Face Detection based Locker Security System using Raspberry Pi

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***Abstract*—**In current scenario, bank and locker robberies are frequently happening this means our locker is vulnerable to theft since it has no ultimate protection rather than a lock and key. Currently, most of the banks use two keys to open the lockers. One key is with the customer and another key is with the bank manager. This system is having some drawbacks. There is a possibility of losing the key which make the system to be insecure and duplication of keys may lead to unauthorized access of the locker. So in order to overcome that we are introducing Locker Security System based on Face Recognition and GSM (Global System for Mobile) technology, which can be used in Banks, Security Offices and Homes for giving protection to expensive possessions. In this system, only the authorized person can access the valuable things like money, licenses and jewels from locker. Face Recognition is done by using active appearance model algorithm with Bayesian classifier, which is used to identify the persons and verify their identity with the Raspberry Pi processor. RFID (Radio-frequency identification) and GSM technology are combined together for accessing the locker securely. When an authorized person tries to access the locker, the system will generate a one-time password and send to the registered mobile number of that person. If the password entered by him is correct, then only he will be allowed to access the locker. If he does any offensive acts on the locker, it will be sensed by the vibration sensor and the sensor will send the control signal to Raspberry pi processor and it will generate alarm sound.

Keywords*—*GSM, RFID,Raspberry Pi,ARM

Raspberry Pi is a credit-card sized computer manufactured and designed in the United Kingdom by the Raspberry Pi foundation with the intention of teaching basic computer science to school students and every other person interested in computer hardware, programming and DIY-Do-it Yourself projects.

The Raspberry Pi is manufactured in three board configurations through licensed manufacturing deals with Newark element14 (Premier Farnell), RS Components and Egoman. These companies sell the Raspberry Pi online. Egoman produces a version for distribution solely in China and Taiwan, which can be distinguished from other Pis by their red coloring and lack of FCC/CE marks. The hardware is the same across all manufacturers.

The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, VideoCore IV GPU and was originally shipped with 256 megabytes of RAM, later upgraded (Model B & Model B+) to 512 MB. It does not include a built-in hard disk or solid-state drive, but it uses an SD card for booting and persistent storage, with the Model B+ using a MicroSD.

The foundation provides debian and arch linux arm distributions for download. tools are available for python as the main programming language, with support for bbc basic (via the risc os image or the brandy basic clone for linux), c, java and perl.

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I Related works without considering the wireless network, the diagram of the core face recognition system is shown in figure 2. in enrollment, the images of the registered users are processed into templates of caricatures by the specific algorithms of the face recognition system, and these templates are stored. the templates can be regarded as the transformed user images encoded by the corresponding processing techniques. the processing techniques and the templates are adjusted concurrently. in verification or identification, the face recognition system receives a new image, defines and stores the new image by the same algorithm, and compares to the templates. the decision process may incorporate all kinds of classifiers. if the classifier is a learning algorithm and its structure needs to be trained such as the neural network or bayesian network, the enrollment database may be split into two parts, one for constructing the templates, and one for learning the classifier structure face recognition techniques can be roughly classified into the following categories. interested readers are encouraged to get more references from reading these provided references

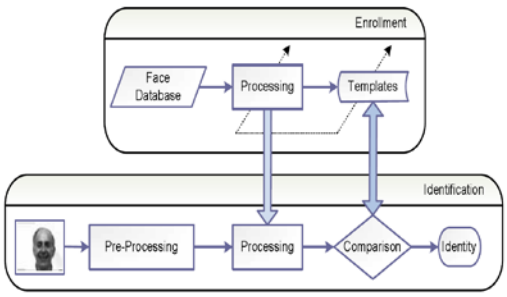


Figure 2. General Diagram of the Face Recognition System

Template based: A typical template-based method is PCA (Principle Component Analysis) based Eigen face method, which uses holistic information of the face.

Feature based: Features are descriptions or quantitative measurements of local facial features such as eyes, nose and mouth for direct comparisons.

Rule based: A learning algorithm, such as support vector machine (SVM), decision tree which constitutes an explicit or implicit set of rules.

Model based: The most popular models include elastic-bunch-graph (EBG) model and hidden Markov model.

Module based: Facial modules are similarly defined or detected as local features, but modules are analyzed as self-contained components.

II INCEPTION OF RASPBERRY PI

A. The Idea to create the Raspberry Pi:

The idea behind a tiny and affordable computer for kids came in 2006, when Eben Upton, Rob Mullins, Jack Lang and Alan Mycroft, based at the University of Cambridge's Computer Laboratory, became concerned about the year-on-year decline in the numbers and skills levels of the A Level students applying to read Computer Science. From a situation in the 1990s where most of the kids applying were coming to interview as experienced hobbyist programmers, the landscape in the 2000s was very different; a typical applicant might only have done a little web design.

Something had changed the way kids were interacting with computers. A number of problems were identified: majority of curriculums with lessons on using Word and Excel, or writing webpages; the end of the dot-com boom; and the rise of the home PC and games console to replace the Amigas, BBC Micros, Spectrum ZX and Commodore 64 machines that people of an earlier generation learned to program on.

B. Initial Design Considerations

By 2008, processors designed for mobile devices were becoming more affordable, and powerful enough to provide excellent multimedia, a feature which would make the board desirable to kids who wouldn't initially be interested in a purely programming-oriented device. The project started to look very realisable and feasible. Eben (now a chip architect at Broadcom), Rob, Jack and Alan, teamed up with Pete Lomas, MD of hardware design and manufacture company Norcott Technologies, and David Braben, co-author of the BBC Micro game Elite, to form the Raspberry Pi Foundation to make it a reality. Three years later, the Raspberry Pi Model B entered mass production through licensed manufacture deals with Element 14/Premier Farnell and RS Electronics, and within two years it had sold over two million units!

III BRIEF DESCRIPTION OF SYSTEM ON CHIP (SOC)

Since smartphones and tablets are basically smaller computers, they require pretty much the same components we see in desktops and laptops in order to offer us all the amazing things they can do (apps, music and video playing, 3D gaming support, advanced wireless features, etc).

But smartphones and tablets do not offer the same amount of internal space as desktops and laptops for the various components needed such as the logic board, the processor, the RAM, the graphics card, and others. That means these internal parts need to be as small as possible, so that device manufacturers can use the remaining space to fit the device with a long-lasting battery life.

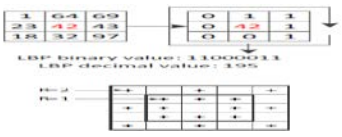
Thanks to the wonders of miniaturization, SoC manufacturers, like Qualcomm, Nvidia or Texas Instruments, can place some of those components on a single chip, the System on a Chip that powers smartphones.

A system on a chip or system on chip (SoC or SOC) is an integrated circuit (IC) that integrates all components of a computer or other electronic system into a single chip. It may contain digital, analog, mixed-signal, and often radio-frequency functions—all on a single chip substrate. SoCs are very common in the mobile electronics market because of their low power consumption. A typical application is in the area of embedded systems.

The contrast with a microcontroller is one of degree. Microcontrollers typically have under 100 kB of RAM (often just a few kilobytes) and often really are single-chip-systems, whereas the term SoC is typically used for more powerful processors, capable of running software such as the desktop versions of Windows and Linux, which need external memory chips (flash, RAM) to be useful, and which are used with various external peripherals. In short, for larger systems, the term system on a chip is a hyperbole, indicating technical direction more than reality: increasing chip integration to reduce manufacturing costs and to enable smaller systems. Many interesting systems are too complex to fit on just one chip built with a process optimized for just one of the system's tasks.

IV FACE RECOGNITION ALGORITHM

The proposed algorithm for face recognition can be divided into several steps. The sequence of steps of the proposed algorithm used for face recognition. The first step is to acquire the image. Next, face detection has to be performed, to find whether the face appears in the captured image or not. The next step is to locate the position of the face in the image. Face detection and face localization is per- formed by using Haar feature-based cascade classifier .The rectangular features needed for Haar classifier are computed using an intermediate representation for the image that is called an integral image.



The integral image at location x; y contains the sum of the pixels above and to the left of x; y, inclusive:

$$i(x,y)=\sum_{x'\le x,y'\le y} f(x',y') \qquad (1)$$

where i(x,y) is the integral image and f(x,y) is the original image. Using the following pair of recurrences:

$$s(x,y)=s(x,y-1)+f(x,y) \quad (2)$$

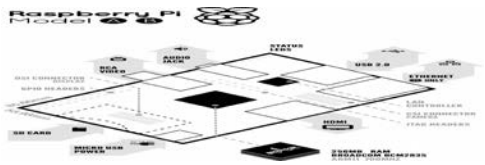
$$i(x,y)=i(x-1,y)+s(x,y) \quad (3)$$

(where s(x, y) is the cumulative row sum, s(x,-1) = 0, and i(-1; y) = 0) the integral image can be computed in one pass over the original image [8]. Using the integral image any rectangular sum can be computed by referencing four array locations (shown in Fig. 2). Difference between two rectangular sums can be computed in eight references. Since the two-rectangle features defined above involve adjacent rectangular sums they can be computed in six array references, eight in the case of the three- rectangle features, and nine for four-rectangle features [8]. If the image contains a face, the algorithm returns a rectangle with coordinates where face was found. However, it is not the final region of interest (ROI) that we use. To calculate the necessary ROI, we use the coordinates of a rectangle and recalculate the ROI position. We use FERET face image database for algorithm evaluation that contains many frontal face images with their respective eye coordinates. Using the obtained rectangle from the Haar classifier and the known eye positions, we developed a method to statistically determine where in the image the eyes are most likely to be located

V PROBLEM DEFINATION

To provide a stable and cost effective system that can be used for facial recognition on a commercial basis at different levels of security.

VI IMPLEMENTATION



Processor / SoC (System on Chip):

The Raspberry Pi has a Broadcom BCM2835 System on Chip module. It has a ARM1176JZF-S processor.The Broadcom SoC used in the Raspberry Pi is equivalent to a chip used in an old smartphone (Android or iPhone). While operating at 700 MHz by default, the Raspberry Pi provides a real world performance roughly equivalent to the 0.041 GFLOPS. On the CPU level the performance is similar to a 300 MHz Pentium II of 1997-1999, but the GPU, however, provides 1 Gpixel/s, 1.5 Gtexel/s or 24 GFLOPS of general purpose compute and the graphics capabilities of the Raspberry Pi are roughly equivalent to the level of performance of the Xbox of 2001. The Raspberry Pi chip operating at 700 MHz by default, will not become hot enough to need a heatsink or special cooling.

Power source:

The Pi is a device which consumes 700mA or 3W or power. It is powered by a MicroUSB charger or the GPIO header. Any good smartphone charger will do the work of powering the Pi.

SD Card :

The Raspberry Pi does not have any onboard storage available. The operating system is loaded on a SD card which is inserted on the SD card slot on the Raspberry Pi. The operating system can be loaded on the card using a card reader on any computer.

GPIO

GPIO – General Purpose Input Output
General-purpose input/output (GPIO) is a generic pin on an integrated circuit whose behavior, including whether it is an input or output pin, can be controlled by the user at run time.

GPIO pins have no special purpose defined, and go unused by default. The idea is that sometimes the system designer building a full system that uses the chip might find it useful to have a handful of additional digital control lines, and having these available from the chip can save the hassle of having to arrange additional circuitry to provide them.

GPIO capabilities may include:

- GPIO pins can be configured to be input or output
- GPIO pins can be enabled/disabled
- Input values are readable (typically high=1, low=0)
- Output values are writable/readable
- Input values can often be used as IRQs (typically for wakeup events)

The production Raspberry Pi board has a 26-pin 2.54 mm (100 mil) expansion header, marked as P1, arranged in a 2x13 strip. They provide 8 GPIO pins plus access to I²C, SPI, UART), as well as +3.3 V, +5 V and GND supply lines. Pin one is the pin in the first column and on the bottom row

DSI Connector

The Display Serial Interface (DSI) is a specification by the Mobile Industry Processor Interface (MIPI) Alliance aimed

at reducing the cost of display controllers in a mobile devic is commonly targeted at LCD and similar display technologies. It defines a serial bus and a communication protocol between the host (source of the image data) and the device (destination of the image data).
A DSI compatible LCD screen can be connected through the DSI connector, although it may require additional drivers to drive the display.

RCA Video

RCA Video outputs (PAL and NTSC) are available on all models of Raspberry Pi. Any television or screen with a RCA jack can be connected with the RPi.

Audio Jack

A standard 3.5 mm TRS connector is available on the RPi for stereo audio output. Any headphone or 3.5mm audio cable can be connected directly. Although this jack cannot be used for taking audio input, USB mics or USB sound cards can be used.

Status LEDs

There are 5 status LEDs on the RPi that show the status of various activities as follows:
"OK" - SDCard Access (via GPIO16) - labelled as "OK" on Model B Rev1.0 boards and "ACT" on Model B Rev2.0 and Model A boards
"POWER" - 3.3 V Power - labelled as "PWR" on all boards
"FDX" - Full Duplex (LAN) (Model B) - labelled as "FDX" on all boards
"LNK" - Link/Activity (LAN) (Model B) - labelled as "LNK" on all boards
"10M/100" - 10/100Mbit (LAN) (Model B) - labelled (incorrectly) as "10M" on Model B Rev1.0 boards and "100" on Model B Rev2.0 and Model A boards

USB 2.0 Port

USB 2.0 ports are the means to connect accessories such as mouse or keyboard to the Raspberry Pi. There is 1 port on Model A, 2 on Model B and 4 on Model B+. The number of ports can be increased by using an external powered USB hub which is available as a standard Pi accessory.

Ethernet

Ethernet port is available on Model B and B+. It can be connected to a network or internet using a standard LAN cable on the Ethernet port. The Ethernet ports are controlled by Microchip LAN9512 LAN controller chip.

CSI connector

CSI – Camera Serial Interface is a serial interface designed by MIPI (Mobile Industry Processor Interface) alliance aimed at interfacing digital cameras with a mobile processor.

The RPi foundation provides a camera specially made for the Pi which can be connected with the Pi using the CSI connector.

JTAG headers

JTAG is an acronym for 'Joint Test Action Group', an organization that started back in the mid 1980's to address test point access issues on PCB with surface mount devices. The organisation devised a method of access to device pins via a serial port that became known as the TAP (Test Access Port). In 1990 the method became a recognised international standard (IEEE Std 1149.1). Many thousands of devices now include this standardised port as a feature to allow test and design engineers to access pins.

sHDMI

HDMI – High Definition Multimedia Interface
HDMI 1.3 a type A port is provided on the RPi to connect with HDMI screens.

VII FACE RECOGNITION SYSTEM

In the heart of the embedded face recognition system is a Raspberry Pi single-board computer, which controls all of the peripherals. The board has a 700MHz ARM CPU and 512 MB of RAM. For image acquisition we use a USB web camera with a 320x240 resolution. To visualize the information and provide user friendly identification procedure, we use mini LCD. A control PCB is developed for voltage con- version and also for electrical door magnet control. As an enclosure we have developed a custom-made metal enclosure for Raspberry Pi, web camera, control board and mounting of LCD. Raspberry Pi runs the Raspbian OS which is a Linux operating system derived from Debian. Our program is written in C++ and uses the OpenCV library for image acquisition and face detection. The developed recognition software can be used as a standalone or a part of a multimodal biometric system. We have developed the data exchange interface so the system could connect to other biometric system to ex- change biometric data. When connected with another biometric system, face recognition system can work as a slave module in capture-send mode. In slave mode system waits for the start signal, performs image acquisition and processing and then sends the acquired data to the master system. Biometric research group has developed the palmprint and palm vein biometric system that acts as a master and controls the face recognition system

VII APPLICATIONS

The major aim behind the Raspberry Pi was to educate people, especially children and teenagers, towards programming and basic hardware interfacing. The open body structure of the Raspberry Pi makes it a machine on which one can learn computer concepts.
Applications of the Raspberry Pi can be given as follows:

- Teaching programming concepts.
- Teaching hardware interfacing.
- Raspberry Pi being very cost effective can be deployed in large numbers in underdeveloped and developing countries like Africa, India, China,

Brazil etc. to schools and colleges and to everyone who is interested in computers and electronics.

- It can be used in robotics for controlling motors, sensors, etc.
- It can be used as a downloading machine replacing desktop computers. It consumes very low power and also can be accessed remotely.
- It can be used as a media centre at home. Any television can be converted to a smart TV with internet capabilities with the Pi.
- It can be used for designing prototypes of DIY projects and certain embedded devices. It becomes very cheap option for testing and evaluation purpose.
- Can be used in creating and handling small servers.
- It can be used for making digital photo frames, tablets etc at home

VIII CONCLUSION AND FUTURE ENHANCEMENT

Raspberry Pi is an innovative product. The sheer number of users and fan base support the fact that the device can see a great future ahead. The device can surely help anyone who really wants to lean electronics and computers. Increasing the processing power can surely help the product in the future. Also supplying a case and a proper instruction manual will improve the product. Also currently Windows operating systems are not compatible because of the ARM processor. If the processor is improved or any workaround is found to run Windows directly on the Raspberry Pi, then it can be a great step for the Pi.

The Raspberry Pi is an amazing piece of hardware because of the combination of the features of a traditional computer and an embedded device. Supporting computer operating systems like Linux and providing simple input/output lines i.e. the GPIO makes it perfect for controlling almost anything. Programming the GPIO is much easy and intuitive then the traditional FPGA or microprocessor. Finally it can be said that Raspberry Pi can be effectively used if its processing power is kept in mind. It can work as a personal computer but cannot replace it.

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