



**Sudan University of Science & Technology**

**Graduate College**

**A Simple Off - Line Signature Verification Method  
Using Geometrical Features**

*A Thesis Submitted in Fulfillment of the Requirements of the Degree  
Of Ph.D in Computer Science*

**By**

**.Saad Mamoun Abdel Rhman**

**:Supervisor**

**. Professor Izze Eldin Mohamed Osman**

**:Co Supervisor**

**Associate Professor Saifeldain Fatch**

**February 2011**



**قال الله تعالى في كتابه الكريم**  
**﴿ ويسئلونك عن الروح قل الروح من أمر**  
**ربي وما أوتيتم من العلم إلا قليلاً ﴾**

سورة الإسراء الآية 85

***Dedication***

***I would like to dedicate this thesis to my mother, wife, and daughter  
and sons .Dedication also to my students in Sudan & Kingdom of Saudi  
Arabia***

***With my best wishes***

## **Researcher Acknowledgments**

*My great debt of gratitude is to my supervisors of this thesis, Professor Izz Eldeen Mohammed Osman and Associate Professor Seif Eldeen Fatoh for their consistence and wise advices during this .work that has contributed much to any process of the study*

*Thanks to my friend Dr. Osama Modawey English Center, Jazan University, KSA , in addition to Mohammed Galiy AbdellRazig Omdurman Islamic University and Mr. Mirghani Mohammed Omdurman Islamic University who helped in . adjustment of thesis' language*

*My thanks extended to Mr. Phirous Mansor Faculty of Computer Science & Information Systems, Jazan University, KSA . who' directed me to use MatLab programming word*

*Finally , my deepest thanks to the staff of Faculty of Computer Science & Information Systems at University of Jazan , KSA , and the staff of Faculty of Computer Science & Information Technology in the University of Sudan Science and Technology – . Sudan*

**The Researcher**

**Saad Mamoun Abdel Rhman**

## **Abstract**

This study presents an off-line signature verification system. The verification is based on geometrical and grid features through conducting two tests. The first one uses geometrical features using four border points in the .direction of right and left, up and down in addition to two lengths  
The first connects the highest point with the lowest, and the second connects the left point with the right. The second test uses grid features taken .from the core of a signature image  
The samples (population for this study) is drawn from 360 personal signature collected from 60 Arabic native speakers. The data that had obtained .(along with one signature specimen) is cached in Oracle Database  
Practical experiments showed that the accuracy of the algorithm under False Rejection Rate (FRR) scale is less than 0.16 for the combined methods .is geometrical and grid features

## الخلاصة

تناولت الدراسة بالبحث التوقيعات الشخصية والتي يستخدم فيها خط اليد ، لبناء خوارزمية مناسبة وتطبيقها باستخدام برنامج الماتلاب للتحقق من صحتها وقد استخدمنا في بناء قاعدة البيانات العلائقية اوركل وربطها مع الماتلاب.

استخدمت الدراسة السمات الهندسية والشبكية لصورة التوقيع الشخصي وذلك بعد استخلاصها من الصورة وتخزينها داخل قاعدة البيانات . وقد أختار الباحث عينة من 360 توقيع جمعت من 60 فرداً يتحدثون اللغة العربية كلغة أصيلة.

في مرحلة اختبار صحة التوقيع يقوم البرنامج باستخلاص السمات الهندسية والشبكية للتوقيع المدخل بمقارنتها مع التواقيع الأصلية المخزنة في قاعدة البيانات ومن ثم إعطاء نسبة لصحة التوقيع من عدمه يتفق عليها مع المستفيد من النظام.

وتوصلت الدراسة على نتائج استخدم فيها مقياس FRR لمعرفة مدى دقة النظام فأعطى نسبة اقل من 0.16 عندما تم دمج طريقة السمات الهندسية والشبكية.

## Table of Contents

	Contents
ii	الآية الكريمة
iii	.Dedication
iv	.Acknowledgment
v	.English Abstract
vi	.Arabic Abstract
vii	.Table of Contents
x	.List of Tables
xi	.List of Figures

### Chapter 1

	Introduction	.1
2	Introduction	1.1
2	Style of signatures	1.2
3	?Why Did The Researcher Select This Field	1.3
3	Problem Definition	1.4
4	Contribution of the Study	1.5
4	Terminology	1.6

### Chapter 2

	Literature Review	.2
6	.Introduction to Authentication Technologies	2.1
6	.Authentication Definition	2.2
7	.Some Thing You Know	2.2.1
9	.Some Thing You Have	2.2.2
10	Some Thing You Are	2.2.3
11	Biometric Biological Measurements	2.3
13	.Historical Development of Biometrics	2.4
15	.Biometric Identification	2.5
17	.Biometrics Classifiers	2.6
17	Verification and Identification	2.7
17	Verification	2.7.1
18	.Identification	2.7.2
19	?What Makes a Good Biometrics	2.8
19	.Application for Biometrics Technologies	2.9
22	.Overview of Handwriting	2.10
25	.Type of Forgeries	2.11
25	.Random Forgery	2.10.1
25	.Unskilled Forgery	2.10.2
25	.Skilled Forgery	2.10.3
26	.Practical Off-line Signature Verification Problems	2.12

28	.Characteristics of the Forged Signatures	2.13	
28	.Features Extractions	2.14	
28	.Global Features	2.14.1	
28	.Statistical Features	2.14.2	
29	.Geometrical and Topological Feature	2.14.3	
29	Review of Related Work	2.15	
29	.First: Statistical Pattern Recognition	2.15.1	
29	Applications Based on Support Vector .Machine (SVM	2.15.1.1	
30	Applications Based on Dynamic Time .Warping (DTW	2.15.1.2	
31	Applications Based on Hidden Markov .Model (HMM	2.15.1.3	
32	Second: Syntactic or Structural Pattern .Recognition	2.15.2	
32	Applications Based on Fuzzy .Modeling	2.15.2.1	
35	.Third: Artificial Neural Networks	2.15.3	
35	Applications Based on Artificial Neural .Networks (ANN	2.15.3.1	
	Chapter 3		
37	Methodology and Implementation		3
38	.Introduction	3.1	
38	.(Data Input Process (Enrollment	3.2	
39	.Preprocessing	3.3	
39	Image Normalization and Filtering	3.3.1	
40	.Resize and Centering the Signature	3.3.2	
41	.Geometrical Features Extraction	3.4	
45	Truncated Matrix of Pixels	3.5	
47	Decision Process	3.6	
	Chapter 4		
51	Evaluation		4
51	Results and Discussion	4.1	
	Chapter 5		
54	Conclusion , Summary and Future Work		5
55	Conclusion	5.1	
55	Recommendations	5.2	
56			
	Reference		
63	Appendixes		



## List of Tables

Page	Title	Table
11	Existing User Authentication Methods .Some Examples of positive and Negative Properties	Table 2.1
17	Biometrics Classifiers	Table 2.2

## List of Figures

Page	Title	No
7	.The Three Basic Ways a Person can Prove Identity	Figure 2.1
17	Physiological Biometric Examples	Figure 2.2
18	.The Biometrics Verification Process	Figure 2.3
19	The Biometrics Identification Process	Figure 2.4
23	Types of Handwriting Biometrics and Application Areas	Figure 2.5
24	Sample of Signatures	Figure 2.6
26	Types of Forgeries	Figure 2.7
26	Signature Image Examples Presenting	Figure 2.8
40	Practical Problems	Figure 2.9
39	Sample Signature's Form	Figure 3.1
40	Sample of Genuine Signatures	Figure 3.2
40	Signatures After Normalization and Filtering Process	Figure 3.3
41	Sample of Genuine Signature	Figure 3.4
41	Signature after Centering	Figure 3.5
42	Signature with Geometrical Features Extraction	Figure 3.6
43	Eight Pints plus Two Lengths for Five Samples	Figure 3.7
44	.Flow Chart Diagram of Test1	Figure 3.8
45	Signature in the Binary Digit	Figure 3.9
46	Truncated Matrix of Pixels	Figure 3.10
47	.Flow Chart Diagram of Test2	Figure 3.11
48	.Steps of Enrollment Phase	Figure 3.12
49	.Data Flow Diagram of the Whole System	Figure 3.13
51	Results of geometrical features extraction test	Figure 4.1
52	Results of Truncated Matrix of Pixels Test	Figure 4.3
52	Results of the Two Tests	Figure 4.3