IIAI Open Conference Publication Series
IIAI Letters on Informatics and Interdisciplinary Research
Vol. 003, LIIR058
DOI: https://doi.org/10.52731/ liir.v003.058

Product Inspection System on Single Evidence

Natsuda Kasisopha *, Boonchai Charoendouysil *,
Taneth Ruangrajitpakorn †, Thanapol Wisuttikul *,
Panita Meananeatra *

Abstract

Thailand requires the Log management server or known as Log Server to store and manage computer traffic information for 90 days according to Computer-related Crime Act B.E. 2560 [1]. Therefore the log server requires to test according to the law. The Product inspection system has been created and used for Log server testing according to the National Electronics and Computer Technology Center standard (NTS 4003.1-2560). To test the Log Server, need a highly trained and experienced tester to evaluate the log server manually. The burden occurs in finding highly trained and experienced testers. To generate knowledge on the Log server test does take years to build. Furthermore, training a tester to acquire competent skills and knowledge would take even longer time. The test evaluation has been done manually, which takes a great time to complete as the tester has to evaluate the evidence one by one without any helping tools. In addition, the chance of an error from emotional or biased judgment can occur and cause the inconsistency verification result. Thus, to overcome the mentioned burdens, an automated log server inspection, and verification system has been developed. This system is called a "Computer traffic data storage system (SAS Log)" [2], which evaluates the evidence based on the label on the log server machine. The system would diminish the unambiguous and inconsistent verification result with Machine Learning in Image Processing [3] and Ontology technology [4].
Keywords: Log management server testing, Functionality testing, Single evidence product inspection system, NECTEC [5] Standard NTS 4003.1-2560, Log management server testing ontology.

1 Introduction

To the Computer-related Crime Act B.E. 2560 [1], the Log management server or known as Log server stores and manage computer traffic information for 90 days in Thailand. The Log server is required to be tested accordingly. In testing the Log server, require evidence that contains information such as product name, model, serial number, current encounter, and other specifications, which obtain from the pictures, documents, system, or label, etc. This has reference to the Log server testing method by the National Electronics and Computer Technology Center [5] standard (NTS 4003.1-2560). To test the Log Server, need a highly trained and experienced tester to evaluate the log server manually. The burden occurs in finding highly trained and experienced testers. To generate knowledge on the Log server test does take years to build. Furthermore, training a tester to acquire competent skills and knowledge would take even longer time. The test evaluation has been done manually, which

* Software Engineering and Product Testing Section, Technology Support Services Division, National Electronics and Computer Technology Center, Thailand
† Language and Semantic Technology Research Team, Artificial Intelligence Research Group, National Electronics and Computer Technology Center, Thailand

takes a great time to complete as the tester has to evaluate the evidence one by one without any helping tools. In addition, the chance of an error from emotional or biased judgment can occur and cause the inconsistency verification result.

This research objectively overcomes the aforementioned burdens by developing an automated log server inspection, and verification system. This system has called a "Computer traffic data storage system (SAS Log)" [2], which evaluates the evidence based on the label on the log server machine. The system would diminish the unambiguous and inconsistent verification result. The SAS Log system has been implemented based on Machine Learning in image processing [3] and ontology technology [4] for the automated, fast, easier testing log server. Thus, the functionality of the SAS Log is put to the test to see the reliable system according to the quality of the product's label. This research presents an Introduction in section 1, Literature review in section 2, Methodology in section 3, Computer traffic data storage system (SAS Log) in section 4, an Experiment in section 5, the Discussion of results in section 6, and a Conclusion in section 7.

2 Literature Review

Our research conducted the functionality test with classifier evaluation metrics to a product inspection System on single evidence such as a Computer traffic data storage system (SAS Log). This product inspection System is image processing and ontology technology based. The related literature has been reviewed by focusing on the following topics: functional tests, assessment tools, assessment processes, and visual inspection systems.

The Visual Inspection Functionality for Precision Manufactured Parts [6]. This literature targeted the reliability of visual inspection for nuclear weapons parts. The confidence rating of the inspector guides multiple inspections to improve overall performance. The results enhance the current understanding of the process of visual inspection and can be applied to improve functionality for precision manufactured parts. The experiment was conducted with Eighty-two inspectors to inspect one hundred forty parts with eight defects. As the result, the inspectors correctly rejected 85% of defects and incorrectly rejected 35% of acceptable parts. Our research, on the other hand, conducted the functionality test with the accuracy metrics to inspect the precision and recall of the product's single-label evidence.

A formative assessment tool to support Computational Thinking in the classroom [7] takes evidence from students to provide an analysis of some Computational Thinking (CT) dimensions. The CT assesses the evidence with criteria selected by teachers, to provide feedback to students. This tool has a good performance in terms of success rate, average response time, and other metrics. This system has a similar concept by taking the evidence and providing feedback. However, different methodologies and domains.

MobiSWAP [8] system presents an assessment tool based on the use of ontologies and the REST architecture. With MobiSWAP learners can generate and answer questions and tests using mobile devices. This system contained the Mobile Assessment Context (MAC) ontology, the Mobile Assessment Object (MAO) ontology, the Mobile Assessment Learner (MAL) ontology, the Mobile Assessment Portfolio (MAP) ontology, the Mobile Assessment Domain (MAD) ontology, and the Mobile Assessment Scenario (MASc) ontology. These ontologies are used to model context dimensions with mobile environments. Such ontologies include all knowledge that the learner has to acquire in a particular domain and provide the semantic context for the generation of mobile self-assessment tests. This literature is an example of a system using ontology. However, our research has focused on a different domain and engages the decision rules for conformity evaluation.

From the literature reviews, our research, the apply the functionality test is based on image processing and ontology technology, which is distinct from the mentioned pieces of literature [6] [7] [8]. Even though the technology engaged in the literature are similar but the domain, scope, and methodology of the system are different. Our research employs classifier evaluation metrics to calculate precision and recall.

3 Methodology

SAS Log system implemented with image processing and ontology technology. The methodology requires the selection of ontology schema, evidence type, the ontology decision rules. Then the label on the Log server transforms into an image and is processed for text extraction. Sequentially, the conformity evaluation between the extracted text against the decision rules. Thence, the result has a display, and to choose whether to save the result to the database or not.

3.1 Ontology Schema

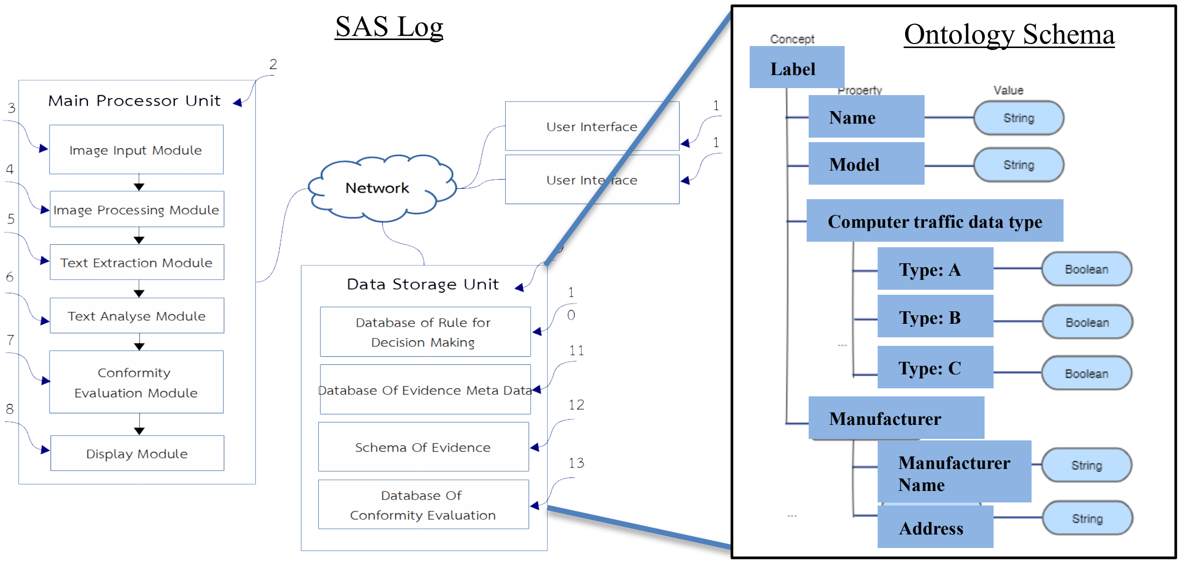


Figure 1: SAS Log architecture diagram and ontology schema

The Introduction of this paper mentioned the National Electronics and Computer Technology Center standard (NTS 4003.1-2560), clause 5 on Marking and Labeling has been used as the test cases. There are nine criteria to verify the products' label as the following: clause 5.1.1 Clear visual and easy to see; clause 5.1.2 Product information which breaks down to clause 5.1.2.1 Model name and clause 5.1.2.2 Name of the company; clause 5.1.3 Types of computer traffic data; clause 5.1.4.1 Processor model; clause 5.1.4.2 Random-access memory (RAM) capacity; clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media. These criteria are used to verify ten test objects on the products' labels. Figure 2 presents the SAS Log architecture diagram and ontology schema.

3.2 Decision Rules

The ontology is to facilitate the user with a fully automatic system. The ontology requires the decision rules to assess the completeness of evidence. By adopting a standard to create a rule in the production rule format, the production rule allows the effect of another rule to be used as a condition part. Chaining can be achieved on multiple levels: rules can allow decision-making from sub-levels on multiple issues before being combined to make the final decision. This rule works with an ontology to obtain rational and factual results, the coverage and potential of the rules, therefore, depend on the quality of the ontology.

The selection of appropriate measures for conformity evaluation decision rules based on label standards emphasizes quantitative values and the presence of values within labels. A decision rule has two main components, the conditions, and the result. The concept value is according to the properties defined in the ontology, such as

(a) Rule of leaf
IF < $Y of $X = $Z> Then < $B of $A = $C>
where $X is a concept in the knowledge base ontology.
$Y is the property of concept $X in the knowledge base ontology.
$Z is the possible value of the property $Y.
$A is the concept in the assessment ontology.
$B is the property of concept $A in the assessment ontology.
$C is the possible value of property $B.

(b) Rules used in conjunction with the rule of intermediate
IF < $B of $A = $C > Then < $B of $A = $C>
$A is the concept in the assessment ontology.
$B is the property of concept $A in the assessment ontology.
$C is the possible value of property $B.

For instance, the tester brings the requirements of the standard to prepare a checklist and prepares the ontology of the standard. Then the two types of decision rules will be able to create as shown in Table 1. Rules 1-8 is type (a), which is used with data values. Additionally, rule 9 is type (b), which is used with values based on evaluation results. From the results section of the 3rd rule -6. The decision rule is the vital function that works with the ontology in the SAS Log system, which defines the quality of product labels.

Table 1: Examples of rules.

No.	Rules	Conditions	Results
1	(a)	IF <‘isClearlyVisible of ‘Label’ = true>	Then <‘5.1.1 Result’ = C>
2	(a)	IF <‘isClearlyVisible of ‘Label’ = false>	Then <‘5.1.1 Result’ = NC>
3	(a)	IF <‘hasModelName’ of ‘Label = not null>	Then <‘5.1.2.1 Result’ = C>
4	(a)	IF <‘hasModelName’ of ‘Label = null>	Then <‘5.1.2.1 Result’ = NC>
5	(a)	IF <‘manufacturedBy’ of ‘Label = not null>	Then <‘5.1.2.2 Result’ = C>
6	(a)	IF <‘manufacturedBy’ of ‘Label = null>	Then <‘5.1.2.2 Result’ = NC>
7	(a)	IF <‘hasCPUModel’ of ‘Label = not null>	Then <‘5.1.4.1 Result’ = C>
8	(a)	IF <‘hasCPUModel’ of ‘Label = null>	Then <‘5.1.4.1 Result’ = NC>
9	(b)	IF <‘5.1.2.1 Result’ = C, ‘5.1.2.2 Result’ = C>	Then <‘5.1.2 Result’ = C>

4 Computer Traffic Data Storage System (SAS Log)

The evidence-based product conformity verification system according to the standard consist of three main units as follows: (1) User interface is the interface between the user and the SAS Log system. The User interface allows the user to upload the label-type image evidence. The (2) Main Processor Unit is for processing evidence-based product conformity checks and saving to the (9) Data Storage Unit. The (2) Central processing unit and (9) Data Storage Unit have contained the sub-modules as demonstrated in Figure 1.

The (2) Central processing unit contains six sub-modules of the (3) Image input module, which receives the label image and transmits it. The (4) Image Processing Machine Learning module converts the image data into a text data form. Then pass those data to the (5) Text Extraction module. This unit finds the value of the text from the evidence with the text pattern (Text Pattern) according to the schema of the evidence. The values will be passed to the (6) Text Analyze module to analyze the context. Thereafter, conformity is assessed in the (7) Conformity Evaluation Module, which takes the values from the database. Thence, substitute the value of the snippet in the decision rule and compare that value to the rule. The results from (7) Conformity Assessment Unit will be displayed by (8) Display module as consistent or inconsistent between the same type of evidence.

The (9) Data storage unit contains four sub-modules as follows (10) Database of Rules for decision-making is the implementation of the production rule method. The (11) Database of Evidence Meta Data stores the value that appears on the evidence and other related data. (12) Schema of Evidence is the data structure of evidence generated by knowledge engineering methods. The (13) Database of Conformity Evaluation stores the consistent result of all evidence.

5 Experimental

The experiment consists of the standards criteria as the test case, the number of test objects, the verification of test object results from the experts (human tester), and the verification of test object results from the automated product inspection system. The ten test objects employ in this experiment are the combination of a good example and a bad example. A good example of the test object would provide all the information as required. The text present on the product label is seen as the font and size are big and readable. A bad example of the test object means the information is not present on the label as required or neither provides irrelevant information. In another word, insufficient information regarding the product provides. Furthermore, the visual text on the product label is poorly seen as the color shade of the font and the background are similar. For instance, yellow background color with white color letters. Additionally, the small font size makes the text hard to see and unreadable.

The verification result operated by the automated product inspection system checks the consistency of the products by an expert. The “Conformance (C)”, “Non-Conformance (NC), and “Not Applicable (N/A)” are present as the verification results. The consistency check of the product by an expert and the automated result is shown in Figure 2. Consequently, the consistency comparison result is shown in Figure 3 with the mathematical equation for calculating the precision, recall, and accuracy. True Positive (TP) is the amount of data that the prediction is correct compared to the answer. False Positive (FP) is the amount of data contained in the solution but not predicted. False Negative (FN) is the amount of incorrect predicted data relative to the solution.

Expert evaluation result

Clauses	General Requirements	Cases									
5	Marking on the label	1	2	3	4	5	6	7	8	9	10
5.1	The system must display a message on the outer shell of the package and on the enclosures of equipment or systems that										
5.1.1	Easy to see and clear	C	C	C	C	C	C	C	C	C	C
5.1.2	Product information	NC	C	C	NC	NC	NC	NC	NC	NC	NC
5.1.2.1	Provide model name	C	C	C	C	C	C	C	NC	NC	C
5.1.2.2	Provide manufacturer name	C	C	C	C	C	C	NC	NC	NC	NC
5.1.3	Provides types of computer traffic data that can be stored.	C	C	C	NC	NC	NC	NC	NC	NC	NC
5.1.4.1	Processor model	NC	C	C	NC	C	C	C	NC	C	C
5.1.4.2	Memory size	NC	C	C	C	C	C	C	NC	NC	C
5.1.5	Provide data storage capacity or the capacity of the hard disk or other desired media	C	C	C	C	C	C	C	NC	NC	NC

Automated evaluation result

Clauses	General Requirements	Cases									
5	Marking on the label	1	2	3	4	5	6	7	8	9	10
5.1	The system must display a message on the outer shell of the package and on the enclosures of equipment or systems that										
5.1.1	Easy to see and clear	C	C	NC	NC	NC	NC	NC	NC	C	C
5.1.2	Product information	C	NC	C	NC	C	C	C	NC	C	C
5.1.2.1	Provide model name	C	C	C	C	C	C	C	C	C	C
5.1.2.2	Provide manufacturer name	C	NC	C	C	C	C	NC	C	C	NC
5.1.3	Provides types of computer traffic data that can be stored.	C	C	C	C	C	NC	C	NC	NC	C
5.1.4.1	Processor model	NC	NC	NC	NC	C	C	C	NC	C	C
5.1.4.2	Memory size	C	NC	C	C	C	C	C	NC	C	C
5.1.5	Provide data storage capacity or the capacity of the hard disk or other desired media	C	C	C	C	C	C	C	NC	C	C

Figure 2: The result of the experts and automated product inspection system.

Clauses	General Requirements	Cases									
5	Marking on the label	1	2	3	4	5	6	7	8	9	10
5.1	The system must display a message on the outer shell of the package and on the enclosures of equipment or systems that										
5.1.1	Easy to see and clear	TP	TP	FP	FP	FP	FP	FP	FP	TP	TP
5.1.2	Product information	TN	FP	TP	FN	TN	TN	TN	FN	TN	TN
5.1.2.1	Provide model name	TP	TP	TP	TP	TP	TP	TP	TN	TN	TP
5.1.2.2	Provide manufacturer name	TP	FP	TP	TP	TP	TP	FN	TN	TN	FN
5.1.3	Provides types of computer traffic data that can be stored.	TP	TP	TP	TN	TN	FN	TN	FN	FN	TN
5.1.4.1	Processor model	FN	FP	FP	FN	TP	TP	TP	FN	TP	TP
5.1.4.2	Memory size	TN	FP	TP	TP	TP	TP	TP	FN	TN	TP
5.1.5	Provide data storage capacity or the capacity of the hard disk or other desired media	TP	TP	TP	TP	TP	TP	TP	FN	TN	TN

System	Expert	Result
C	C	TP
C	NC	FP
NC	C	TN
NC	NC	FN

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

Figure 3: The consistency comparison rules with Precision, Accuracy, and Recall equation.

6 Discussion of Results

Section 3 has explained the procedure to obtain the verification results from the SAS Log system and expert. This section explains the result of ten test objects verified by the system and verified by the expert in detail as presented in Figure 4 and in graph form in Figure 5.

Test object 1 obtained TP = 5, FP = 0, TN = 2, and FN = 1. The TP presents both system and the expert evaluation "C" for five clauses. The clauses that verify conform results are as follows: clause 5.1.1 Clear visual and easy to see, clause 5.1.2.1 Model names, clause 5.1.2.2 Name of the company, clause 5.1.3 Type of computer traffic data, clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media. The FP value reflects the system verifies the product label as "C" and the expert verifies "NC" for zero clauses. The TN value reflects the system verifies the product label as "NC" and the expert verifies

"C" for two clauses. The clauses that verify conform results are as follows: clause 5.1.2 Product information, clause 5.1.4.2 Random-access memory (RAM) capacity. The FN value reflects the system verifies the product label as "NC" and the expert verifies "NC" for one clause of clause 5.1.4.1 Processor model.

Test object 2 obtained TP = 4, FP = 4, TN = 0, and FN = 0. The TP presents the system and the expert evaluation as "C" for four clauses. The clauses that verify conform results are as follows: clause 5.1.1 Clear visual and easy to see, clause 5.1.2.1 Model names, clause 5.1.3 Type of computer traffic data, clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media. The FP value reflects the system verifies the product label as "C" and the expert verifies "NC" for four clauses as follows: clause 5.1.2 Product information, clause 5.1.2.2 Name of the company, clause 5.1.4.1 Processor model, clause 5.1.4.2 Random-access memory (RAM) capacity. The TN value reflects the system verifies the product label as "NC" and the expert verifies "C" for zero clauses. The FN value reflects the system verifies the product label as "NC" and the expert verifies "NC" for zero clauses.

Test object 3 obtained TP = 6, FP = 2, TN = 0, and FN = 0. The TP means both system and the expert evaluation "C" for six clauses. The clauses that verify conform results are as follows: clause 5.1.2 Product information, clause 5.1.2.1 Model name, clause 5.1.2.2 Name of the company, clause 5.1.3 Types of computer traffic data, clause 5.1.4.2 Random-access memory (RAM) capacity, clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media. The FP value reflects the system verifies the product label as "C" and the expert verifies "NC" for two clauses as follows: clause 5.1.1 Clear visual and easy to see, and clause 5.1.4.1 Processor model. The TN value reflects the system verifies the product label as "NC" and the expert verifies "C" for zero clauses. The FN value reflects the system verifies the product label as "NC" and the expert verifies "NC" for zero clauses.

Test object 4 obtained TP = 4, FP = 1, TN = 1, and FN = 2. The TP means both system and the expert evaluation "C" for four clauses. The clauses that verify conform results are as follows: clause 5.1.2.1 Model name, clause 5.1.2.2 Name of the company, clause 5.1.4.2 Random-access memory (RAM) capacity, clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media. The FP value reflects the system verifies the product label as "C" and the expert verifies "NC" for one clause for clause 5.1.1 Clear visual and easy to see. The TN value reflects the system verifies the product label as "NC" and the expert verifies "C" for one clause for clause 5.1.3 Type of computer traffic data. The FN value reflects the system verifies the product label as "NC" and the expert verifies "NC" for two clauses as follows: clause 5.1.2 Production information, clause 5.1.4.1 Processor model.

Test object 5 obtained TP = 5, FP = 1, TN = 2, and FN = 0. The TP means both system and the expert evaluation "C" for five clauses. The clauses that verify conform results are as follows: clause 5.1.2.1 Model name, clause 5.1.2.2 Name of the company, clause 5.1.4.1 Processor model, clause 5.1.4.2 Random-access memory (RAM) capacity, clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media. The FP value reflects the system verifies the product label as "C" and the expert verifies "NC" for one clause for clause 5.1.1 Clear visual and easy to see. The TN value reflects the system verifies the product label as "NC" and the expert verifies "C" for two clauses as follows: clause 5.1.2 Production information, and clause 5.1.3 Type of computer traffic data. The FN value reflects the system verifies the product label as "NC" and the expert verifies "NC" for zero clauses.

Test object 6 obtained TP = 5, FP = 1, TN = 1, and FN = 1. The TP means both system and the expert evaluation "C" for five clauses. The clauses that verify conform results are as follows: clause 5.1.2.1 Model name, clause 5.1.2.2 Name of the company, clause 5.1.4.1 Processor model, clause 5.1.4.2 Random-access memory (RAM) capacity, clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media. The FP value reflects the system verifies the product label as "C" and the expert verifies "NC" for one clause for clause 5.1.1 Clear visual and easy to see. The TN value reflects the system verifies the product label as "NC" and the expert verifies "C" for one clause as follows: clause 5.1.2 Production information. The FN value reflects the system verifies the product label as "NC" and the expert verifies "NC" for one clause on clause 5.1.3 Type of computer traffic data.

Test object 7 obtained TP = 4, FP = 1, TN = 2, and FN = 1. The TP means both system and the expert evaluation "C" for four clauses. The clauses that verify conform results are as follows: clause 5.1.2.1 Model name, clause 5.1.4.1 Processor model, clause 5.1.4.2 Random-access memory (RAM) capacity, clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media. The FP value reflects the system verifies the product label as "C" and the expert verifies "NC" for one clause for clause 5.1.1 Clear visual and easy to see. The TN value reflects the system verifies the product label as "NC" and the expert verifies "C" for two clauses as follows: clause 5.1.2 Production information, and clause 5.1.3 Type of computer traffic data. The FN value reflects the system verifies the product label as "NC" and the expert verifies "NC" for one clause on clause 5.1.2.2 Name of the company.

Test object 8 obtained TP = 0, FP = 1, TN = 2, and FN = 5. The TP means both system and the expert evaluation "C" for zero clauses. The FP value reflects the system verifies the product label as "C" and the expert verifies "NC" for one clause for clause 5.1.1 Clear visual and easy to see. The TN value reflects the system verifies the product label as "NC" and the expert verifies "C" for two clauses in clause 5.1.2.1 Model name and clause 5.1.2.2 Name of the company. The FN value reflects the system verifies the product label as "NC" and the expert verifies "NC" for five clauses in clause 5.1.2 Production information, clause 5.1.3 Type of computer traffic data, clause 5.1.4.1 Processor model, clause 5.1.4.2 Random-access memory (RAM) capacity, clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media.

Test object 9 obtained TP = 2, FP = 0, TN = 5, and FN = 1. The TP means both system and the expert evaluation "C" for two clauses in clause 5.1.1 Clear visual and easy to see, and clause 5.1.4.1 Processor model. The FP value reflects the system verifies the product label as "C" and the expert verifies "NC" for zero clauses. The TN value reflects the system verifies the product label as "NC" and the expert verifies "C" for five clauses in clause 5.1.2 Production information, clause 5.1.2.1 Model name, clause 5.1.2.2 Name of the company, clause 5.1.4.2 Random-access memory (RAM) capacity, clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media. The FN value reflects the system verifies the product label as "NC" and the expert verifies "NC" for one clause in clause 5.1.3 Type of computer traffic data.

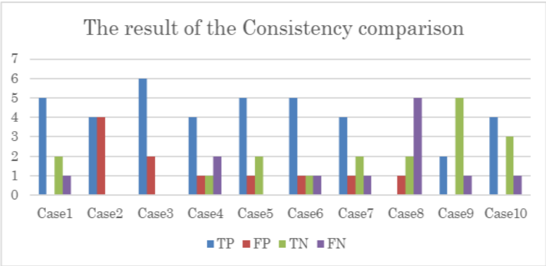
Test object 10 obtained TP = 4, FP = 0, TN = 3, and FN = 1. The TP means both system and the expert evaluation “C” for four clauses in clause 5.1.1 Clear visual and easy to see, clause 5.1.2.1 Model name, clause 5.1.4.1 Processor model, and clause 5.1.4.2 Random-access memory (RAM) capacity. The FP value reflects the system verifies the product label as “C” and the expert verifies “NC” for zero clauses. The TN value reflects the system verifies the product label as “NC” and the expert verifies “C” for three clauses in clause 5.1.2 Production information, clause 5.1.3 Type of computer traffic data, and clause 5.1.5 Provide data storage capacity or the capacity of the hard disk or other desired media. The FN value reflects the system verifies the product label as “NC” and the expert verifies “NC” for one clause in clause 5.1.2.2 Name of the company.

Precision, recall, and accuracy is calculated to see the functionality of the system. The calculation for test object 1 of Precision = 1, Recall = 0.83, and Accuracy = 0.88. The calculation for test object 2 of Precision = 0.5, Recall = 1, and Accuracy = 0.5. The calculation for test object 3 of Precision = 0.5, Recall = 1, and Accuracy = 0.5. The calculation for test object 4 of Precision = 0.8, Recall = 0.67, and Accuracy = 0.63. The calculation for test object 5 of Precision = 0.83, Recall = 1, and Accuracy = 0.88. The calculation for test object 6 of Precision = 0.83, Recall = 0.83, and Accuracy = 0.75. The calculation for test object 7 of Precision = 0.8, Recall = 0.8, and Accuracy = 0.75. The calculation for test object 8 of Precision = 0.0, Recall = 0.0., and Accuracy = 0.25. The calculation for test object 9 of Precision = 1, Recall = 0.67, and Accuracy = 0.88. The calculation for test object 10 of Precision = 1, Recall = 0.80, and Accuracy = 0.88. The value of “1” refers to 100 percent, the value of “0” refers to 0 percent, and the value of “0.83” refers to 83 percent.

The highest value of 100 percent in precision is the test object 1, test object 9, and test object 10. The highest value of 100 percent in the recall is test object 2, and test object 3. The highest value of 88 percent in accuracy is test object 1, test object 5, test object 9, and test object 10. The average Precision is 75 percent, the average Recall is 76 percent, and the average accuracy is 71 percent. The average number has proved that the system is reliable and works accordingly.

	Case1	Case2	Case3	Case4	Case5	Case6	Case7	Case8	Case9	Case10	Avg
TP	5	4	6	4	5	5	4	0	2	4	3.9
FP	0	4	2	1	1	1	1	1	0	0	1.1
TN	2	0	0	1	2	1	2	2	5	3	1.8
FN	1	0	0	2	0	1	1	5	1	1	1.2
Total	8	8	8	8	8	8	8	8	8	8	8
Precision	1	0.5	0.75	0.8	0.83	0.83	0.8	0	1	1	0.75
Recall	0.83	1.00	1.00	0.67	1.00	0.83	0.80	0.00	0.67	0.80	0.76
Accuracy	0.88	0.50	0.75	0.63	0.88	0.75	0.75	0.25	0.88	0.88	0.71

Figure 4: Precision and Recall calculation results.



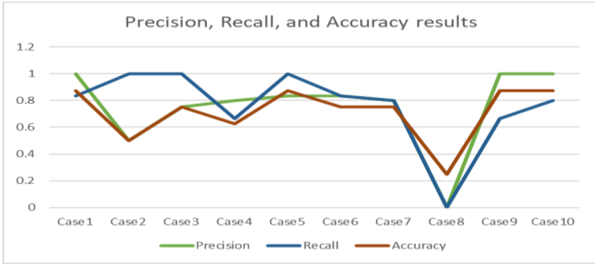


Figure 5: The graph of consistency comparison results and Precision, Recall, and Accuracy results.

7 Conclusion

The Functionality test could be applied to a variety of areas such as the inspection of defective nuclear weapon parts or the Log management server inspection system. The system requires verifying the test object according to the standard criteria. The standard criteria are the test case that is executed. The test result of the Product Inspection system of the Computer traffic data storage system (SAS Log) [2] is compared with the expert verification evaluation. Thence, the results convert to mathematical mean to calculate the statistical Precision and Recall. Overall, the average Precision is 75 percent, the average Recall is 76 percent, and the average accuracy is 71 percent. The average number has proved that the system is reliable and works accordingly.

The future work, the research's test case will be increased according to the number of customers who consent to use their data. In addition, the IoT device testing system functionality test will be explored.

References

[1] "Ministry of Digital Economy and Society, Thailand." https://www.mdes.go.th/law/detail/3618-COMPUTER-RELATED-CRIME-ACT-B-E--2550--2007-

[2] "SAS-LOG."

[3] O. Lézoray, C. Charrier, H. Cardot, and S. Lefèvre, *Machine learning in image processing*. Springer, 2008.

[4] N. Guarino, D. Oberle, and S. Staab, "What Is an Ontology?," 2009, pp. 1-17.

[5] "Home - NECTEC : National Electronics and Computer Technology Center," ed, 2007.

[6] J. E. See, "Visual Inspection Reliability for Precision Manufactured Parts," (in en), *Human Factors,* vol. 57, no. 8, pp. 1427-1442, 2015-12-01 2015, doi: 10.1177/0018720815602389.

[7] L. Orozco-Garcia, C. Gonzalez, J. Montano, C. Mondragon, and H. Tobar-Munoz, "A Formative Assessment Tool to Support Computational Thinking in the Classroom," in *2019 International Conference on Virtual Reality and Visualization (ICVRV)*, 18-19 Nov. 2019 2019, pp. 185-188, doi: 10.1109/ICVRV47840.2019.00043.

[8] A. Harchay, L. Cheniti-Belcadhi, and R. Braham, "MobiSWAP: Personalized Mobile Assessment Tool Based on Semantic Web and Web Services," in *2017 IEEE/ACS 14th International Conference on Computer Systems and Applications (AICCSA)*, 30 Oct.-3 Nov. 2017 2017, pp. 1406-1413, doi: 10.1109/AICCSA.2017.143.