Intelligent Ambulance Detection System

F.Andronicus[1], Maheswaran[2]
[1]P. G. Scholar, [2]Assistant Professor
[1,2]Saveetha Engineering College, Thandalam, India

Abstract— In a Traffic system, a visible CMOS image sensor is placed to detect an Ambulance vehicle, the captured video is processed by Digital Image Processing using Matlab software based on a ripple algorithm. The ripple algorithm uses the templates of an ambulance from the number of frames abstracted from the input video. Then it compares all the frames with the selected template one by one. Thresholding is done to convert grayscale images in to binary images. Template Matching is done for image matching with the similarity matrix. The maximum correlation occurs when the template and corresponding image are identical. Hence from the given template the Ambulance can be detected and output is sent through UART to ARM processor where traffic lights can be controlled. If an Ambulance is detected the signal goes green and if it is not detected the light goes red, normally the regular routine continues between green, yellow and red lights.

***Index Terms*— IADS, CMOS image sensor, ARM processor, MATLAB, Thresholding and Template Matching.**

I. INTRODUCTION

Traffic management on the road has become a severe problem of today's society because of growth of the population, urbanization and industrialization. There has been a tremendous growth in traffic. With growth in traffic, there is occurrence of bundle of problems. This problem includes traffic jams, accidents and traffic violation at the heavy traffic signal. This in turn has an adverse effect on the economy of our country as well as the loss of lives. So problem given above will become worst in the future. Most of the traffic lights around the world follow a predetermined timing circuit. As a result, emergency vehicles such as ambulance, fire brigade or V.I.P vehicles get stuck in traffic signal and waste their valuable time and golden hour. High priority must be given to human lives in the Ambulance which is travelling through a traffic signal.

Intelligent Ambulance Detection System (IADS) aims to detect and identify many types of Ambulances and to give green signal to the traffic light in a traffic jam. The system is able to detect the Ambulance from different view angles and have fast recognition speed. IADS is developed for real-time working can obtain visible images with low cost by using a visible image sensor. The captured images are processed by a digital image processing (DIP) based Matlab software, which contains an IADS algorithm called ripple algorithm. The name of the algorithm comes from that the target features are extracted by groups of concentric circles which look like ripples on the surface of water.

The ripple algorithm first uses several templates to create the model of the Ambulance in different view angles. After the offline modeling step, the ripple algorithm converts the greyscale images into binary images using thresholding. Then, a group of concentric circles are drawn on the surface of each black region to extract the target features. Finally, the feature vector of each candidate region is compared with those of the templates to recognize the target.

II. MONITORING UNIT

Camera is used to capture the traffic video. The output of the camera connected with the PC for the image processing. PC is used for doing the image processing using by MATLAB software. The video frames are converted by the PC using by MATLAB. Here we are using Thresholding, Image Segmentation and Template Matching for detecting Ambulance vehicle. Thresholding is used to convert the RGB color image to gray scale image. For the image processing in the MATLAB the input should be gray scale. Binary Image is Logical array containing only 0s ad 1s, interpreted as black and white, respectively. Greyscale is also known as a gray scale or gray level image. The Array of class uint8, uint16, int16, single or double where its pixel values specify intensity values. For the single or double arrays, values range from [0, 1]. For uint8, values range from [0, 255]. For uint16, values range from [0, 65535]. For int16, values range from [-32768, 32767]. True color image is also known as an RGB image. A true color image is which each pixel is specified by three values one each for the red, blue and green color components of the pixel scalar. Mby-n-by-3 array of class uint8, uint16, single or double where its pixel values specify the intensity values. For single or double arrays the values range from [0, 1]. For uint8, values range from [0, 255]. For uint16, values range from [0, 65535].

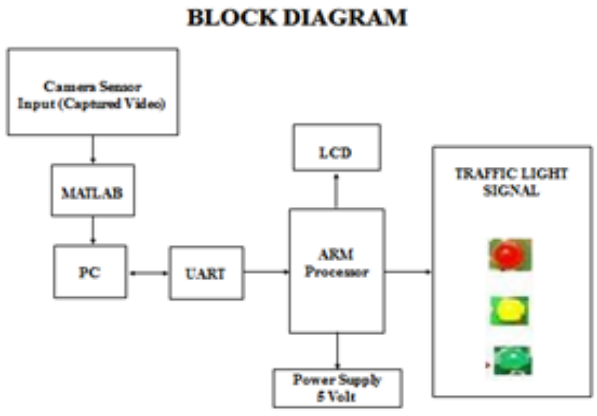

Figure 1

Gray levels represent the interval number of quantization in gray scale image processing. In present, the most commonly used storage method is 8-bit storage. There

are 256 gray levels in an 8-bit storage. There are 256 gray levels in an 8bit gray scale image and the intensity of each pixel can have from 0 to 255 with 0 being black and 255 being white. The other commonly used storage method is 1-bit storage. There are 2 gray levels with 0 being black and 1 being white binary images, which are frequently used in medical images, is being referred to as binary image. As binary images are easy operate, other storage format images are often converted into binary images when they are used for enhancement or edge detection.

In RGB color model, each color appears in its primary spectral components of red, green and blue (RBG), described by three corresponding intensities. Color components are also known as color channels or color planes (components). In the RGB color model, a color image can be represented by the intensity function.

1 RGB = (FR, FG, FB)

Where FR(x, y) is the intensity of the pixel (x, y) in the red channel, FG(x, y) is the intensity of pixel (x, y) in the green channel, and FB(x, y) is the intensity of pixel (x, y) in the blue channel. The intensity of each color channel is usually stored using eight bits, which indicates the quantization level is 256. That is a pixel in a color image requires a total storage of 24 bits. In Object Segmentation the objects are segmented from the background. It is also called background subtraction. This method is used to calculate the density of vehicles. Contrast Stretching is a process that expands the range of intensity in an image so that it spans the full intensity range of the recording medium or display device.

In Template Matching, w is referred to as a template and correlation is referred to as template matching, r(x, y) has values in range [-1, 1] and is thus normalized to changes in the amplitude of w and f. The maximum value of r (x, y) occurs when the normalized w and corresponding normalized region is F are identical. This indicates maximum correlation and thus the best possible match.

III. CONTROLLING UNIT

a. ARM PROCESSOR

The LPC2119/LPC2129 is based on a 16/32 bit RM7TDMI-S“CPU with real-time emulation and embedded trace support, together with 128/256 kilobytes (kB) of embedded high speed flash memory. A 128bit wide memory interface and unique accelerator architecture enable 32-bit code execution at maximum clock rate. In critical code size applications, the alternative 16bit Thumb Mode reduces code by more than 30 % with minimal performance penalty. With their compact 64pin package with low power consumption, various 32bit timers, 4channel 10bit ADC, 2 advanced CAN channels, PWM channels and 46 GPIO lines with up to 9 external interrupt pins these microcontrollers are particularly suitable for automotive and industrial control applications as well as medical systems and fault-tolerant maintenance buses. With the wide range of additional serial communications interfaces, they are suited for communication gateways and protocol converters as well as many other general-purpose applications.

b. INPUT / OUTPUT PORTS

Device pins that are not connected to a specific peripheral function are controlled by the GPIO registers. The Pins may be dynamically configured as inputs or outputs. Separate registers allows setting or clearing any number of outputs simultaneously. The values of the output register may be read back, as well as the current state of port pins.

Features

•Direction control of the individual bits.
• Separate control of the output set and clear.
• All I/O default to inputs after a reset.

c. ON-CHIP FLASH PROGRAM MEMORY

The LPC2119/LPC2129 incorporates a 128 kb and 256 kb Flash memory system respectively. This memory may be used for the code and the data storage. Programming the Flash memory may be accomplished in several other ways. It has been programmed in System via serial port. The application program may also erase and/or program the Flash while the application is running, allowing a great degree of the flexibility for the data storage held firmware upgrades, etc. hence on-chip boot loader is used, 120/248kb of Flash memory is available for the user code. The LPC2119/LPC2129 Flash memory provides a minimum number of 100,000 erase/write cycles and 20 years of data retention. On-chip boot loader (as of revision 1.60) provides Code Read Protection (CRP) for the LPC2119/LPC2129 on-chip Flash memory. When CRP is enabled, the JTAG debug port and ISP commands accessing either the on-chip RAM or Flash memory are disabled. However ISP Flash Erase command can be executed at any time (no matter whether the CRP is on or off). The Removal of CRP is achieved by reassure of full on-chip user Flash. With the CRP off the full access to the chip via the JTAG and/or ISP is restored.

d. ON-CHIP STATIC RAM

On-Chip Static RAM may be used for code and/or data storage. The SRAM can be accessed as 8-bits, 16-bits, and 32-bits. The ARM processor LPC2119/LPC2129 provides 16 kb of static RAM.

e. INTERRUPT CONTROLLER

The Vectored Interrupt Controller (VIC) accepts all of the interrupt request inputs and categorizes them as FIQ, vectored IRQ, and non-vectored IRQ as developed by programmable settings. Programmable Assignment Scheme means that priorities of interrupts from the various peripherals can be dynamically assigned and adjusted. Fast Interrupt request (FIQ) has the highest priority. If there is more than one request is assigned to FIQ. VIC combines the requests to produce the FIQ signal to the ARM processor. The fast possible FIQ latency is achieved when only one request is classified as FIQ, because the FIQ service routine can simply start dealing with that device. If more than one request is assigned to FIQ class. The FIQ service routine can read a word from the VIC that identifies which FIQ source(s) is (are) requesting an interrupt. The Vectored IRQs have the middle priority. Sixteen of interrupt requests can be assigned to this category. Any of interrupt requests can be assigned to any of the 16 vectored IRQ slots, among which slot 0 has highest priority and slot 15 has lowest. Non-vectored IRQs have lowest priority. The VIC combines requests from all the vectored and non-vectored IRQs to produce the IRQ signal to the ARM processor. IRQ service routine can start by reading a register from the VIC and jumping there. If any of vectored

ISSN: 2278 – 7798

IRQs are requesting, VIC provides the address of the highest-priority requesting IRQs service routine, otherwise it provides address of a default routine that is shared by all the non-vectored IRQs. Default routine can read another VIC register to see what IRQs are active.

f. UARTs

The LPC2119/LPC2129 each contains two UARTs. One UART provides a full modem control handshake interface, other provides only transmit and receive data lines.

Features

•16 byte Receive and Transmit FIFOs.
•Register locations conform to Ô550 industry standard.
•Receiver FIFO trigger points in 1, 4, 8, and 14 bytes
•Built-in baud rate generator.
•The Standard modem interface signals included on UART1.

g. Real time clock

The Real Time Clock (RTC) is designed to provide a set of counters to measure time when normal or idle operating mode is selected. The RTC is designed to use little power and making it suitable for battery powered systems where the CPU is not running continuously (Idle mode).

Features

☐RTC Measures the passage of time to maintain a calendar and clock.
☐Ultra Low Power design is to support battery powered systems.
☐RTC Provides Seconds, Minutes, Hours, Day of Month, Month, Year, Day of week and Day of Year.
☐ A Programmable Reference Clock Divider allows adjustment of the RTC to match various crystal frequencies.

h. Watchdog Timer:

The purpose of the Watchdog is to reset the microcontroller within a reasonable amount of time if it enters an erroneous state. When enabled the Watchdog timer will generate a system reset if the user program fails to fee (or reload) the Watchdog within a predetermined amount of time.

Features

☐Internally the resets chip if not periodically reloaded.
☐Debug mode.
☐It is enabled by software but requires a hardware reset or a Watchdog reset/interrupt to be disabled.
☐ The Incorrect/Incomplete feed sequence causes reset/interrupt if enabled.
☐Flag to indicate Watchdog reset.
☐Programmable 32-bit timer with internal pre-scalar.
☐Selectable time period from (tpclk ´ 256 ´ 4) to (tpclk ´ 232 ´ 4) in multiples of tpclk ´

IV. DISPLAY UNIT

a. Color LED

A monochrome or a single color LED emits light in a narrow spectral band. The spectral power distribution is a representation of the radiant power emitted by a light source as a function of wavelength. The semiconductor material used in an LED determines its wavelength or color of light. As mentioned earlier InGaN and InGaAIP are the two primary semiconductor materials and slight changes in the composition of these alloys changes the color of the emitted light.

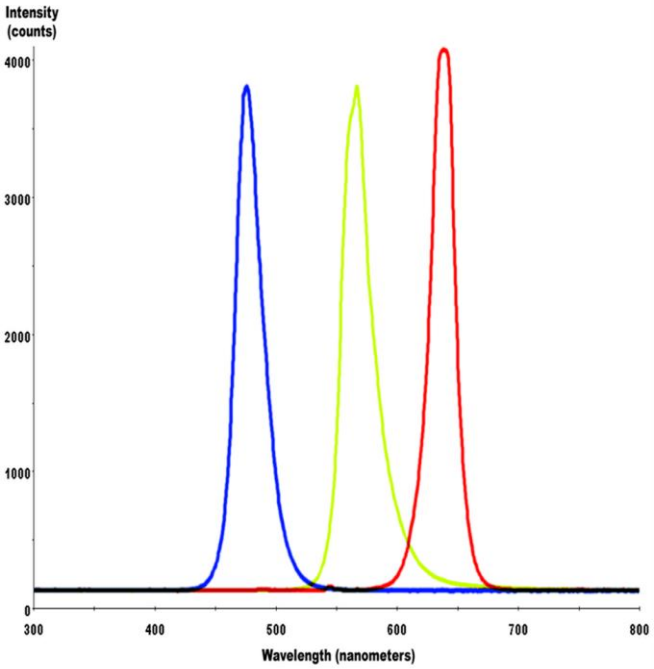

Figure 2

b. LCD

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. The 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are being preferred over seven segments and other multi segment LEDs. The reasons being LCDs are economical and easily programmable and have no limitation of displaying special & even custom characters (unlike in seven segments) animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are two such lines. In this LCD each character are displayed in 5x7 pixel matrix. This LCD has the two registers namely Command and Data. The command register stores command instructions given to LCD. A command is an instruction given to the LCD to do a predefined task like initializing it, clearing its screen, setting up the cursor position and controlling display, etc. Data register stores the data to be displayed on LCD. The data is the ASCII value of the given character to be displayed on the LCD.

V. RIPPLE ALGORITHM

The ripple algorithm is proposed and aims to detect the Ambulance from images obtained by a visible image sensor. It can extract features of target which are almost invariant when image rotations or target translation and scaling, such that it can detect targets which rotate or swing and sway. Moreover, by the templates representing targets in different views, it also can detect the target in different view angles. Furthermore, it has low computational complexity such that it is applicable to real-time applications of the robotics embedded system. The ripple algorithm involves three stages. First, some target templates are computed using images from image database.

Second, a target segmentation method is used to extract the target from background. Third, the features of the segmented.

a. OFFLINE TARGET TEMPLATE COMPUTING

We first define the view angle. Then the longitudinal section of the Ambulance is labeled as plane K, and the axis of rotation and the position of the sensor decide another plane H. The angle α between the planes K and H is defined as the view angle. The angle β between the optical axis of the visible image sensor and the rotation axis of the Ambulance is defined as the depression angle. For the sake of simplicity, β is chosen to be 45°. When Ambulance is viewed from different angles, its contour will make projective transformation. Thus the feature of the target contour will change. To address this problem, some templates are computed. These templates represent the contours of the Ambulance in different view angles. Based on these different templates, the Ambulance can be detected from different angles.

Ambulances are used as targets in the proposition of the ripple algorithm and in the experimental evaluation of the algorithm. We build an image database to cope with shape change caused by target rotation. Considering the symmetry of the Ambulance, the ripple algorithm can obtain almost the same feature values when the view angles are symmetrical about the X-axis or Y-axis. For example, when the view angles are 45°, 135°, 225° and 275°, the obtained feature values will be nearly the same. Consequently, we only consider view angles in the range from 0° to 90°. Note that if the Ambulance images are not symmetrical, the range from 0° to 180° should be used. Specifically, a total of 18 reference images have to be taken for each Ambulance from different view angles (with an increment of 5°) on a clear background.

Template Matching is a high-level machine vision technique that identifies the parts on an image that match a predefined template. The Advanced template matching algorithms allow to find occurrences of the template regardless of their orientation and local brightness. The Template Matching techniques are flexible and relatively straightforward to use which makes them one of the most popular methods of object localization. Applicability is limited mostly by the available computational power as identification of big and complex templates can be time-consuming.

b.THRESHOLDING

The simplest property that pixels in a region can share is intensity. So the natural way to segment such regions is through thresholding, separation of the light and dark regions. The Thresholding creates binary images from grey-level ones by turning all pixels below some threshold to zero and all pixels about that threshold to one. If the g(x, y) is a thresholded version of f (x, y) at some global threshold T. g is equal to 1 if f (x, y) ≥ T and zero otherwise.

Figure 3

Figure 4

c. IMPLEMENTATION

The video input is given to PC. The PC is used for doing image processing to detect the Ambulance in the input video. The MATLAB software is used to do the image processing works in PC. The Ripple Algorithm is implemented for Ambulance Detection and sample templates of the Ambulance are taken as Input, The Video frames are captured as image format from the camera sensor, these video frames are RGB color frames. To do the image processing works the RGB images must be converted in to grayscale images.

The image conversion technique is used to convert RGB to gray scale images, Thresholding is used to convert gray scale images in to binary images. Object segmentation technique is used to subtract the background from the objects. Template matching technique is used to compare the templates with the video frames which are abstracted from the input video frame by frame. From this the Ambulance is detected when it arrives in the video.

VI. SUMMARY AND CONCLUSION

In this system, the RGB color video frames are extracted from the input video. Ripple Algorithm is implemented, Image Conversion, Thresholding, Object Segmentation, Contrast Stretching and Template Matching are done in digital image processing using Matlab Software to detect the Ambulance vehicle from the input video.

In the Future work, After the detection of Ambulance, the output value is sent to ARM processor through UART to control the LED traffic lights, when an Ambulance is detected the LED traffic lights goes green signal and after it passes the traffic, the signal goes to regular routine.

ISSN: 2278 – 7798

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Mr. F.Andronicus is currently a PG student who studies M.E Embedded System Technologies in Saveetha Engineering College, Saveetha Nagar, Thandalam, Chennai, India.

Mr.G.Maheswaran is an Assistant Professor in the EEE Department of Saveetha Engineering College, Saveetha Nagar, Thandalam, Chennai, India.

