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An Expert System Based on Belief Rule to Assess Bank Surveillance Security

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***Abstract*— Surveillance is the monitoring of the behavior, activities or other changing information whereas security means the state of being protected from harmful activities. Nowadays proper surveillance security is considered as a challenging issue in the world and security has become a major concern from real life to virtual life. Tech-giants are implementing new solutions & techniques for better security assessment. This paper illustrates the design and implementation of a Belief Rule Based Expert System (BRBES) to overcome the uncertainty problems during bank security assessment. The proposed expert system has been developed based on generic Belief Rule Based (BRB) inference methodology using Evidential Reasoning algorithm (RIMER). Real-time security data has been taken from several banks of Bangladesh in conjunction with the expert's opinion to construct the knowledge base. This expert system provides more reliable and effective result under uncertainties which is better than any other traditional expert's prediction. Real life case studies were used for the validation of this system. Also, the outcome is compared with the real-life security system. Furthermore, the architectural design, implementation and utilization of an expert system to assess bank security under uncertainty are also discussed in this paper.**

Keywords—— surveillance security; belief rule base; RIMER approach; banking security; security assessment

I. INTRODUCTION

In recent days, we have seen several bank plunders like ATM skimming, card skimming, jackpotting malware attacks, shimming etc. These are all hints of week security system. To overcome this risk, a close video monitoring system is being used to detect typical unusual behaviors in ATM booth, such as fraud and robbery [1], [2]. To handle threats on online banking an independent solution based on Keystroke Dynamics methodology has been discussed on these paper [3], [4].

In July 2018, IBM Security and Ponemon Institute jointly released the result of global data breach study that found $3.86 million global average cost for data breach which is increased 6.4 percent from 2017 report [5]. The study also measured $40 million and $350 million estimated total cost respectively for one million to fifty million compromised records. According to Sputnik news in recent SWIFT-based cyber-heist, a Russian Bank and Bangladesh Bank lost $6 million and $81 million respectively [6]. Hackers have stolen around 90,000 customer's data from two major Canadian Bank, Reuters reported [7]. Bank security is the measurement of taking security step to secure the bank. We can see that in the recent time bank robbery and ATM hacking is cause due to weak security measurement. Security of the bank services can be assessed using some prevalent systems such as server security, vault room security, ATM security, shimmer security etc. Howbeit, these systems are not capable to provide 100% security as they are not designed to handle variant uncertainty issues. To stave off all types of fraudulent activities, we need to use some foolproof security solution which can be integrated with modern technologies. Using biometric technology, iris scanning, voice recognition, palm scanning, fingerprints, pressure detection, blockchain technology etc. can help to generate an extreme security level for the bank to reduce online & mobile banking transaction frauds and ATM skimming [8-12].

In this paper, we presented an expert system based on belief rule (BRBES) which is developed and designed by using RIMER approach to handle various types of uncertainty [13-17]. This system is capable to provide better assessment result as it can gather information under uncertainty. The leftover of this paper is formed as follows. In section II, RIMER Methodology is discussed. In section III, the BRBES for assessing bank surveillance is explained with its architecture and framework and also simulation result is given in this section. And then in section IV, the discussion is going on analyzing the result and comparison with real-life security system. And the last section which is section V, the conclusion is drawn.

II. METHODOLOGY

A. Domain knowledge representational using BRB

The value of the attribute contains a reference to the precedent of the BRB precedent. For example, the behavior of the referential value of the surveillance activity is a continuation of information, security behavior or other changes. The antecedent attribute as shown in equation (1).

IF
(bank Surveillance is Low) and (ATM security is middle) and (online transaction is high)

THEN
Bank Surveillance Assessment =
{(High(0.5)),(Middle(0.3)), (Low (0.2))} (1)

Hence, the entire degree of belief = (0.5+0.3+0.2) =1.

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B. *Inference Engine of BRB Expert System*

The Inference engine may deduce conclusions or solutions based on the user-supplied facts that stored on knowledge-base. It behaves as a scheduler or an interpreter that detects the cross-correlation between rules and facts. The procedure of BRBES contains three basic elements like input processing, determining rule activation weight, mechanism for rule update which are followed by aggregation rules based on Evidential Reasoning.

At first, we need to find out the input value of i^{th} antecedent of a rule and it is represented by equation (2).

$$H(\pi_{\iota},\equiv_{\varphi}) =\{(A_{\iota\varphi},\langle_{\iota\varphi}),\ldots=1,..,\ldots\iota\}, \geq =1,..,T_{\kappa} \quad (2)$$

Where,

H= The assessment for assigning the input value of the i^{th} antecedent attribute.

In our work, the primary value for antecedent attribute collects from the bank security expert. For calculation of ω_k the equation (3) is illustrated below.

$$\omega_{k} = \frac{\theta_{k}\alpha_{k}}{\sum_{j=1}^{I}\theta_{j}\alpha_{j}} \frac{\theta_{k}\prod_{i=1}^{L^{k}}(\alpha_{i}^{k})\overline{\delta_{k}}}{\sum_{j=1}^{I}\theta_{j}[\prod_{i=1}^{T^{\kappa}}(\alpha_{i}^{j})\delta_{jl}]}$$

and

$$\overline{\delta_{ki}} = \frac{\delta_{ki}}{ma\, x_{i}=r,\ldots,\, r_{k}\{\delta_{ki}\}} \quad (3)$$

To calculate β_i which indicates the belief degree associated with one of the consequent reference values is carried out by equation (4).

$$\beta_{j} = \frac{\mu\times\left[\prod_{k=1}^{L}\left(\left(\omega_{k}\beta_{jk}+1-\omega_{k}\sum_{j=1}^{N}\beta_{jk}\right)\right)-\prod_{k=1}^{L}\left(1-\omega_{k}\sum_{j=1}^{N}\beta_{jk}\right)\right]}{1-\mu\times\left[\prod_{k=1}^{L}1-\omega_{k}\right]} \quad (4)$$

Where μ is calculated by,

$$\mu=[\sum_{j=1}^{N}\prod_{k=1}^{i}(\omega_{k}\beta_{jk}+1-\omega_{k}\sum_{j=1}^{N}\beta_{jk})-(N-1)\times\prod_{k=1}^{\alpha}(1-\omega_{k}\sum_{j=1}^{N}\beta_{jk})] \quad (5)$$

The final combination of result or output generated by ER is represented by equation (6).

$$\{(c_{1},\beta_{1}),(c_{2},\beta_{1}),(c_{3},\beta_{1}),\ldots(c_{N},\beta_{N})\} \quad (6)$$

This output can be converted into equity / digital assigning memos to individual referential value of the consequent attribute. [16]

$$H(A^{*})\sum_{j=1}^{N}\mu(c_{j})\beta_{j} \quad (7)$$

III. BRBES FOR ASSESSING BANK SURVEILLANCE

A. *System design and implementation of the BRB Expert System*

Imagine how the components of the system architecture, Inputs, consisting of processes, and outputs are arranged. It is considered in the organizational model of the system, known as architectural styles. BRBES consists of three layers' architectural style, as shown in figure 2, and the figure 1, shown the factors considered for this architecture.

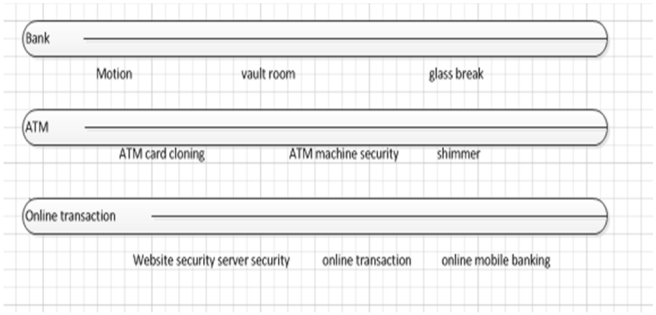

Fig. 1. Factors to assess bank surveillance security

Architecture Layer:

I) Interface Layer: Web-based user interface has been designed using various web-technologies such as HTML5, CSS3, JavaScript, jQuery.

II) Application Layer: PHP language along with Zend engine has been used to facilitate user interface and database.

III) Data Management Layer: To store and handle data, MySQL RDBMS is used in the back-end which is flexible and easy to use. It also ensures smooth performance and faster secured data access.

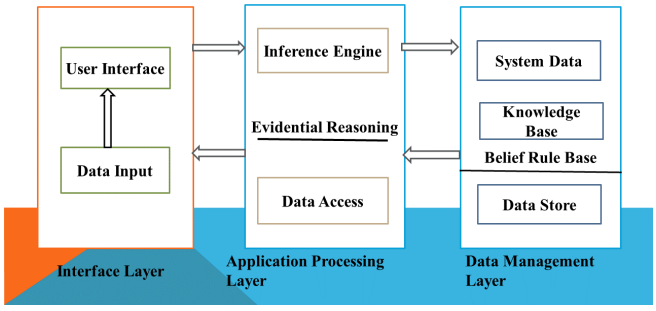

Fig. 2. BRB Expert System architecture

B. *Knowledge-based construction for BRBES framework*

Knowledge base creation is an important part of security Assessment. In order to construct the knowledge base for the BRBES need to involve of BRB Tree and BRB Rule. The BRB framework of Security assessment is shown in figure 3, which has been developed by taking account of the bank surveillance security system factors.

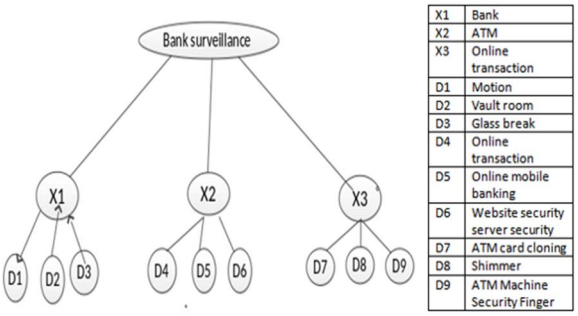

Fig. 3. BRB Expert System framework

In the framework of BRB system, the center nodes represent the bank surveillance security system factors such as security system motion, vault room, website security, server security, shimmer and measured security. The whole framework is like a tree and each node of that tree dependent on other nodes of the tree. For example, security of bank surveillance factor relies on three elements such as "bank security", "ATM" and "online transaction". Following the procedure, a multilevel and nonlinear framework has been developed to assess bank security.

The BRB contains fifteen sub-rule bases. The bank surveillance security assessment sub-rule base includes eleven attributes, each with separate referential values. Equation 8 is used to calculate the sum of rules exist in this sub-rule base.

$$L = \prod_{i=1}^{T} j_i \tag{8}$$

Where, J_i indicates the number of referential values of an attribute while L signifies the number of rules.

C. Initial Rule Base

Initial rule base creation is one of the most important parts of the work. This part is very important because the expert system uses this initial rule base as the knowledge base from which it can draw an output. Table I. shows the data for initial rule base for banking security.

TABLE I. INITIAL RULE BASE

Serial	Bank	ATM	Online transaction	Ref. value High	Ref. value Medium	Ref. value Low
01	High	High	High	1.0	0.0	0.0
02	Low	High	Medium	0.6	0.4	0.0
03	Medium	High	Low	0.7	0.3	0.0
04	Low	Medium	High	0.6	0.4	0.0
05	Low	Medium	Medium	0.5	0.5	0.0
06	High	Medium	Low	0.0	0.8	0.2
07	Medium	Low	High	0.3	0.0	0.7
08	High	Low	Medium	0.8	0.0	0.2
09	Low	Low	Low	0.0	0.0	1.0

D. Collection of information for the System

For the proposed expert system, our data have been collected more than ten Bank of Bangladesh illustrate in Table II. The experts and IT Officer of the bank predict the severity of in a bank by several factors. Mostly related to their reaction to certain situations as to determine their expression and difficulties and activity towards a task to test their motor, sensory and intelligence.

TABLE II. COLLECTION FROM BANK

Bank ID	Bank Name	Branch
01	Sonali Bank Limited	Bangabandhu Avenue Corporate Branch
02	Islami Bank Bangladesh LTD	Agrabad
03	AL Arafah Islami Bank LTD	Agrabad C/A
04	Social Islami Bank Bangladesh LTD	Agrabad C/A
05	Shahjala Islami Bank LTD	Agrabad
06	First Security Islami Bank LTD	Agrabad C/A
07	Dutch Bangla Bank LTD	Agrabad
08	Exim bank LTD	Agrabad C/A
09	Eastern Bank LTD	Agrabad
10	Standard Bank LTD	Agrabad
11	AB Bank LTD	Agrabad

A system interface can be defined as the interaction between the users and the system which is illustrated by figure 4. All of the data used for security assessment are collected from various Bank, shown in Table II.

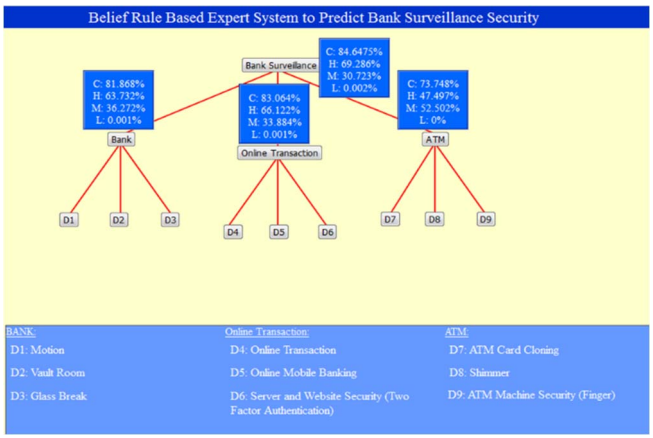

Fig. 4. System interface of BRB Banking Expert System

TABLE III. APPRAISEMENT BY BRBES AND EXPERT

Serial No	Bank			Online Transactions			ATM			BRBES Output	Expert Prediction
	Motion	*Vault Room*	*Glass Break*	*Online transaction*	*Online Mobile Banking*	*Website &Server Security*	*ATM Card Cloning*	*Shimmer*	*ATM Machine Security*		
01	Middle	Low	Low	Low	Middle	Low	Low	Middle	Low	45.023%	45%
02	Middle	Low	Middle	Middle	Low	Middle	Low	Low	Middle	51.347%	51%
03	High	Middle	Low	High	Middle	Middle	High	Middle	Low	58.032%	58%
04	High	Middle	High	Low	Middle	High	Middle	Middle	High	67.276%	67%
05	High	High	High	Middle	High	High	High	Middle	High	84.6475%	84%

IV. EXPERIMENTAL EVALUATION

The system which is proposed here is very flexible. The feedback of the factors is verified by a security expert at Islamic bank, Agrabad branch Chittagong. Because of the flexibility of security Assessment System and the capability of handling any sorts of uncertainty, this system gives an efficient result comparing with expert's prediction and other existing systems. Table III. shows the appraisement of bank surveillance security of the bank, produce by the BRBES and the counsel given by the adept by taking the calculation of the eleven bank surveillance security factors. For simplicity, Table III. shows the data of ten banks. These bank practice ISO-27001 and PCI-DSS standard for information and transaction security.

In this research, the goal of the security assessment based on the expert system is to create an efficient way to solve the problems of the assessment of security and achieve the goal of reducing tiresome issues during security assessment under uncertainty. With these advantages user-friendly interface, simple maintenance, fast evaluation time, less error rate facilities are also achieved. This system will contribute in banking system to assess security with more precision.

V. CONCLUSION

Belief rule-based banking expert system is introduced in this paper which has the capability to handle various types of security portion subsisted in the bank surveillance. We are hopeful to add more real data to the system for better security assessment in our future work. The referential value may be increased for better performance and validation of the BRB system. Moreover, the optimal learning model and the training module will be developed in the future.

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