Forward-chaining approach to expert system for machine maintenance

S.N. Mohamad[1,*], A.Y. Bani Hashim[1]

[1)] Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.

*Corresponding e-mail: sitinurliza.mohamad@gmail.com

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ABSTRACT – This paper is about the machine maintenance of the Square Foiling Machine. Maintenance of the machine relates to the concern of controlling the condition of equipment. Most of the peoples used checklists to store the information but, since technology improved, there is a system that more reliable in maintenance management. There is an expert system that emulates human making decision ability. Knowledge of educated person and the experience of experts will be combined with a particular justification until a perfect decision achieved. Inference Techniques used is forward chaining method to draw the antecedent and consequent of the domain problems. The expert system will be written by using the Python language with graphical user interface (GUI).

1. INTRODUCTION

The Square Foiling Machine (SFM) is a sealing machine that is used for foiling purpose and the model type is BRT-5000SA. It was invented by Boryung Technology (BRT), a Korean-based company [1].

Figure 1 Square foiling machine (Source: [1])

The BRT-5000SA is designed to seal condoms in a square shape by manual loading with four side seals. Sealing process is a process that some heat is applied to the mold to melt a foil for packaging purpose. [1]. Table 1 shows the specification of the SFM.

Table 1 Specifications of square foiling machine (Source: [1])

No	Specifications	Details
1	Model no.	BRT-5000SA
2	Dimension	2200L x 1000W x 1650H mm
3	Power supply	240V. Single-Phase
4	Package size	55 x 57 mm
5	Capacity	About 70 to 100 pieces per minutes
6	Electric power	2~3.0 kWh
7	Automatic Grade	Semi-automated

Operating instructions that produced by BRT clearly stated the symptoms, causes to the symptom and the remedy. Several symptoms are main switch is on and entire electric part not alive, motor does not start, the set point for heating controller cannot be reached in spite of longer time, heater does not work, indicating temperature is unstable, open sealing or air leaking of package, and double sealing. With this available symptoms, causes and remedy, an expert system will be develop with Python Language [1].

2. BACKGROUND

Expert system (ES) is a branch of artificial intelligence. It is extensive use of specialized knowledge to solve problems at the level of human expertise. Human expert is a person who has expertise in a certain field. The expert has knowledge and skill in handling problem efficiently. Thus, expert systems perform reasoning over representations of human knowledge [2].

The fundamental component of an expert system is the knowledge. Human experts will transfer the knowledge and related information to the system to be analyzed. The system, upon having embedded with knowledge, will then respond to a respective situation. The knowledge engineer must communicate with the human experts. Transcribing the knowledge into pseudo codes is performed by the knowledge engineer while extracting the actual knowledge from the human experts. This stage is analogous to the system designer in conventional programming. Once ready, the human experts will then evaluate the ES. This process continues until the human experts satisfy with the system performance. Figure 2 summarizes the process of developing an ES.

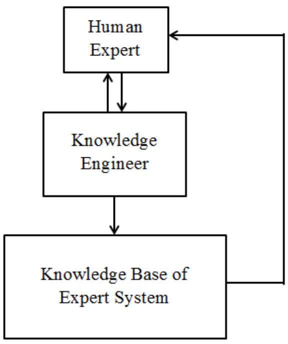

Figure 2 The development process of an ES (Source: [3])

Rule-base ES is the most popular system. It is easy to summarize the knowledge and expand the ES by incremental development as shown in Figure 3. The knowledge base stores expert knowledge as condition action rules. Working memory stores initial facts and generated facts derived by inference engine. Inference engine will matches the condition part of rules against facts stored in working memory. Explanation facility provides justification of solution (reasoning chain). Knowledge acquisition facility helps to integrate new knowledge. User interface act in insert the facts, query the system, solution presentation.

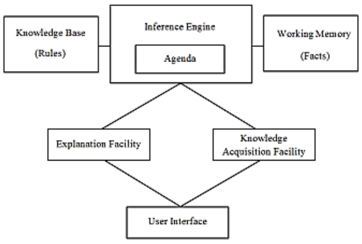

Figure 3 Structure of Rule-based ES (Source: [3])

Furthermore, the rules specified correctly. Rules act as a knowledge representation technique [3]. In any rules, they must consist of two parts. For example, the basic syntax should include at least an antecedent and a consequence.

IF <antecedent> **THEN** <consequent>

An inference is a method to stimulate the antecedent and consequent event. The process helps to draw a conclusion or to derive any starting point to some problem or consequents. This type of technique occurs repeatedly that performing the corresponding actions based on the knowledge base [4].

The objective of this paper is therefore, to discuss the system requirements, then generating the source code that translates the knowledge explicitly into the knowledge base module. A complete set of codes will produce an effective system.

3. METHODOLOGY

The seven symptoms listed in the defect checklist by Boryung Technology will be used in constructing the system. Based on Figure 4, the forward chaining inference technique showed the combination of antecedent and consequent event. The following equations define the rules for ES of the maintenance problem for a square foiling machine.

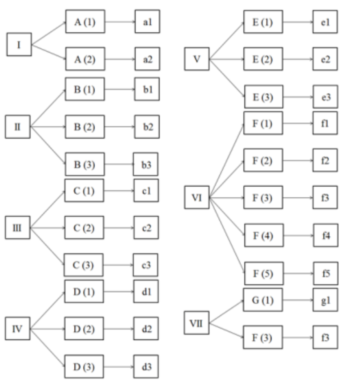

Figure 4: Forward chaining inference technique

Inference techniques used is Forward Chaining Method. Starting from an antecedent that is the problems, it will be a series of consequences that causes and remedy. Capital roman represents the problems, capital alphabet is the causes and the small letter is the remedy.

i) *Rule 0 (Initiation)*
IF Rule 1 **THEN** I
elif Rule 2 **THEN** II
elif Rule 3 **THEN** III
elif Rule 4 **THEN** IV
elif Rule 5 **THEN** V
elif Rule 6 **THEN** VI
elif Rule 7 **THEN** VII

ii) *Rule 1*
IF < I ∩ A(1) > **THEN** < a1 > (Rule 1.a)
IF < I ∩ A(2) > **THEN** < a2 > (Rule 1.b)

iii) *Rule 2*
IF < II ∩ B(1) > **THEN** < b1 > (Rule 2.a)
IF < II ∩ B(2) > **THEN** < b2 > (Rule 2.b)
IF < II ∩ B(3) > **THEN** < b3 > (Rule 2.c)

iv) *Rule 3*
IF < III ∩ C(1) > **THEN** < c1 > (Rule 3.a)
IF < III ∩ C(2) > **THEN** < c2 > (Rule 3.b)
IF < III ∩ C(3) > **THEN** < c3 > (Rule 3.c)

v) *Rule 4*
IF < IV ∩ D(1) > **THEN** < d1 > (Rule 4.a)
IF < IV ∩ D(1) > **THEN** < d2 > (Rule 4.b)
IF < IV ∩ D(1) > **THEN** < d3 > (Rule 4.c)

vi) *Rule 5*
IF < V ∩ E(1) > **THEN** < e1 > (Rule 5.a)
IF < V ∩ E(2) > **THEN** < e2 > (Rule 5.b)
IF < V ∩ E(3) > **THEN** < e3 > (Rule 5.c)

vii) *Rule 6*
IF < VI ∩ F(1) > **THEN** < f1 > (Rule 6.a)
IF < VI ∩ F(2) > **THEN** < f2 > (Rule 6.b)
IF < VI ∩ F(3) > **THEN** < f3 > (Rule 6.c)
IF < VI ∩ F(4) > **THEN** < f4 > (Rule 6.d)
IF < VI ∩ F(5) > **THEN** < f5 > (Rule 6.e)

ix) *Rule 7*
IF < VII ∩ G(1) > **THEN** < g1 > (Rule 7.a)
IF < VII ∩ F(3) > **THEN** < f3 > (Rule 7.b)

4. SUMMARY

The ES will be built based on information listed in the BRT user manual using forward chaining method. The codes will be written in the Python language and used of Graphical User Interface (GUI). Figure 5 shows the expert system of maintenance problem for SFM.

Figure 5 Expert System of Maintenance Problem

5. REFERENCES

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