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The "Engineer" publishes the most significant results of scientific and applied research carried out in universities of transport profile, as well as other higher educational institutions, research institutes, and centers of the Republic of Uzbekistan and foreign countries.

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Model and algorithms for research and diagnostics of the track control sensor

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Abstract: One of the important elements of automation and telemechanics is continuous rail circuits, but existing rail circuits have a receiving end, which is only a relay. A new type of jointless rail circuits with current pickup is proposed and the development of artificial intelligence in railway transport and its areas of application are considered. The element was researched and based on the knowledge base function, used to create expert systems. A mathematical model has been developed to determine the operating mode of a jointless rail circuit with current collection. A simulation model has been developed. Algorithms and programs for creating expert systems for these models have been developed.

Keywords: expert system, knowledge repository, production model, semantic model, frame model, formal logical models, algorithm, track circuits, decision-making mechanism

1. Introduction

All specialists in the signaling of centralization and blocking of the signaling system know that on the railway the main and important element of all devices is rail circuits (RC) [1]. For this reason, the diagnosis and early identification of the cause of the malfunction is considered a relevant area of research [2].

Most failures in track circuits occur during under voltage due to high attenuation. Which can be caused by breakage or poor welding of connectors and jumpers in rails, as well as disturbing factors of natural origin, and it is necessary to take into account the asymmetry of the current along the rail line [3]. Also, attenuation in track circuits can be caused by reduced insulation resistances [6]. Despite the fact that failures in the equipment of the supply and relay ends make up a small fraction of failures in the rail circuit, when determining the cause of the failure, it is these elements that should be checked first [4, 5, 7].

2. Research methodology

To implement the task, the initial stage of software creation was the development of a mathematical model of the rail line.

To justify the choice of these devices, consider the diagram presented in Fig. 1.

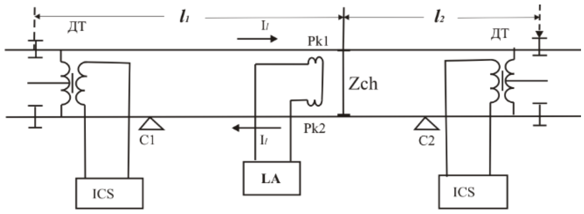

Fig. 1. Type of block area

where C1 and C2 are wheel pair axle counters at the entrance and exit of the controlled section; PK1, PK2 are the receiving coils of the locomotive; LA – locomotive devices; ICS – equipment for coded signals for transmitting information to a locomotive via a rail line.

To develop a mathematical model, we use the created equivalent circuit for this section

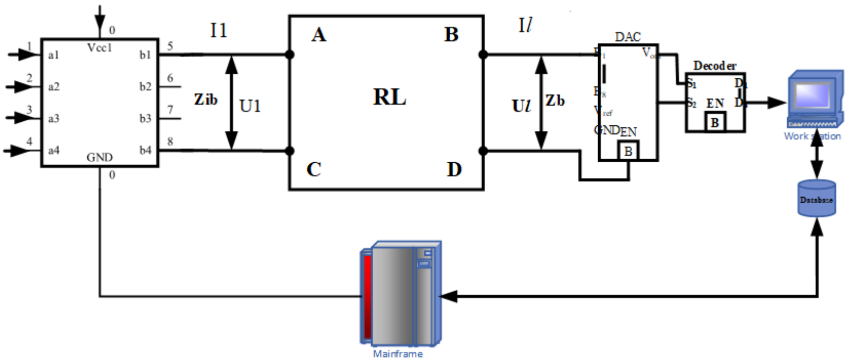

Fig. 2. Equivalent scheme

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We have

$$A = \cosh \gamma l_1; B = Z_v \sinh \gamma l_1; \quad (1)$$

$$C = \frac{1}{Z_v} \sinh \gamma l_1; \; D = \cosh \gamma l_1; \quad (2)$$

$$Z_{vx1} = \frac{AZ_{vxk}+B}{CZ_{vxk}+D} \quad (3)$$

Substituting the values of the coefficients A, B, C, D into equation (3) with their values, we obtain:

$$Z_{vx1} = \frac{\cosh \gamma l_2 Z_{vxk} + Z_v \sinh \gamma l_2}{\frac{1}{Z_v} \sinh \gamma l_2 Z_{vxk} + \cosh \gamma l_2} \quad (4)$$

From the theory of quadripoles we know:

$$U_1 = A_1 U_l + B_1 I_l; \quad (5)$$

$$I_1 = C_1 U_l + D_1 I_l \quad (6)$$

Let us express U*l* through I*l*

$$U_l = I_l * Z_{vxch} \quad (7)$$

Then

$$U_1 = A_1 I_l * Z_{vxch} + B_1 I_l; \quad (8)$$

$$I_1 = C_1 I_l * Z_{vxch} + D_1 I_l. \quad (9)$$

E.D.S. equivalent generator is calculated by the expression

$$E_э = U_1 + I_1 * Z_{ib}^I \quad (10)$$

Substituting the values U_1 and I_1 from formulas (8) and (9) into formula (10), we obtain:

$$E_э = I_l[A_1 * Z_b + B_1 + Z_{ib}^I * (C_1 * Z_b + D_1)]. \quad (11)$$

As the train approaches the supply end, the current in the rails increases significantly, the nature of its change is determined by the dependence of the transmission resistance of the main equivalent circuit Z_{pl} on the length of the rail line $Z_{pl} = f(l)$

Using the above expressions, the automatic locomotive signaling current is analyzed and the required power of the rail line power source is determined.

The resulting mathematical expressions for the operation of directional sensors largely depend on the conditions in which they are located. To develop a simulation model of diagnostic systems and subsequent examination, an algorithm for testing a tone track circuit with current information collection has been developed, which is presented in Figure 3. [8, 9]

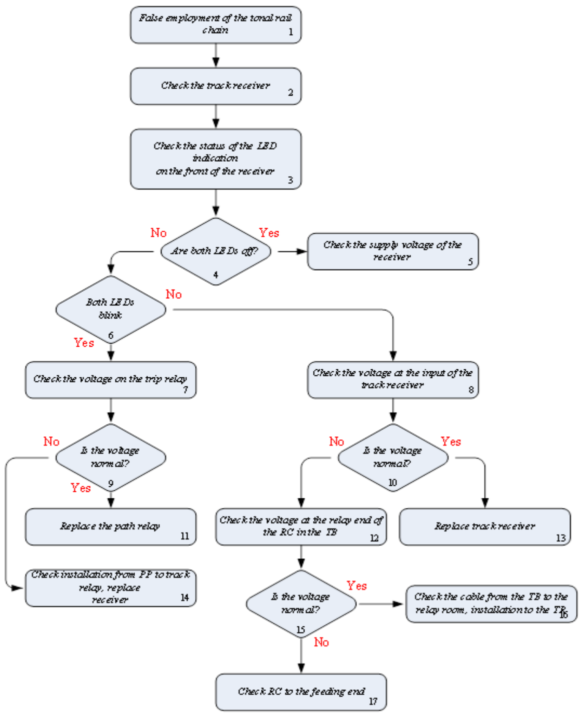

Fig. 3. Algorithm for troubleshooting TC

Thus, the use and implementation of neural networks in the railway industry will solve the problem of a shortage of qualified specialists and, in general, will become a useful system that provides recommendations for identifying and eliminating faults in automation and telemechanics systems.

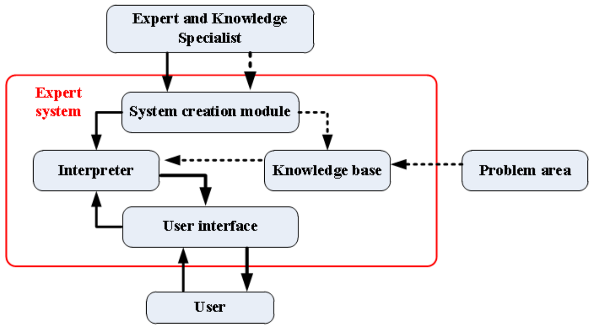

Fig. 4. Structural diagram of the expert system [9]

Figure 4 shows the structure diagram of the expert system, which is represented by the structure elements:

The knowledge base contains facts describing the problem area, as well as the logical connection between these facts. Rules are central to the knowledge base. An interpreter is a logical machine that processes knowledge. System creation module - a program that allows you to create a set of rules (Lisp, Prolog or any algorithmic language). To create expert systems, it is necessary to correctly understand all the nuances in this area

3. Research results

Algorithms for determining the optimal parameters of control sensors without insulating joints with a current track receiver

On the basis of the condition of ensuring the normal mode according to the formulas, an algorithm was developed (Figure 5), a program was drawn up and research was carried out on a computer. The algorithm for determining the optimal length of the track state monitoring sensor is shown in Figure 5.

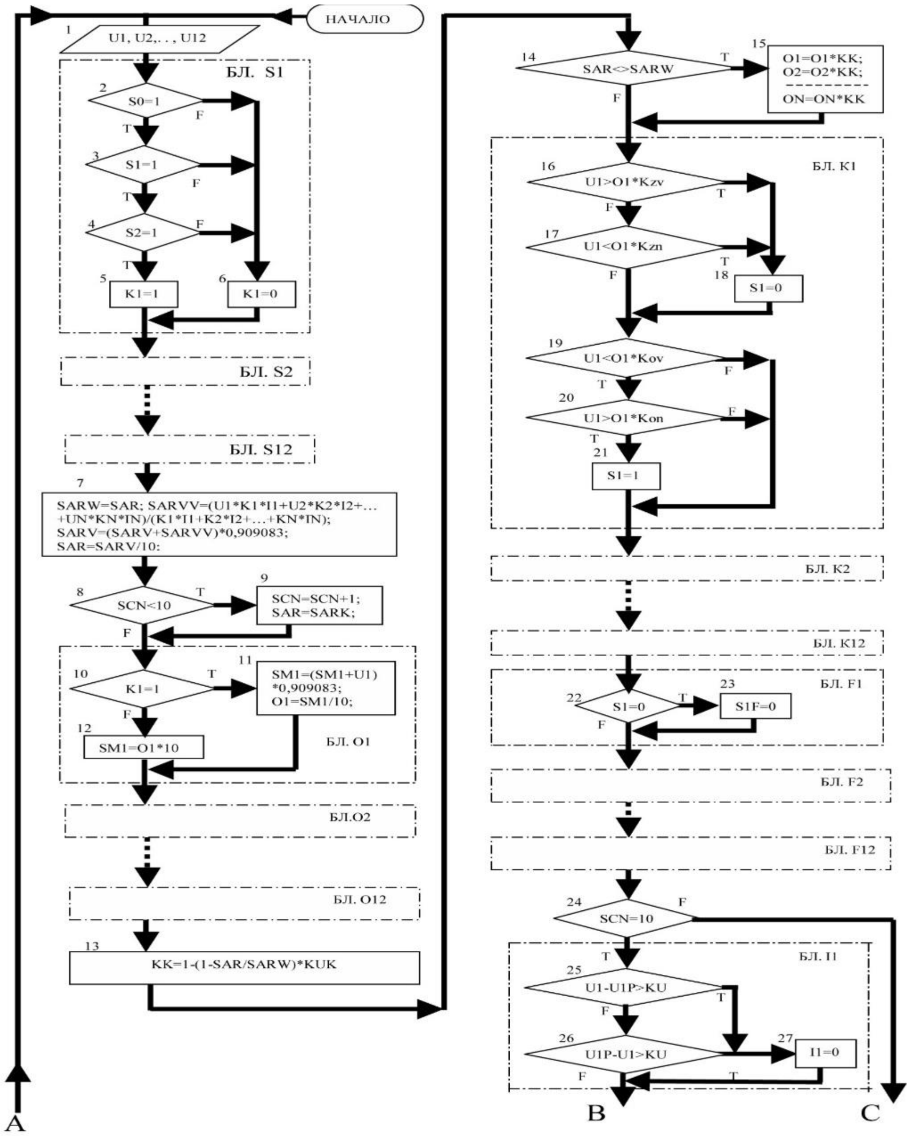

Fig. 5. Algorithm for determining the optimal parameters of the control sensor

Based on the algorithms described above, we create a prototype of the Expert system and test it Figure 6. The prototype of the expert system was created on the basis of the Delphi and Python programming language using the expert library.

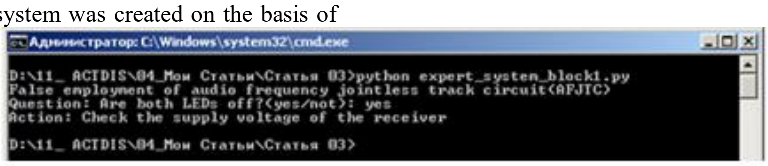

Fig. 6. Expert system prototype

Research program regarding connected full-featured rail chains and monitoring the condition of track sites

usesdos,graph,modyl,C1;

procedure Time; {Таймер – определяетвсевременныеинтервалы}

procedure TimeCikl;{Таймер – определяетвремяобщегоциклапрог.}

procedure CMouse; {Инициализация мыши и контроль коорд. мыши}

IMPLEMENTATION

procedure Time;{Таймер -определяет все временные интервалы}

begin

{Возвращает доли секунды..., год}

GetTime(Hour,Minute,Second,Sec100);

GETDATE(YEAR,MONTH,DAY,DAYOFWEEK);

{Датчик длительности нажатия клавиши мыши}

SEC100I:=F; IF SS=1{5} THEN BEGIN

```
SS:=0;SEC100I:=T;end;
     IF SEC100W<>SEC100 THEN
     BEGIN SEC100W:=SEC100;SS:=SS+1;END;
   {Датчик 0,5 сек для создания режима мигания на экране}
     {создает импульс в одном цикле через каждые 0,5 с}
   If Sec100>50 then Sec05:=t else Sec05:=f;
     Sec05IF:=F;Sec05IT:=F;
     If Sec05W<Sec05 then Sec05IT:=T;
     If Sec05W>Sec05 then Sec05IF:=T;
     Sec05W:=Sec05;
   {   If Sec100>90 then Sec05:=t else Sec05:=f;
     Sec05IF:=F;Sec05IT:=F;
     If Sec05W<Sec05 then Sec05IT:=T;
     If Sec05W>Sec05 then Sec05IF:=T;
     Sec05W:=Sec05;}
   {Датчик 1 сек}
     SECONDI:=F;
     IF SECONDW<>SECOND THEN BEGIN
   SECONDW:=SECOND;SECONDI:=T;END;
   {Вывод текущих значений времени и даты в общую (нижнюю) строкуэкрана}
     IF SECONDI THEN
      BEGIN
       SetColor(0);
       if (PUSK=1) THEN KolSec:=KolSec+1;{время работыпрограммынасчет}
       IF (KolSecW<>KolSec) THEN
        BEGIN
         KolSecW:=KolSec;
         STR( KolSec,KolSecS);

Bar(17,462,39,469);OUTTEXTXY(17,462,KolSecS);
        END;
   etc.
```

4. Conclusion

To detect a fault in the track circuit and provide expert control, a mathematical model has been developed, as a result of which, in the event of a fault in the track circuit, the fault is detected and diagnosed, providing data to the operator. In conclusion, it should be noted that the use of artificial intelligence for expert system tasks in the field of automation and telemechanics allows employees and engineers servicing these systems to receive advice on troubleshooting in real time.

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