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Four-way Integrated Authentication for Android Smart-phone

Shubham Raut, Nilesh Shinkar, Dhananjay Sathe, Lalit Nehete, Amey More, Prof. Hitesh Mohapatra

***Abstract*— In this era of digital world, the number of smartphone users have been increased to a significant number. Right from personal to business needs, smartphones are finding multiple applications in human life. Personal pictures and videos, business documents, mails, etc. are always carried in mobile. Mobile, being small size device, can be lost or stolen easily. Thus, mobile security is an important issue to prevent the theft of user's privacy. Hence, we are presenting a novel approach named, "Four-way Integrated Authentication for Android Smart-phone", in this technique we are integrating four authentication techniques viz. 1)Gait pattern, 2)Location pattern, 3)Emotion sequence and 4)Image context.**

***Index Terms*— Accelerometer, Emotion Sequence, Gait Pattern, GPS, Gyroscope, Image Context, Location Pattern, Mobile Authentication.**

I. INTRODUCTION

Day-by-day there is increment in the usage of mobile phones. Mobile user varies from business man to general people. Many companies are launching mobile phones with new features for meeting the purpose of the customers. Some people use it as multimedia devices, some for business needs and some for study purpose. Business man carries important mails and documents related to business whereas a general person carries personal pictures and videos of family members.

A mobile Traditional authentication technique in mobile devices does not use the combination of user bio-metrics, environmental information and information provided by the sensor within the pervasive system. So to make authentication more powerful we are providing pervasive authentication for mobile devices, a four way fusion technique wherein the authentication will be provided based on the location traces, image context and emotions of user and gait pattern. In this technique user is not required to remember alphanumeric password. The location traces, gait pattern, emotion of user and context of an image is used as metric for authentication. This system silently does authentication using location traces and gait pattern of its user. If the silent authentication fails then system authenticates its users based on user's emotion sequence and an image context previously stored by the user.

A. Scope

1. Fusion of four authentication techniques making mobile devices highly secured.
2. Silent authentication technique to prevent the user remembering an alphanumeric password.
3. Continuous authentication training in background.
4. Making authentication process easy and intelligent.

B. Objective

1. To collect the gait pattern data using accelerometer and gyroscope. And trained the system to learn about its user.
2. To collect the location traces of the user and make the system to learn the location pattern of its user.
3. To create emotion database by collecting emotion data from user and create emotion password with sequence of emotion provided by user.
4. To create context knowledge base by collecting pictures

II. SYSTEM OVERVIEW

In four-way authentication system, the system will initially learn user's gait and location pattern. During learning phase, it build the predictive model based on previous data. During authentication phase, it will compare the current user's pattern with predictive model and if the pattern is matched, then mobile will be unlocked. This authentication technique comes under silent authentication where user is not supposed to give any input. If this authentication technique fails to authenticate, then system will check for user's emotion sequence where system will verify user's emotions. Even if this technique fails to authenticate, then system will ask user to describe image context for authentication.

This system will work in hierarchy manner. It is shown in Fig.1.

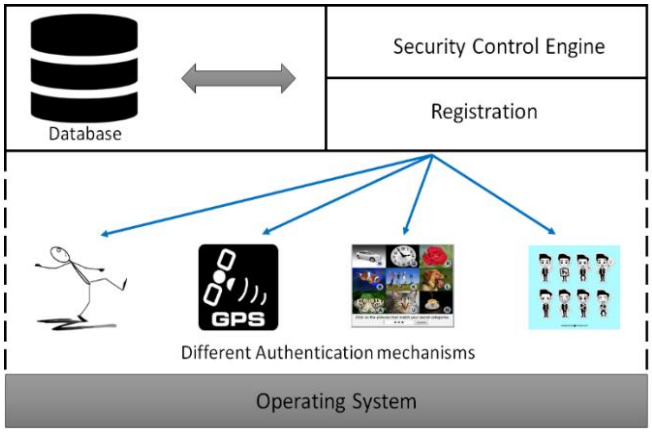

Fig.1 System Architecture

Shubham Devidas Raut, Computer Department, Savitribai Phule Pune University, Kopargaon, India, +91 9881194154.
Nilesh Kashinath Shinkar, Computer Department, Savitribai Phule Pune University, Kopargaon, India, +91 8149076967.
Dhananjay Dnyaneshwar Sathe, Computer Department, Savitribai Phule Pune University, Kopargaon, India, +91 7330368699.
Lalit Onkar Nehete, Computer Department, Savitribai Phule Pune University, Kopargaon, India, +91 86800589697.
Amey Avinash More, Computer Department, Savitribai Phule Pune University, Kopargaon, India, +91 8624819532.
Prof. Hitesh Mohapatra, Asst. Professor in Computer Department, Savitribai Phule Pune University, Kopargaon, India, +91 9028940285.

A. Security Control Engine

Security control engine is an algorithm which will take the efforts in executing authentication hierarchy. If gait authentication fails, then location pattern. If location pattern fails, then emotion and so on with the last one as alphanumeric password. It will match the present and past data to verify whether the user is legitimate or illegitimate.

B. Registration

User will register himself with registration module. He can access and change the settings as per his choice with registration phase.

C. Authentication Techniques

There is the fusion of four authentication techniques viz. `Gait', `Location', `Emotion' and `Image Context'. Gait and location based authentication falls under silent authentication phase. Emotion and image context base authentication falls under input based authentication.

D. Gait Pattern

Gait implies the rate of moving, running or walking. Integrated accelerometer of mobile can be used to collect human motion data. The data can be collected while performing daily activities like walking, climbing stairs, the way of handling mobile, etc. Then the collected Data (signals) can be processed and converted/transformed into unique patterns that can used to differentiate the owner and intruder.[2]

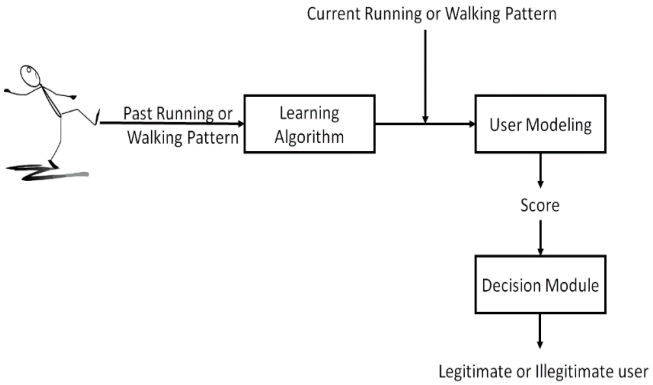

Fig. 2 Gait Pattern

E. Location Pattern

Location traces with respect to time can used to differentiate between legitimate and illegitimate user. With the help of GPS, user location can be traced. Collected location traces and time information will be used as location parameters. There will be two location parameters, one will be based on the list of frequent visited locations and the second on the time. System will be adaptive and will update with time.[3]

F. Emotion Sequence

Facial expression gives rich information about the particular user and can be used as a type of authentication for mobile devices. Emotions like happiness, sadness, angry, surprise, fear, etc. are unique for specific user. A particular sequence of emotion can be given and user needs to enter the emotions in that sequence only. If the sequence and emotion gets matched, the user can be authenticated.[4]

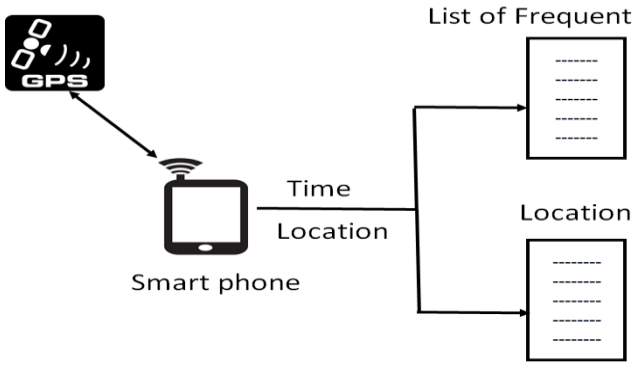

Fig. 3 Location Pattern

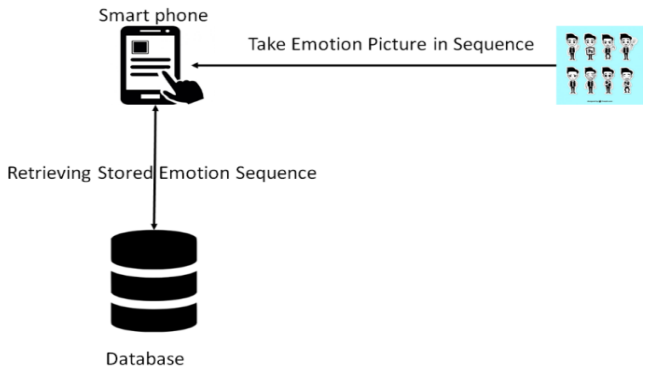

Fig. 4 Emotion Sequence

G. Image Context

The picture based authentication techniques are of two type's viz. Recognition based and Recall based. In recognition based, user needs to select the image given at the registration phase and if it matches then he is authenticated. In recall based technique, the user is asked to reproduce something w.r.t the image given at registration phase. Hence, one of the technique can adopted over traditional alphanumeric authentication technique.[5]

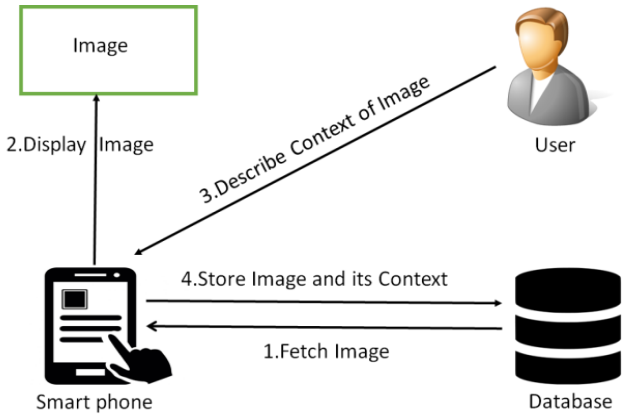

Fig. 5 Image Context

III. ALGORITHMS USED FOR IMPLEMETATION

A. Decision Tree Algorithm (J48)

J48 classifier is a simple C4.5 decision tree for classification. It is basically used for Gait Pattern. It creates a binary tree. The decision tree approach is most useful in classification problem. With this technique, a tree is constructed to model the classification process.

Algorithm [1] J48:
INPUT:
D //Training data
OUTPUT
T //Decision tree
DTBUILD (*D)
{
T=φ;
T= Create root node and label with splitting attribute;
T= Add arc to root node for each split predicate and Label;
For each arc do
D= Database created by applying splitting Predicate to D;
If stopping point reached for this path, then
T'= create leaf node and label with appropriate class;
Else
T'= DTBUILD(D);
T= add T' to arc;
}
While building a tree, J48 ignores the missing values i.e. the value for that item can be predicted based on what is known about the attribute values for the other records. The basic idea is to divide the data into range based on the attribute values for that item that are found in the training sample.

B. Geolocation Algorithm

In Location pattern we uses Geolocation algorithm. For Geolocation we will use Google play services to get the location using play services. By using Eclipse we can create GPS manager class.
Writing GPS Manager Class:

1. Create a new class and name it as GPSTracker.java and extend the calls from Service. Also implement this class from LocationListener.
   Public class GPSTracker extends Service implements LocationListner {
2. Add the required global variables and a constructor for this class.
   public class GPSTracker extends Service implements LocationListener {
   private final Context mContext;
   // flag for GPS status
   boolean isGPSEnabled = false;
   // flag for network status
   boolean isNetworkEnabled = false;
   boolean canGetLocation = false;
   Location location; // location
   double latitude; // latitude
   double longitude; // longitude
   // The minimum distance to change Updates in meters
   Private static final long MIN_DISTANCE_CHANGE_FOR_UPDATES = 10;
   // 10 meters
   // The minimum time between updates in milliseconds
   private static final long MIN_TIME_BW_UPDATES = 1000 * 60 * 1; // 1 minute
   // Declaring a Location Manager
   protected LocationManager locationManager;
   public GPSTracker(Context context) {
   this.mContext = context;
   getLocation();
   }
3. Getting user's current location (Latitude and Longitude)
4. Prompting user to turn on GPS.[8]

C. PCA Algorithm (Principal Component Analysis)

The main goal of a PCA analysis is to identify patterns in data; PCA aims to detect the correlation between variables. If a strong correlation between variables exists, the attempt to reduce the dimensionality only makes sense. In a nutshell, this is what PCA is all about: Finding the directions of maximum variance in high dimensional data and project it onto a smaller dimensional subspace while retaining most of the information.
PCA generally used for Emotion Sequence.
Six general steps for performing a principal component analysis:

1. Take the whole dataset consisting of dd-dimensional samples ignoring the class labels.
2. Compute the dd-dimensional mean vector (i.e., the means for every dimension of the whole dataset).
3. Compute the scatter matrix (alternatively, the covariance matrix) of the whole data set.
4. Compute eigenvectors (ee1,ee2,...,eedee1,ee2,...,eed) and corresponding eigenvalues (λ1,λλ2,...,λλdλλ1,λλ2,..,λλd)
5. Sort the eigenvectors by decreasing eigenvalues and choose kk eigenvectors with the largest eigenvalues to form a d×kd×k dimensional matrix WWWW (where every column represents an eigenvector).
6. Use this d×kd×k eigenvector matrix to transform the samples onto the new subspace. This can be summarized by equation: yy=WWT×xxyy=WWT×xx (where xxxx is a d×1d×1-dimensional vector representing one sample,
7. and yyyy is the transformed k×1k×1-dimensional sample in the new subspace.).

D. Naive Bayes Algorithm

It is a classification technique based on Bayes Theorem with an assumption of independence among predictors. In simple terms, a Naive Bayes classifier assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature. For example, a fruit may be considered to be an apple if it is red, round, and about three inches in diameter. Even if these features depend on each other or upon the existence of the other features, all of these properties independently contribute to the probability that this fruit is an apple and that is why it is known as 'Naive'.
Naive Bayes model is easy to build and particularly useful for very large data sets. Along with simplicity, Naive Bayes is known to outperform even highly sophisticated classification methods.

Bayes theorem provides a way of calculating posterior probability P(c|x) from P(c), P(x) and P(x|c). Look at the equation below:

$$P(c|x) = \frac{P(x|c)P(c)}{P(x)} \qquad (1)$$

$$P(c|x) = P(x_1|c) * P(x_2|c) \ldots\ldots * P(x_n|c) * P(c) \qquad (2)$$

Where,
P(c|x) is the posterior probability of class (c, target) given predictor (x, attributes).
P(c) is the prior probability of class.
P(x|c) is the likelihood which is the probability of predictor given class.
P(x) is the prior probability of predictor.

IV. CONCLUSION

The integrated authentication approach is an adaptive technique better than traditional authentication mechanism. Gait and location pattern enables silent authentication, authentication without any input from user. Hence, alphanumeric password unlikely to be needed frequently. Emotion based authentication authenticates the system with user's emotion as an input. Image context asks user to describe the image know to him. Thus, this authentication is personal to user and cannot be intruded. So, this authentication mechanism can be used in android based smart phones for high-end and dynamic security.

In certain cases, the existing gait pattern and location pattern algorithms may face some problems. For indoor positioning system, GPS will not give better accuracy.

And in case of gait pattern, Due to newly updating data, System will take too much time to adopt it. So there will be too much load on system. And in image context existing algorithm is having a good successor rate. Due to data scarcity Naive Bayes algorithm may give bad results. PCA algorithm which is used in Emotion sequence assumes approximate normality of input space distribution. But in future we will make something new which helps to get better results than existing system.

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Prof.Hitesh Mohapatra currently working as Asst. Professor at Sanjivani college of Engineering. He has total 8 yrs. of experience both in teaching and corporate. So far he published 7 international journal and 3 national level conference paper. He has B.Tech (IT) and M.Tech (CSE) as qualification. He also wrote a book on software engineering which is under review. His area of interest is wireless sensor network and software engineering

Mr Shubham Devidas Raut currently pursuing BE Computer Engineering in Sanjivani college of Engineering, Kopargaon

Mr Nilesh Kashinath Shinkar currently pursuing BE Computer Engineering in Sanjivani college of Engineering, Kopargaon

Mr Dhananjay Dnyaneshwar Sathe currently pursuing BE Computer Engineering in Sanjivani college of Engineering, Kopargaon

Mr Lalit Onkar Nehete currently pursuing BE Computer Engineering in Sanjivani college of Engineering, Kopargaon

Mr Amey Avinash More currently pursuing BE Computer Engineering in Sanjivani college of Engineering, Kopargaon