Image Acquisition Using Raspberry Pi

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Abstract- *The project mainly reflects the face recognition by using PIR sensors and stores the captured image in database and it can be processed using Adaptive resonance theory(ART) neural networks for classifier, multilayer perceptron model for detection, CMU PIE as database, wavelet packet decomposition transform for processing. This project overcomes the problem of poor verification of face and provide accuracy of 0.6-0.8%*

Keywords- Adaptive resonance theory(ART) neural networks; multilayer perceptron model; CMU PIE database; wavelet packet decomposition transform.

I. INTRODUCTION

In last few years, face recognition and verification becomes as an interesting field to research. Researchers provide many articles related to face recognition. As, the human brain is not capable of identifying and verifying many faces in the world. Thus, the use of database plays vital role to store the information.The project mainly involves three stages. At the initial stage, face can be recognized by hardware circuit and stored in CMU PIE database and the image is further proceeded by using wavelet decomposition transform method and at the second stage feature extraction takes place. This stage can be done using multi layer perceptron model for feature extraction. Finally, classifer is used to verify the image. Here, we use Adaptive resonance theory neural network as an artificial intelligence system. Here, the complete project can be termed under hardware and software. The software can be done using matlab 2017A version. For, recognizing the face raspberry pi is used along with camera and some hardware component to capture the image and store in database. This paper follows, feature extraction method basd on multi objective classification method(ARTNNS),and then comparative experimental results of proposed face recognition strategy for database CMU PIE.

II. RELATED WORKS

Mehren kafai, proposed an effective and compact methodology in the field of face recognition and followed by feature extraction. This paper explains a reference based framework for solving practical pose invariant recognition. It performed using reference individual defines the reference based on descriptors on the face image. However, this method requires multiple databases,which is the major drawback of this method. It always works on combination of databases.

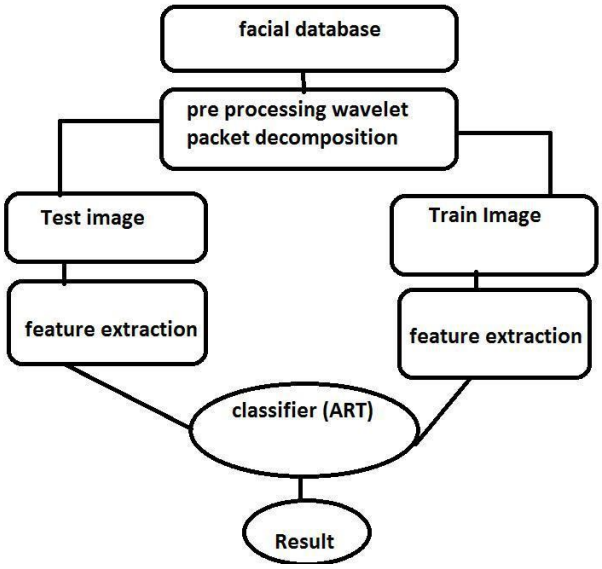
[2]Young et al. working as a part of CTI 2 project, used ART neural network for region of interest for detection and noise characterization. The specific neural networks used are ART1, but the accuracy range is very less.

[3]Chao. Xu working on image coding methods based on wavelet decomposition shows more potential than other wavelet transform technique. The experimental result shows that proposed algorithm out performs SPIHT and JPEG 2000. But it failed to show quality visuals.

To overcome above mentioned drawbacks multilayered perceptron detection with ART neural network as classification is implemented.

III. PROPOSED METHODOLGY

The proposed methodology for recognizing human faces are divided into three steps. Image preprocessing, feature extraction and classification.



A. Pre processing

A wavelet decomposition or transform simply re-expresses a function in terms of the wavelet basis $\{\psi_{j,k}(t)\}$. This amounts to decomposing the function space L^2 into a direct sum of orthogonal subspaces $\{W_j\}$ and choosing the combination of the orthonormal bases for Ws as the orthonormal basis for L^2. In the case of finite data with information up to a resolution level J, a wavelet transform performs a decomposition of the space V_J into a direct sum of orthogonal subspaces

$$V_J = W_{J-1} \oplus V_{J-1} = W_{J-1} \oplus W_{J-2} \oplus V_{J-2} = \cdots = \bigoplus_{j=0}^{J-1} W_j \oplus V_0$$

and the union of the bases of these subspaces forms a basis for the wavelet decomposition. This, of course, is by no means the only way to decompose the space L^2 or V_J. In this section we generalize the wavelet decomposition and introduce a whole family of orthonormal bases for function space.

From multiresolution analysis, we know that given the basis $\{\phi_{1,k}(t)\}$ V_1 $\{\phi(t-k)\}$ $\{\psi(t-k)\}$ functions of , and constitute an orthonormal basis for and W_0 respectively, and $V_1 = V_0 \oplus W_0$where

$$\phi(t) = \sqrt{2} \sum_k h_k \phi(2t-k) \text{ and } \psi(t) = \sqrt{2} \sum_k g_k \phi(2t-k).$$

So the V space can be decomposed into a direct sum of the two orthogonal subspaces defined by their basis functions given by the above two equations. This "splitting trick" or splitting algorithm can be used to decompose W spaces as well. For example, if we analogously define

$$w_2(t) = \sqrt{2} \sum_k h_k \psi(2t-k) \text{ and } w_3(t) = \sqrt{2} \sum_k g_k \psi(2t-k),$$

then $\{w_2(t-k)\}$ and $\{w_3(t-k)\}$ are orthonormal basis functions for the two subspaces whose direct sum is W_1. In general, for $n = 0, 1, \cdots$, we define a sequence of functions as follows:

$$w_{2n}(t) = \sqrt{2} \sum_k h_k w_n(2t-k) \qquad (5.12)$$

and

$$w_{2n+1}(t) = \sqrt{2} \sum_k g_k w_n(2t-k).$$

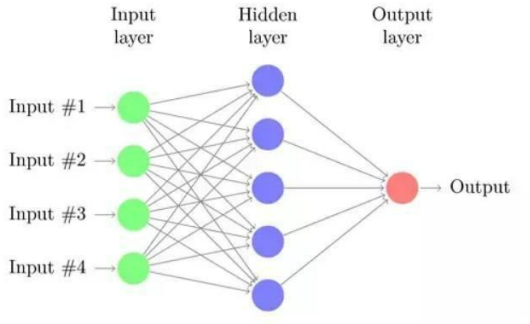
Clearly, setting $n = 0$, we get $w_0(t) = \phi(t)$, the scaling function, and $n = 1$ yields $w_1(t) = \psi(t)$, the mother wavelet. So far we have been using the combination of $\{\phi(2^j t-k)\}$ and $\{\psi(2^j t-k)\}$ to form a basis for V_J, and now we have a whole sequence of functions $w_n(t)$ at our disposal. Various combinations of these and their dilations and translations can give rise to various bases for the function space. So we have a whole collection of orthonormal bases generated from $\{w_n(t)\}$. We call this collection a "library of wavelet packet bases", and the function of the form $w_{n,j,k} = 2^{j/2} w_n(2^j t-k)$is called a wavelet packet.

Let us call the space formed by the basis $\{w_{n,j,k}(t)\}$, $\mathbf{w}_{n,j}$; the following diagram illustrates the decomposition of the space $\mathbf{w}_{0,3}$ (*i.e.*, V_3) using wavelet packets.

B. Feature extraction

A multilayer perceptron is a neural network connecting multiple layers in a directed graph, which means that the signal path through the nodes only goes one way. Each node, apart from the input nodes, has a nonlinear activation function. An MLP uses backpropagation as a supervised learning technique. Since there are multiple layers of neurons, MLP is a deep learning technique.

MLP is widely used for solving problems that require supervised learning as well as research into computational neuroscience and parallel distributed processing. Applications include speech recognition, image recognition and machine translation.



The idea is that each node in the Hidden layer is a function of the nodes in the previous layer, and the Output node is a function of the nodes in the Hidden layer. If we use the following notation:

Input layer = in1,...,in4in1,...,in4

Hidden layer = hid1,...,hid4hid1,...,hid4

Output = out1out1

The most common choice of function is something like:
hid1=hid1= tanh(a11·in1+a12·in2+...+a14·in4)tanh(a11·in1+ a12·in2+...+a14·in4)
hid2=hid2= tanh(a21·in1+a22·in2+...+a24·in4)tanh(a21·in1+ a22·in2+...+a24·in4)

C. Classification

ART1 neural networks cluster binary vectors, using unsupervised learning. The neat thing about adaptive resonance theory is that it gives the user more control over the degree of relative similarity of patterns placed on the same cluster.

An ART1 net achieves stability when it cannot return any patterns to previous clusters (in other words, a pattern oscillating among different clusters at different stages of training indicates an unstable net. Some nets achieve stability by gradually reducing the learning rate as the same set of training patterns is presented many times. However, this does not allow the net to readily learn a new pattern that is presented for the first time after a number of training epochs have already taken place. The ability of a net to respond to (learn) a new pattern equally well at any stage of learning is called plasticity (e.g., this is a computational corollary of the biological model of neural plasticity). Adaptive resonance theory nets are designed to be both stable and plastic.

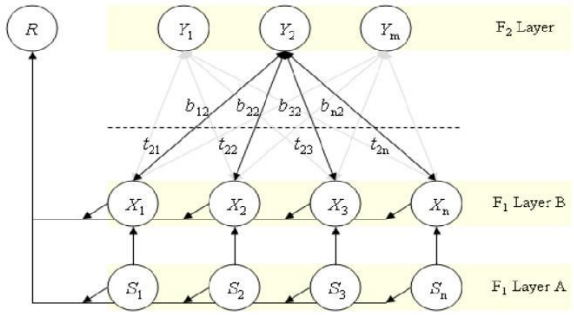
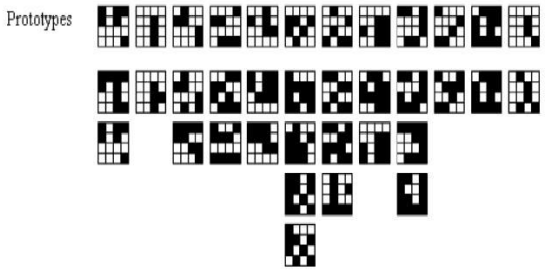


Figure 1. A simple ART1 structure.



IV. PERFORMANCE METRICS

A.

$$\text{specificity} = \frac{\text{number of true negatives}}{\text{number of true negatives} + \text{number of false positives}}$$

B.

$$\text{sensitivity} = \frac{\text{number of true positives}}{\text{number of true positives} + \text{number of false negatives}}$$

C.

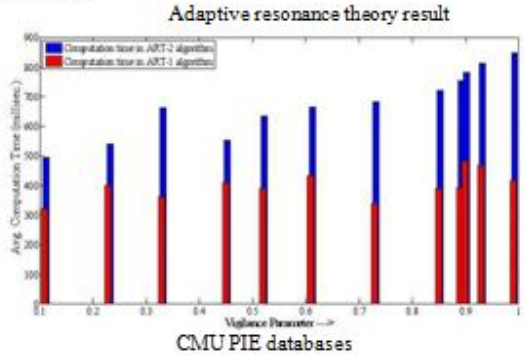
$$\textbf{Precision} = \frac{tp}{tp + fp}$$

$$\textbf{Recall} = \frac{tp}{tp + fn}$$

D.

$$F_\beta = \frac{(1+\beta^2)\cdot \text{true positive}}{(1+\beta^2)\cdot \text{true positive} + \beta^2 \cdot \text{false negative} + \text{false positive}}.$$

E. *Results*



CMU PIE databases

V. RASPBERRY PI BASED FACE RECOGNITION SECURITY SYSTEM

A **security alarm** is a system designed to detect intrusion – unauthorized entry – into a building or other area. Security alarms are used in residential, commercial, industrial, and military properties for protection against burglary (theft) or property damage, as well as personal protection against intruders. Car alarms likewise help protect vehicles and their contents. Prisons also use security systems for control of inmates.

Some alarm systems serve a single purpose of burglary protection; combination systems provide both fire and intrusion protection. Intrusion alarm systems may also be combined with closed-circuit television surveillance (CCTV) systems to automatically record the activities of intruders, and may interface to access control systems for electrically locked doors. Systems range from small, self-contained noisemakers, to complicated, multiarea systems with computer monitoring and control. It may even include two-way voice which allows communication between the panel and Monitoring station.

All home security systems work on the same basic principle of securing entry points, like doors and windows, as well as interior space containing valuables like art, computers, guns, and coin collections. Regardless of the size of your home, or the number of doors and windows or interior rooms a homeowner decides to protect, the only real difference is in the number of security components deployed throughout the home and monitored by the control panel.

What is a security system?

The most basic definition of any security system is found in its name. It is literally a means or method by which something is secured through a system of interworking components and devices.

In this instance, we're talking about home security systems, which are networks of integrated electronic devices working together with a central control panel to protect against burglars and other potential home intruders.

A control panel, which is the primary controller of a

home's security system

Door and window sensors

Motion sensors, both interior and exterior

Wired or wireless security cameras

A high-decibel siren or alarm

A yard sign and window stickers F.

How does a security system work?

Home security systems work on the simple concept of securing entry points into a home with sensors that communicate with a control panel or command center installed in a convenient location somewhere in the home.

The sensors are typically placed in doors that lead to and from a house as well as easily accessible windows,

particularly any that open, especially those at ground level. Open spaces inside of homes can be secured with motion sensors.

Control Panel:

The control panel is the computer that arms and disarms the security systems, communicates with each installed component, sounds the alarm when a security zone is breached, and communicates with an alarm monitoring company.

They typically feature a touchpad for easy programming and interaction, is where pass codes are entered to arm and disarm the system, can work on voice commands, and can be programmed to work with wireless remote controls called key fobs.

Door and Window Sensors:

Door and window sensors are comprised of two parts installed adjacent to each other. One part of the device is installed on the door or window and the other on the door frame or window sill. When a door or window is closed, the two parts of the sensor are joined together, creating a security circuit.

When the security system is armed at the control panel, these sensors communicate with it by reporting that the point of entry is secure. Should a monitored door or window suddenly be opened, the security circuit is broken and the control panel interprets this as a breach of a secured zone. A high-decibel alarm is sounded and in most instances the alarm monitoring company is automatically notified.

Motion Sensors:

These security components, when armed, protect a given space by creating an invisible zone that cannot be breached without sounding an alarm. These are typically used to protect rooms containing valuables, as well as areas less frequented in larger homes.

Surveillance Cameras:

Available in both wired and wireless configurations, surveillance cameras can be used in several different ways as part of an overall security system.

Typical uses include monitoring

- Hard to see or distant areas of your property
- Remote buildings like garages, barns, and workshops
- Entry points, both exterior and interior, like garage doors and front doors

Surveillance cameras can be accessed remotely on computers, smartphones, and tablets. They are often used in this method when homeowners are out of town, to watch for deliveries and other service personnel like caregivers and landscapers, and to monitor the arrival of children after school. They can also be used to record any security breaches, which could result in having footage of a home invasion, including a good look at the burglars and perhaps even the vehicle they drove.

In this Proposed system we have designed a Raspberry pi Face recognition based security system. Raspberry Pi Model 3, PIR Sensor, USB Webcam, LCD 2x16 Module, Flash Driver and Buzzer is used to design this system. Raspbian Operating System is used to run this Raspberry Pi. 8GB Mirco SD Memory is loaded with this Operating System. PIR Sensor and USB webcam is interface with Raspberry PI Development board.

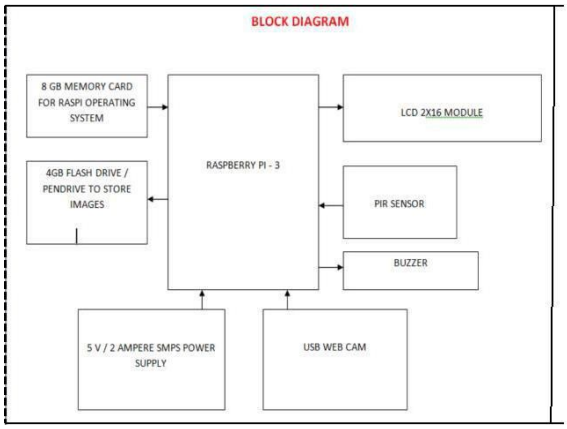
When any Motion is detected with PIR Sensor, it trigger Raspberry Pi. It further takes Image of the Area and save it to Flash Drive. 4 GB flash drive is connected to USB port of Raspberry pi to save images taken by USB Webcam.

Python Scripting language is used to code Raspberry PI.

This system thus can be used in many domestic applications and in industrial setups. The power supply setup of the system contains a step down transformer of 230/12V, used to step down the voltage to 12VAC. To convert it to DC, a bridge rectifier is used. Capacitive filter is used which makes use of 7805 voltage regulator to regulate it to +5V that will be needed for microcontroller and other components operation, in order to remove ripple.

Major Components used in this Project

- Raspberry Pi Model 3
- PIR Sensor
- USB Web Camera
- Transformer
- Buzzer
- LCD 2x16 Module
- Voltage Regulators
- SD Card and Flash Drive
- Filter Capacitors
- Other Misc Components



Components Description
RASPBERRY PI

The **Raspberry Pi** is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. Several generations of Raspberry Pis have been released. All models feature a Broadcom system on a chip (SoC) with an integrated ARM compatible central processing unit (CPU) and on-chip graphics processing unit (GPU).

Processor

The Raspberry Pi 2 uses a 32-bit 900 MHz quad-core ARM Cortex-A7processor.

The Broadcom BCM2835 SoC used in the first generation

Raspberry Pi is somewhat equivalent to the chip used in first modern generation smartphones[clarification needed](its CPU is an older ARMv6 architecture),[22] which includes a 700

MHzARM1176JZF-S processor, VideoCore IV graphics processing unit (GPU),[23] and RAM. It has a level 1 (L1) cache of 16 KB and a level 2 (L2) cache of 128 KB. The level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible.

RAM

On the older beta Model B boards, 128 MB was allocated by default to the GPU, leaving 128 MB for the CPU.On the first 256 MB release Model B (and Model A), three different splits were possible. The default split was 192 MB (RAM for CPU),

which should be sufficient for standalone 1080p video decoding, or for simple 3D, but probably not for both together. 224 MB was for Linux only, with only a 1080p , and was likely to fail for any video or 3D. 128 MB was for heavy 3D,possibly also with video decoding (e.g. XBMC).Comparatively the Nokia 701 uses 128 MB for the

Broadcom VideoCore IV.[7]

Performance

The Raspberry Pi 3, with a quad-core ARM Cortex-A53 processor, is described as 10 times the performance of a

Raspberry Pi 1.[This was suggested to be highly dependent upon task threading and instruction set use. Benchmarks showed the Raspberry Pi 3 to be approximately 80% faster than the Raspberry Pi 2 in parallelized tasks.

Raspberry Pi 2 V1.1 included a quad-core Cortex-A7 CPU running at 900 MHz and 1 GB RAM. It was described as 4–6 times more powerful than its predecessor. The GPU wasidentical to the original.] In parallelized benchmarks, the Raspberry Pi 2 V1.1 could be up to 14 times faster than a Raspberry Pi 1 Model B+.

While operating at 700 MHz by default, the first generation Raspberry Pi provided a real-world performance roughly equivalent to 0.041 GFLOPS.On the CPU level the performance is similar to a 300 MHz Pentium II of 1997–99. The GPU provides 1 Pixel/s or 1.5 l/s of graphics processing or 24 GFLOPS of general purpose computing performance. The graphical capabilities of the Raspberry Pi are roughly equivalent to the performance of the Xbox of 2001.

Raspberry Pi 3 - Model B Technical Specification

Broadcom BCM2387 chipset

1.2GHz Quad-Core ARM Cortex-A53

802.11 bgn Wireless LAN and Bluetooth

4.1 (Bluetooth Classic and LE)

1GB RAM

64 Bit CPU

4 x USB ports

4 pole Stereo output and Composite video port

Full size HDMI

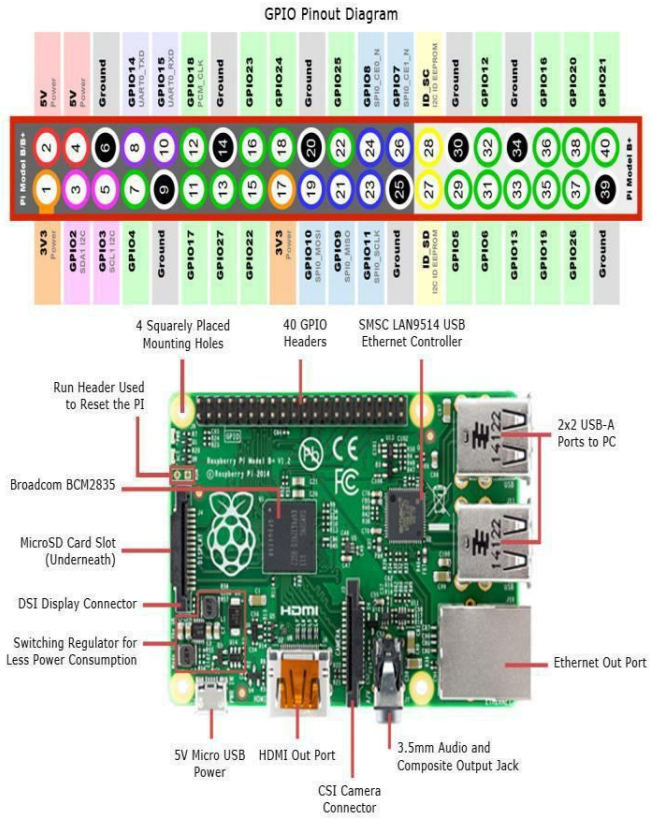
10/100 BaseT Ethernet socketbr

CSI camera port for connecting the Raspberry Pi camera

DSI display port for connecting the Raspberry Pi touch screen display

Micro SD port for loading your operating system and storing data

Micro USB power source



Technology

Flash memory combines a number of older technologies, with lower cost, lower power consumption and small size made possible by advances in microprocessor technology. The memory storage was based on earlier EPROM and EEPROM t echnologies. These had limited capacity, were slow for both reading and writing, required complex high-voltage drive circuitry, and could be re-written only after erasing the entire contents of the chip.

Passive Infrared Sensor (PIR)

A **passive infrared sensor** (**PIR sensor**) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors.

Operating Principle

All objects with a temperature above absolute zero emit heat energy in the form of radiation. Usually this radiation isn't visible to the human eye because it radiates at infrared wavelengths, but it can be detected by electronic devices designed for such a purpose.

The term *passive* in this instance refers to the fact that PIR devices do not generate or radiate energy for detection purposes. They work entirely by detecting infrared radiation emitted by or reflected from objects. They do not detect or measure "heat".

infrared radiation enters through the front of the sensor, known as the 'sensor face'. At the core of a PIR sensor is a solid statesensor or set of sensors, made from materials—materials which generate energy when exposed to heat.

VI. CONCLUSION

In this paper, we proposed a new model for face recognition acknowledging which is based on multilayer perceptron , ART and wavelet packet decomposition. MPT is used to extract feature and decrease the divisions of facial image after that classification can be done by using ARTNN, CMU andPIE databases will add some combine multiple feature extraction approaches with multiclass learning methodologies.

REFERENCES

[1] Carpenter, G.A. & Grossberg, S. (2003), In micheal Arbib (Ed.), The Handbook of Brain Theory and Neural Networks, Second Edition (pp. 87-90). Cambridge, MA: MIT Press

[2] T. Kanade, H. Saito, and S. Vedula. The 3D room: Digitizing time-varying 3D events by synchronized multiple video streams. Technical Report CMU-RI-TR-98-34, CMU Robotics Institute, 1998. [Kanade et al., 2000]

[3] Grossberg, S. (1987), adaptive resonance theory, 11, 23-63