IECMA 2024 Conference

The 2nd International Electronic Conference on Machines and Applications

18–20 June 2024 | Online

Fault Diagnosis of the Hydraulic System for a Bridge Erecting Machine Based on Ontology Bayesian Networks

Zhang Huan, Wang Gangfeng*

Key Laboratory of Road Construction Technology and Equipment of MOE, School of Construction Machinery, Chang'an University, Xi'an 710064, China   E-mail: wanggf@chd.edu.cn

INTRODUCTION

The hydraulic system is the main power unit of the bridge erecting machine. Due to the complex internal structure of the hydraulic system and strong correlation among hydraulic components, it is difficult to accurately determine the cause of system failures, leading to unclear localization of faulty components in the bridge erecting machine and low diagnostic accuracy. Traditional sources and structures of fault diagnosis knowledge vary, making data processing cumbersome and diagnostic accuracy inadequate. Therefore, a reasonable and efficient hydraulic system fault diagnosis method is of great significance to ensure the normal operation of the bridge erecting machine.

RESULTS

Maximum posterior probability reasoning

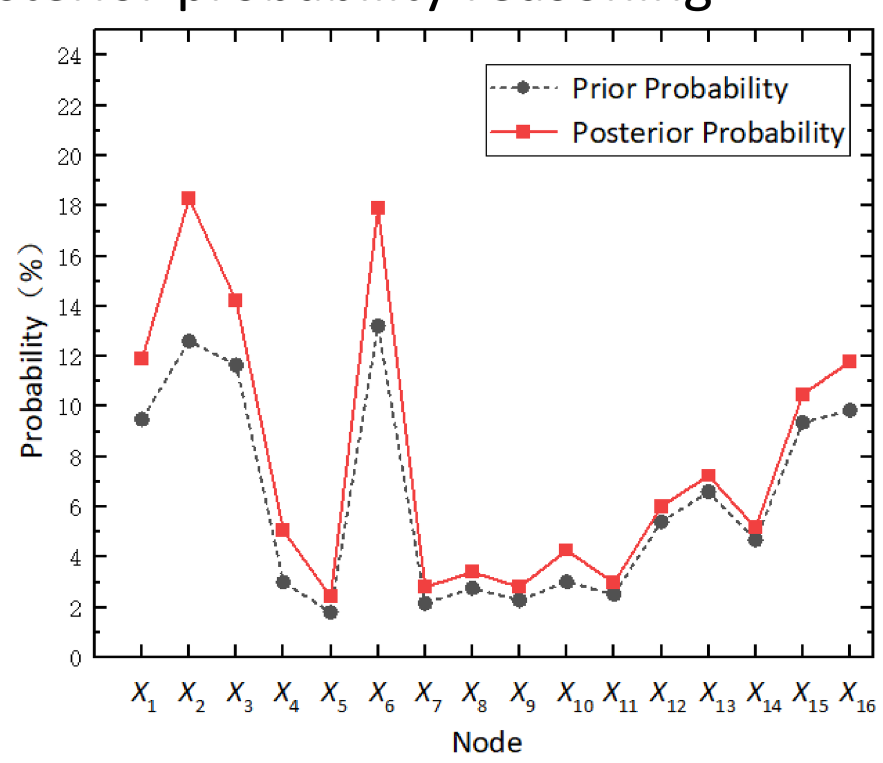

Figure 4. Prior Probability and Posterior Probability of Root Nodes

Table 2. Fault diagnosis test results

fault phenomenon	diagnostic times	accuracy rate/%
dynamic fault	243	94.32
filter stoppage	79	93.65
abnormal oil	75	95.66
hydraulic cylinder failure	58	93.83
control element failure	124	92.47

CONCLUSION

(1) The effective organization and utilization of fault information have been achieved through the use of ontology technology.

(2) Fuzzy set theory was employed to obtain conditional probability tables and perform fault reasoning on the hydraulic system of the Bridge Erecting Machine.

REFERENCES

[1] Wang Yan-ying, Wang Zeng-shan, Ma Hua-bing, et al. Numerical Modeling And Field Test on Bearing Capacity of a Subcrust Under Front Leg of a Self-advance Large-tonnage Pipe Gallery Installation Machine. Science Technology and Engineering[J], 2022, 22(28): 12590-12597.

[2] Li Jian, Huang Mei-fa, Wang Zhi-yue. Research on Automatic Generation Ontology of Machining Methods Considering Geometric Constraint[J]. Machinery Design & Manufacture, 2023, (8): 117-121+125

[3] Qian Cun-hua, Hua Fei. Research on reliability of hydraulic system based on Dynamic Bayesian Network[J]. Machine Tool & Hydraulics, 2023, 51(20): 219-224.

METHOD

1. Organizing bridge erecting machine hydraulic system fault knowledge effectively using Ontology technology.

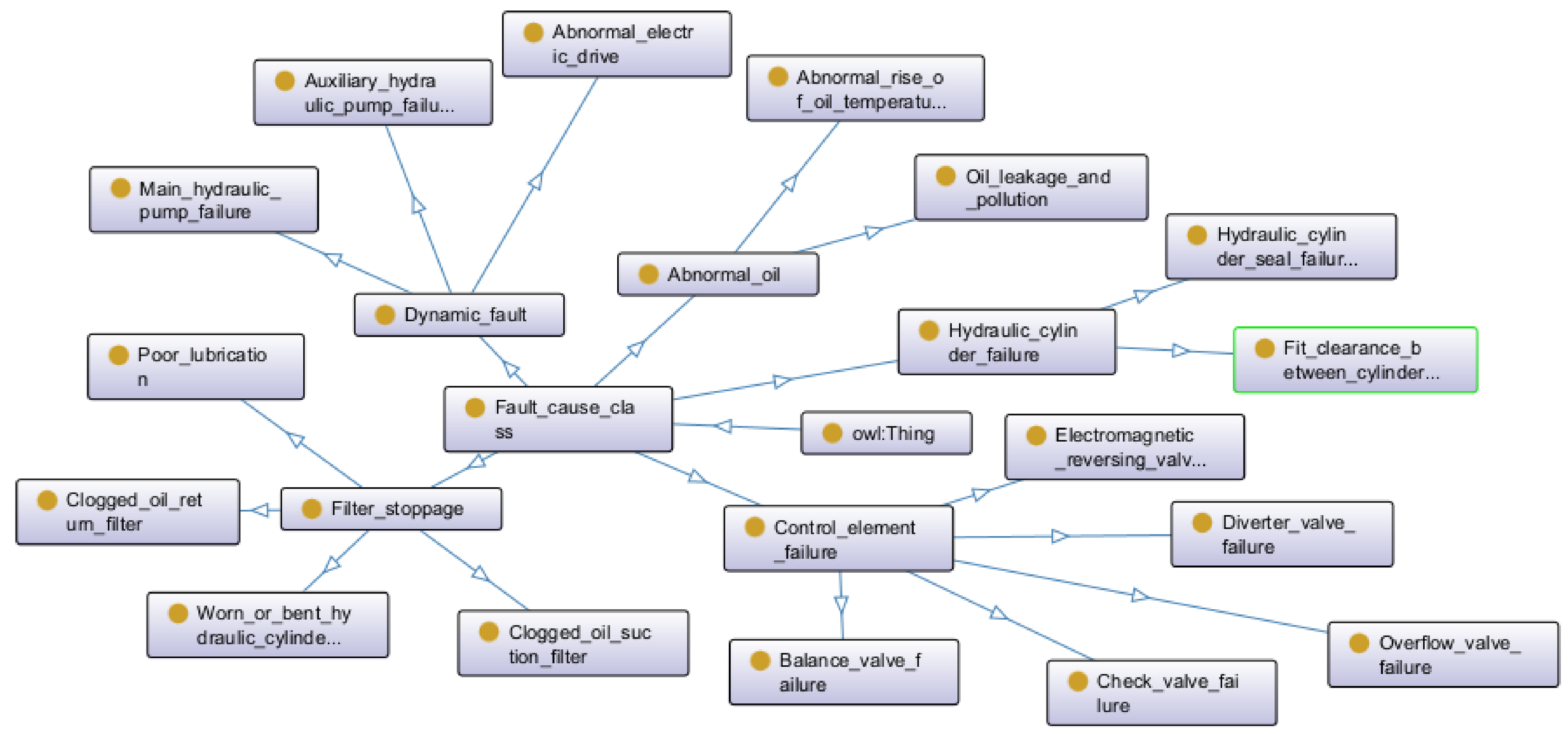

Figure 1. Fault knowledge of hydraulic system of bridge erecting machine

2. Transforming the fault knowledge organized by ontology into a Bayesian network using Jena rules.

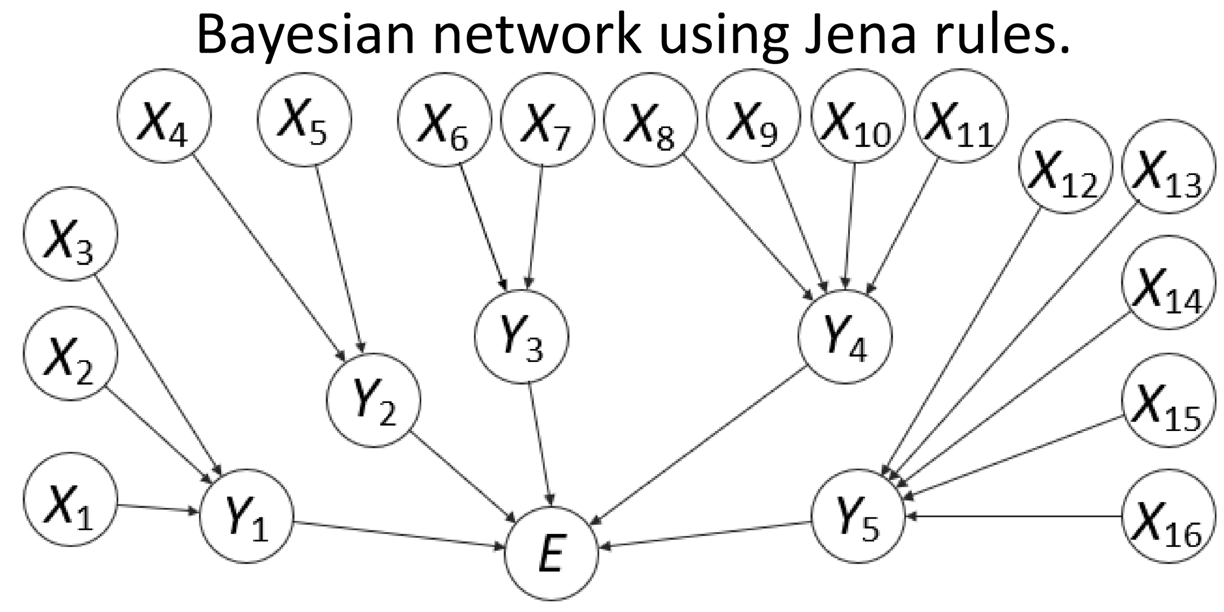

Figure 2. Directed acyclic graph of Bayesian network

3. Calculating node conditional probability tables using fuzzy theory.

Table 1. Node Conditional Probability Table

X_1	X_2	X_3	$P(Y_1=1)$
1	1	1	0.8
1	1	0	0.6
1	0	1	0.75
1	0	0	0.3
0	1	1	0.75
0	1	0	0.55
0	0	1	0.3
0	0	0	0.0875

4. Using Netica to implement Bayesian network node learning and probability inference.

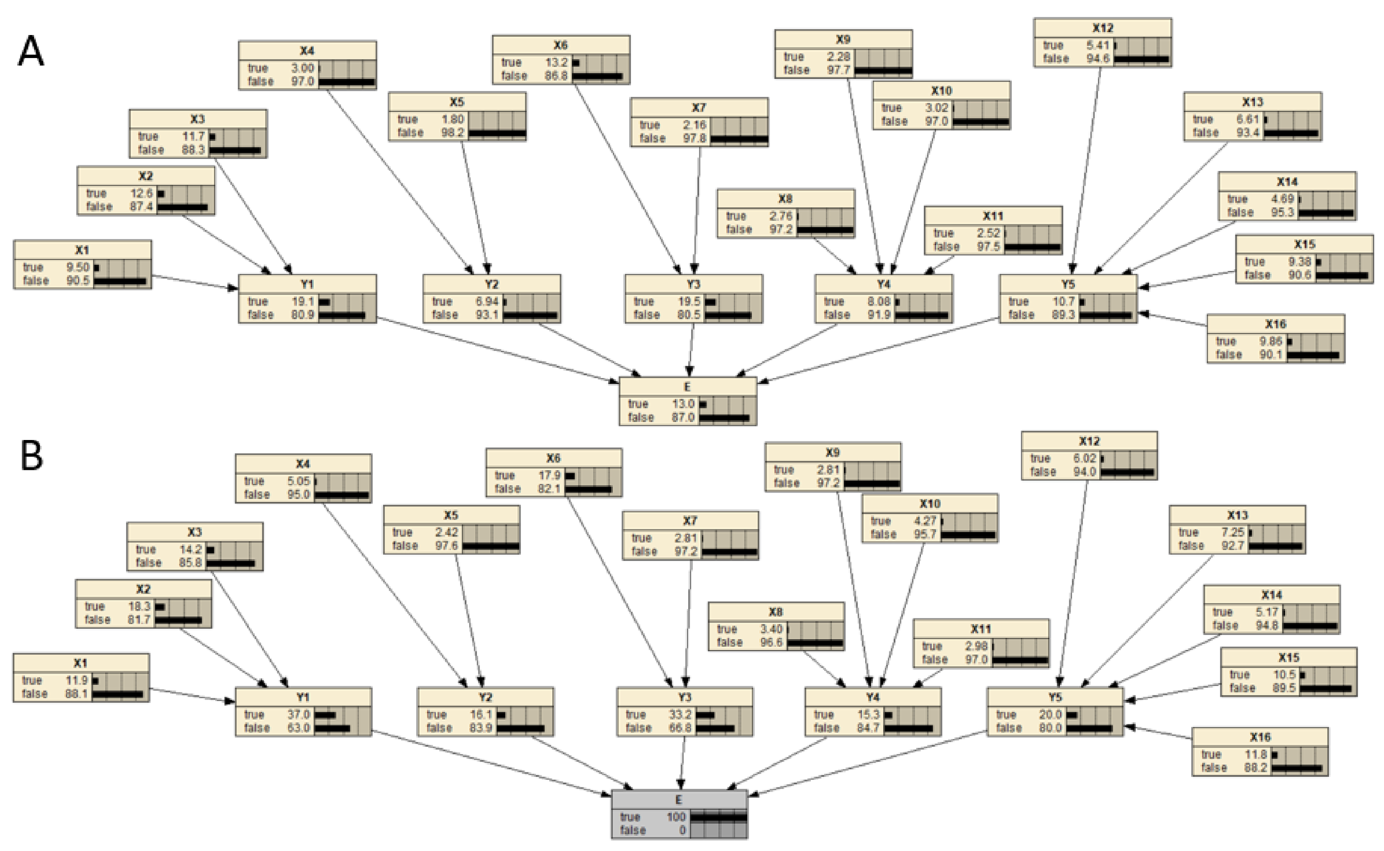

Figure 3. Bayesian network learning and inference using Netica. A) Learning results of Bayesian network B) Posterior probability of each node