FACIAL RECOGNITION BASED SMART DOOR

PROJECT REPORT

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by

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CERTIFICATE

This is to certify that the project entitled

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Submitted by

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is a bonafide record of the work done by him.

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ABSTRACT

This research designs face detection and recognition systems for smart home security application. The design is implemented using raspberry pie.. The image of a person is acquired via webcam connected to raspberry pieusing USB cable. The face detection system is built based on the template matching, while the face recognition is based on the principle component analysis. The testing is done to examine the performance of the face detection in various change of distance, light intensity, light position angles, person's accessories and shirt colour. The face detection modul has good performance in some conditions as distance between the person and the camera is less than 240 cm, person doesn't use accessories that cover part of face, person doesn't use shirt with colour similar to skin colour, and background colour is difference from skin colour. While the face recognition system has 80% of accuracy when it is tested using realtime image. The combination with password is needed in order to increase the security level as it is applied in real smart home security systems.

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1 INTRODUCTION

Home security becomes one of the important things that must be considered by the community as well as in the smart home systems. Home security system currently used, is a conventional home security system, that is a security system with a mechanical system that requires users to always use the key to open or close the door. This makes the home security level is low due to several factors, namely: the ease of duplication of keys, the probability of a lost key or changing hands, and others. In addition to the low security side, the use of conventional security systems is also considered less effective and efficient. This is because the user is required to open the door by first inserting the key into the key's mother then turning the key in a certain direction so that the door can be opened. The process of opening the door is long enough, this makes the conventional security system becomes ineffective and inefficient. Therefore, it is needed a home security system which is more effective, efficient and has a high level of security.

Home security system can be developed by using face recognition method. Face is used as a key to access home. By using real face, the process of opening the door will be more effective and efficient because it just needs to direct a face on the camera, so the camera can identify whether the person is allowed for coming in or not. By using the face, the level of security becomes higher because the face can not be duplicated as well as changed hands.

2 LITARATURE SURVEY

No	Developers	Working	Disadvantages
1	Hteik Htar Lwin & et L.Have	The door will open automatically for the known person due to the command of the microcontroller.	Input images are taken through a web camera continuously until the 'stop camera' button is pressed
2	Sadeque Reza Khan and et al. Have	It collects information from the sensors, makes a decision and sends SMS to a corresponding number by using a GSM modem.	Require extra hardware components like Sensors, GSM Modem. Alerts are sent through only SMS.
3	B. Udaya Kumar and et al.	The detection of the intruder motion, gas leakage detection and visual surveillance of the home were provided with the help of Passive Infrared Sensor (PIR), Gas sensor (GH-312) and Camera (LS-Y201).	Multiple micro controllers are used, usage of ZigBee based network to communicate with the base station is limited to 100-150 meters long distance only.
4	J. Shankar Kartik and et al. Have	based on GSM technology and other uses web camera to detect the intruder	Require extra hardware components, limited to 100-150 meters long distance only.
5	Jayashri Bangali and et al.	It collects information from the sensors, makes a decision and sends SMS to a corresponding number by using a GSM modem. If it finds any interruption in its sensors (for example IR sensor) then microcontroller will send a SMS to the home owner.	Security alerts are sent by extra GSM Modem not from the internet.

3 SYSTEM ARCHITECTURE

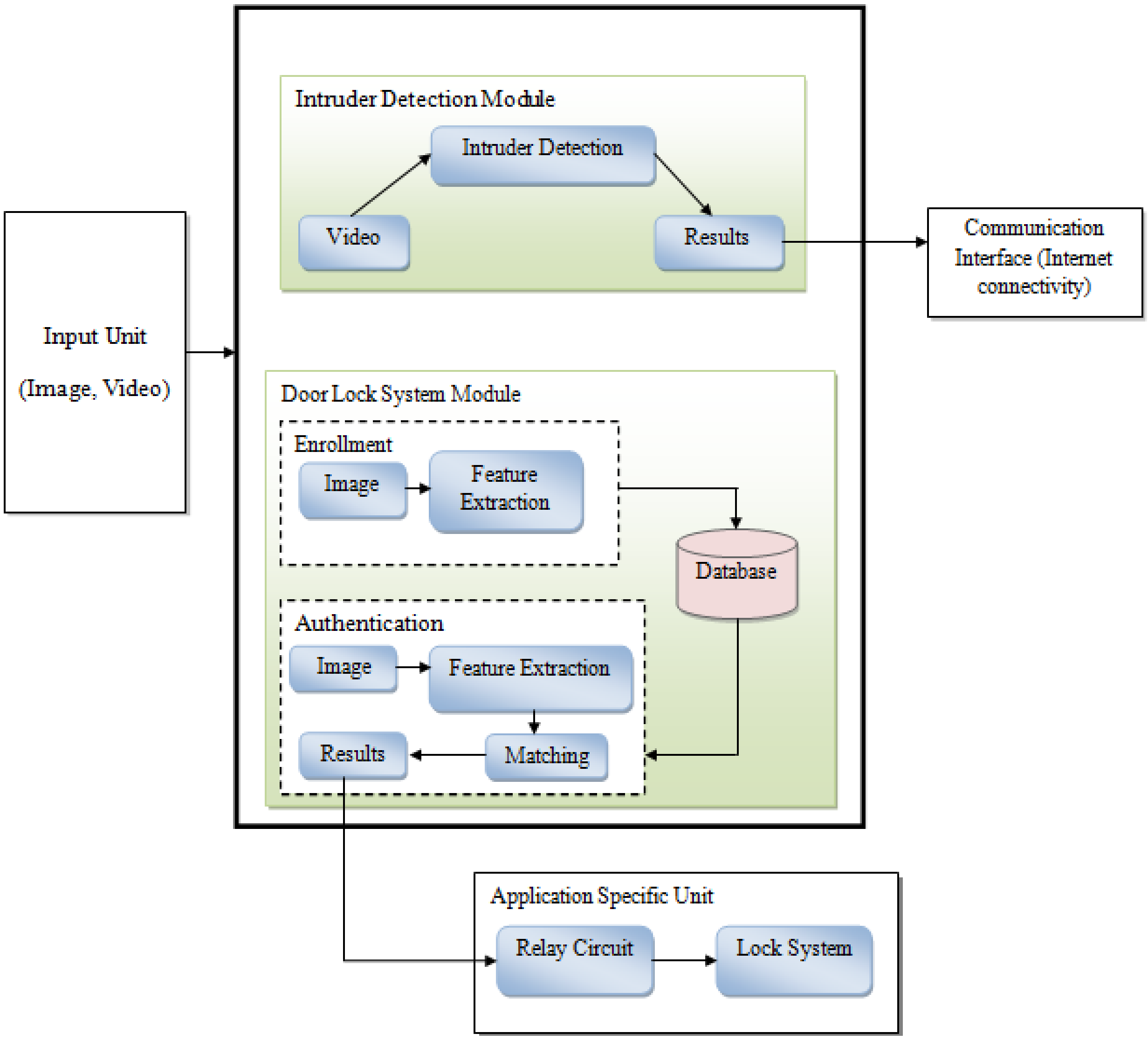

Figure 3.1: System Arcitecture

4 COMPONENTS

4.1 HAAR CLASSIFIERS

Haar-like features are digital image features used in object recognitionHistorically, working with only image intensities (i.e., the RGB pixel values at each and every pixel of image) made the task of feature calculation computationally expensive. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums. This difference is then used to categorize subsections of an image. For example, let us say we have an image database with human faces. It is a common observation that among all faces the region of the eyes is darker than the region of the cheeks. Therefore a common Haar feature for face detection is a set of two adjacent rectangles that lie above the eye and the cheek region. The position of these rectangles is defined relative to a detection window that acts like a bounding box to the target object (the face in this case).

In the detection phase of the Viola–Jones object detection framework, a window of the target size is moved over the input image, and for each subsection of the image the Haar-like feature is calculated. This difference is then compared to a learned threshold that separates non-objects from objects. Because such a Haar-like feature is only a weak learner or classifier (its detection quality is slightly better than random guessing) a large number of Haar-like features are necessary to describe an object with sufficient accuracy. The key advantage of a Haar-like feature over most other features is its calculation speed. Due to the use of integral images, a Haar-like feature of any size can be calculated in constant time (approximately 60 microprocessor instructions for a 2-rectangle feature).The key advantage of a Haar-like feature over most other features is its calculation speed. Due to the use of integral images, a Haar-like feature of any size can be calculated in constant time (approximately 60 microprocessor instructions for a 2-rectangle feature).

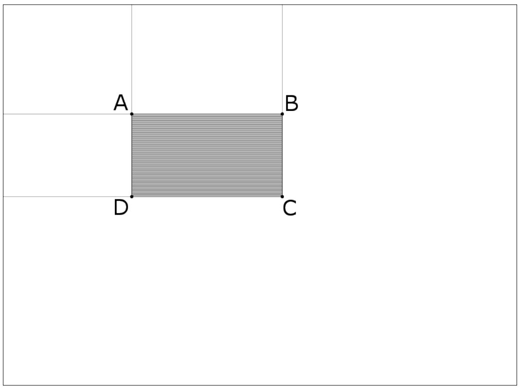

Figure 4.1: Finding the sum of the shaded rectangular area

One of the contributions of Viola and Jones was to use summed-area tables, which they called integral images. Integral images can be defined as two-dimensional lookup tables in the form of a matrix with the same size of the original image. Each element of the integral image contains the sum of all pixels located on the up-left region of the original image (in relation to the element's position). This allows to compute sum of rectangular areas in the image, at any position or scale, using only four lookups

$$sum = I(C) + I(A) - I(B) - I(D) \tag{1}$$

where points A , B , C , D belong to the integral image I , as shown in the figure.

4.2 SIAMESE NEURAL NETWORKS

Siamese neural network is a class of neural network architectures that contain two or more identical subnetworks. identical here means they have the same configuration with the same parameters and weights. Parameter updating is mirrored across both subnetworks. Siamese NNs are popular among tasks that involve finding similarity or a relationship between two comparable things. Some examples are paraphrase scoring, where the inputs are two sentences and the output is a score of how similar they are; or signature verification, where figure out whether two signatures are from the same person. Generally, in such tasks, two identical subnetworks are used to process the two inputs, and another module will take their outputs and produce the final output. The picture below is from Bromley et al (1993)[1]. They proposed a Siamese architecture for the signature verification task.

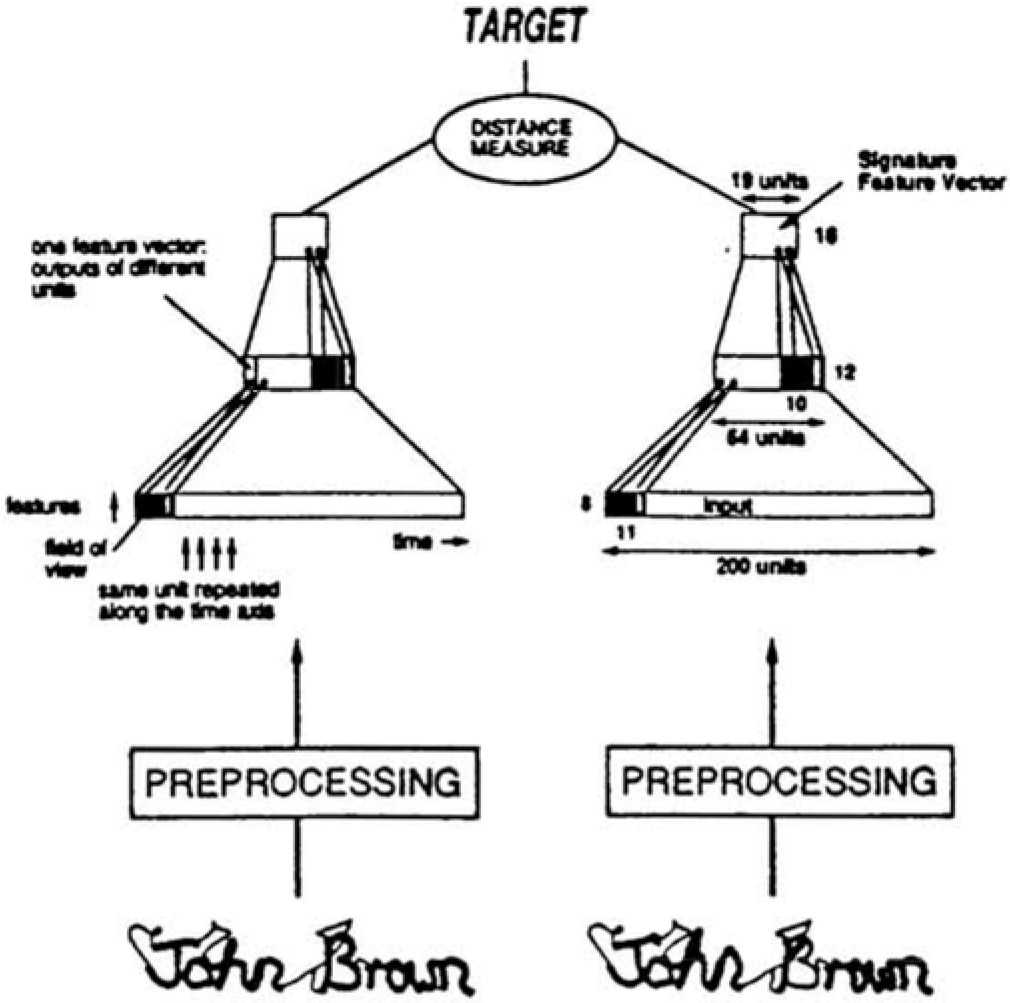

Figure 4.2: Siamese Neural Networks

4.3 PRINCIPAL COMPONENT ANALYSIS

Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables (entities each of which takes on various numerical values) into a set of values of linearly uncorrelated variables called principal components. If there are n observations with p variables, then the number of distinct principal components is min ($n - 1$, p) . This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to the preceding components. The resulting vectors (each being a linear combination of the variables and containing n observations) are an uncorrelated orthogonal basis set. PCA is sensitive to the relative scaling of the original variables. PCA is mostly used as a tool in exploratory data analysis and for making predictive models. It is often used to visualize genetic distance and relatedness between populations. PCA can be done by eigenvalue decomposition of a data covariance (or correlation) matrix or singular value decomposition of a data matrix, usually after a normalization step of the initial data. The normalization of each attribute consists of mean centering – subtracting each data value from its variable's measured mean so that its empirical mean (average) is zero – and, possibly, normalizing each variable's variance to make it equal to 1; see Z-scores.[4] The results of a PCA are usually discussed in terms of component scores, sometimes called factor scores (the transformed variable values corresponding to a particular data point), and loadings (the weight by which each standardized original variable should be multiplied to get the component score).[5] If component scores are standardized to unit variance loadings must contain the data variance in them (and that is the magnitude of eigenvalues). If component scores are not standardized (therefore they contain the data variance) then loadings must be unit-scaled, ("normalized") and these weights are called eigenvectors; they are the cosines of orthogonal rotation of variables into principal components or back. PCA is the simplest of the true eigenvector-based multivariate analyses. Often, its operation can be thought of as revealing the internal structure of the data in a way that best explains the variance in the data. If a multivariate dataset is visualised as a set of coordinates in a high-dimensional data space (1 axis per variable), PCA can supply the user with a lower-dimensional picture, a projection of this object when viewed from its most informative viewpoint[citation needed]. This is done by using only the first few principal components so that the dimensionality of the transformed data is reduced.

4.4 CONTRASITIVE LOSS

A contrastive loss function is employed to learn the parameters W of a parameterizedfunction GW, in such a way that neighborsare pulled together and non-neighborsare pushed apart. Priorknowledgecan be used to identify the neighbors for each training data point. The method uses an energy based model that uses the given neighborhood relationships to learn the mapping function. For a family of functions G, parameterized by W, the objective is to find a value of W that maps a set of high dimensional inputs to the manifold such that the euclidean distance between points on the manifold,

$$D_w(\overrightarrow{X_1}\overrightarrow{X_2}) = ||G_w(\overrightarrow{X_1}) - G_w(\overrightarrow{X_2})||_2 \tag{2}$$

approximates the ”semantic similarity” of the inputs in input space, as provided by a set of neighborhood relationships. No assumption is made about the function GW except that it is differentiable with respect to W.

5 HARDWARE SETUP

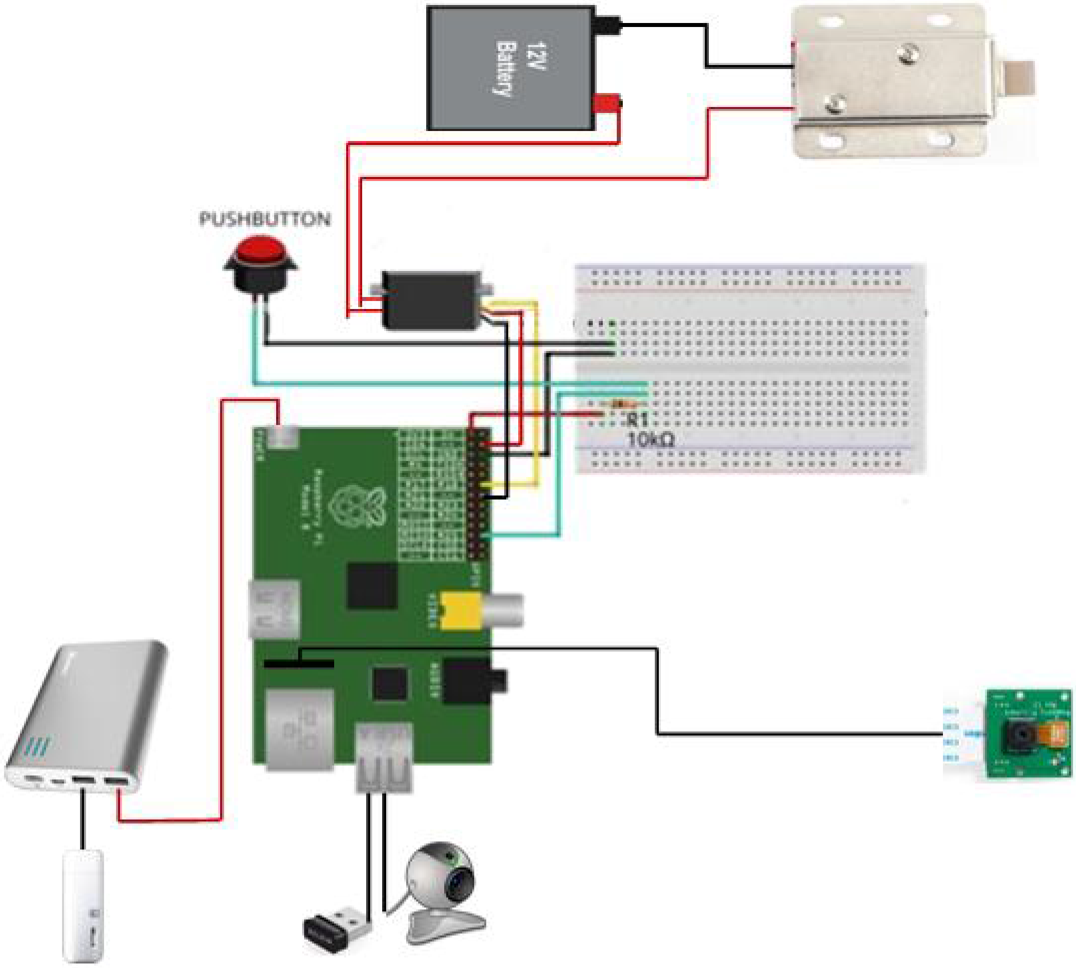

Figure 5.1: Hardware Setup

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