Design & Implementation an E-Commerce Sites Security System based on Local Binary Pattern Fingerprint Verification

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Abstract— E-Commerce has played a major role in changing the global economic thought, but it still suffers from serious threats concerning the protection of e-commerce transactions. As a result, there is a great demand for advanced protection system to increase consumer confidence and the institution in the field of e-commerce. In this paper, an e-commerce system is presented, which is a web application designed for browsing and purchasing products from the net. This system provides improved security techniques which are password and fingerprint verification to complete the purchasing procedure and protect e-bank and the system from intruder. The verification algorithm in purchasing procedure includes a series of steps starting with using canny edge detection filter and then using Local Binary Pattern (LBP) and histogram properties as statistical approaches for feature extraction from fingerprint image. A fingerprint image is first divided into (3*3) regions from which LBP histograms are extracted and then converted into a single feature vector. This feature vector forms an efficient representation of the fingerprint and is used to measure similarities between images.The result of matching has been compared by using the Chi Square Statistic (X^2) that depend on the resulted feature vector which is a powerful information to prove identity of a person. ASP.NET 2013, SQL Server 2014, VB.NET 2013 and C# 2013 programming language has been used to execute the paper algorithms. Finally, it must be mentioned that an excellent results have been obtained using different fingerprint images.

Index Terms— E-Commerce, Local Binary Pattern (LBP), Histogram properties, Feature vector.

1 INTRODUCTION

We have brought about the growing developments in the field of information and communication noticeable change in international trade structure, and led to the emergence of a new type of trade called the Electronic commerce or e-commerce term, which was characterized by a set of characteristics that distinguished it from traditional commerce, where that e-commerce, refers to economic activity that occurs online [1]. It also pertains to any form of business transaction in which the parties interact electronically rather than by physical exchanges or direct physical contact. E-commerce is usually associated with buying and selling over the Internet, or conducting any transaction involving the transfer of ownership or rights to use goods or services through a computer-mediated network. Though popular, this definition is not comprehensive enough to capture recent developments in this new and revolutionary business phenomenon. A more complete definition is E-commerce is the use of electronic communications and digital information processing technology in business transactions to create, transform, and redefine relationships for value creation between or among organizations, and between organizations and individuals[2].

Security is one of the principal and continuing concerns that restrict customers and organizations engaging with e-commerce [3]. Web e-commerce applications that handle payments (online banking, electronic transactions or using debit cards, credit cards, PayPal or other tokens) have more compliance issues, are at increased risk from being targeted than other websites and there are greater consequences if there is data loss or alteration [4].

Confidentiality and privacy of the important obstacles facing workers in e-commerce and which is affecting on accept some customers to the idea of e-commerce. The process of e-commerce need some data from the customer such as name, sex, nationality, address, method of payment and credit card numbers, So an urgent need to use special software to maintain confidentiality and privacy of electronic commercial transactions and thus to ensure the privacy and security of information via the internet. For this reason, in this research the systems has been developed which is keen to confirm the identity of the persons through the verification of the distinctive characteristics found in the human body, for example, a facial features, fingers and human eye can be adopted to confirm the identity of the person and distinguish it from hackers to the security of electronic commercial transactions. The fingerprint, which represents one of the most biometric technologies, has been adopted in this research to extract unique features of the people, and then use it to distinguish between people accurately.

The origin of biometrics can be traced back to the primordial Greek society [5]. The technology of biometrics entails the use of intrinsic physical, behavioural and psychological features of individuals as a means of identification and verification (i.e. Authentication). The most commonly used biometric features for the purpose of identification and identity management include: facial features, hand geometry, vascular pattern, fingerprints, retina, iris, keystroke, handwriting, gait and voice. These features have either being used singly or in combination in different security applications with the attendant advantages of robustness, universality, permanence and accessibility [6].

The aim of this research is to design and implement a security system for the purchase, which works directly within the proposed and designed e-commerce system to browse and buy products online, where this system contributes to protect bank and the purchase procedure in e-commerce sites because

of importance in obtaining accurate information that ensure the identity of the trusted persons by adopting not only a password but also on the fingerprint. The way of confirm the identity of the person have two stages, the first is the stage of the discovery and identify the most basic features in a fingerprint using canny filter to determine the edges. The second stage is dedicated to extract the vector of characteristics and that is used to confirm a person's identity and distinguish it from others. Also in this research, a new ways to extract the properties of the fingerprint are being used, which are the Local Binary Pattern (LBP) method and the Histogram properties method as a powerful statistical techniques used to create the basic features of the fingerprint.

2 E-COMMERCE SECURITY

E-commerce security is the protection of e-commerce assets from unauthorized access, use, alteration, or destruction. While security features do not guarantee a secure system, they are necessary to build a secure system. Security features have four categories [7]:

1. Authentication: Verifies who you say you are. It enforces that you are the only one allowed to logon to your Internet banking account.
2. Authorization: Allows only you to manipulate your resources in specific ways. This prevents you from increasing the balance of your account or deleting a bill.
3. Encryption: Deals with information hiding. It ensures you cannot spy on others during Internet banking transactions.
4. Auditing: Keeps a record of operations. Merchants use auditing to prove that you bought a specific merchandise.
5. Integrity: prevention against unauthorized data modification.
6. Nonrepudiation: prevention against any one party from reneging on an agreement after the fact.
7. Availability: prevention against data delays or removal.

3 ANALYSIS AND DESIGN OF BIOMETRIC SYSTEM

It has been advocated at different quarters that data and system security is the next frontier of information technology in the coming centuries. As more people access the internet infrastructure, more businesses go online, and most traditional operations become internet based, reliable means of user identification and verification become of high essence. The only means of attaining this height of online internet security is via biometric technology.

Basically, a complete biometric system majorly is characterized by three elements namely;

1. Enrollment sub-system.
2. Template representation.
3. Matching process subsystem.

These three main elements are depicted in the figure 1 below [8]:

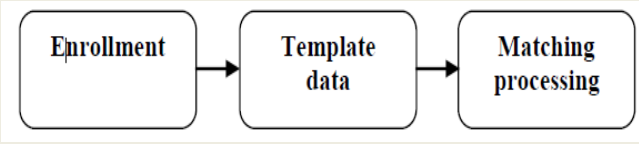

Fig.1. The general block diagram representation of a typical Biometric System.

1. THE ENROLLMENT STAGE: At this stage, data samples are collected from the enrollee. Mostly devices such as scanners and readers are employed for this purpose. This stage is usually crucial as any mistake will lead to identity misrepresentation.
2. THE TEMPLATE REPRESENTATION STAGE: At this stage of biometric operation, data samples obtained at the enrollment stage are gathered and stored for future referencing. This operation is usually carried out by some specific software tools.
3. MATCHING PROCESS SUBSYSTEM: Here, input data is compared with the already store data template within the system for the purpose of identification and verification.

4 Fingerprint Description with Local Binary Patterns

Feature extraction is presented in order to reduce the input fingerprint data and transfers it to feature vector. If the features extracted are carefully chosen, it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input fingerprint image. In this paper both Local Binary Pattern and histogram properties are presented in order to extract the features of a fingerprint image to get the feature vector required for verification.

4.1 Local Binary Patterns

Local Binary Pattern (LBP) is an efficient method used for feature extraction and texture classification it was first introduced by Ojala et al in 1996 [9]. The operator labels the pixels of an image by thresholding the 3x3-neighbourhood of each pixel with the center value and considering the result as a binary number. Then the histogram of the labels can be used as a texture descriptor. See Figure 2 for an illustration of the basic LBP operator.

Later the operator was extended to use neigbourhoods of different sizes [10].Using circular neighbourhoods and bilinearly interpolating the pixel values allow any radius and number of pixels in the neighbourhood. For neighbourhoods we will use the notation (P,R) which means P sampling points on a circle of radius of R. See Figure 3 for an example of the circular (8,2) neighbourhood.

Another extension to the original operator uses so called uni-

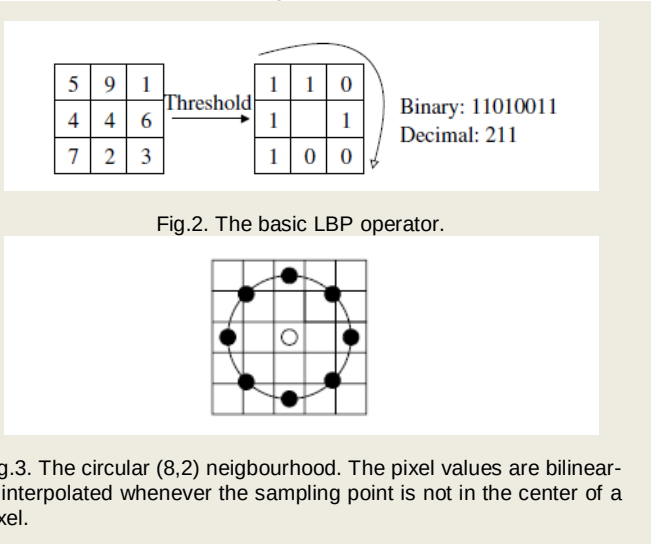

Fig.2. The basic LBP operator.

Fig.3. The circular (8,2) neigbourhood. The pixel values are bilinearly interpolated whenever the sampling point is not in the center of a pixel.

form patterns [10]. A Local Binary Pattern is called uniform if it contains at most two bitwise transitions from 0 to 1 or vice versa when the binary string is considered circular. For example, 00000000, 00011110 and 10000011 are uniform patterns[11].

The histogram of the uniform patterns in the whole image is used as the feature vector [12].Uniform pattern can be used to reduce the length of the feature vector and implement a simple rotation-invariant descriptor.

A histogram of the labeled image fl(x, y) can be defined as [11]:

$$H_i = \sum_{x,y} I\{f_l(x,y) = i\}, i = 0,\dots,n-1, \quad (1)$$

in which n is the number of different labels produced by the LBP operator and

$$I\{A\} = \begin{cases} 1, & A \text{ is true} \\ 0, & A \text{ is false.} \end{cases}$$

The image is divided into regions R0,R1, . . . Rm−1 and the spatially enhanced histogram is defined as

$$H_{i,j} = \sum_{x,y} I\{f_l(x,y) = i\} I\{(x,y) \in R_j\}, i = 0,\dots,n-1, j = 0,\dots,m-1. \quad (2)$$

4.2 Histogram Properties

Image histogram is a first order statistics which is one pixel level, there are many statistical measures that can be extracted from the histogram using first order probability distribution, such as mean value among the intensity of pixel values. Histogram statistics include range, mean, geometric mean, harmonic mean, standard deviation, variance, and median. Histogram comparison statistics, such as L1 norm, L2 norm, Mallows or EMD distance, distance, Histogram intersection, Chi-square, and Normalized correlation coefficient, can also be used as texture features [13]. After LBP is computed, a set of the histogram features is computed together for LBP to construct the feature vector. Computation of the histogram, over the cell is needed to determine the frequency of each "number" occurring (i.e., which pixels are smaller and which are greater than the center), and then normalize the histogram to get the feature vector [14]. In this research, to compare two face images, a sample (S) and a model (M), the difference between the feature vectors has to measure. This can be done with Chi square statastic dissimilarity measures for histograms [11]:

$$\chi^2(\mathrm{S},\mathrm{M}) = \sum_i \frac{(S_i - M_i)^2}{S_i + M_i} \quad (3)$$

5 THE PROPSED E-COMMERCE SYSTEM SECURITY

The propsed e-commerce system is a web application to browse and buy products over the Internet and is compossed of parts as shown in figure 4.

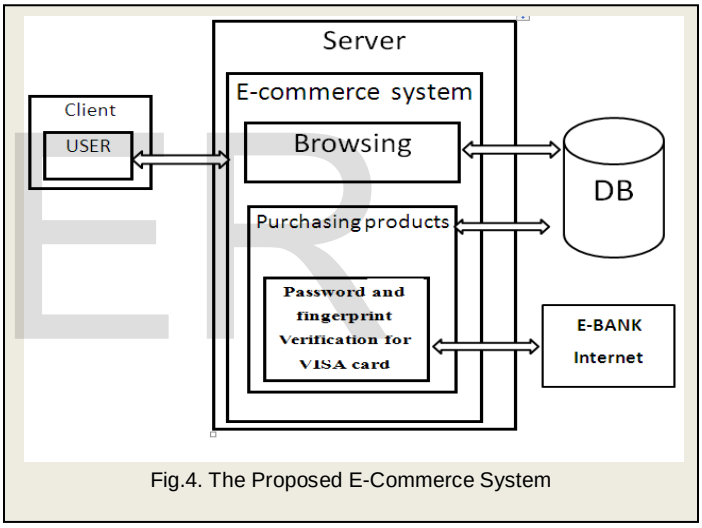

Fig.4. The Proposed E-Commerce System

1. **User**: Is the person in the client side, which brows the products and may be use the application to buy or purchasing products from e-commerce using visa card or other electronic payments. He uses the browser to navigate the internet and reach the e-commerce site.
2. **E-Commerce System**: A proposed e-commerce system is a web application designed for browsing and purchasing products directly from the net. This system provide improved security techniques which are (Password and fingerprint verification) to complete purchasing procedure. The system allow the user to perform two function (Browsing and purchasing products) the purchasing procedure required user password and fingerprint verification from system and e-bank. The fingerprint is unique, there for it is powerful information to approve identity of person. It protects e-bank and system from intruder in purchasing procedure. The proposed e-commerce System works on server computer in the internet to be accessed from cli-

ent computer in remote position.

3. **DB (Database)**: It is a hug database contains relational tables of information about products in e-commerce system. This data base usually designed in scalable way by using SQL server. In general it contains all information about products (price, image, size). This database accessed by system in secure way. By using query and report we can read all available information about products.
4. **E-Bank**: Usually e-bank is an electronic system on website provides an electronic way to access bank using electronic card (Visa card, Master card, PayPal). E-Bank contains information about all customs member on this bank and their accounts and personal information.During enrollment the feature vector obtained from an individual's fingerprint is stored as a template for that subject in the database bank. In the verification process, the fingerprint given as input is compared or matched with the templates to provide the decision of verification. This process is known as matching. For matching to be effective the input fingerprint should be registered to the template fingerprint using the feature vector of the fingerprint. After registration the features vectors are compared using the Chi Square statistc metric. E-Bank has management procedures to manage user account of bank to (add and remove money) from account and purchasing process. And it provides high level security using passward and fingerprint verification method.

The proposed purchase system requires from customer do several steps to complete the purchase and transport of goods to the people:

1. Enter a password, and select one of the payment methods which are :(Visa card, Master card, Pay pal).
2. Enter a fingerprint of customer using a fingerprint reader device, which represents the most important part in order to access to the user's data within the bank, and after making sure that a person is authorized, the funds from the customer's account is withdrawn. The withdrawal of money in this manner represents the safe and confidentiality way for the bank and the customer.
3. Execute the proposed fingerprint verification process which consists of four main parts as shown in algorithm 1.
4. Implement the process of withdrawing money from e-bank and transfer the goods to the user after completion of the verification of the user fingerprint and the rest of its data.

Algorithm 1: The proposed fingerprint verification algorithm

Step 1: *Upload input fingerprint images.*

Step 2: *The Preprocessing Stage:*

- *Converting the fingerprint image to grayscale image.*
- *For each pixels of the image Do*
  - *Get the RGB value of the pixel.*
  - *Find the average of RGB.*
  - *Replace the R,G and B value of the pixel with the average calculated in the previous step .*

  End For
- *Applying Canny edge detection method to obtain a black image that contains a set of white dots that describe all the edges in the original image.*

Step 3: *Extract the fingerprint features using both LBP and Histogram Prosperities in order to obtain the feature vector.*

- *Divide fingerprint image to (3*3) blocks B1,B2,…Bn*
- *For n=1 to no. of image blocks Do*

For i=2 to (number of block row -1)
For J=2 to (number of block column -1)
BCenter=BOld[i,j]
IF (BOld[i-1,j-1]> BCenter) Then BNew[i-1,j-1]=1
Else BNew[i-1,j-1]=0
IF (BOld[i-1,j] > BCenter) Then BNew [i-1,j]=1
Else BNew [i-1,j]= 0
IF (BOld[i-1,j+1] > BCenter) Then BNew [i-1,j+1]=1
Else BNew[i-1,j+1]= 0
IF (BOld[i,j+1] > BCenter) Then BNew[i,j+1]=1
Else BNew[i,j+1]= 0
IF (BOld[i+1,j+1] > BCenter)Then BNew [i+1,j+1]=1
Else BNew[i+1,j+1]= 0
IF (BOld[i+1,j] > BCenter) Then BNew [i+1,j]=1
Else BNew [i+1,j]= 0
IF (BOld[i+1,j-1]> BCenter) Then BNew[i+1,j-1]=1
Else BNew[i+1,j-1]=0
IF (BOld[i,j-1] > BCenter) Then BNew [i,j-1]= 1
Else BNew [i,j-1]= 0
*LBP[n]= BNew [i-1,j-1]*2^7+ BNew [i-1,j]*2^6+*
*BNew [i-1,j+1]*2^5+ BNew [i,j+1]*2^4+*
*BNew [i+1,j+1]*2^3+ BNew [i+1,j]*2^2+*
*BNew [i+1,j-1]*2^1+ BNew [i,j-1]*2^0*
Next J
Next i
Next n

- *Compute the histogram, over the block, of the frequency of each decimal number occurring.*
- *Concatenate histograms of all blocks which give the feature vector for the image.*

Step 4: *Matching: Test the fingerprint image by comparing it against the fingerprint image in the database using Chi Square dissimilarly metric. The comparison is performed using the feature vector obtained in the previous step.*

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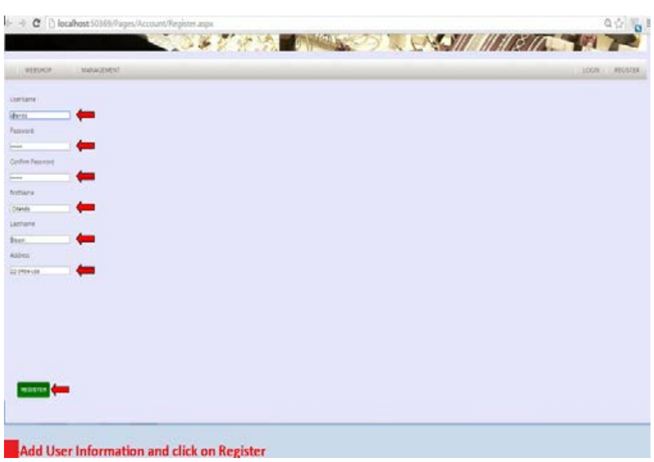
6 PRACTICAL IMPLEMENTATION

Experimental results are performed in order to evaluate the performance of the proposed method. The Proposed e-commerce site is designed using ASP.NET 2013. Two databases are built: one for bank account and client information, and another for products information. The propsed e-commerce site registeration process and the database for bank and products are illustrated in the windows mode below:

a) Registeration process

b) Register with a fingerprint



c) User information registeration

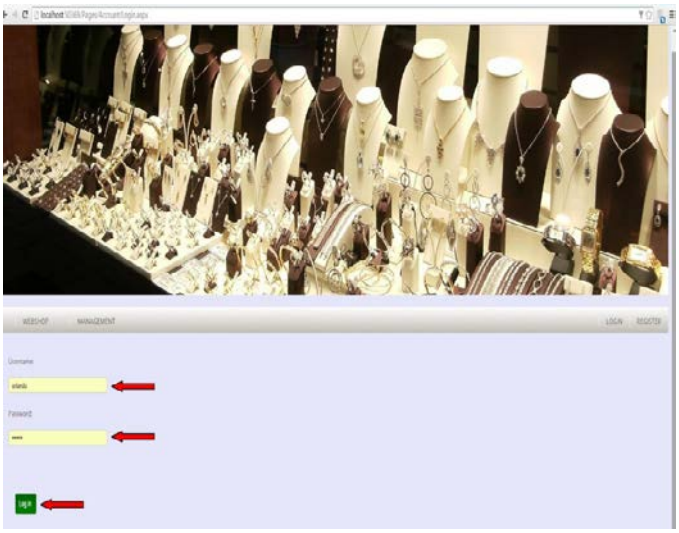
	ID	firstName	LastName	Address	balance	GUID
Edit Delete	25	Rachel	Bilson	409-13-4	6500	30954e43-ad75-4824-8319-edf07d61d1ba
Edit Delete	27	Johnny	Depp	409-13-5	60000	274bb33c-f445-4f5c-a2f9-66e1c7415f6d
Edit Delete	28	Robbie	Williams	409-13-6	0	6038867b-9488-4d4e-9840-01c4fbf01c64
Edit Delete	29	Reese	Witherspoon	409-13-5	0	aec69d8c-440d-469f-b7e9-6ce6e6b7dfff
Edit Delete	30	JANET	BASIL	409-13-58	0	c0d26073-af35-48ec-8979-ea21d25d7437
Edit Delete	31	LEON	DANA	409-13-56	0	00fc1bc3-8221-4f9e-a478-24c08034bf5e
Edit Delete	32	JOHNE	LAWRENCE	409-13-4	0	0e57a8e3-728d-4f13-9b7f-83719be61b09
Edit Delete	33	amjed	amjed	409-13-4	0	2a5d1f70-c032-40b2-854b-429963e159db
Edit Delete	35	JOHNNY	MICHAEL	409-13-4	0	d5c20e5f-74f4-4dc8-86a0-092efbbb680c
Edit Delete	36	EDITH	MARIAN	409-13-4	100000	7455ffe8-2073-4845-81ee-d5fcd847429a
Edit Delete	37	TAMMY	NARA	409-13-4	0	6bd83467-3ea7-4e1d-9eac-4ab746af7474
Edit Delete	38	Barclay	Baron	409-13-58	0	ce72483f-0151-48e5-a40c-f589bf3c2bec
Edit Delete	39	Basil	Benedict	409-13-4	33500	9573e404-3fb9-46e4-ba6d-0c39ecdead85
Edit Delete	40	Benjamin	Benton	409-13-4	0	5c210f1b-9e82-415b-8c3d-b2b82ba517b5
Edit Delete	41	Crispin	Crosby	409-13-5	1	44018c41-dc9a-46b7-bce7-9dc556665301

d) Bank account database

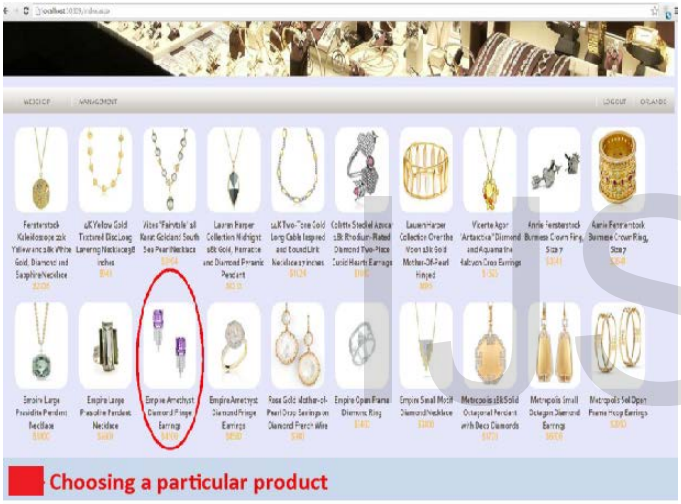
Id	TypeId	Name	Price	Description	Image
1106	1014	Fensterstock K...	2338	The jewelry of ...	Annie .jpg
1107	1014	4K Yellow Gold ...	943	The hammered...	14K Yellow Gol...
1108	1014	Vibes "Fairytale...	2464	The minute yo...	Fairytale.jpg
1109	1014	Lauren Harper ...	1313	Edgy, modern a...	Lauren Harper ...
1111	1014	14K Two-Tone ...	1024	Beautifully desi...	Tone Gold Lon...
1113	1014	Colette Steckel ...	1010	Colette Steckel ...	Colette Steckel ...
1114	1014	Lauren Harper ...	895	This handmade...	Lauren Harper ...
1115	1014	Vicente Agor "...	1525	The unfettered ...	Vicente Agor.jpg
1120	1014	Annie Fensterst...	3641	The jewelry of ...	Colette Steckel ...
1121	1014	Annie Fensterst...	3641	The jewelry of ...	Colette Steckel ...
1122	1015	Empire Large Pr...	5900	Ivanka Trump p...	Empire Large Pr...
1123	1015	Empire Large Pr...	5900	Ivanka Trump p...	Empire 18k Gol...
1124	1015	Empire Amethy...	4500	Ivanka Trump e...	Empire Amethy...
1125	1015	Empire Amethy...	4500	Ivanka Trump e...	Patras Octagon...
1126	1015	Rose Gold Mot...	940	Ivanka Trump fi...	Rose Gold Mot...
1127	1015	Empire Open Fr...	3400	Ivanka Trump ri...	Empire Open Fr...
1128	1015	Empire Small M...	3800	Ivanka Trump p...	Empire Small M...
1129	1015	Metropolis 18k ...	3700	Ivanka Trump fi...	Metropolis 18k ...
1130	1015	Metropolis Sma...	6800	Ivanka Trump fi...	Metropolis Sma...
1131	1015	Metropolis Sol ...	3950	Ivanka Trump h...	Metropolis Sol ...
1132	1015	Patras 18k Yello...	5950	Ivanka Trump fi...	Patras 18k Yello...
1133	1015	Signature Medi...	15500	Ivanka Trump fi...	Signature Medi...

e) Products database

Based on the propsed purchasing method the user should log in to e-commerce site and select the desired product then the input fingerprint image is compared with the bank database image for verification. User Orlando is selected to achieve the purchasing process and the fingerprint verification result is shown in window mode below:

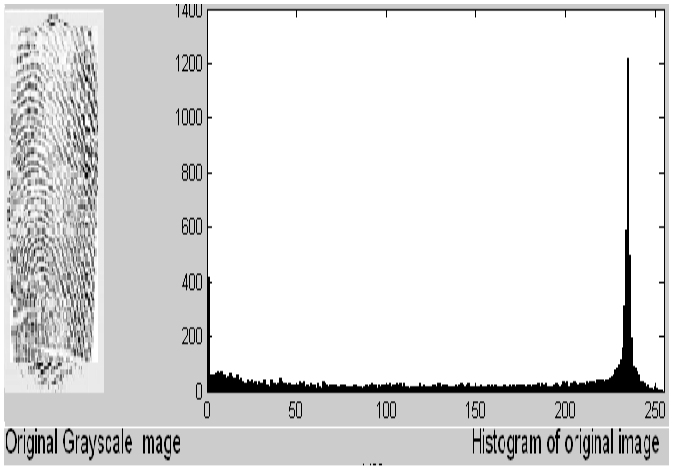


f) Log in for user Orlando

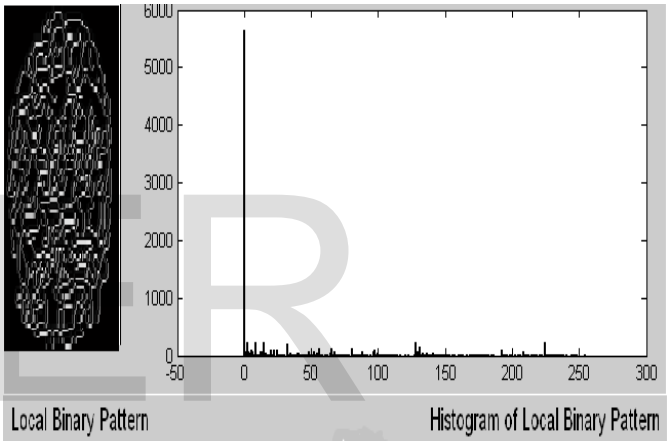


g) Desired product selection

h) The verification process



i) The input fingerprint image with its histogram



j) The local binary pattern with its histogram

Table 1 shows the results obtained with different fingerprint images, when using (P=8, R=1) and the resulting histogram properities. The results show that the histogram properties with LBP are more reliable and effective for fingerprint pattern description. The feature vector forms an efficient representation of the fingerprint and is used to measure similarities between images. To complete the purchasing process a comparission is made between the inpute fingerprint image and many fingerprint imges from database. We found that our proposed method has the highest verification rate. Different fingerprint images are selected from the bank database to compare with the original fingerprint image as shown in figure 5.

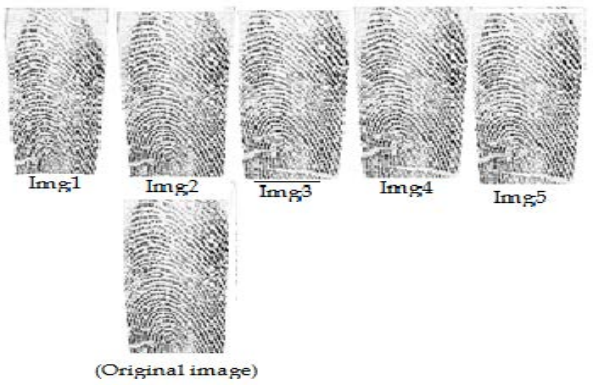
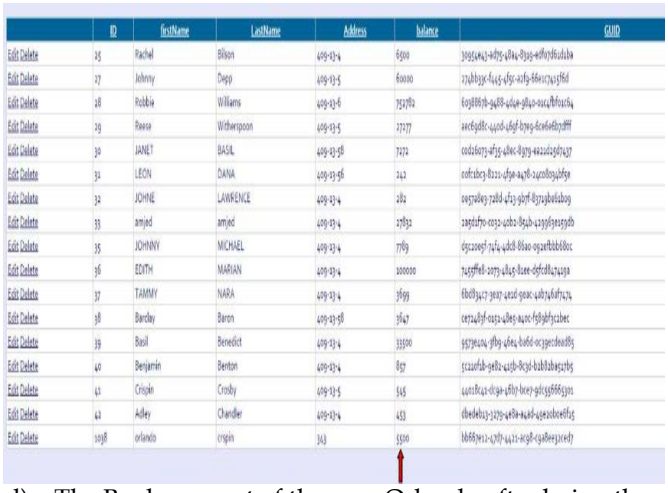


Fig.5. The selected fingerprint images

Table 1: The reullts obtained using LBP and histogram properities.

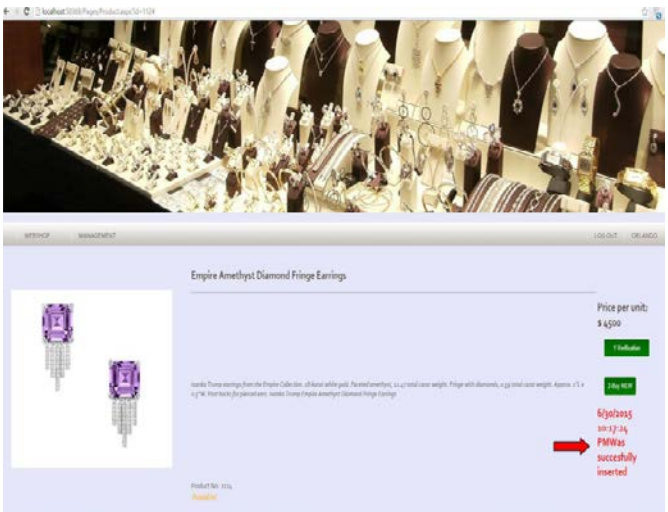
Finger-print images	LBP case (P=8, R=1)	Histogram properities	Chi square statistic	Verification ratio
OImg (Original image)	48.62	266.133		
Img1	46.87	265.744	0.03602537	75.74%
Img2	48.62	266.133	0.00000000	100.00%
Img3	51.85	267.147	0.00960095	88.86%
Img4	52.77	266.021	0.00832235	90.55%
Img5	55.22	268.654	0.00115676	96.71%

k) The Bank account of the user Orlando befor bying the product



l) The Bank account of the user Orlando after bying the product

m) Purchasing process information



n) Buying process successful

7 CONCLUSION

1. The importance of e-commerce is increasing whenever the spread rate and use of the Internet has icreased.
2. This paper presents a new security system to buy in e-commerce sites, which depends on the use of modern techniques to distinguish between authorized persons and hackers persons.
3. Combining the fingerprint with the password increases the security of the procurement process in e-commerce sites, as well as it provides high protection for e-banks that deal with these sites, resulting in a positive impact on the development prospects of e-commerce.
4. In this paper, an efficient method for human verification in e-commerce sites is presented, which includes a series of steps starting with the preprocessing step by using canny edge detection, then using the Local Binary Pattern(LBP) approach and histogram properties which is a very powerful feature for describing the characteristics of the fingerprint image.
5. LBP is a statistical pattern approach used to extract the fingerprint features to get the feature vector which is the most important factor required to measure the similarity between the images, by calculating the distancce between the histograms using Chi Square statistic method.
6. The proposed system gives a high verification rate 100 % by using the Chi Square statistic method on different fingerprint images.

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