A KNOWLEDGE BASED SYSTEM FOR 220 kV NETWORK OF NORTHERN EGYPT POWER SYSTEM RECONFIGURATION

استخدام نظام المعرفة لإعادة بناء شبكة ٢٢٠ ك.ف. في مصر الشمالية

BY

E.E. Abd Raboh **A.M.M. Aly**

Mansoura University, Faculty of Engineering, Electrical Power and Machines Dept., EL-Mansoura, Egypt.

الخلاصة:

تمثل مسألة الحفاظ على أمان الشبكات الكهربائية في مواجهة الأحداث الطارئة أهمية عظمى في مجال تشغيل الأنظمة الكهربائية، لذلك فمن الضروري أن يتوفر لدى مراكز التحكم برنامج تعطي الحلول السريعة للتغلب على تأثير التحميل الزائد. وحديثاً اتجهت الأبحاث صوب الطرق التي تخلص الشبكة من التحميل الزائد عن طريق إعادة تغيير سريان القدرة بتغيير شكل الشبكة وقد استخدمت الطرق الرياضية في ذلك أولاً. إلا أنه في الآونة الأخيرة قد تردد في الساحات العلمية ما يعرف باستخدام عنصر الذكاء الاصطناعي والاستفادة من الخبرة البشرية في إنشاء قاعدة معرفة لاستعمالها فيما بعد في نظام يمكن به حل مشاكل التحميل الزائد. وبالتالي تجنب الكثير من العقبات التي تنجم عن استخدام الطرق الرياضية، ولما كانت للطرق الرياضية بعض المزايا مثل عنصر السرعة في إيجاد الحلول فإنه في هذا البحث أمكن الجمع بينها وبين القواعد المستفادة من الذكاء الاصطناعي لعمل برنامج يفي بتلك المتطلبات مثل الحفاظ على اقتصاديات التشغيل واخذ القيود المختلفة في الاعتبار وكذلك عنصر السرعة في إيجاد الحلول.

وتم إعداد برنامج على الحاسب لاختيار الطريقة الملائمة وإعطائها لمشغل الشبكة لتنفذها وقد طبق هذا على شبكة الدلتا جهد ٢٢٠ ك.ف. وأكدت مصداقية وكفاءة هذه الطريقة.

Abstract:

This paper presents an approach to remove the overloads on a transmission network (E.T.N). This approach tries the algorithmic approaches the heuristic techniques for building a knowledge based system. The expression of the E.T.N. constrains taken into account in this technique. The technique implemented on the 220 kV network of Northern Egypt Power System.

The obtained results show that the efficiency and validity of such approach ean be implement in the context of real time advanced applieutions in an Energy Management System.

Key-Word:

Overloads alleviation. Knowledge base system 220 kV network of Northern Egypt.

INTRODUCTION:

No one ean deny that the security of the power system is one of the important objectives. so many researchers are continually offered to study this problem. The problem becomes more difficult in case of occur of an unexpected event. such an outage of transmission line or generator. Particularly. if an overload appear on a transmission line, a corrective action must be quickly taken.

In the past, the eorreetive action was calculated using a linear programming solution and results in a shift in generation [1,2]. Such shifts are generally in the confliet with the carefully considered economic dispatch of the generation. The

Accepted July 27, 1999

researchers have gone along another type of the corrective actions, that is a modification of the network topology through either line switching or busbar splitting. These actions do not affect neither the loads nor the cost of operation.

Reference [3] proposed an algorithm for automatic selection and ranking the possible lines to be switched to relieve line overload. The approach used the linear sensitivity factors, which are calculated from relevant elements of the spars bus impedance matrix.

Reference [4,5] proposed a method to find the line to he switched using the z matrix representation. if a line between buses P, Q is overload in the base case, then to check the effect of switching the line between buses R, S the quantity:

$$(Z_{PR}-Z_{QR}) \cdot (Z'_{PR}-Z'_{QR})$$

is computed. if it is positive, then the overload will be reduced by switching the line R-S where Z_{PR}-Z_{QR} are the Z matrix elements of the base case while Z'_{PR}-Z'_{QR} are the matrix elements after switching the line R-S.

Referenee [6-9] proposed an approach to find the corrective topology using the coneept of eurrent injection between the line to he switched, such current injection is distributed among the other lines of the network. The distribution of this current injection depends on the matrix of node branch distribution factors, derived from the Z matrix of the base case and the branch currents in the overload case.

Reference [10] offered a fast algorithm to alleviate transmission lines overloads by changing the network topology. The algorithm used the concept of line outage distribution factors, derived from the network admittance to solve the problem by either line switching or busbar splitting.

Nowadays, another way is used to find the corrective network topology, that is the "knowledge based system". The AMPERE system [11,12], which was started at the end of 1987 and was presented at Stockholm in 1988, is an example for this work. AMPERE system is designed on the basis of heuristic teehniques and uses multiple seareh strategies and control strategies to find network reconfigurations for removing one or several overloads on the transmission lines.

The goal of this paper is to use the algorithm proposed in [10] which uses the advantages of the heuristic techniques stated in [11] to find an approach which can achieve the hest results in the field of removing overloads.

Problem Formulation:

Although algorithms are able to provide and answer the question of how to modify the network topology to remove the overloads, they are generally limited in seleeting the hest corrective action.

Recently, the researchers tend to use the heuristic knowledge obtained from the dispatcher's experience in this aspect. The problem will be solved with the best results, if the algorithms are coupled to the heuristic techniques to benefit from the advantages of both

Methodology.

The research described in this paper deals only with the MW overloading of transmission lines. The process of relieving such overloads begins with developing a tool to reduce the power flow on an overloaded line by a switching action. The line outage distribution factors (DF) are used to express the flow modification on line L due to the outage of line K as follows:

$$P_L = P_L^0 - D(L,K) \times P_K \qquad (1)$$

Where:

P_L : flow on line L after the outage of line K.
P^o_L : Initial flow on line L.
$D_F(L.K)$: line outage distribution factor.
P^o_K : Initial flow on line K.

The line outage distribution factors are computed [10] from the network topology after inverting the admittance matrix as follows:-

$$D_F(L.K) = \frac{X_k(X_{in} - X_{jn}\ X_{im}\ X_{jm})}{X_l[X_k\ (X_{nm} + X_{mm}\ 2X_{mm})]} \qquad (2)$$

Where:

$D_F(L.K)$: Line outage distribution factors giving the change in flow on line L when line K is outaged.
X_k : The individual line reactances for lines K, L respectively.
n, m : Sending and receiving buses for line K.
i, j : Sending and receiving buses for line L.

Procedure:

The above-developed methodology is implemented as depicted in the bloek diagram (Fig. 1) as follows:

- The network topology and system state (generation and loads at different buses) are read by the program.
- Build the network admittance matrix and invert it to obtain the Z matrix.
- Compate line outage distribution factors by equation (2) and store them for further analysis.
- Compute base case load flow and check whether there is any overloads in the base case or not. If overloads do exist, take necessary action to relieve such overloads, otherwise start to implement the outage list to eheck their effeet and necessary corrective action to be taken.
- The corrective action adnpted in the current work are divided into:

Line Switching Action:

If the flow on line L exceeds the max limit P_L^{max}

$$P_L > P_L^{max} \qquad (3)$$

Then, the elements on the row of such line in the line outage distribation matrix are the candidates to be screened one at a time as shown in [10] until the overload is removed. Then using equation (1), the new flow on line L is computed. This flow is eompuled with the maximum limit using equation (3).

If the flow is within limit, the effect of the removal of the K^{th} line on the loading of the remaining line is checked. If no overloads are detected on the remaining lines, then the removal of the K^{th} line would be the corrective action necessary in this case.

If none of the candidates screened led to the removal of the overloads without causing new overloads, then the candidate circuits that led to the reduction of the overloads to the permissible levels shall be considered using the following criteria:

$$B_L = |\,P''_L\,| - P_L^{max} \qquad (4)$$

$$B_V = |\,P''_V\,| - P_V^{max} \qquad (5)$$

Where:

B_L: The value of the old overload on line L was removed by switching line K.
B_V: The value of the new overload on line V was removed by switching line K.
P''_V: Flow on line V after the outage of line K.
Then, the candidate circuits which make $B_V > B_L$ are rejected

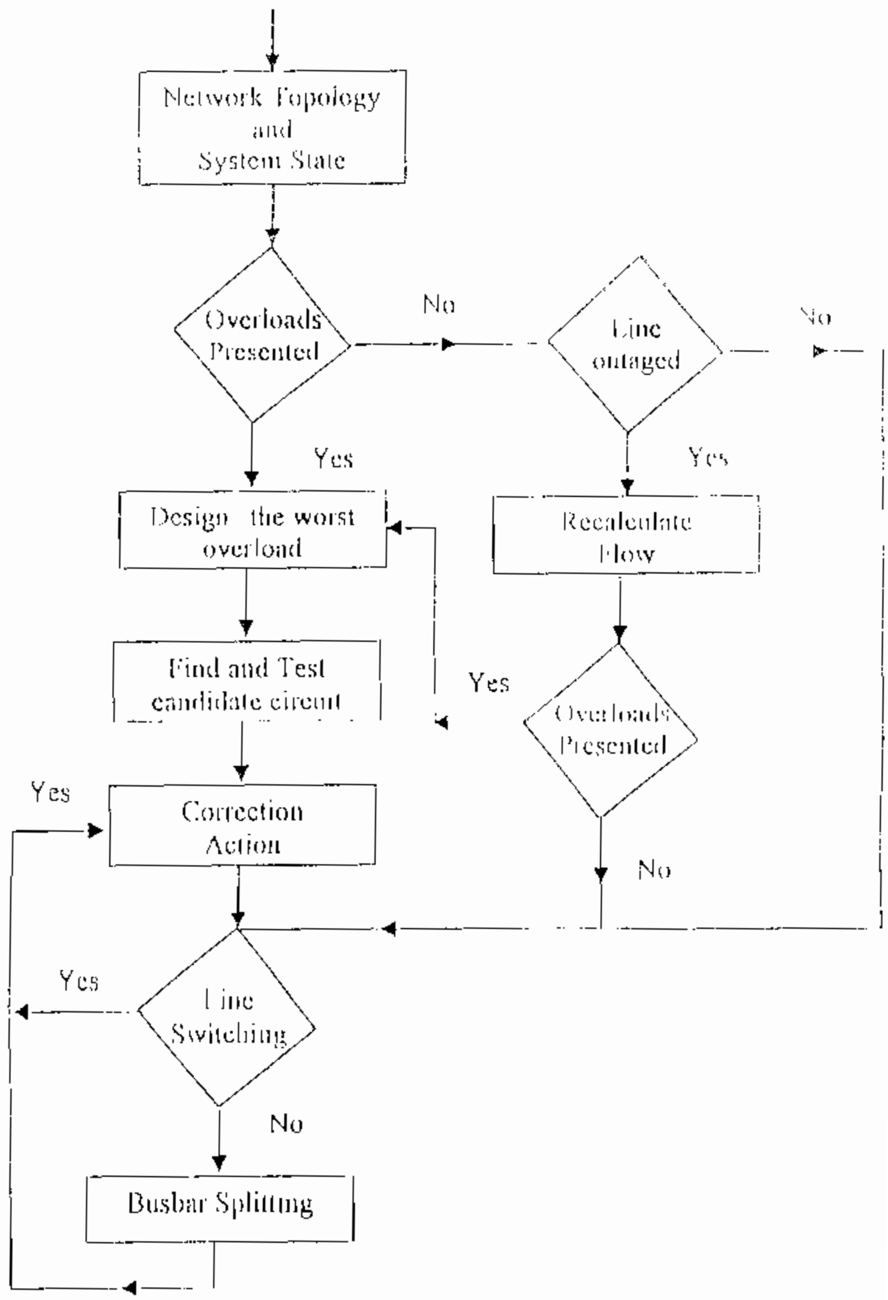

Fig (1) Block Diagram of 220 kV network Northern Egypt switching program.

Line Switching Action:

The switching algorithm is easily extended to the case where a breaker operation splits a bus. To do this, each breaker which is to be a candidate for corrective switching is represented as a zero impedance circuit made up of two circuits in series having equal but opposite reactances. The resulting network has one additional node and two additional circuits for each breaker. The previously described algorithm will treat the two circuits forming the zero impedance link in the same way as other circuits in the network. Therefore, select either circuits representing the breaker itself as a corrective switching action. A special note needs to be made concerning the use of a series combination [10]. The building of the reactance matrix of the network may feces troubles in the factorization routines unless one guarantees that no pivot occurs on this bus until after one fillin term has been made at the diagonal term.

Overview of the Search Process:

Fig. (2) gives the contingency list, the resulting overload line list, and the corresponding corrective action list, this figure is formed as follows:

1- The network lines are outaged one at a time. if overloads are detected, then the algorithm in [10] will find a list of corrective actions. If a candidate is chosen to remove the overloads, this candidate is passed into several rules:
   a. Satisfaction of all general specific constraints.
   b. Comparison between forecasted transit patterns in a given reconfiguration and the patterns required by the network.
   e. Cheek of network convexity.
   d. Satisfaction of all or some of the following rules gained from the operator's experienee.

A reconfiguration has a stronger effect locally than on distant point of the network.

- The direction of power flow around a particular line can be used to select parts of the network interesting to alleviate the overload on that time.
- The load on a line can be alleviated by the reduction of the impedanee of the rest of the network.

2. Repeat this procedure over all the lines of the network and write down the results in a figure such as Fig. (2).
3. Onee Fig. (2) is formed, then the information in this figure gives the solutions directly for future use by the system operators.

Test Results:

An application on the 220 kV network of the Northern Egypt Power System is carried out. The tested system consists of 42 buses and 54 lines. Fig. (3) shows a single line diagram of the tested system. The system data are shown in Tahle (1) and the base case data are shown in Table (2).

In this application, as an example:

- Due to the outage of line "3", line No. 10 is overloaded and the corrective action produced in splitting at bus 12.
- Also, if the line No. "17" is outaged, lines 18, 22 will be overloaded and then for relieving the overloads, the line No. 37 must be opened.

The complete results are shown in Table (3).

Conclusions:

Contingency list	The resulting overloading lines	The corresponding Corrective action
[illegible] of line "2"	[illegible] A,B	Opening line "F"

Figure (2): Towards building a knowledge based system

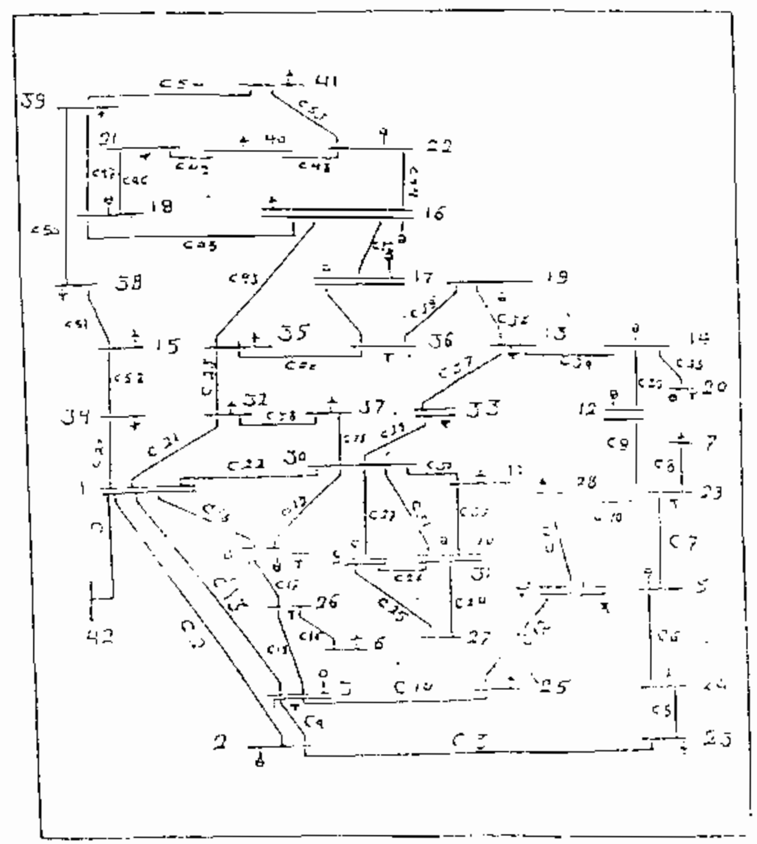

Fig. (3): Northern Egypt 220 KV Network

Table ( ): Test system data

Branch No. 1 is a transformer branch

Branch Num.	Branch From	Branch to	Xser (ohm/Km)	Lenght (Km)		Branch Rating (MW)
1	1	42	0.410	43.0		1500
2	1	2	0.410	50.0		230
3	2	23	0.410	3.0		300
4	2	3	0.3119	10.0		230
5	23	24	0.3119	20.0		280
6	5	24	0.4100	5.0		360
7	5	29	0.4100	5.0		360
8	7	29	0.1100	39.0		360
9	12	29	0.4180	45.0		360
10	28	29	0.4180	8.0		280
11	4	28	0.4180	5.0		260
12	4	25	0.4180	40.0		260
13	1	3	0.4180	10.0		230
14	3	25	0.4180	11.5		250
15	3	26	0.4180	91.0		360
16	6	26	0.3020	11.5		360
17	8	26	0.4100	5.5		360
18	1	8	0.4100	4.5		380
19	8	30	0.1180	35.5		300
20	1	34	0.3920	30.0		460
21	1	32	0.4100	10.0		360
22	1	30	0.4100	21.5		380
23	12	35	0.4100	5.0		360
24	10	27	0.1344	5.0		500
25	9	27	0.0918	1.0		600
26	9	31	0,0910	1.3		600
27	9	30	0.0918	20.0		900
28	30	37	0.4180	9.0		350
29	30	33	0.4180	10.0		350
30	11	30	0.4180	4.0		400
31	31	30	0.1180	9.5		360
32	11	31	0.4100	10.5		500
33	12	14	0.4100	37.5		500
34	13	14	0.1100	40.0		450
35	14	20	0.4100	60.0		350
36	13	19	0.4180	26.0		180
37	13	33	0.1100	21.0		360
38	32	37	0.1100	50.0		360
39	19	36	0.1100	13.0		302
40	35	36	0.4180	33.0		380
41	17	36	0.3020	7.0		360
42	16	17	0.1780	31.5		360
43	16	35	0.1130	20.0		360
44	16	22	0.3119	13.5		360
45	16	18	0.1180	11.5		360
46	18	21	0.1180	17.5		366
47	18	39	0.1170	8.5		340
48	22	40	0.1170	8.5		360
49	21	10	0.1170	2.5		360
50	38	39	0.1100	15.5		360
51	15	38	0.3920	26.0		360
52	15	34	0.3920	22.5		460
53	41	22	0.4100	2.5		360
54	41	39	0.3020			360

Table (2). Data of test case

No.	Bus Gen	Bus Load
1	0	0
2	59	152
3	50	117
4	36	84
5	290	0
6	0	105
7	0	30
8	260	102
9	1140	0
10	0	139
11	0	160
12	555	35
13	77	114
14	19	16
15	0	36
16	136	15
17	119	33
18	-279	15
19	125	279
20	34	36
21	120	132
22	500	[illegible]
23	0	18
24	0	9
25	0	114
26	0	[illegible]
27	0	[illegible]
28	0	24
29	0	15
30	0	[illegible]
31	0	[illegible]
32	0	78
33	0	[illegible]
34	0	6
35	0	19
36	0	[illegible]
37	0	78
38	0	[illegible]
39	0	[illegible]
40	0	[illegible]
41	0	125
42	0	1003
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		

Table (3). : Using the algorithm to build a knowledge base system

Contingency list	The resulting overloading lines	The corresponding corrective action
Outage of line "1"	-	
Outage of line "2"	-	-
Outage of line "3"	line 10	Splitting at bus "12"
Outage of line "4"	-	-
Outage of line "5"	lines 10,11,12	Splitting at bus "29"
Outage of line "6"	lines 10,11,12	Splitting at bus "29"
Outage of line "7"	Line 5	Opening line 1
Outage of line "8"	-	-
Outage of line "9"	Line 22	Splitting at bus 30
Outage of line "10"	Line 5	Splitting at bus 3
Outage of line "11"	Line 5	Splitting at bus 3
Outage of line "12"	Line 5	Splitting at bus 3
Outage of line "13"	-	-
Outage of line "14"	-	-
Outage of line "15"	-	-
Outage of line "16"	-	-
Outage of line "17"	Lines 18,22	Opening line "37"
Outage of line "18"	Line 22	Splitting at bus 30
Outage of line "19"	Line 22	Splitting at bus 30
Outage of line "20"	Lines 18, 22	Opening line 38
Outage of line "21"	Lines 18, 22	Opening line 41
Outage of line "22"	Lines 18, 19	Splitting at bus 30
Outage of line "23"		
Outage of line "24"	Line 27	Opening line 30
Outage of line "25"	Line 27	Splitting at bus 9
Outage of line "26"	Line 27	Splitting at bus 9
Outage of line "27"	Lines 24,25,31	Splitting at bus 9
Outage of line "28"	-	-
Outage of line "29"	-	-
Outage of line "30"	-	-
Outage of line "31"	-	-
Outage of line "32"	Line 27	Splitting at bus 28
Outage of line "33"	Line 5,10,11,12	Generation shift
Outage of line "34"	Line 5,10,11,12	Generation shift
Outage of line "35"	-	-
Outage of line "36"	-	
Outage of line "37"	Lines 10, 11	Opening line 7
Outage of line "38"	-	
Outage of line "39"	-	
Outage of line "40"	-	
Outage of line "41"	Line 13	Splitting at bus 16
Outage of line "42"	-	-
Outage of line "43"	-	
Outage of line "44"	-	-
Outage of line "45"	-	-
Outage of line "46"	-	-
Outage of line "47"	Line 51	Opening line 51
Outage of line "48"	-	-
Outage of line "49"	-	-
Outage of line "50"	Lines 18,22	Opening line 38
Outage of line "51"	Lines 18,22	Opening line 38
Outage of line "52"	Lines 18,22	Opening line 38
Outage of line "53"	Line 17	Opening line 50
Outage of line "54"	-	-

An approach is presented to build a knowledge-based system for network reconfiguration (to alleviate line overloads). A preliminary work is carried out to build necessary corrective actions for different line outages accompanied by different overloads according to the tables, which are obtained.

The proposed approach using the algorithms coupled with the heuristic knowledge, which is obtained from the operator's experience, builds a knowledge-based system and gives a rapid solution in a short time. For a specified loading condition then must be added.

The results confirmed that the proposed approach is confident and valid to be used in the energy control centers, along with Artificial Intelligent Techniques.

References:

1- Masiello, R.D. and Wollenberge "Cost Benefit Justification of Ener Control System" IEEE Trans, On Power Apparatus and Systems, Vol. Pas 100, May 1981.PP.2568-2574.

2- Allen J. Wood, B.F. Wollenberge "Power generation operation and control", John wiley & Sons inc., 1987.

3- A.A. Mazi, B.F. Wollenberge, M.H. Hesse "Corrective Control of Power System flows by line and busbar switching" IEEE Trans. On Power System, Vol., PWRS-1, No. 3, August 1986.

4- Homer E. Brown "Alleviating line overload by line switching" IEEE Computer Applications in Power 1988.

5- E.B. Makram, K.P. Thorton and H.E. Brown "Selection of lines to be switched to eliminate overloaded lines using a Z matrix method" Winter Power Meeting 1987.

6- Vg. Schnyder, H. Glavitsch "Security Enhancement using an optimal switching" IEEE Trans. On Power Systems, Vol. 5, No. 2, May 1990.

7- VR. Bacher, M. Glavitsch "Network Topology Optimization with Security Constraints" IEEE Trans. On Power System, Vol. RWRS No.4, November 1986.

8- Report of Power System Operating Conditions during 1990 National Energy Control Center, Egyptian Electricity Authority.

9- K. Yassin, et al, "Optimal Security constrained hydrothermal scheduling in the Egyptian Power System", MEPCON 89- paper No. PG 29-146.

10- K. Yassin, et al, "On line algorithm for lines overloads alleviation", MEJ Vol. 16, No. 2, Dec. 1991.

11- P. Oliver and L. Dubost "A knowledge-based system for network reconfiguration" Proceeding IFAC 1988.

12- L. Subost and A. Hertz "Export Systems as network control support tools" Proceeding IFAC 1989.

Mansoura Engineering Journal, (MEJ), Vol. 24, No. 3, September 1999. E. 11

GloveSignature: A Virtual-Reality Based System for Dynamic Signature Verification

توقيع قفاز البيانات: نظام يعتمد على الواقع الإفتراضى للتحقق من صحة التوقيع بطريقة ديناميكية

A.S. Tolba

Electrical Eng. Dept., Suez-Canal University, Port-Said

ملخص البحث.

يقدم البحث طريقة جديدة تعتمد على استخدام قفاز البيانات للتعرف على التوقيع والتحقق من صحته وذلك بتسجيل البيانات الخاصة بزوايا انحناء الأصابع ودوران رسغ اليد وميل اليد أثناء عملية التوقيع. نظرا لكبر حجم هذه البيانات يتم تركيزها في عدد محدود من السمات التي تمثل البيانات بدرجة عالية من الدقة وتحافظ على المعلومات بها وذلك باستخدام طريقة تحليل المركبات الأساسية . تستخدم السمات المستخلصة من سبع إشارات رقمية في تدريب شبكة عصبية اصطناعية ذاتية التنظيم لتصنيف التوقيع والتحقق من صحته

Abstract

A survey of the principal schemes in the literature suggested that a new way of addressing the problem of signature recognition be formulated in order to find a satisfactory solution for eliminating random forgeries. A fundamental problem in the field of off-line signature recognition is the lack of a pertinent shape representation or shape factor. This paper introduces a novel idea for a dynamic signature recognition system. An initial attempt is presented to demonstrate the data glove as an effective high-bandwidth data entry device for signature recognition. GloveSignature is a virtual reality based environment to support the signing process. The proposed approach retains the power to discriminate against forgeries. This paper extends the use of instrumented data gloves - gloves equipped with sensors for detecting finger bend, hand position and orientation for recognizing hand signatures. Several researchers have already explored the use of gloves in other application areas but using the gloves for the recognition of hand signatures is never reported. An attempt is made in this research to explore the feasibility of using the 5[th] Glove in on-line signature recognition. Two hundred signatures were collected from twenty subjects, and features were extracted. We demonstrate the effectiveness of a hybrid technique which is based on both the most discriminating eigenfeatures and self-organizing maps (SOFMs) for signature recognition.

Index Terms – Virtual reality, on-line signature recognition, principal component analysis, eigen signatures, feature selection, self-organizing maps, signature recognition, data gloves.

1. Introduction

Having a reliable method to prevent unauthorized transaction or disclosure is essential in the use of computers for business transactions or for access of proprietary data. The problems with current systems such as keyboards or special input terminals such as remembering the various passwords, or Personal Identification Numbers (PINs), keeping them secret and keying them inaccurately render them unreliable. On-line signature verification with data gloves solves most of these problems and makes the forging impossible.

In this paper, we outline a new approach for signature recognition that is secure to skilled forgery (see section 4). Hand gloves provide data on both the dynamics of the pen motion during the signature and the individual's hand shape. Signature verification using the dynamic signature data results in much simpler and faster approach than the most widely used image analysis approaches. Significant in this regard is that skilled forgers cannot reproduce the movement dynamics that occur with an authentic signature. Another point is that hand size is considered while using the data glove.

Accepted August 16, 1999