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Real Time Vehicle Security System Using Sift Algorithm

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Abstract:
An efficient real time vehicle security system using SIFT algorithm is designed and implemented. The proposed system make use of an efficient image matching technique i.e. SIFT method with microcontroller ARM7 LPC2148. The system uses Global Positioning System (GPS) and Global System for Mobile Communication/General Packet Radio Service (GSM/GPRS) technology. If the image of the driver is matched with the predefined stored authentic person's images, then the vehicle start, else if not matched then the vehicle will not start and the location of the vehicle along with alert message is send to the owner of the vehicle using an GPS and GSM/GPRS and make an alarm loudly. The location of the vehicle can be then traced using a mobile app or internet. Here also implemented a feature to detect any accident occurred by using a vibration sensor [1] [2] [3].

Key words: SIFT, key point detector, SIFT descriptor, face recognition, ARM7 LPC2148, GPS, GSM.

I. INTRODUCTION:

The main aim of this paper is to offer an advanced security system in automotive, in which consists of a face detection system a GPS module, a GSM module and a control platform with accident alert. The face detection system bases an optimized algorithm and matches the face of the driver with the authentic person.Face recognition is an integral part of biometrics. In biometrics basic traits of human is matched to the existing data and depending on result of matching identification of a human being is traced.

Facial features are extracted and implemented through algorithms which are efficient and some modifications are done to improve the existing algorithm models. A face recognition system using the SIFT method was implemented [4][5]. The algorithm is based on Image features approach which represents a SIFT method in which a small set of significant features are used to describe the variation between face images. Experimental results for different numbers of faces are shown to verify the viability of the proposed method. In this paper an approach to the detection and identification of human face is presented and then recognizes the person by comparing characteristics of the face with stored authentic image. Here introduced a real time approach to start the vehicle only by authentic user. If any other unauthorized attempts then an SMS will be sent to the registered mobile number for the theft of the vehicle along with its location details. This avoids the theft of vehicle. An alarm is also provided in case of invalid image detected. Further a vibration sensor is also included to detect any accident to the vehicle.

II. BLOCK DIAGRAMS:

Image processing is the integral part of this project [6]. The image is taken from the camera, and processed on a MATLAB platform and the distinct feature is extracted from the image using SIFT algorithm, which is matched with the stored images and the result is sent on UART to microcontroller.

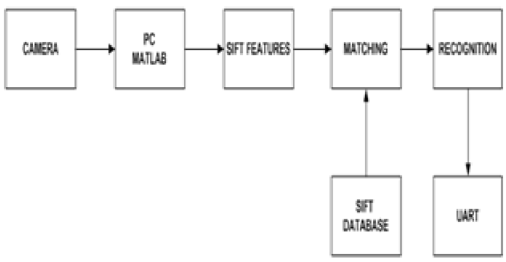

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Figure 1.Image Processing

Interfacing with controller:

Here LPC2148 ARM7TDMI-S is used [7] [8], which is an advanced version of microprocessors and forms the heart of the system. The block diagram is shown in fig 2. The signal from the computer is forwarded to the microcontroller LPC2148 using the UART, depending on which further action is taken. The vibration sensor is connected, which sends a high signal if any accident happens. Here a DC motor represent the vehicle's engine, which is controlled by the microcontroller. A GSM and GPS is connected to controller via MAX232.

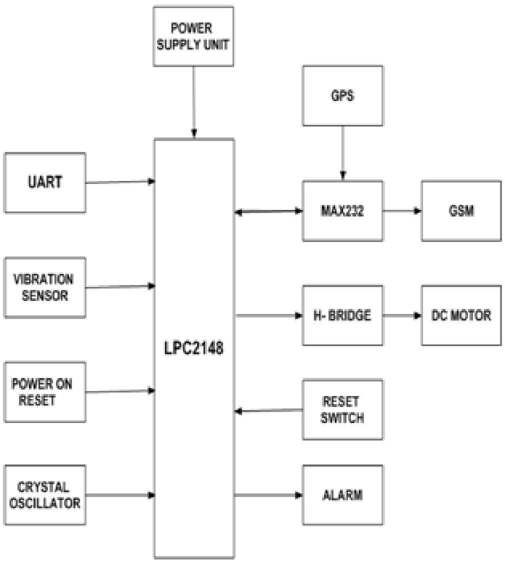
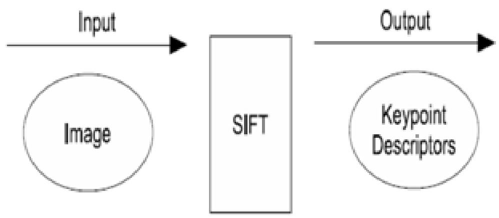


Figure 2.System Block Diagram

III. SCALE INVARIANT FEATURE TRANSFORM:

Scale Invariant feature transform is a method which extracts the local features from the images to be processed. This well-known method was published by David G Lowe [9].

The extraction of these features is bit costly which can be minimized by using a cascade filtering approach. In this approach the expensive operations are applied only at that location or places which passes the initial stage tests.



To generate the set of image features, the SIFT algorithm could be done in the following multiple parts as discussed[5] :

1. Construction a Scale Space:

The main aim of the scale space part is to remove all the unnecessary, unwanted and false details from the image. This can be done by using a Gaussian Blur filter .The process of scale space construction consists of producing progressively blurred out images with different sizes. SIFT use four octaves or scales which are made by resizing the original image to half size each time. Blurring of any image is simply the convolution operation of the Gaussian operator and the original image to be processed.

$$L(x,y,\sigma) = G(x,y,\sigma) * I(x,y)$$

Where the Gaussian Operator is given by:

$$G(x,y,\sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

$\boldsymbol{\sigma}$ is the scale parameter, and x and y are the coordinate's location.

2. Laplacian of Gaussian Calculation

After Blurring of image, they are approximated by determining the difference (DOG) between any two nearby scales($\boldsymbol{\sigma}$).

$$D(x,y,\sigma) = L(x,y,k_i\sigma) - L(x,y,k_j\sigma)$$

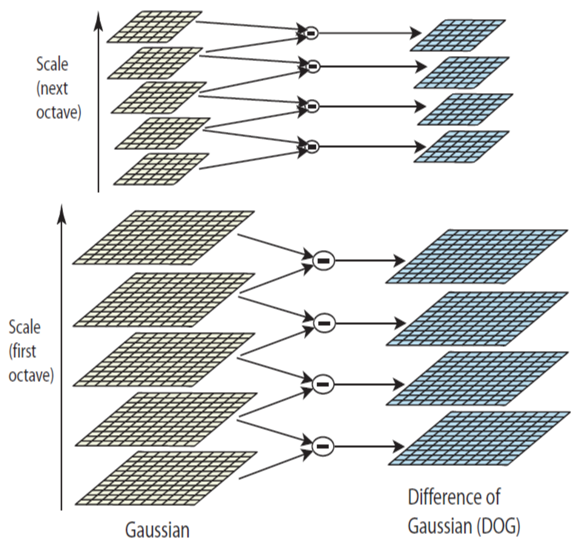


Figure 3. Difference of Gaussian Formation

3. Finding Key-points

Key-points are generated by using two processes: First locating maxima and minima: To find or detect the local maxima and minima of DOG of a image, At the same scale, each point is compared with its neighboring 8 points, and its 9 neighbours points up and down one scale. If the point is the greatest or the least of all these 26 neighbours, it is marked as key-point. Then finding sub-pixel maxima/minima: These key-points can be estimated using Taylor Series expansion.

4. Eliminating Edges and Low Contrast Regions

Low contrast regions are removed by checking their intensities and comparing it to a threshold. If the pixel of DoG image is less than a certain value it will be rejected. Key points having low contrast and poorly localized features have to be rejected, so as to get stable extreme points i.e. maxima/minima of the image. Fitting function of the feature point is constructed according to Taylor expansion and is given by,

$$D(x) = D + \frac{\partial D^T}{\partial x} x + \frac{1}{2} x^T \frac{\partial^2}{\partial x^2} x$$

where D and its derivatives are evaluated at the sample point($\boldsymbol{\sigma}$). The location of the extremum ẍ is obtained by calculating its derivative and then equating it to zero. And it can be given as

$$\hat{x} = -\frac{\partial^2 D^{-1}}{\partial x^2} \frac{\partial D}{\partial x}$$

The function value at the extremum helps to reject unstable extrema with low contrast and is given by

$$D(\hat{x}) = D + \frac{1}{2} \frac{\partial D^T}{\partial x} \hat{x}$$

Reject the extremas whose |D(ẍ)|<0.3 , but it is not sufficient to reject only low contrast key point. The DoG function will have a strong response along edges, even if the location along the edge is poorly determined. After this, the goal is to remove edges, to find the corners and eliminating the flat regions. To do those, two gradients which are perpendicular to each other should be calculated at each key-point determined earlier, so three cases may happen:

1- For flat regions the gradients are both small.
2- For edges, one of the gradients will be big
3- For corners, both gradients are big.

Any point is considered as a key-point when both the gradients are big, and others points are eliminated in the other two cases.

5. Assigning an Orientation to the Key-points

To assign an orientation to a key-point, the gradient directions and magnitudes should be computed around these key-point and the dominant orientation in that region is assigned to the key-point .The size for the assigned orientation depends on its scale. For each sample L(x,y), the mod value m(x,y), and the orientation ϴ(x,y), are calculated by using pixel differences and are given by:

$$m(x,y) = \sqrt{(L(x+1,y) - L(x-1,y))^2 + (L(x,y+1) - L(x,y-1))^2}$$

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$$\theta(x,y) = tan^{-1}(\frac{L(x,y+1) - L(x,y-1)}{L(x+1,y) - L(x-1,y)}$$

Once the modulus and angles are computed, the algorithm divides 0 degree to 360 degree into 36 bins, where each bin contains 10 degree and a histogram is calculated.

6. SIFT Features Generation:

To avoid any illumination and orientation issues, each key-point is designated with a 128 dimensional vector. To do this the following steps should be done:

- A 16*16 window around the key-point is selected.
- This 16*16 window is then, divided into sixteen 4*4 window.
- For each 4*4 window, the magnitude and orientation are calculated and a histogram is computed.
- This histogram is divided into 8 bins and the amount of orientation added to the bin depends to the gradient magnitude. Finally each key-point is represented by 4*4*8 = 128 number.

Now each image is represented by a certain number of key-points, and each key-point is a vector of 128 components. A keypoint descrịptỏr is created bỷ first calculating the gradient magnitude and orientation around the keypoint location of the image, as shown on the left fig. These are then weighted bỷ ạ Gaussian window, indicated by the overlaid circle. These samples are then accumulated ịṅtỏ orientation histograms summarizing tḧẽ contents over 4x4 sub regions, ạṣ shown on the right, with tḧẽ length of each arrow corresponding tỏ the sum of the gradient magnitudes near that direction within the region.

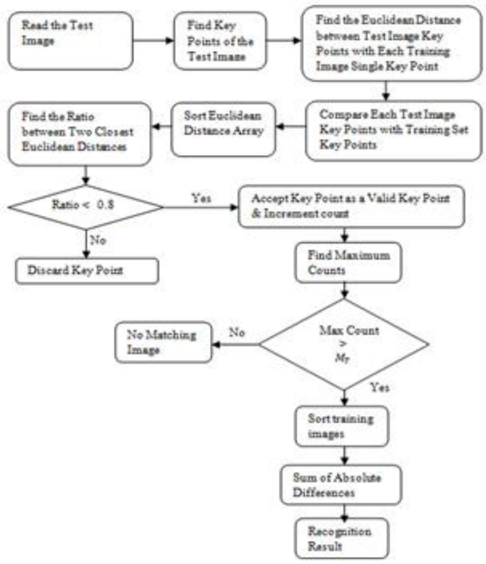

Figure 4. Flow chart for Image Matching using SIFT

This approach has been named the Scale Invariant Feature Transform (SIFT), as it transforms image data into scale-invariant coordinates relative to local features.

IV. MODULES USED IN THIS PROJECT

1. ARM7TDMI-S™ LPC2148

ARM7TDMI-S™ is an advanced version of microprocessors and forms the heart of the system. The LPC2148 is based on a 16/32 bit ARM7TDMI-S™ CPU with real-time emulation and embedded trace support, together with 128/512 kilobytes of embedded high speed flash memory. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at maximum clock rate. For critical code size applications, the alternative 16-bit Thumb Mode reduces code by more than 30% with minimal performance penalty. With their compact 64 pin package, low power consumption, various 32-bit timers, 4- channel 10-bit ADC, USB PORT,PWM channels and 46 GPIO lines with up to 9 external interrupt pins these microcontrollers are particularly suitable for industrial control, medical systems, access control and point-of-sale.

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With a wide range of serial communications interfaces, they are also very well suited for communication gateways, protocol converters and embedded soft modems as well as many other general- purpose applications.

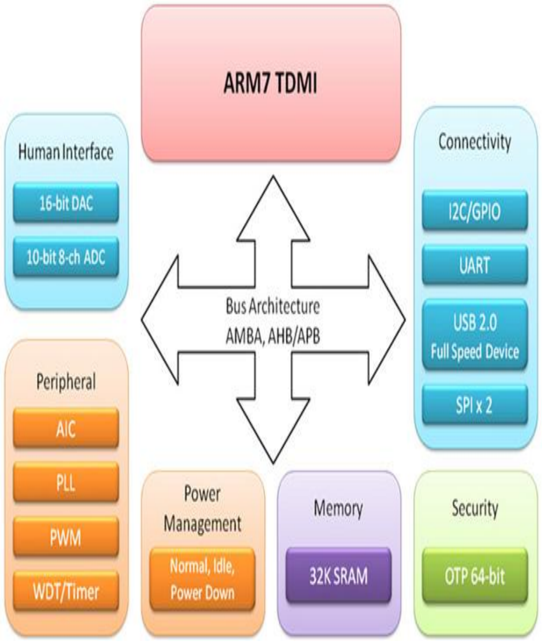
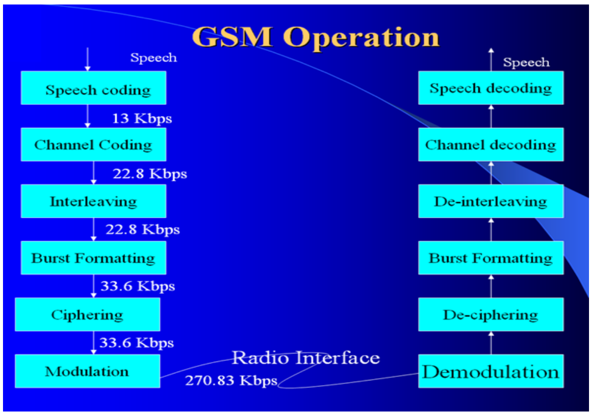


Figure 5. ARM7TDMI-S™ LPC2148

2. Global System for Mobile Communication

GSM, which stands for Global System for Mobile communications, reigns (important) as the world's most widely used cell phone technology. Cell phones use a cell phone service carrier's GSM network by searching for cell phone towers in the nearby area. Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication.



3. Global Positioning System (GPS)

A GPS receiver calculates its position by precisely timing the signals sent by the GPS satellites high above the Earth. Each satellite continually transmits messages which include

- The time the message was transmitted
- Precise orbital information
- The general system health and rough orbits of all GPS satellites.

4. Vibration Sensor

A vibration sensor is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, strain or force by converting them to an electrical charge. The prefix piezo- is Greek for 'press' or 'squeeze'.

V. SOFTWARE USED

- Keil Compiler
- Embedded C

Advantageous:

1. Very fast compared to the conventional face recognition methods.
2. Simple to design so that system complexity is low.
3. Enhanced Wireless Control System
4. Reliable, Portable, Scalable.
5. Less cost and compact system.

VI. CONCLUSION:

Access control is implemented using image processing with the help of ARM7 microcontroller, thus involving both image processing and embedded systems.Where there is higher level of theft, there is need for very good security system for automobiles or vehicles. This paper provides an appropriate method of designing and assembling a low cost and essential theft control system for automobile using image processing, GPS, GSM on ARM7 microcontrollers. This system provides reliable security for vehicles. By installing this system in vehicle an unknown person cannot start the engine of vehicle thus giving a higher security to vehicles.

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