Introduction:

Nowadays, automatic personal identification in access control has become popular by using biometrics data instead of using cards, passwords or pattern. And, the target objects have to touch with the required hardware in the stage of data collection. The advantage of this system is that face recognition, which does not require any physical contact. Face is detected automatically by using principle component analysis (PCA) technique. Face detection is the first step of the face recognition system. PCA is an effective feature extraction method based on face as a global feature. It reduces the dimension of images effectively and holds the primary information at the same time. We are implementing PCA algorithm using JAVA programming. USB cable is used as interface between PC and Arduino UNO hardware kit. Web camera is used to take the picture of the person entering the home. Servo motor is used for opening and closing of the door along with pressure sensor. If any unauthorized person tries to forcefully open then pressure will be sensed by the door and buzzer will buzz.

Objective:

Most doors are controlled by persons with the use of keys, security cards, password or pattern to open the door. The aim of this proposal is to help the users to enhance the door security of sensitive locations by using face detection and recognition. This project consists of mainly three subsystems: namely face detection, face recognition and access to door control. Face detection is the process of detecting the region of face in an image. The face recognition is implemented by using the Principal Component Analysis (PCA). Face Recognition based on PCA is generally referred to as the use of Eigen faces. If a face is recognized, it is known, else it is unknown. Buzzer will buzz for the unknown person. Since PCA reduces the dimensions of face images without losing important features, facial images for many people can be stored in the database. Although many training images are used, computational efficiency cannot be decreased significantly.

Methodology:

The overall working of system is described briefly in below flowchart.
Software designing:

To extract the relevant features of facial images, Principal Component Analysis (PCA) method is used. Face Recognition based on PCA is generally referred to as the use of Eigen-faces. Eigen faces are Principal Components of the distribution of faces, or equivalently, the Eigen vectors of the covariance matrix of the set of the training images, where an image with N by N pixels is considered as a point in N2dimensional space [5]. The PCA algorithm is shown in the following steps:

Step-1. Firstly, the image matrix I of size (N x N) pixels is converted to the image vector \( \Gamma \) of size \( (P \times 1) \) where \( P = (N \times N) \).

Training Set: \( \Gamma = [\Gamma_1 \Gamma_2 \ldots \Gamma_M] \)

Step-2. Average face image is calculated by

\[ \psi = \frac{1}{M} \sum_{i=0}^{M} \Gamma_i \]

Each face differs from the average by

\[ \Phi_i = \Gamma_i - \psi \]

Difference Matrix: \( A = [\Phi_1 \Phi_2 \ldots \Phi_M] \)

Step-3. A covariance matrix is constructed as:

\[ C = A A^T \]

where size of C is \( (P \times P) \).

This covariance matrix is very hard to work with due to its huge dimension that causes computational complexity.

The covariance matrix with reduced dimensionality is

\[ L = A^T A \]

where size of L is \( (M \times M) \).

Step-4: Calculate the eigen vector from the obtained covariance matrix.

Step-5: Select ‘k’ best eigen-faces, such that \( k < M \) and can represent the whole training set.

Step-6: Convert lower dimensional ‘k’ Eigen vector to original face dimensionality.

\[ B = A \times L \]

Step-7: Represent each face image a linear combination of all ‘k’ eigen vectors. In this step we get weight vector for each image.
Step-8: The weight vector of input image is determined in the same way as explained in the above steps.

Step-9: The weight vector of input image is compared with the weight vector of every image and the Euclid distance is calculated. If the distance is within the threshold range then a positive signal will be sent to the hardware part to open the door.

Hardware designing:
The hardware configuration of this system is composed of Ardiumo Uno (ATmega 328P, Atmega 168P), Servo motor, Pressure sensor, Web camera, Buzzer USB to RS232 converter is used as the interface between personal computer and the Ardiumo UNO.

Figure [2]: Block Diagram

a. **Ardiumo UNO**: The ATmega48A/PA/88A/PA/168A/PA/328/P provides the following features: 4K/8Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 256/512/512/1Kbytes EEPROM, 512/1K/1K/2Kbytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte-oriented 2-wire Serial Interface, an SPI serial port, a 6-channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), a programmable Watchdog Timer with internal Oscillator, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, USART, 2-wire Serial Interface, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption.

b. **Servo motor**: A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft. Standard servo can rotate approximately 120 degrees (60 in each direction).
c. **Pressure sensor:** A pressure sensor is a device for pressure measurement of gases or liquids. Pressure is stated in terms of force per unit area. A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed. For the purposes of this article, such a signal is electrical.

d. **Buzzer:** A buzzer is an audio signaling device which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

e. **Web camera:** A webcam is a video camera that feeds or streams its image in real time to or through a computer to a computer network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks.

**RESULTS AND CONCLUSION:**

In PCA based face recognition, increase in the number of Eigen value will increase the recognition rate. However, the recognition rate saturates after a certain amount of increase in the Eigen value. Increasing the number of images and variety of sample images in the covariance matrix increases the recognition rate however noisy image decrease the recognition accuracy. In general, the image size is not important for a PCA based face recognition system. Expression and pose have minimal effect to the recognition rate while illumination has great impact on the recognition accuracy. As such, continuous works have been carried out in order to achieve satisfactory results of face recognition system. All these discussion provide useful performance evaluation criteria for optimal design and testing of human face recognition system.

   a. The image of the person is captured with the help of Web camera which is connected to the Arduino UNO.
   b. An alert message is sent to the owner if any unauthorized person tries to open the door forcefully.

This paper presents a system that can authenticate a person based on his facial pattern. Two main possibilities have been taken care of here like,

   a. When the match is found in database, the door opens automatically.
   b. When the match is not found in the database and the person is found to trying to break in, then the system will generate some kind of alert and specific message will be sent to the owner using SMS gateway.

**Scope for future work:**

   a. In order to prevent the frauds of ATM in India, it is recommended to prepare the database of all ATM customers with the banks in India & deployment of high resolution camera and face recognition software at all ATMs. So, whenever user will enter in ATM his photograph will be taken to permit the access after it is being matched with stored photo from the database.
   b. Duplicate voter are being reported in India. To prevent this, a database of all voters, of course, of all constituencies, is recommended to be prepared. Then at the time of voting the resolution camera and face recognition equipped of voting site will accept a subject face 100% and generates the recognition for voting if match is found.
   c. Passport and visa verification can also be done using face recognition technology as explained above.
   d. In defense ministry and all other important places the face technology can be deployed for better security.
e. It can also be deployed in police station to identify and verify the criminal