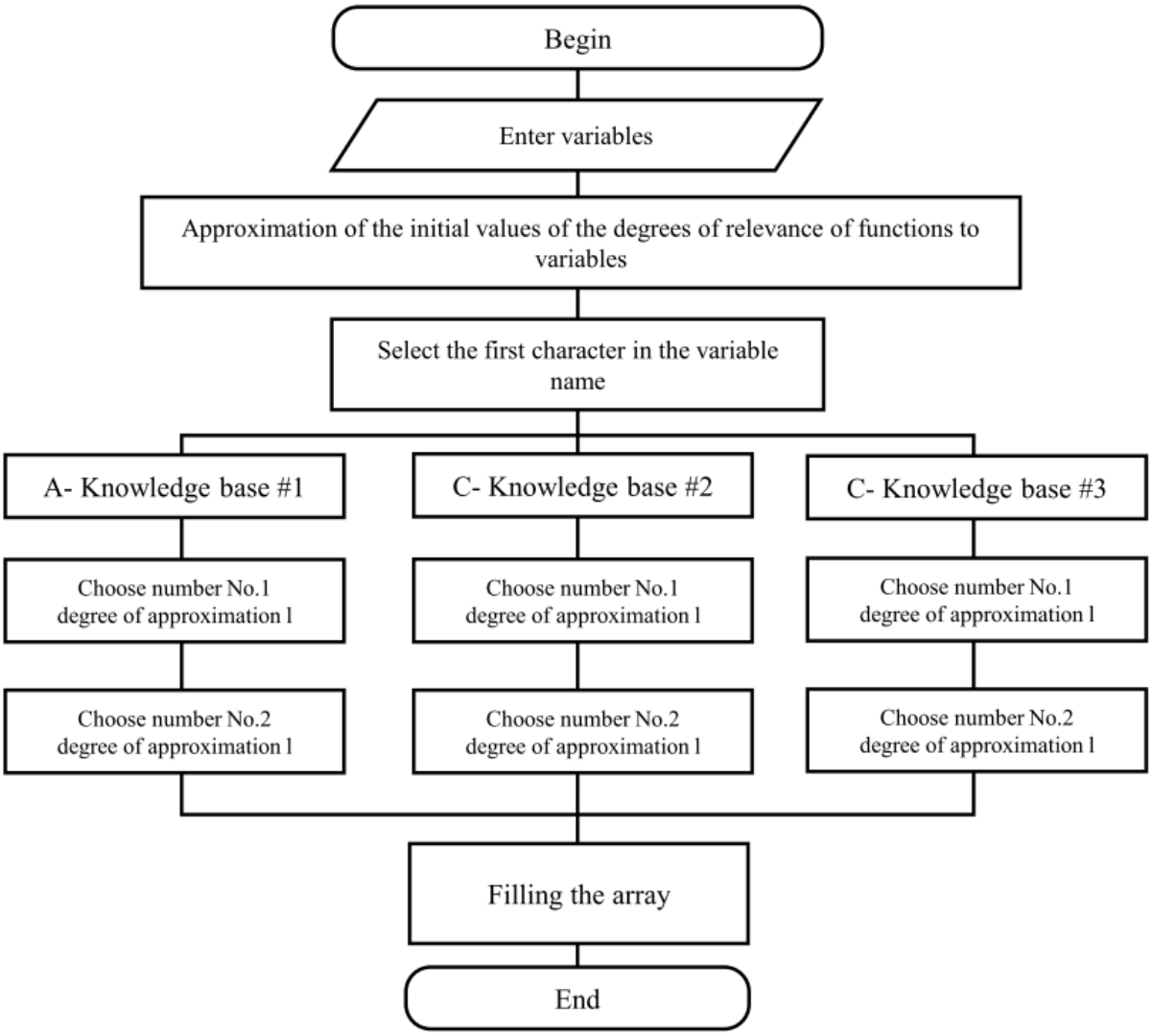

Figure 1. Algorithm for initialization of the values of relevance functions of the intelligent measurement system.

The program for selecting the values of relevance functions forms variables in the working area of the MATLAB environment and gives the initial values of the levels of approximation of relevance functions.

Here we assume that the letter in the name of the variable indicates the number of the knowledge base of the relevance functions. The first digit indicates the number of the approximation level, the second digit indicates the state at time k. The numbers are taken from the training algorithm. Variables accept two-dimensional vectors. The first element of a vector is always a unit vector. The second element is the value of the degree of direct approximation. Resources included in the MATLAB system were used to model the problems.

It is known that the digital filter consists of two modes of operation - training and signal processing modes. We use the second approach, taking into account the capabilities of the operating modes, because the description of the first operating mode requires the consideration of many auxiliary blocks.

The functional scheme of the software model in the MATLAB environment includes the following subsystems: Control, Bank subsystems, Multiport, Fazzyfilter switches, etc. In MATLAB, the functional scheme of the model is part of subsystems of multi-system software blocks. By means of these subsystems, the values of the relevance functions are loaded.

Each of these subsystems loads a knowledge base composed of four relevance functions. Subsystem1 subsystem (one of the parts of the Knowledgebase1 subsystem) is designed to call x_{n-k} signal values of relevance function in $k\pm1$, Subsystem2 – $k\pm2$, Subsystem3 – $k\pm3$, Subsystem4 – $k\pm4$.

The fitness function is expressed by the following formula:

$$\mu_n = \frac{\sum_{k=-N}^{N} \mu(x_n - k) x_{n-k}}{\sum_{k=-N}^{N} \mu(x_{n-k})}. \qquad (1)$$

In the definition of the formula (1), Subsystem1 loads the subsystem μ_{j1}, Subsystem2 loads the values μ_{j21}, and so the process continues.

Eight values of the relevance function (by the number of approximation levels) are loaded from the working space of the environment. The remaining processes are described in detail in [2-5].

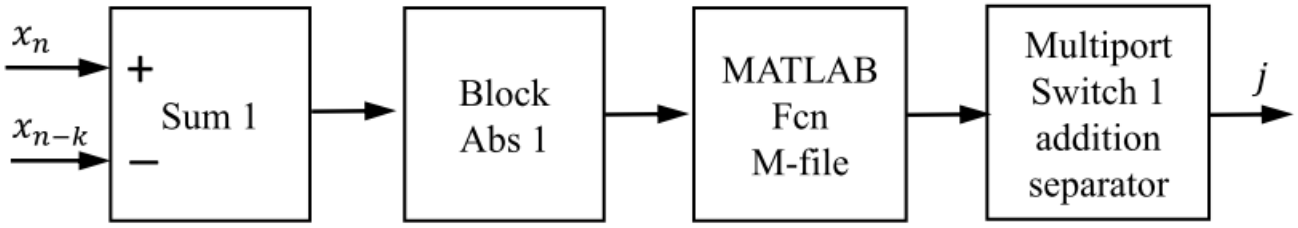

Figure 2. Functional diagram of Sub1 subsystem.

Subsystem Sub1 is a part of the Fuzzyfilter subsystem, which performs the selection of weight coefficients of signal counts (Fig. 2). In the sum1 blog, the counts of xn and x_{n-4} signals are subtracted and the absolute value of the obtained difference is calculated. The output signal from the Abs1 device comes to the input of the MATLAB Fcn1 block, which processes the signal in the form of a file-function (M-file). The algorithm of the program is presented in Figure 3.

Depending on the difference between the counts of the signal, the block gives the number of the degree of approximation. MATLAB Fcn1 block output signal comes to the control input of the Multiport Switch1 switching connector.

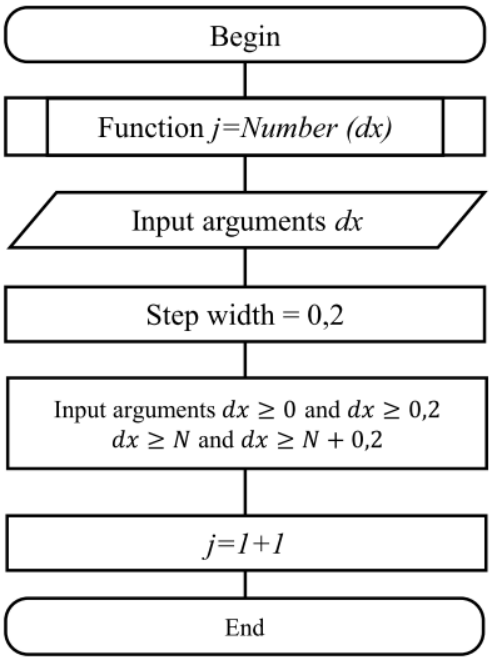

Figure 3. Algorithm for determining the number of approximation stages of the intelligent measurement system.

The replacement connector outputs the value of the chosen approximation level of the membership function.

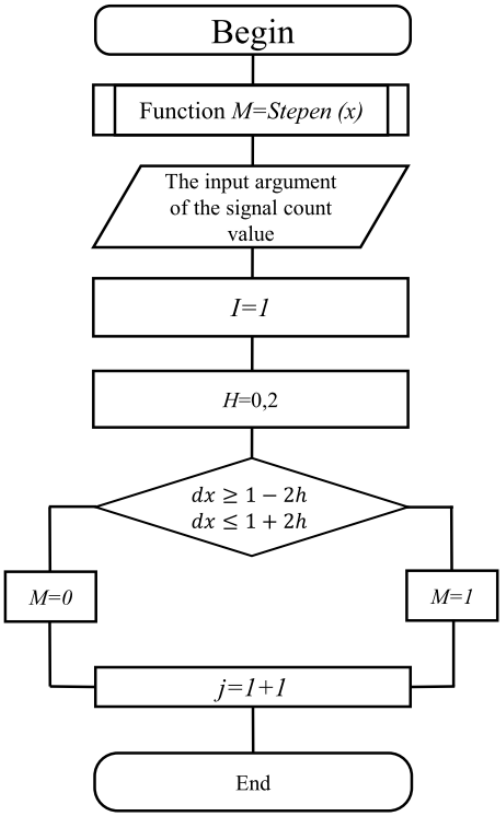

Figure 4. Algorithm for calculating the degree of relevance of the intelligent measurement system signal.

The signal of the MATLAB Fcn1 block (Figure 4) is also directed to the output of the Sub1 subsystem and then to the output of the Fuzzyfilter subsystem. The Control subsystem is designed to generate a signal that guides the selection of relevance functions knowledge bases. The operation algorithm of the Contro1 subsystem is presented in Fig. 4. Thus, Subsystem1 outputs two signals - a four-dimensional first signal and a one-dimensional second signal.

Conclusion

Algorithms for initialization of the values of relevance functions of the intelligent measurement system were developed. Its component software package includes: component listing, CUSTOMADCard analog-to-digital converter board base class listing, RSL 818L series ADC multi-function board class, Input-Output port reference module, components, data types and structures, statistical functions, instructions for using components, instructions for using demonstration software. A classical multilayer network with proper connections is convenient for solving the problem of signal filtering.

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