Research on Pedestrian Recognition Based on DM642 Driver Assistance System on Vehicle

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Abstract. Road pedestrian recognition is a core issue in the field of automotive safety, the pedestrians captured by the video cameras installation on the road ahead of the vehicle. To determine and mark pedestrians and estimate the potential risks according to the image processing and pattern recognition technology. Taking measures to protect pedestrian in the vehicle have important applications in driver assistance. The paper collected road ahead of the vehicle video information in the DM642 hardware platform, extracted the lane edge line by improved Hough transform method, and the extraction of candidate regions according to the features of pedestrians itself, using the Adaboost method of training the classifier. The results show that the classification accuracy rate reached 92\%, conform to the real-time performance of the system requirement. With the development of DSP technology, pedestrian’s collection, processing, recognition as one of the embedded pedestrian recognition system has a broad research value and business prospects.

1. Introduction

About two-thirds of the traffic accidents that occur each year are responsible for motor vehicles, drunk driving, fatigue driving, driver distraction. Those are the main causes of traffic accidents. In China, three-quarters of those who died as a result of accidents were weak traffic, Driver mortality rate is 13.4\% and pedestrians and cyclists accounting for 45\% of deaths. Pedestrians on the path of the vehicle or pedestrians who are about to walk on the path of the vehicle will be at risk of potential impact if the driver does not notice it.

In order to prevent pedestrians from causing personal injury and property damage, car active safety technology will become the research focus of the future car. In this paper, the camera is used to collect the pedestrian video in front of the vehicle and identify the pedestrians in front of the vehicle according to the shape characteristics. If the pedestrian enters the road of the car within the dangerous distance, the alarm system will automatically issue a warning to the driver's attention. At this time, the driver is not timely. Taking measures, the system will automatically brake to protect pedestrians from entering the route.

Firstly, based on the hardware platform of DM642-based image acquisition system, the image acquisition and pre-processing of the road environment in front of the vehicle is carried out. Then, the region of interest of the pedestrian image is extracted, and the complex background outside the lane line...
is removed to avoid Exhaustive search, improve the speed of the system [6]; Finally, target recognition, further verification of the extracted pedestrian candidate area, to determine whether it contains pedestrians. The whole recognition process includes the acquisition, preprocessing, feature extraction and target recognition of pedestrian images.

2. Pedestrian identification hardware platform and software development

2.1. Pedestrian identification hardware platform

The hardware platform for pedestrian recognition is the platform for the whole system to run. It requires the system to have abundant resources, sufficient storage space, powerful data processing and moving ability, and has high requirements on the real-time and robustness of the system.

This article uses a 32-bit fixed-point DSP chip for digital multimedia applications. The TMS320 DM642 completes TI's C64*DSP core chip and integrates a complete set of video/audio/I/O interfaces to achieve system versatility. The chip can process complex audio and video algorithms at high speed and parallel, and can conveniently output data to interface decoding devices and EMAC/PCI. It has a dedicated video interface VP0~VP2, supports BT.656 data format, and can be externally connected. PAL system and NTSC camera, image acquisition has a special hardware circuit, which can simply pre-process the image, make full use of the advantages of DM642 in image processing, and the chip has a higher frequency, embedded in the internal image. The processing algorithm can improve the operation speed and detection frequency.

In vehicle assisted driving, the DM642 based pedestrian recognition system includes video input, video storage and processing, video output, and display output modules. The video in front of the vehicle collected by the CCD camera is converted into a PAL standard television analog signal, and decoded into a digital parallel signal BT656 code stream by the video decoding chip TVP5150 to be sent to the DM642 video interface. The DM642 video interface decodes the BT656 code stream and automatically transfers it to the SDRAM for storage via EDMA. The CPU accesses the image in the SDRAM, preprocesses the pedestrian image, extracts the region of interest, and recognizes the target of the pedestrian. After processing, the buffer is sent out to the buffer SDRAM. The data is automatically output from the SDRAM through EDMA, and the BT656 code stream is formed and sent to the video decoding chip SAA7121, and finally the display is displayed.

2.2. Pedestrian identification software development environment

In order to improve the speed, real-time and accuracy of road pedestrian identification, the system must control the external equipment efficiently. This article uses a scalable and scalable DSP/BIOS real-time operating system, which has the advantages of good algorithm isolation, portability on DSP, standardization and portability of algorithms, and good application stability. DSP/BIOS supports four types of threads including hardware interrupt (HWI), software interrupt (SWI), task (TSK), and background thread (IDL). The use of DSP/BIOS real-time operating system for road pedestrian identification enables the system algorithms to operate independently and is easy to maintain and modify.

TI has defined standard peripheral driver models for DSPs, namely class drivers and microdrives. The two layers communicate using the API function interface. The class driver is between the application and the microdrive. It is independent of the hardware. The application interface is provided upwards, and the adapter is connected to the microdrive. The microdrive is connected to the peripheral, related to the hardware, and initializes the external device. The microdrive controls the underlying layer through the command issued by the class driver.

The pedestrian recognition system consists of three TSK (tasks), which are two video acquisition input and output TSKs, one video processing TSK, and the video stream is passed in the task to achieve pedestrian recognition.
3. Road pedestrians' interest area extraction
The extraction of the interest area of the road pedestrian refers to the acquisition, binarization, filtering and lane line extraction of the video image in front of the vehicle, eliminating image information other than the lane line, reducing the data processing amount and the execution time of the algorithm, and satisfying System real-time requirements.

3.1. Collection of road pedestrian images
Under the a priori condition that the pedestrian recognition of the road is not very high on the pixel and resolution requirements, this paper uses the model ZS-2073 low-cost CCD camera to collect the video image of the front of the vehicle. The camera pixel is 300,000, the resolution is 720*576, and the wide-angle lens The vertical field of view is 27°, the focal length is fixed at 7.5mm, and the USB2.0 interface. The camera is mounted under the vehicle's built-in windshield, facing the front of the vehicle and at a height from the rear view mirror. In order to improve the performance of the system and reduce the amount of data processing and data volume, only the Y luminance signal of the image is extracted as the data information of the image, that is, the grayscale image of the road pedestrian is extracted, and the camera installation and acquisition are as shown in Fig. 1.

3.2. Extraction of regions of interest
Because the road video in front of the vehicle is constantly changing, this paper chooses the adaptive maximum inter-class variance method for binarization, and the method can meet the real-time requirements of the system. According to the grayscale features of the image, adaptive binarization is performed to divide the image into two regions, foreground and background. The larger the variance between the background and the target, the more obvious the image target and background, as shown in Fig. 2. (b) shown.

On the basis of Gaussian filtering, this paper adds the limitation of pixel point difference. According to the similarity of gray level and the close relationship between two pixel spaces, only the weighted average is performed locally. For the place where the edge point pixel changes greatly, it is not. Will be affected by the filter, using this filtering method to process the image, the best edge preservation effect, as shown in Fig. 2. (c).

Figure 1. The installation of cameras and image acquisition

Figure 2. (a) The original image; (b) Quasi-binary image; (c) The filtered image; (d) Lane recognition

The detection of the edge of the road, assuming that the lane line is in a straight line mode, the point and sinusoidal duality principle, the point in the image space collinear, in the parameter space is the
intersecting sinusoid [3], because the road edge is mainly divided into two left and right lanes. The line, and the lane line does not change much, and the angle of the lane line is set within a certain range, so that the lane edge line is extracted by the improved HOUGH transform, as shown in Fig. 2(d).

The extraction of the region of interest removes the background outside the lane edge line, which can reduce the amount of system data processing, the amount of image information searched and the amount of calculation, and improve the computing speed and time of the system. As shown in Fig. 3.

\[\text{Figure 3. Mark of the ROI}\]

4. Road pedestrian identification

4.1. Marking of pedestrian candidate areas

By segmenting the edge of the lane line, the region of interest is obtained, and pedestrian recognition is performed in the region of interest according to the shape characteristics of the pedestrian on the road, that is, the verticality and the symmetry. Firstly, the region of interest is preprocessed to prepare for the subsequent extraction of pedestrian candidate zone annotation. Using the vertical features of pedestrians on the road, this paper uses the sobel vertical edge detection operator to perform edge detection on pedestrians. As shown in Fig. 4(b).

Since pedestrians are upright on the road, there is strong symmetry on the vertical edges, especially the legs, so measure this symmetry and find the symmetry axis of the pedestrian [1] in each region of interest. The symmetry axis, for each unit of action, searches for pixels on both sides of the symmetry axis within a certain pixel range, and meets a certain threshold, then the matrix corresponding to the symmetry axis is incremented by one. After the search, the symmetry is measured. The column with the largest value as shown in Fig. 4(c) is the symmetry axis of the pedestrian. From the above calculation, the position of the pedestrian exists, and the symmetry measure is the largest, that is, the symmetry axis of the pedestrian is located. Position, according to Fig. 4(c) can get the pedestrian's axis of symmetry as shown in Fig. 4(d).

After the pedestrian symmetry axis is determined, the pedestrian image of the road is vertically and horizontally projected [5] as shown in Fig. 4(e)(g). Take a certain value from the vertical projection chart of the pedestrian to make a difference, determine the width of the pedestrian. Since there may be multiple pedestrians on the road, search for a certain range according to the symmetry axis of the pedestrian, and determine the width of the pedestrian according to the symmetry measure. According to the pixel boundary pixel accumulating value, the left and right boundaries of the pedestrian can be determined to determine the width of the pedestrian.

Because the foot of the pedestrian is in contact with the ground, it shows a great horizontal feature. The pedestrian's area of interest is horizontally projected, the foot of the pedestrian touches the ground, and the maximum point of the horizontal projection is found to determine the starting line of the pedestrian label. This determines the bottom edge of the pedestrian candidate area. According to the prior knowledge, the long width of the pedestrian has a certain proportional relationship, and the candidate area of the pedestrian is marked, as shown in Fig. 4(h).
Figure 4. (a) Original image; (b) Image edge detection (c) Symmetry measures; (d) The axis of pedestrian symmetry; (e) Vertical projection; (f) Width; (g) Level projection; (h) Mark the candidate region
Through the calculation and statistics of the edge and vertical features of the pedestrian, the pedestrians of the road are marked according to the shape of the pedestrian, as shown in Fig.5.

4.2. Pedestrian recognition

Pedestrian's sample feature extraction is the most critical step for pedestrian recognition. The quality of feature extraction directly determines the accuracy of pedestrian sample classification. Firstly, according to the vertical feature and contour information of the pedestrian, the pedestrian candidate area is marked, and the result of the labeling is normalized into a picture of 64*128 size, and then the texture feature of the pedestrian is extracted to verify and identify the candidate area of the pedestrian.

In this paper, 100 pedestrians and 100 non-pedestrian samples are randomly collected on campus. As shown in Figure 3.3, the pedestrian candidate regions in the image are extracted, and the gray-scale co-occurrence matrix in four directions in the pedestrian image is calculated, and then according to the gray scale. The texture features defined by the co-occurrence matrix calculate the energy, entropy, moment of inertia, local stationarity, and the mean value of the five pedestrian texture eigenvalues in five directions, which are used as subsequent classification features. Since the range of values of each component is different from the physical meaning, it should be further normalized so that each physical quantity has a certain weight.

Based on the knowledge of the category of the pedestrian sample, the Adaboost method is used to train the classifier. Then the trained classifier is used to carry out the road pedestrian recognition experiment. The actual category of the test sample and the output category of the classifier are compared. Finally, Count the correct recognition rate.

| Category            | Energy | Entropy | Moment of inertia | Local stationarity | Related |
|---------------------|--------|---------|-------------------|--------------------|---------|
| Pedestrian sample   | 0.401  | 1.448   | 1.098             | 0.760              | 0.103   |
|                     | 0.452  | 1.427   | 1.990             | 0.734              | 0.115   |
|                     | 0.381  | 1.744   | 1.986             | 0.715              | 0.196   |
|                     | 0.393  | 1.534   | 1.226             | 0.736              | 0.459   |
| Non-pedestrian      | 0.558  | 0.964   | 0.292             | 0.885              | 0.758   |
| Sample              | 0.568  | 0.776   | 0.096             | 0.951              | 0.693   |
|                     | 0.733  | 0.533   | 0.146             | 0.927              | 0.635   |
|                     | 0.605  | 0.899   | 0.312             | 0.890              | 0.654   |

The experimental data collected 100 pedestrian and non-pedestrian samples, trained by the texture features of pedestrians, and obtained m weak classifiers in the training process. When the weak classifier is 80, the recognition rate is the highest, and the sample classification is shown in Fig.6(a) shown. After the Adaboost cascade classifier is trained, it can maintain the accuracy and real-time detection. The test results are shown in Fig.6(b). The circle represents the pedestrian sample, the plus sign represents the non-pedestrian sample, and the cross number represents the sample of the fault class. From the results,
it can be seen that there are 16 sample classification errors, the correct rate is 92%, and the detection time is 0.045s.

![Image](image_url)

(a) Adaboost correct rate curve; (b) Training results

5. Conclusion
In this paper, the pedestrian recognition algorithm is studied. Firstly, the system software and hardware platform is designed to collect the pedestrian video in front of the vehicle, then the region of interest of the pedestrians is extracted. The maximum inter-class variance method is used to binarize, filter and then use the improved Hough. The transformation principle is used to detect the lane line, extract the starting point and the ending point of the lane line, extract the region of interest, and reuse the vertical and symmetry features of the pedestrian shape on the road to mark the pedestrian candidate area. Finally, the Adaboost classifier is used to classify and calculate the texture features of pedestrians. The experiment proves that the classification effect is good and the classification accuracy is 92%. Finally, the pedestrian recognition algorithm is transplanted to DM642, its hardware and software settings, debugging and code optimization. The pedestrian identification is proved by real-time evaluation, CPU processing power and storage capacity. The system is capable of real-time performance.

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