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DESIGN AND IMPLEMENTATION OF SMART SECURITY SYSTEM BASED ON ARTIFICIAL NEURAL NETWORK

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ABSTRACT

Visual surveillance are used in surveillance sensitive application like as borders, stores ,banks, crowded public places, highways, etc... Smart surveillance, is the use a technologies of automatic analysis of video surveillance. Due to the technology of smart surveillance being a critical security infrastructures component, the architecture of smart system assumes a critical importance. Artificial Neural Networks (ANN) shown a promise in a wide areas of applications. Their intrinsic parallelism and massive makes ANN proper to solve difficult problems in computer vision application sand image analysis, chiefly when environments of non-stationary is occur. This research aim to design and implement surveillance system for building and government complex to detect most threads that may be exposed. In this research, a smart video surveillance system has been designed to detect and track moving object (such as human or cars) in real time, beside recognized human faces and recognized cars license plate. The systems consist of two main parts: Surveillance visual system and license plate recognition (LPR) system. The surveillance camera system are consist of multi cameras which have been connected to monitoring server that contains a program employee the ANN for smart detection of threat such as motion detection, face recognition etc. LPR system consist of fast camera connected to computer that include program to detect license plate of car that pass the gate of institute and detect if it authorized or unauthorized

Keywords: security system, face recognition, artificial neural network, license plate recognition**.**

INTRODUCTION

Visual surveillance is a significant tool to improve privacy protection and public safety. It has widely used in homeland security interests like subway stations, airports, train and, city centres, etc. It is also been used in commercial and government places such as (parking areas, military bases, government complexes,supermarkets, automated teller machines (ATMs), banks, etc.) to track and prevent criminal activities. The video surveillance consumer adoptions in recent years have also been soared because of increase the concern on privacy protection. Figure-1 illustrated the video surveillance systems basic diagram of [1].

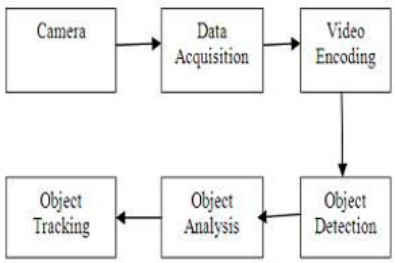


Figure-1. Basic diagram of video surveillance system.

Recent visual surveillance systems acquire attention in various field of computer vision. Intelligent visual surveillance systems (Automated visual surveillance systems) have more interest in the fields of personal assistance and security. It constitute a video sensors network to observing people as well as other interacting and moving objects in a given environment for patterns of interesting events, abnormal/normal activities, and other specific goals. These visual surveillance systems are designed in order to perform several tasks from human presence detection to recognition of their activities [3].

THEORETICAL BACKGROUND

The basic theoretical concepts relevant for the work can be described in follows:

A. Image enhancement: It is the process of modified picture in such way to improve or remove unwanted features like remove noise, separate edges etc. The aim of image processing is to simplify an image and prepared it to second stage (segmentation). There are many types of filters can be used in this process and the selection of proper method is depending on what we neeed to obtained and what should be get to simplified image to next step.

B. Segmentation: It is the process of separating a digital image into many segments (super pixels) which is sets of pixels. The aim of segmentation is to simplify image and/or change its representation into something that is much Easier and meaningful to analyze. The segmentation of image is generally used to locate boundaries and objects (curves, lines, etc.) in images. In specific, the segmentation is the process that assigning a label to each pixel in a digital image in which the pixels that that have same label have a certain visual characteristic. The image segmentation result is group of segments or a contour that can be extracted from the image [4].

C. Object and video recognition: in computer vision the object recognition is a very difficult task even it extremely trivial for humans that can recognize objects

even if they are scaled, rotated, partially obstructed from view or translated. Several approaches have been applied for recognition of object for single still images or video. A Neural Network (NN) is a computational or mathematical model that is inspired by functional aspects and the structure of biological NN. A Neural Network are composed of an artificial neurons interconnected group and it processes the information by using an approach of connection list to computation. Generally,the Neural Network is an adaptive system which changes its structure through internal or external information which is flow over the network during the phase of learning. Recently, ANN are statistical data nonlinear modeling tools, which are generally use to model some complicated relationships between outputs and inputs or to find patterns in data [5].We have been proposed a technique of supervised learning to recognition object in video sequences

SMART SURVEILLANCE APPLICATIONS

Smart surveillance technology applications can be group into three broad categories: situation awareness, automatic forensic video retrieval and real time alerts [6].

Real time alerts: smart surveillance system can be generated two types of alerts: automatic unusual activity alerts and user defined alerts.

A. User defined alerts: In these alerts the system need to recognize a many defined events of user that happen in the monitored field beside real time notification of the user. Consequently, this alert make the user enable to evaluate the situation and make a decision to preventive action if necessary. In follows some of typical events.

1. Generic alerts: These alerts are solely depending on the properties of objects movement within the monitoring zone. In follows some of main examples.

- **Object removal:** This alert detect user-specified movements which not expectant to move such as a painting or ancient in a museum.
- **Motion characteristic detection alerts:** It detects a many objects motion properties including bounds checking of object velocity (object moving very fast), object movement specific direction (entry over exit lane).
- **Motion detection alert:** It based on detection of any object movement within a monitoring zone.
- **Abandoned object:** It is detecting objects that are abandoned, e.g., a car parked in a loading zone or unattended baggage piece in an airport.

Class specific: These alerts are using the object type beside the properties of object movement. In follows a few general examples.

- **Statistics alerts:** it is a statistics applications such as, densities of people (example detect if the crowded reach unacceptable level) or people counts alerts (example if there is more than one person in security locker).
- **Detection of specific movement:** this alert detect some specific movement, such as camera that monitoring airport runways. In this case, the system give an alert when people are moving or presence on the tarmac but not the aircrafts.

High value video capture: It is an application that forceful alerts in real time through capturing video selected clips that is pre-specified criteria based. It is very relevant in the situation of smart camera networks that used a wireless communication

Behavioral alerts: It based on deviation from, or adherence to, motion patterns learnt models. These models are commonly trained through analyzing the movement patterns through a period of time. These alerts use a context information significant amount and tend to be very specific, for example.

- **Shopping groups detecting:** this alert using in retail checkout counters, it and when the queue length at a counter be over the specified number.
- **Suspicious behavior detecting:** example of this alert parking lots, when a person trying to open multiple cars.

B. Automatic unusual activity alerts: These alerts will be automatic generate alert when detect some behavior which was trained to know it. In this alert, the system give an alerts when any activity that deviates from the norm has been detects. To achieve this, the smart surveillance should be based on learning the patterns of normal activity. An example of this alert, a security system in streets which learns that “people move about on the side walk”and “vehicles move about on the road”. Thus when a car be on the sidewalk the system will generate an alert

Automatic Forensic Video Retrieval (AFVR): In this method ,the video (as footage) is processing to get features from it and then build a video index, so when an incident happen, the investigators can searches the video footage through checking available features. Examples of features that could be extracted automatically by a video retrieval system are color, size, type and shape of the object. It also could be contains object activity, objects temporal trajectories through time, and object identity if available. Some query example is to get all car footage that is color white in al jadrea -area street #18, at the section #923. For this type of surveillance systems, it could be save very large hours of video retrieval with ability to browsing and retrieve the desired footage in a large surveillance cameras network in extremely time consuming.

A. Mining video surveillance: In some incident, the mining surveillance video application is very helpful, for example when a crime happened, it could attempt to investigate present of users or cars incident crime locations, this give the investigative the ability to answer questions such as if there is a single car or person found in all of the incident locations.

B. Temporal- Spatiovideo retrieval: this will retrieve clips of video with some details through a period of time. For example need retrieve all video clips of a car

that color is red drove in front of al-Mansour mall between the "1th of January10am and 5th of February4pmwith a speeds >60Kph.

Awareness situation: To get a full security at a facility, the systems require having ability to permanently track vehicles or people activity, location and identity within the monitored space. Typically, the surveillance systems have focused on tracking activity and location, while biometrics systems will identify the individuals.

With improvement in smart surveillance technologies, it is possible to combine all these three methods into a single system that will give ability to builds a powerful surveillance system.

SMART SURVEILLANCE METHODS

In follows some of main methods and techniques that been used to design a smart surveillance system:

Behaviour analysis

Detecting moving objects in monitoring area such as vehicles and people is the basic step that commonly used in most vision system because it give a focus on attention andthesimplifies the processing steps of subsequent analysis. Because of dynamic changes in natural scenes like as weather changes and sudden illumination, the detection of motion been a difficult problem to process reliably. The common techniques used for detection of moving object are statistical methods, background subtraction, optical flow, and temporal differencing. In follows the descriptions of these techniques [6].

Background subtraction

This technique is generally used in segmentation of motion in static view. It endeavours to detect the area of moving object by subtracting image of current frame from a reference frame image (background image) with pixel-by-pixel subtraction. The reference image is creating by averaging an image in initialization period over time. Pixels that be in area where the difference is above the threshold will be classifying as a foreground. After generating map of foreground pixel, several post processing morphological operations like as closing, dilation and erosion are implement to decrease the noise effects and improve the detection regions. The reference image is updating over time with images to adjust with dynamic view changes.

Silven and Heikkilause the simplest way. Theyassume thepixel at (x, y) position in the current image been as foreground [7]:

$$\text{If } |I_t(x,y) - B_t(x,y)| > \tau \quad \ldots\ldots (1), \text{ is satisfied;}$$

Where: τ is the predefined threshold, B_t is the background image. The $B_t$will be updatingthroughusing an IIR filter (Infinite Impulse Response) that calculated as follows:

$$B_{t+1} = \alpha I_t + (1-\alpha)B_t \ldots\ldots (2)$$

Additionally, the techniques of background subtraction are proceed well for extracting major of the moving area relevant pixels.

Temporal differencing

This technique try to discover the moving area by calculate difference (pixel-by-pixel) of sequential frames in a video sequence and it's very adaptive to changes in dynamic scene. Nevertheless, it fails to find most relevant pixels of some moving objects types. Lipton has been presented a scheme of two-frame differencing in which the pixels will marked as foreground if it satisfy the following equation [6]:

$$|I_t(x,y) - I_{t-1}(x,y)| > \tau \quad (3)$$

This algorithm is segments moving object in video successfully without the defects of background subtraction and temporal differencing.

Statistical methods

This technique is more advanced than background subtraction methods, which used some of individual pixels statistical characteristics. It get over the lack of basic methods of background subtraction. Statistical methods are inspired mainly by methods of background subtraction in terms of dynamically updating and keeping the statistics of the pixels that belong to the background image process. To identify the foreground pixels, it comparing each statistics of pixel with the pixel of the background model. This method is become more prevalent because of its reliability with scenes that have an illumination changes, shadow and noise.

In this technique,each pixel is represented with its intensity values of maximum (N)and minimum (M) with a maximum intensity difference (D) between each sequential frames found through initial period of training where the scene includes no moving objects. The pixel classified as foreground in the current image when it satisfies [6]:

$$|M(x,y) - I_t(x,y)| > D(x,y) \ldots\ldots (4)$$

or

$$|N(x,y) - I_t(x,y)| > D(x,y) \ldots\ldots (5)$$

After thresholding, a morphological erosion single iteration is used to the found afore ground pixels to remove one pixel thick noise. A sequence of dilation and erosion performed foreground on the pixel map in order to increase the eroded regions to their original sizes. In addition, a small sized regions are discarded after applying connected component labeling to find the regions. The background pixels statistics that return to the nonmoving regions of present image are updated with a new image data.

Light and shadow change detection

This method are susceptible to both local changes (example: highlights and shadows) and global changes in illumination (e.g. sun being uncovered or covered by clouds). The shadows make the methods of motion detection unsuccessful to segmenting the moving objects only and make the upper classification to perform inaccurate.

Optical flow

These methods use a moving objects flow vectors through the time to determine the moving area in an image. They could be detect motion in a video sequences. Nevertheless, methods of optical flow are computationally complex, and need specialized hard ware to use in real-time.

Face cataloguer (Face recognition)

Different models and architectures of face recognition and detection has been improved in recent years. ANN is one of useful and efficient way that can be used in face recognition and detection due to it can simulate the human brain work. There are two dominant approaches to problem of face recognition: photometric (view based) and geometric (feature based). There are different ANN algorithms were developed; Omaima has been summarized the researches of face detection based on ANN as follows [7]:

Back Propagation Neural Networks (BPNN)

Multilayer back propagation neural networks (BPNN) has been widely used in pattern recognition due to relatively low computational requirement, fast and best recognition result. [8].

We have been presented a training methods based on BPNN. We trained network to detect selectable faces in different illumination conditions, and determined an empirical results on a large test set. Finally, we checked recognition results for faces that are in other illumination and orientation that are not trained for it.

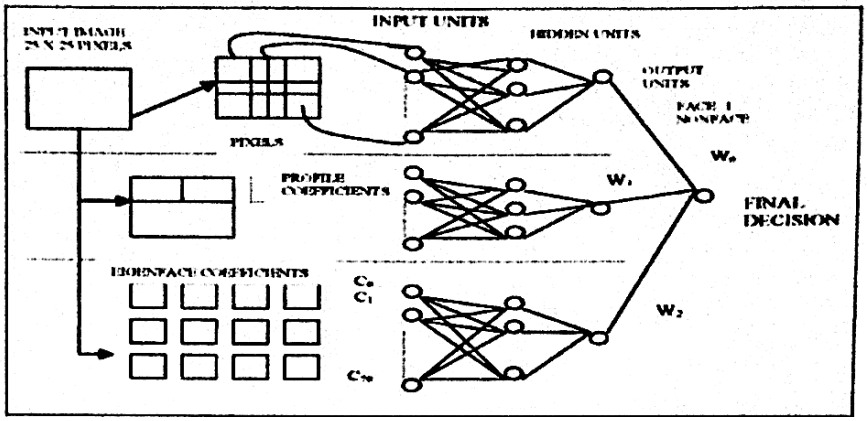


Figure-2.BPNN architecture for face detection [8].

Retinal Connected Neural Network (RCNN)

Face recognition that based on RCNN will check a small window of face image to determine if each window includes a face or not. Figure-2 illustrates RCNN approach.The RCNN training progresses used an algorithm of bootstrap for training NN to put detections false into the training set. This override the hard task of removing non-face features manually from training. At first, an image processing step is applied to an image window, and then it passed through a NN that determine if the window includes a face [9].

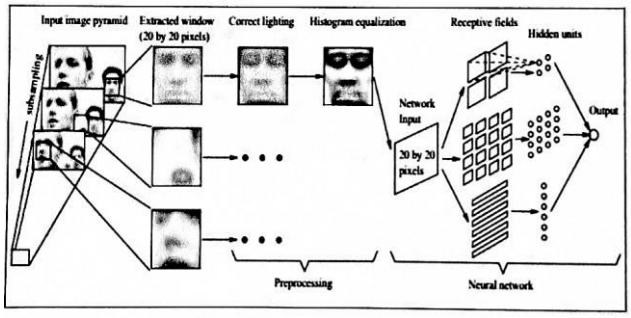


Figure-3.RCNN for face detection [9].

Rotation Invariant Neural Network (RINN)

RINN differs from other face recognition systems in face detection that the other methods have limitation in detection frontal or upright faces while RINN detects faces at any rotational degree in the image plane. The RINN used multi-networks; at first of this network is router network that preprocesses every input window to define its orientation then use it to prepare the window for one or

more networks. Figure-3 illustrated the RINNapproach [10].

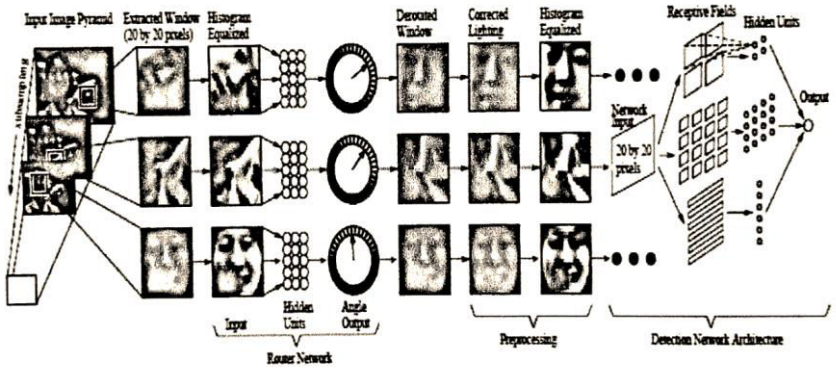


Figure-4. RINN for face detection [10].

Principal component analysis (PCA)

The PCA with class specific linear projection has been used to recognized and detect faces in video stream in real-time [11]. As shown in Figure-4.

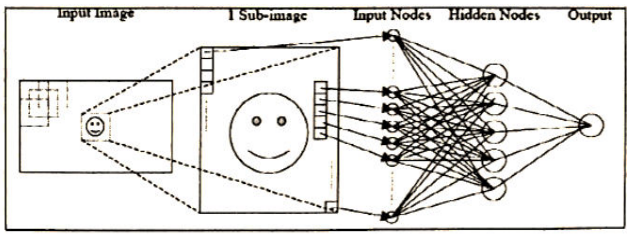


Figure-5. PCAand ANN for face detection [11].

Polynomial Neural Network (PNN)

In this method, the PNN classified the local regions of multi scale sliding windows by two classes (non-face and face) to determine the faces in an image. The PNN takes the projection binomials of local image onto a feature subspace learned by PCA as inputs. They determine the PCA effect of on either the pooled face or face samples and non-face samples [12].

Fast Neural Networks (FNN)

FNN has been used to minimize the computation time for detection the human faces. In this method, each image is divides into small sub images, then each one is separately tested by using a FNN [13]

The other method of face detection with ANN can summarize in follows [7]:

- Evolutionary Optimization of Neural Networks.
- Convolutional Neural Network (CNN).
- Multilayer Perceptron (MLP)
- Gabor Wavelet Faces with ANN
- Skin Color and BPNN
- Cascaded Neural Network

SMART SECURITY SYSTEM MODEL

The system is composed of a multiple cameras (Fixed, PTZ and fast), a strong computing device (workstation, high performance PC computer, etc.) a frame grabber and image analysis software and character recognition software. Software will be proposing with Matlab program, after practical experimental, we select the best algorithms, and it can be design as stand-alone software. The automatic visual analysis has been used not just to know what happen in the scene, but also automatically detected events or activities of interest. The system can be using for many applications. In this research, we focus on three categories:

a) **Behaviour analysis:** detection of moving object aims at segmenting moving regions such as humans and vehicles from the rest of an image. Restriction detection on moving object only will give a focus on this regains from later processes (like behaviour analysis and tracking) because these regions just need to be in consideration in that processes.

b) **Face recognition:** It is aims to capture a high-resolution images for face region of all people passing inside monitoring area .System will be tracks and detects people and using the PTZ cameras to move and zoom and capture a high resolution face pictures and then recognized them to identify are they strange or employers.

Licence plate recognition and driver Identification: The system will automatically detect moving car and then pre-process and detect the region of licence plate area to extract it and applying optical character recognition (OCR) to verify the plate number. For example, cars that reach checking point, the camera will capture front image for car, and then pre-processed the image and applying segmentation to extract only licence plate, then applying character recognition to identifying the plate number. The system will take car number then compared it with information saved in database to identify is it authorized or not then give an alarm if the number of car strange.

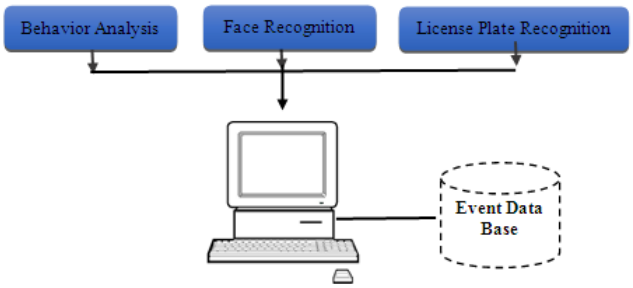


Figure-6. Smart security system architecture.

The video signal is first record then digitized and modeled. The next step is extracted features from the relevant parameters for recognition. These parameters are sent to a recognition module to identify each of categories. The database includes

Behaviour analysis algorithm

As described previously, there are numerous approaches for moving detection in a real time video stream. They are mostly based on comparison between current frames of video with first frame (background image), or with previous frames. In follows the algorithm of three method of behavior analysis has been described.

Background subtraction

Background Subtraction Algorithm

Step 1: Start.
Step 2: Conversion video in to frame.
Step 3: Pre-processing on each frame.
Step 4: Initialization of the background frame.
Step 5: Subtraction background frame from current frame.
Step 6: Segmentation using thresholding.
Step 7: Morphological filtering on the subtraction image.
Step 8: Moving object detect frame.

License plate recognition (LPR) and driver Identification

This research designed and implements an ANN based artificial vision system. The system is capable to analyses the car image captured by a camera, detect the license plate, extract it then recognize the car registration number.Figure-6 represents the sample design for LPR system.

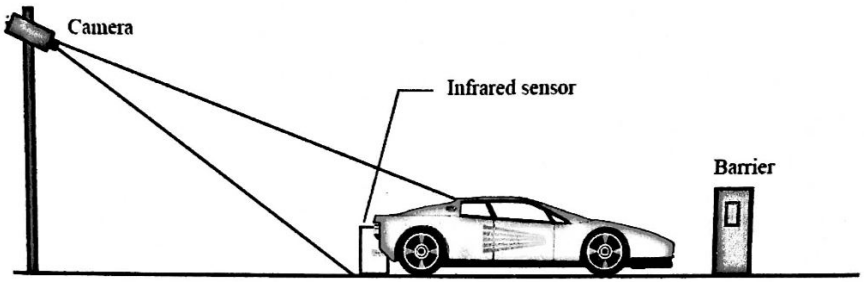


Figure-7. LPRSystem[13].

License plate recognition System Algorithm

a. Start.
b. Conversion video in to frame.
c. Request images (still images or fps from cam) by used open CV library.
d. Image preprocessing
a. Activate Noise Filter (Smoothing algorithm). And/ Or Activate Characters Noise Filter
b. Convert RGB image to Gray scaled image
c. Calling canny edge algorithm from Open Cv to determine edge of character.
d. Applying smoothing algorithm by calling smoothed with a Gaussian filter and adaptive noise filter to suppress noise.
e. Image segmentation
a. Get the characters object size range (minimum character length and area)
b. Generate scalar product of contours (complex number).
c. Get the minimum value of intercorrelation function and autocorrelation function.
d. Calculate intercorrelation function and autocorrelation.
e. Find contour of character and extract the outer contour of the binarized segment, by using chain approximation algorithm by calling CHAIN algorithm with used chin approximate as method with type LIST.
f. Filter co canny algorithm has been used to determine the edge of objects to apply on object.
g. Remove any noise. (Image enhancement algorithms).
h. Find the intensity gradient of the image.
i. calculate the offsets of the contour points by a clockwise step;
j. the output is a chain of sequential vectors normalized by their perimeters;

k. Compare the chain result to the set of patterns describing valid structures

f. Classifier training

a. Take characters dataset as input (Arabic and English letters and numbers data matrix).
b. Form network by setting its parameters (input layer, hidden layer units, output labels).
c. Load training data (input layer arrays, output labels).
d. Resize character image into 10x10 matrix
e. Read desired output labels (text) and its corresponding input layer arrays.
f. Random initialize weights within the specified ± weight-bias value.
g. for each character:
h. First: calculate the output of the FFNN.
i. Second: compare the output of the FFNN with the desired output corresponding to the character and then compute the error
j. back propagate error via each link to adjust the weights
k. go to the next character and repeat step 5 until all characters are visited
l. calculate the average error of all characters
m. repeat steps 5 and 8 until all patterns are correct
n. Is all patterns are correct? If so abort iteration
o. If not continue iteration
p. **License plate recognition**

a. Load plate images captured from video.
b. Applying preprocessing algorithms and recognition parameters:
c. Compere each separated object with pattern (weighted update file) and identify the best matching result for each character and get corresponding value (text).
d. Export text with image

Face cataloguer algorithm

As described previously, there are wide approaches of face detection in a real video stream. We focused on used BPNN. The method is composed of three stages: Preprocessing, artificial neural network classifying with backpropagation (ANN BP).Every stage receives, as its input, the output data from the previous stage. The first stage (preprocessing) receives as input the image where the faces should be detected. The last stage produces the desired output: a set of face-like images and its positions founded in the initial image.

Face Cataloguer Algorithm

Step 1: Start.
Step 2: Conversion video in to frame.
Step 3: Image Preprocessing

a. Color space transform from RGB to Grayscale.
b. Image region to pattern transformation.
c. Resized image to desired size (such as 128x128, etc.)
d. Generate input image data and output labels.

Step 4: Classifier training

a. Take face dataset as input16128 images*.
b. Define the learning parameters values(input layer sizes , output labels)
c. Set the initial update value to train the network.
d. initialize the Δ max to which is used to prevent the weights becoming too Large
e. initialize the Δ min to which is used to prevent the weights becoming too Small.
f. Implementing Feed-forward Computation.
g. Calculate the NN partial derivatives of cost function.
h. BP Algorithm)
i. Compute distance between each couple of face-like regions L on to obtain a matrix of distances.
j. Checking the Gradient
k. Reduce the Cost Function

Step 5: Image preprocessing

a. Every face has an associated face set.
b. For each face-like region, if the distance between it to the representing face of a face set is lesser than a given value, this face belongs to the face set.
c. Remove duplicate faces sets
d. Remove sets that are in included on other sets.
e. Compute the average value of every set averaging positions of the faces belonging to it.

Step 6: Weight Update

* Image that used as face input was taken from the Yale Face Database B for8 human front faces under 64 illumination and 9 poses conditions.

SIMULATION AND RESULTS

Simulation was taken out in Matlab and in order to simulate the analytics discussed previously. At first test behavior analysis methods and evaluate the best way depends on time of detection, accuracy, and computer requirement. In second part we used a face recognition system based on BP algorithm, and calculated the efficiency of this method.

The behavior analysis, face cataloguer and license plate program has been designed and tested by using a workstation laptop (HP elite book) with following specifications:

- CPU 2.3GHz Core i7
- RAM 32GB DDR3
- VGA NVidia Quadro 2000m (2GB)
- HDD SSD256GB
- OS Windows 10 64bit
- MATLAB® and Simulink® version 2015b

Behaviour analysis results

The motion detection in our test is based on used background subtraction type (non-recursive largest binary

blob finding) which give best result in surveillance applications. The result of detection applied in real time without any slowness and it detect multiple moving object in same time.

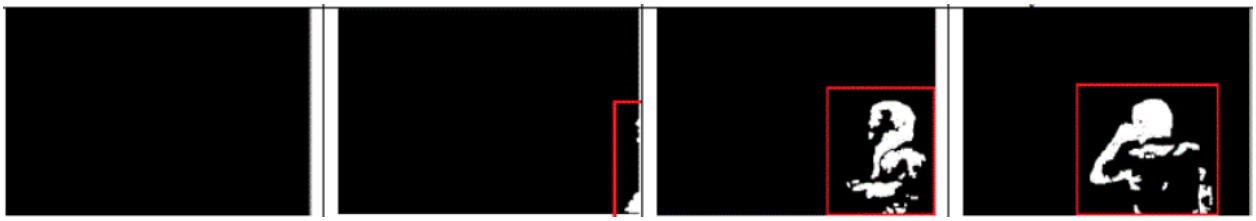


Figure-8. Detection results of moving human with some behaviour based on background subtraction.

Face cataloguer results

The training part of program load input data and randomly select 100 image as shown in Figure-3.7. There are 520 face image (65 for each person) has been used to build training data image, where each training image is an X pixel by Y pixel gray scale image of the digit. All facial images has been resized to (64x64, 128x128), the hidden layer used has been calculated from equation (Number of Neurons = (Input Layers + Output Layers) * 2/3 ()), which is(2736), and the number of iteration was 100.Each pixel is represented by a floating point number indicating the gray scale intensity at that location.

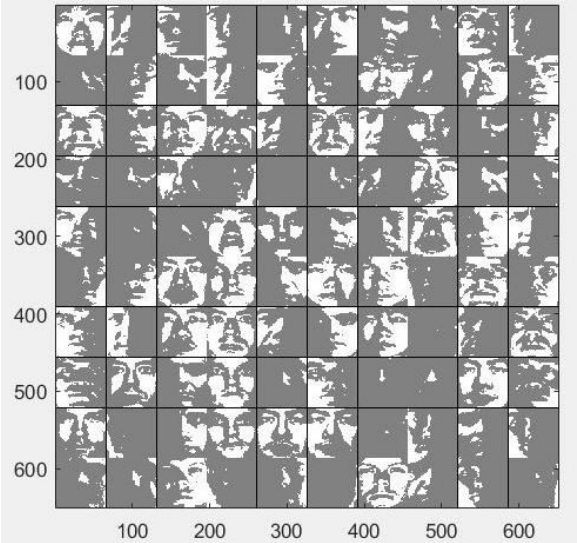


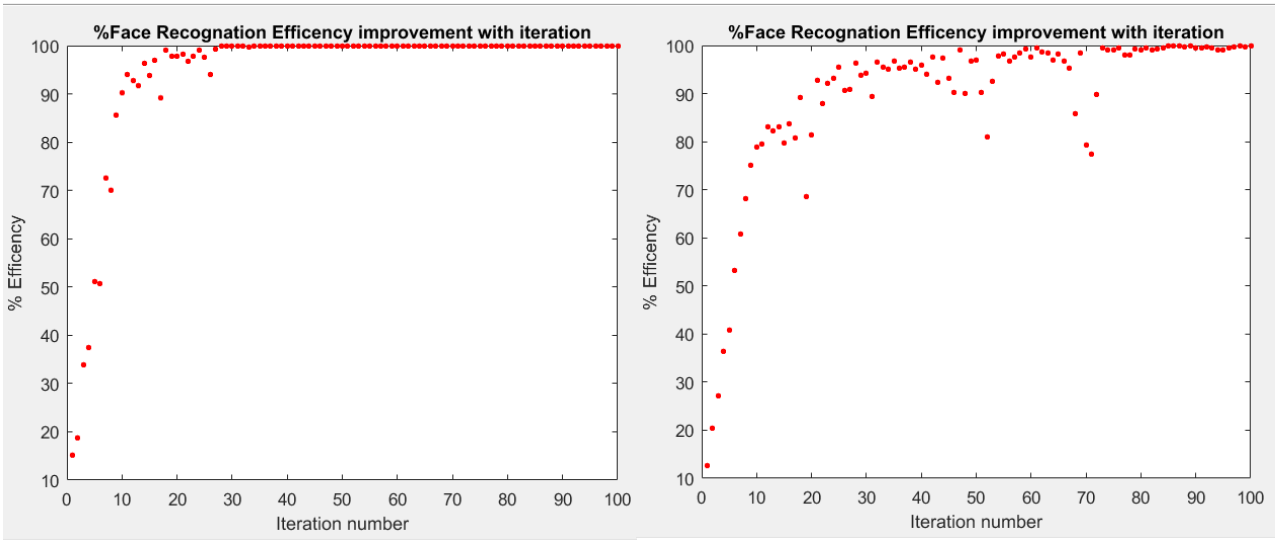
Figure-9. 2D displaying data.

Table-1, shown the training data efficiency, processing time, and the computational requirement for each input sizes.

Table-1. Training data efficiency, processing time, and the computational requirement for each input sizes.

Data matrix				Consumption of system resources			Training efficiency
Input layer units		Output labels	Hidden layer units	Processor	Memory*	Computational time / Sec	
1	64x64	8	2700	63 %	~5.5 GB	139.477468 sec.	100%
2	128x128	8	2700	64 %	~7.3GB	509.102596 sec.	100%

* The memory has been calculated for increased of used memory over the memory used by system



(a) (b)

Figure-10. Training Efficiency with iteration (a) input data size 64x64, (b) input data size (128x128).

Recognition has been tested using recognition program (shown in Figure-9), to identify persons face for every input image. The recognition program tested thepersons faces images which were used in trained the ANN, then it tested untrained faces images for same persons. The recognition program used two weights for two input sizes, the integrated way) with an iteration value of (100), the recognition results are classified in Table(4.6).

Table-2. Face recognition results for trained/untrained faces images.

Recognition type		No. of images	Image resolution					
			64 x 64			128 x 128		
			Detect	Failed	Eff. %	Detect	Failed	Eff. %
1	Trained Face (all persons)	250	241	9	96.4%	249	1	99.6%
2	Untrained Face (all persons)	250	167	83	66.8%	223	27	89.2%

Face cataloguer results

At first the program capture licence plate from moving car then applying pre-processing. To verify numbers only and segment each number then recognized each number to identify the license number. The results shows an excellent results with license plate that are clear even with any orientation with processing time less than 2 second.

Figure-11. License plate recognition result for Iraq license plate.

CONCLUSIONS

The emphasis of this paper is to describe and develop a smart surveillance system based on using several security techniques such as (face recognition, motion detection, LPR, etc...). The proposed system used some of algorithms that has been shown a good results from related works for each technique and testes its results. The motion detection results shows that the background subtraction even it simple algorithm but it appeared its very efficient algorithm for that purpose because it so fast need little computational requirement and practically more enough to alarm about intruders. the results of face recognition shows that BP gives a best result in face recognition that reach to 100% for training, and for real recognition results its shown as increasing in input data size (image size) side by side trained multiple face situations such as (lighting condition, emotions, face directions, etc.), we get an improvement in recognition results for real time recognition which reach 96.4% and 99.6% for 64x64 and 128x128 respectively of trained image, for non-trained images (new directions and new lighting conditions that was not trained), it reaches to 66.8% and 89.2% for 64x64 and 128x128 respectively. In LPR, the results show very good results to identified Iraqi license plate, for different types and front side directions reach to be 100%. The system need more testes to compare every algorithm that can be used in that techniques and verified which one is faster and more efficient and recombined it in one smart system.

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