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# Diagnosis of the Pneumatic Chamber of Cotton Pickers using Boolean Functions

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**ABSTRACT:** Consider control and diagnostics methods of air flow speed in the cotton pickers' pneumatic chamber. Chosen method for diagnosing air flow speed variation in the pneumatic chamber. For controlling and diagnosing air flow speed variation is proposed to use the logical method of diagnosis using Boolean functions. To diagnose the state of the pneumatic chamber adopted conditional designations: $D_1$ -diagnosis, evaluating unsatisfactory condition of pneumatic chamber, $D_2$ - diagnosis, evaluating the satisfactory condition of the pneumatic chamber and $D_3$ - diagnosis, evaluating the good condition of the pneumatic chamber. A mathematical model describing the process of diagnosing the state of the pneumatic chamber, based on the use of Boolean functions. At the same time according to variation of the input signals-symptoms (the air flow speed in the pneumatic chamber) built truth table showing the combination of the output of all possible states of the diagnostic device. During constructing Boolean functions of diagnosing the state of air flow speed in the pneumatic chamber, analyzed identify symptoms (diagnoses $D_1$, $D_2$ and $D_3$) depending on the appearance of the input signals $x_1$, $x_2$ and $x_3$. In fact, in real cases when there is an input signal $x_2$ (a symptom of the diagnosis $D_2$), there is (will be present) the input signal $x_1$ (a symptom of the diagnosis $D_1$), and when there is input signal $x_3$ (a symptom of the diagnosis $D_3$), there are (will be present) inputs $x_1$ and $x_2$. When there is a symptom of diagnosis $D_1$, should be absent diagnoses $D_2$ and $D_3$. And finally, when there is symptom of the diagnosis $D_2$, should be absent diagnoses $D_1$ and $D_3$. It is noted that the complexity of the delivery (identify) the actual diagnoses related to both variation of input signal levels and variation of air flow speed in the pneumatic chamber of cotton pickers that in some cases give rise to uncertainties and complexities of distinguishing one symptom from another, leading to a false assessment of the actual state of the pneumatic chamber. To improve the reliability of delivery of diagnoses of the input symptoms prompted to add additional parameters, or to take measures helping to clearly differentiate one diagnosis from another.

**KEYWORDS:** pressure in the pneumatic chamber, control and diagnostics method of air flow speed, diagnosis using Boolean functions.

## I. INTRODUCTION

During the collection of raw cotton with vertical spindle cotton pickers type MX-1.8 [1, p.23-24] because of the inability of automatic control gap between the drums, as well as contamination of the green mass of cotton bushes, as well as due to thickness of cotton bushes and other plants occur jamming spindles, strippers and stuck the pneumatic chamber of cotton picker, resulting in increased gather losses, reduced productivity of cotton picker and purity of the harvested raw cotton. That's why, air flow speed variation (relative pressure) in the pneumatic chamber of cotton picker is required to diagnose.

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## II. STATEMENT OF A PROBLEM

It is known that for diagnosing changes of status or symptoms of objects can be used a variety of methods: Basie method, sequential analysis method, methods of separation in space signs, the method of potential functions to detect multiple diagnoses, metric feature recognition techniques, diagnosis by distance in feature space, logical recognition methods and diagnostic tests.

The analysis of these methods has shown that for automation of delivery of the diagnosis variation of symptoms (states) of the controlled objects, especially to assess the state of change in pressure (flow speed) of air in the pneumatic chamber, the most effective is the use of a logical method of recognition using Boolean functions [2. p.68-71].

It is known that the logic functions normally carried out recognition of the two states, the presence of a "1" or not "0" signs and use them to construct the optimal structure of the combinational circuit machines. In contrast, in this study by Boolean functions we have attempted to evaluate the three states of air flow speed variation the in pneumatic chamber of cotton picker: unsatisfactory condition (diagnosis $D_1$), satisfactory (diagnosis $D_2$) and in good condition (diagnosed $D_3$). We assume that the diagnosis of $D_3$ signal level exceeds the level of the diagnosis signal $D_2$, and the diagnosis $D_2$ signal level exceeds the level of the diagnosis signal $D_1$.

The diagnostic device represents an instrument (apparatus) modulating communication symptoms and conditions. The device must provide automatic input ternary states in the microcomputer, differing by levels or other characteristics. Communication symptoms and conditions of systems will be expressed by Boolean function. Here, we do not build the combination machine through the Boolean functions. We will use them to build intellectual algorithm, supporting to distinguish complicated condition or symptoms, which can then be processed by the onboard microcomputer.

## III.DIAGNOSIS OF THE PNEUMATIC CHAMBER

So we make a diagnosis of the state of the pneumatic chamber by three attributes $x_1$, $x_2$, $x_3$. The presence of the unsatisfied state ($x_1$) denote the number "1" – absence the number "0"; the presence of a satisfactory state ($x_2$) denote the number "1*" - absence the number "0"; having a good state ($x_3$) denote the number "1**", - absence the number "0", so we have:

$$D_1 = \begin{cases} 1\text{-}availabilty\ symptom\ unsatisfied\ state\ of\ object \\ 0\text{-}non\text{-}availablity\ symptom\ unsatisfied\ state\ of\ object \end{cases}$$

$$D_2 = \begin{cases} 1^*\text{-}availability\ symptom\ satisfied\ state\ of\ object \\ 0\text{-}non\text{-}availability\ symptom\ satisfied\ state\ of\ object \end{cases}$$

$$D_3 = \begin{cases} 1^{**}\text{-}availability\ symptom\ of\ good\ state\ of\ object \\ 0\text{-}non\text{-}availability\ symptom\ of\ good\ state\ of\ object. \end{cases}$$

Here, input signal levels $x_i$ ($x_1 = 1$, $x_2 = 1^*$, $x_3 = 1^{**}$) differ in amplitude and occur sequentially. They are corresponds with the presence of corresponding symptoms of diagnoses $D_1$, $D_2$, $D_3$.

The system should provide diagnosis state of air flow speed (pressure) variation in pneumatic chamber according to simplified technical specifications given in the truth table (Table 1).

Table 1

| № | Status of input signals | Status of output signals | | |
|---|---|---|---|---|
| | $x_i$ | $y_1$ | $y_2$ | $y_3$ |
| 1 | 0 | 0 | 0 | 0 |
| 2 | 1 | 1 | 0 | 0 |
| 3 | 1* | 0 | 1 | 0 |
| 4 | 1** | 0 | 0 | 1 |

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According to Table 1, by the method of preparation and transformation of logic functions [3, p.148-155] can be composed a simplified Boolean functions, the availability of diagnoses: $D_1$, $D_2$, $D_3$, in the following simple disjunctive normal forms:

$$\begin{aligned} D_1 &= y1 \vee \overline{y2} \vee \overline{y3}, \\ D_2 &= \overline{y1} \vee y2 \vee \overline{y3}, \qquad (1) \\ D_3 &= \overline{y1} \vee \overline{y2} \vee y3. \end{aligned}$$

Before making a final conclusion in the evaluation of the corresponding states of symptoms by Boolean functions, we will analyze the appearance of the input signals $x_1$, $x_2$, $x_3$ depending on the appearance of symptoms (diagnoses $D_1$, $D_2$ and $D_3$). In actual situations, when there is an input signal $x_2$ (symptom of diagnosis $D_2$), there is (will be present) the input signal $x_1$ (symptom of diagnosis $D_1$), and when there is an input signal $x_3$ (symptom of diagnosis $D_3$), are (will be present) input signals $x_1$ and $x_2$. When there is symptom of diagnosis $D_1$ shouldn't be symptoms of diagnoses $D_2$ and $D_3$. Finally, when there is an symptom of diagnosis $D_2$ shouldn't be symptoms of diagnoses $D_1$ and $D_3$. However, when the cotton balls opening degree is satisfactory or good the relative pressure in the pneumatic chamber becomes close to the pressure, showing unsatisfied state of relative pressure, i.e. diagnosis $D_2$ and $D_3$ converge to diagnosis $D_1$. In such situations, there are uncertainty and difficulty distinguishing one symptom from another, and it leads to a false assessment of the actual state of the relative pressure in the pneumatic chamber.

In order to implement logic functions with considering the uncertainty it requires a complex combination machine having memory elements and working according to the synthesized intelligent algorithm. To distinguish these three levels of diagnoses necessary to use analog sensors, converters with integrated comparators and logic circuits that form the corresponding logical symptoms $D_1$, $D_2$, $D_3$. The complexity of implementing these functions is based on a different signal level that can be distinguished by applying the ADC or comparator.

Considering the complexity and uncertainty assessment of the occurrence of the output symptoms associated with a variation of the incoming signals (the flow intensity of cotton) x1, x2, x3, truth table, displaying the dependence of possible output states of the device from the possible states of the input signals can be represented as follows (Table 2).

Table 2

| N | Status of inputs | Status of outputs | | | Note |
|---|---|---|---|---|---|
| | $x_i$ | $y_1$ | $y_2$ | $y_3$ | |
| 1 | 0 | 0 | 0 | 0 | Impossible condition |
| 2 | 1 | 0 | 0 | 1 | Symptom diagnosis $D_3$ |
| 3 | 1 | 0 | 1 | 0 | Symptom diagnosis $D_2$ |
| 4 | 1 | 0 | 1 | 1 | Impossible condition |
| 5 | 1 | 1 | 0 | 0 | Symptom diagnosis $D_1$ |
| 6 | 1 | 1 | 0 | 1 | undefined state |
| 7 | 1 | 1 | 1 | 0 | undefined state |
| 8 | 1 | 1 | 1 | 1 | Impossible condition |

According to Table 2, we write the possible Boolean functions (system of equations) in disjunctive normal form, describing the presence or absence of symptoms - diagnoses $D_1$, $D_2$, $D_3$ on the pneumatic chamber.

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$$D_i : \begin{bmatrix} \overline{y_1} \vee \overline{y_2} \vee \overline{y_3} \\ \overline{y_1} \vee \overline{y_2} \vee y_3 \\ \overline{y_1} \vee y_2 \vee \overline{y_3} \\ \overline{y_1} \vee y_2 \vee y_3 \\ y_1 \vee \overline{y_2} \vee \overline{y_3} \\ y_1 \vee \overline{y_2} \vee y_3 \\ y_1 \vee y_2 \vee \overline{y_3} \\ y_1 \vee y_2 \vee y_3 \end{bmatrix} \qquad (2)$$

From Table 2 (and the system of equations 2) we define a function that describes the presence of symptoms of unsatisfactory condition of the air pressure in the pneumatic chamber. Table 2 shows the output state of the device (the fifth line) is actually correctly assesses presence of symptom diagnosis $D_1$, and in other states symptom of diagnosis $D_1$ is uncertain, i.e. $D_1$ is actually not "0", because in these states, there are symptoms of diagnoses $D_2$ and $D_3$. In addition, in the first and the eighth rows of the table shown the impossible conditions (symptoms) that should be drop out. Reasoning and other states, assessing diagnoses D1 and D2, as well as after filtering rough impossible conditions, the system of equations (2) can be rewritten in the disjunctive normal form:

$$D_i : \begin{bmatrix} \overline{y_1} \vee \overline{y_2} \vee y_3 \\ \overline{y_1} \vee y_2 \vee \overline{y_3} \\ \overline{y_1} \vee y_2 \vee y_3 \\ y_1 \vee \overline{y_2} \vee \overline{y_3} \\ y_1 \vee \overline{y_2} \vee y_3 \\ y_1 \vee y_2 \vee \overline{y_3} \end{bmatrix} \qquad (3)$$

Therefore, for a correct assessment of the presence of the symptom of unsatisfactory state ( $D_1$ ) we will accept only Boolean function disjunctive normal form, describing the fifth row of the table 2:

$$D_1 = y_1 \vee \overline{y_2} \vee \overline{y_3} \qquad (4)$$

Similar reasoning we will write a boolean function, respectively describing the unique symptoms of a satisfactory and good condition of diagnoses D2 and D3 in the disjunctive normal form:

$$D_2 = \overline{y_1} \vee y_2 \vee \overline{y_3} \qquad (5)$$

$$D_3 = \overline{y_1} \vee \overline{y_2} \vee y_3 \qquad (6)$$

The rest of the last two Boolean functions in the system of equations (3) or the table (2) show the undefined state of symptoms in the disjunctive normal form.

## IV. CONCLUSION

Analysis of the system of equations, assessing the status of symptoms corresponding diagnoses showed that only by these input signals and output states it is impossible to assess the actual condition of the pneumatic chamber, as there are many uncertain conditions. To exclude the uncertain states of symptoms need to enter additional parameters (measures) easing distinguish one symptom from others. Continuation of the proposed method will be described in the following article.

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## REFERENCES

[1] A.D.Abdazimov, E.Uljaev, U.M.Ubaydullaev, N.N.Omonov. Basics of automation control and monitoring of cotton pickers' technological parameters.. - Tashkent, Tashkent State Technical University, 2014. - 164.
[2] I.A. Birger Technical diagnostics. - M .: "Mashinostrenie", 1978. - 240 p.
[3] S.A.Mayorov, G.I.Novikov, O.F.Nemolochnov and others. Design of digital computers. Edited by S.A.Mayorov. Textbook for university students. M: "High School", 1972. s.344.

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