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Using CMOS image sensor to design of detection and statistical pedestrian in motion target

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ABSTRACT

Image acquisition mode of the CMOS sensor is active, charge photosensitive diode of the output by direct amplification transistor. Moving object scale change and deformation; moving target in the tracking process or rotary motion, change and camera distance and perspective, will cause the target image scale change and deformation. In this paper, with a pedestrian movement target specific, statistic of pedestrian is based on pedestrian detection and segmentation. The paper presents Using CMOS Image Sensor to Design of Detection and Statistical Pedestrian in Motion Target. Experiments show that these technologies have achieved good results.

Keywords: Motion target, CMOS image sensor, Statistical pedestrian.

INTRODUCTION

Moving target detection technology is mainly through the analysis of image sequences captured the image sensor, judge and estimate the moving object in each frame image position. The video image sequence is generally divided into two types: one is a static background, a situation is changing background. A situation occurs in the position of the camera is fixed, fixed camera video sequences such as monitoring of a scene captured; the latter occurs can be relative motion at the camera position, such as servo control for target tracking camera motion [1]. The method for detecting and processing point of view is generally used to highlight the target or eliminate the background thoughts. The camera is relatively static, processing is relatively simple, can use frame difference or adaptive background suppression method.

Image acquisition mode of the CMOS sensor is active, charge photosensitive diode of the output by direct amplification transistor, but CCD sensor is a passive collection, voltage to charge mobile in each pixel, and the applied voltage usually need to reach 12~18V; because of this, the CCD sensor in addition to the more high in power management circuit design the difficulty of the outside (additional Power IC), high driving voltage more make its power consumption is much higher than the CMOS sensor level.

With a pedestrian movement target specific and it is statistic on pedestrian based on pedestrian detection and segmentation. At present, the pedestrian statistical system many is the tilt angle of the camera, such as cameras must be vertically downward, the camera vertically downward to distinguish between people and people, reduce overlap between people, accuracy will improve the statistics that pedestrians. But some monitoring sites in the camera are not vertical, vertical camera angle and narrow, camera angle oblique placed wide.

Comparison and large amount of image data, to realize real-time image processing more difficult, but by taking certain measures can realize image acquisition and processing system with low cost. Image acquisition can use analog camera, CCD image sensor and CMOS image sensor. CMOS digital image sensor because of its high cost and the direct output of digital image data has been the most widely used.

In order to pedestrian statistics, first pedestrian detection on video. Video streams can be viewed as a set of static image with image sequence in strict sequence, have strong correlation between adjacent frames. In time, the results of the segmentation requires not only the intra frame still image with reasonable segmentation, but also keep the inter frame motion object segmentation continuity. However, due to irregular flow of movement, in order to ensure pedestrian counting system smoothly, with high sampling rate to ensure smooth traffic feature vector. The paper presents the algorithm of detection and statistical pedestrian in motion target based on CMOS image sensor.

2. Detection of Motion Target based on CMOS Image Sensor

In order to ensure the CMOS imaging unit output synchronous data written to the SRAM, we design the address counter SRAM within FPGA, and the design of the storage time according to the output characteristics of CMOS imaging unit, which consists of a write cycle and read cycle. In the write cycle when the CMOS imaging unit output of data stored in the storage unit, during the read cycle, the image acquisition card to special image data storage unit stores the data into computer for processing.

When there is relative motion between the observers and the observed, the observed surface optical features of the objects will be moving, varies as the image irradiance, this change is included in the motion and structure information is observed. Between the camera and the scene motion brightness mode relative motion observed called optical flow. Ideally the optical flow and motion field should be relative, but also have not corresponding, motion of the optical flow, a flow must have motion exists, but not a motion must have optical flow.

Corner of the image edge detection algorithm that corner is a kind of edge point based on, is a kind of special boundary. This kind of algorithm to detect the edge of image, and then detect corner points on the boundary as mutations detected. Methods based on edge, the first edge, then the corner detection, therefore, computational complexity, operation time is longer, and the greater dependence on edge extraction algorithm. If the error occurs the extracted edge, or edge line interruption (in practice often encounter this kind of situation), will corner point extraction results caused a great influence.

Moving object scale change and deformation; moving target in the tracking process or rotary motion, change and camera distance and perspective, will cause the target image scale change and deformation, these changes will cause changes in the expression of nonlinear target image, which leads to the failure of tracking; image brightness scene light changes; the same target has significant difference in different light conditions, effects of light intensity changes is one of the bottlenecks of many outdoor tracking system hinder performance, as is shown by equation1.

$$\overline{(x(t)-\overline{x(t)})\overline{x(t)}}=0 \tag{1}$$

The CMOS sensor flexibility, manufacturing can be as independent components, which can also be combined with digital image stream processor chip camera system, establish complete (SOC) solution. SOC can execute a series of complex processing functions, including color, color correction, sharpening and automatic exposure [2]. Integrated SOC further simplifies application design, reduces the number of chips, allowing designers to maximize the use of space on the circuit board.

Moving object segmentation in the process, the need to consider an important factor: the shadow. Because of the influence of sun and light and other factors, moving object in video images often contain the shadow. The shadow is not fixed, it with light intensity, direction and other factors in constant change, which has properties of moving target, in moving object segmentation as not to great distinction may be part of the shadow as a moving target. This will lead to serious results, such as merger, the target shape between the target distortions, even losing of target. All of these will lead to recognition of failure process of target identification in the next step of the. Therefore, in the process of moving target segmentation must be carried out in the shadow detection.

$$p(s(k)\mid a(k))=\frac{p(a(k)\mid s(k))p(s(k))}{p(a(k))} \tag{2}$$

Usually, transfer good image quality of equipment using CCD image sensor, and pay attention to the consumption and cost of products using CMOS image sensor. But new technology is overcome each device body inherent weakness, while retaining certain properties suitable for specific applications. At present, two kinds of image sensors are still with the development of information, communication, Internet and portable electronic equipment and development.

Camera motion actual is unpredictability, jitter severe extent also on different occasions, the experiments show that the algorithm based on N filter fixed length cannot be applied to all scenes. When the n is too small is not up to the smoothing effect, too much time in N, may produce a smooth excessive, and cannot obtain smooth with satisfactory results.

According to the relative movement of target and background, and it can be divided into: tracking algorithm for static target moving target moving object in dynamic background tracking algorithm, dynamic background tracking algorithm, the static background tracking algorithm, the static background. This paper used three kinds of moving target tracking algorithm is the focus of the study (tracking algorithm mentioned below did not specifically refers to moving target tracking algorithm) [3].

$$SSD = \sum_{X \in \Omega_t} [I_k(W(X, P+\Delta P) - I_{k-1}(X)]^2 \tag{3}$$

Frame difference method has simple principle, low computational complexity. Dynamic scene for change, but not the target completely separated, requires accurate segmentation combined with other algorithms complete moving target, using two frame difference method to detect moving objects from the video image; the background removal method can detect moving targets, but it needs to construct the background, more sensitive changes in the environment, the general can only be used in static scenes circumstances, and the need for background estimation and support updating algorithm.

Between the two frame time interval is relatively small (about 40ms), and the motion of the target are continuous change, so it can be measured information to predict as the target in the next frame image position by a known amount, then to predict the region near the position as the center of the search, this is compared to the whole image search small calculation quantity many, reduces the matching error interference from other similar goals, to improve the tracking accuracy.

Motion can be used to describe the motion field; the field is composed of each point in the image motion vector (speed). At a given moment, corresponding to a point in the image to the target point on the surface, as shown in Figure 1, and it is the two points on the projection relationship together. Assumed to be relative to the speed camera, this movement will lead to the corresponding point on the image generated for the speed of movement.

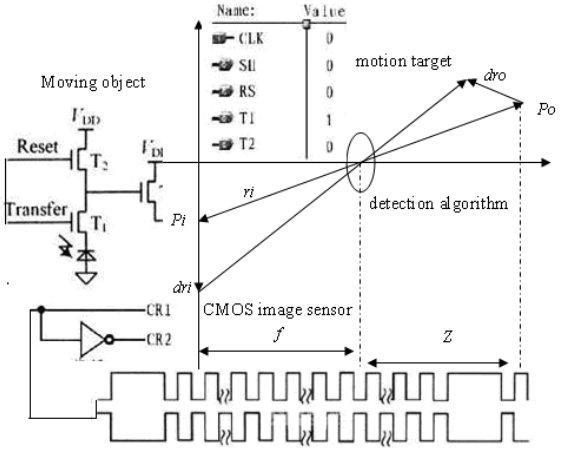

Fig. 1. Detection of Motion Target based on CMOS Image Sensor

CMOS image sensor has the advantages of low cost, simple digital interface, operation simple, high rate can achieve intelligent processing functions and features to be widely applied; and because it has a low noise, low power consumption, wide dynamic range, high spectral sensitivity, miniaturization, digitalization and easy to realize the commercialization, especially his the image sensor array, a timing control circuit, signal processing circuit, A / D converter and interface circuit are integrated, the real implementation of the single chip imaging.

Find the corresponding relationship of feature points in the image, also called feature matching. Before calculating the motion information, need to frame by frame tracking of feature points on the target of it [4]. Matching algorithms are introduced rigid constraint conditions, the existing technology including template matching, matching, tree matching, and constraint relaxation matching and hypothesis test match. For non rigid object tracking

the main contour tracking method based on active contour model, including measurement and contour model.

The relative motion of the camera, processing more complex, often need background motion compensation, then the frame difference and background cancellation method, if the target, also need after the background motion compensation for multi frames accumulation of energy and noise suppression. In addition, and it is detection method based on optical flow field. Moving object detection and segmentation of this chapter focuses on static background.

The CMOS camera has a faster frame rate, can be dynamic range to capture the sharp, clear image and high, can ensure the high quality image in different light conditions, the advantages of CMOS camera will help drive the adoption of video chat.

$$Cov[X,Z]=E[(X-\mu_X)(Z-\mu_Z)^T]=C_{XZ} \quad (4)$$

Stabilizing the global motion parameters calculated by matching algorithm source image basically can be divided into two ways [5]. One is the fixed frame matching, a frame of image at the beginning of operation were collected as the reference frame image, after the image as the matching frames and compare it to the calculation of relative motion parameters; another is the matching of adjacent frames, as the name suggests, is the two image frames for each adjacent all were compared, to compute the motion parameters. Two methods have their advantages and disadvantages, the fixed frame matching method because there is no cumulative error, so the parameter estimates more accurate, fixed-point shooting video stabilization effect is good, and relatively simple, is also commonly used in motion estimation algorithm.

The signal of the video image sequence, the most useful information is the change information of image signal between two adjacent frames, if no changes between each frame image sequence, then the amount of information will be greatly reduced. And the changes of inter frame image signal often contains the target information rich, which is exactly what we use the motion information of the video moving object segmentation based on it.

CMOS image sensor can also achieve high resolution. If the signal to noise ratio and improve the 10dB CMOS monochrome and color image sensor, light sensitivity and increased 4 ~ 5 times, then the CMOS image sensor to replace CCD devices will point the day and wait for it. If we take into account the CMOS image sensor has the advantages of small volume, low power consumption, give full play to the advantages of these have not been in the past, can give full play in the future, then a new image era.

The first image pixels per point as the value of the corresponding mean mixture of Gauss distribution, and to each of the Gauss model assign a high variance and small weights. When the new image arrives, the parameter to be mixed Gauss model for each pixel is updated, the ideal situation is that in every moment with T, contains the observation data of new period of time data, began to use the K means algorithm to estimate parameters of mixed Gauss model, but this matching algorithm the calculation is complex, can not achieve the requirement of real-time computation, so using an approximate algorithm, namely the K Gauss distribution according to weight and the ratio of the standard deviation from big to small order.

3. The Model Statistical of Pedestrian in CMOS Image Sensor

Complementary metal oxide semiconductor (CMOS) is the technology of natural advantages, this technique can join the CMOS logic circuit in the sensor chip, so that the image acquisition and control, switching and sensing function com. The high density of integration and the implementation of small single chip system are possible. The more system functions are integrated together to develop the photoelectric sensor system, control the realization of this goal is currently only by return on investment, market capacity and development costs and other economic factors.

For a pedestrian statistics, there is a need to study the two aspects: the first aspect is the research framework built; second aspects are some algorithms, including pedestrian detection, extraction and statistics from three aspects of the algorithm, related to the machine vision, artificial intelligence and pattern recognition of the three field of study. To set up the framework of the system, this system uses data flow based model, focused on the data processing, the algorithm and the data objects are considered separately, this model is suitable for applications which involve a number of different algorithms, need to deal with different types of data.

$$H_e=-\sum_{l=0}^{L-1}P(l)\log_2 p(l) \quad (5)$$

In order to improve the image quality of CMOS image sensor, the main noise source image and analyzes the image

distortion, this paper presents a new type of CMOS active pixel image sensor [6]. The CMOS image sensor using 4T active pixel, greatly improving the sensitivity of the image sensor. By integrating the function of image preprocessing in the sensor, made a very good effect on improving the quality of image.

M2 increases the width to length ratio (W / L): can be reduced Vgs2. Due to the use of minimum length process layout, MOS tube length L invariant, thus increasing the width of the M2 W can reduce the Vgs2. From equation (4) can also see Ibid reduce the bias current source follower can also reduce Vgs2. The appropriate increase of M2 according to the actual situation of layout in the pixel unit width, and properly reduce the bias current according to the load of two times of sampling circuit, can effectively reduce the Vgs2, thereby reducing the lower voltage VN.

Due to the sequential charge transfer requires continuous, high-speed driving shift register, which requires more electric power. The X-Y addressing and transmission Figure 2 CMOS image sensor is usually used, in this way, each pixel has its own amplifier, to transmit signals by column scanning and line scanning, and output to the image processing unit. It has a data transmission line, so it can achieve high speed, but if you carefully observe the output image, we can find easily appear in separate line image distortion.

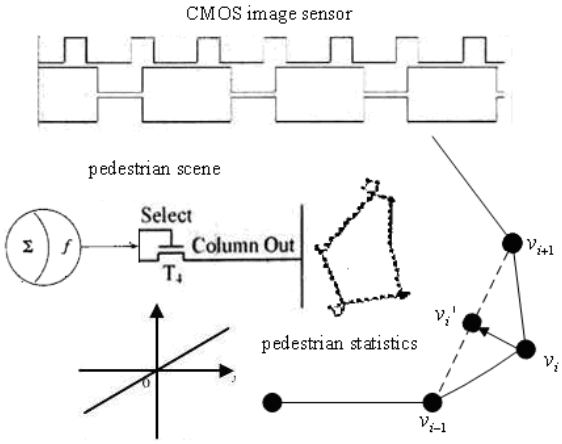

Fig. 2. The structure of IT monitoring system by RFID magnetoresistive sensor

After a great deal of difference image histogram analysis, differential image gray distribution function to form uniform distribution, as shown in Figure 2, the A was poor, mean gray level, image, D is the distribution function of the standard deviation, through a great deal of difference image segmentation test, the corresponding pixel gray value the h>B of moving target, and the h<B point corresponding to the background, in the image of the majority, so a B and we are looking for value, separate the background and moving target.

Space partitioning method can get the accurate edge objects from images. But the spatial segmentation often exist blindness, because a stationary object in the background are separated, and then merged together [7]. People interested in is often moving objects, object motion parameters is very important. But the movement letter nasty often fail to get the target accurately. Such as edge, using frame difference, can conveniently, quickly change between the two frames, the difference templates is incomplete, and the background part contains exposed, therefore cannot take the difference templates directly as the object template.

Therefore, the system is divided by two chips to a new generation of monitoring CMOS imaging sensor camera based system to provide the best price. This system also provides greater flexibility for system designers, allowing the digital control chip with different resolution (CIF, VGA, such as 1300000 pixels) and different output data format (Bayer and YUV) of the latest CMOS imaging sensor, which is diverse and rapidly growing demand for residential and commercial market development variety the surveillance camera system, feature rich.

FPGA complete sequence of EPP protocol. PC stops check whether READY signal, until the READY is valid, PC can read image data, while the ACK is high, said PC is reading the image data in the data cache. Then FPGA stopped collecting images (no write signal), FPGA detection of PC through EPP issued read pulse (CPU_DS), creating a cache MEM_RD (read signal) and address, from the cache reads a byte in parallel, at the same time to the PC to send it a BUSY signal, PC can read a byte of data at this moment, to complete the data read and write. In the process of reading data port of EPP PC_WRITE (write signal) to stay at a high level.

Video segmentation method based on the combination of space-time is not overlap assumptions on the moving

object in. If you have had motion overlapping phenomenon of two or a plurality of moving objects in video scenes, according to the above method can detect the motion changed region, but moving change region includes not only the moving object is single, but contains multiple moving objects overlap, so only depend on boundary characteristics in motion changed region is not accurate segmentation of each video object, therefore, the method is applied to moving objects do not overlap when the situation [8]. When multiple moving objects overlap, must be based on other characteristics, such as the motion parameters of each moving object is different, the occurrence of video objects overlap to distinguish.

$$\mu_{s_0} = E_{k}\{s_0(k)\} = \sum_{k \in \mathcal{R}_k} p(k) s_0(k) \tag{6}$$

While in CMOS image sensor is amplifier MOSFET amplifier. In the camera shutter is off the light receiving end moment, for MOSFET gate open at the same time charge transfer, all memory is transferred to the JFET gate. In addition, the JFET gate is equivalent to the measuring cup, through the JFET can read how much light load is transferred to the "Cup". JFET grid voltage is with the charge from the photodiode to the transfer of it. The JFET makes the signal voltage rises, and as a column signal lines, read data output. After the image signal readout, JFET gate will take charge to the MOSFET to reset, so you can open and close control of the gate of the JFET.

The purpose is to segment the pedestrian scene in the same background separated, each part of the same pedestrian tend to have the same attribute, overall. Two aspects are nothing more than: the attribute of time and space. This is the physical basis of all video segmentation algorithms. Spatial attribute is mainly: the characteristics of brightness, color, texture or other transformation or statistics. There are two different consideration: regional (consistent focus on spatial attributes) and edge (differences focusing on the spatial attributes [9]. Attributes (properties) time motion) mainly for the inter frame difference, optical flow or motion vector, which can detect the inter frame change (movement) region and movement.

The pedestrian of statistical techniques for oblique placed cameras can video are explored, respectively discusses the pedestrian detection, segmentation and statistical techniques; gives a in the difference image threshold segmentation technology, the segmentation technology comprehensive statistical knowledge; at the same time, closed on the edge of the introduction of active contour, experiments show that these two technologies have achieved good results.

4. Algorithm of Detection and Statistical Pedestrian in Motion Target based on CMOS Image Sensor

Background subtraction method of comparing the frame difference more accurately extract the moving target, the frame difference method if the method is not combined with other changes can extract the moving area (including true moving target, and revealing the covered background) and not directly extract the moving target [10]. However, when we also consider the use of background subtraction lot of questions to get a background image b (x, y, t); easiest way is to first frame without moving target image frame as a background image. However, in the actual environment over time is constantly changing background image, background change caused by many factors, such as: light changes, changes in the environment and so on. Can not simply be an image of an object without moving the frame without updating the background.

Three dimensional reconstruction of object image; mapping motion to two-dimensional images of three-dimensional space itself lost depth information is important, because moving object with scale change, deformation and brightness scene light changes in the tracking process, need reasonable definition of template update strategy, avoid moving target drift.

CMOS is favored by high speed imaging technology. In the current market, we can find that the high speed image sensor has three tendencies, one is to the development of very high speed direction, the two is the development of the on-chip integrated direction, the three is the development of high speed image sensor to the general direction, resolution and frame rate combination, play an important role. At present, we can launch image sensor with 1024 x 1024 pixels per second, the speed of 5000 full frame. If the conversion is 10 words, then the total data rate of up to 55Gbit. Per second that is on the camera.

$$H = \sum_{X \in \Omega_i} \left[\frac{\partial I}{\partial W} \frac{\partial W}{\partial P} \right]^T \left[\frac{\partial I}{\partial W} \frac{\partial W}{\partial P} \right] \tag{7}$$

System model of pedestrian statistics, both the data and the algorithm using the object representation: an algorithm is represented as a Filter, which accepts input, generates an output, the input and output are all data objects, and the

output of an algorithm can do for another algorithm input. By such a model, a series of algorithms can be strung line, forming a unified computing framework. This system according to the data flow model is divided into 4 modules: image acquisition, pedestrian detection, pedestrian detection and pedestrian statistics.

CMOS technology provides a platform for the implementation of a strong ability to: Although the external logic circuit of CCD image sensor still need to use another technology (for control and analog / digital conversion), but the CMOS camera chip to realize image sensor, controller, transducer and the evaluation logic circuit and the HF transmitter using the same technology allow, thus it can be above them in the same chip.

After the pedestrian detection and segmentation, image is obtained after two value image contour processing, for the larger distance between pedestrians, get each pedestrian contour, when pedestrians are more and the crowded conditions, so the image contour was treated groups throughout the profile, in order to improve the statistics precision, we set up a statistical window in the video window, called window, as shown in Figure 3, the width and the video image of the window of the same.

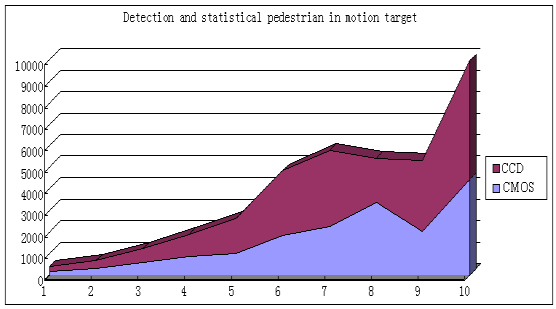

Fig. 3. Comparison Algorithm of Detection and Statistical Pedestrian in Motion Target based on CMOS Image Sensor with CCD

The sensor with large area, as a traditional, and it is complex ray film program alternatives. The so-called "rolling" technology can be in 8 inch wafer (in the future in 12 inch wafer) on the realization of economic production of CMOS image sensor. During the shooting of this journey about 25 minutes of video, video image size is, the use of the system development environment for VC+ DirectorShow, the actual number of pedestrian in video is 99889, while the number of system statistics for 854, the statistical accuracy of 98%, error is 12%.

This paper expounds the moving target detection and segmentation techniques, including the basic principles of three kinds of basic methods of frame difference method, background subtraction and optical flow method are discussed, and some improved algorithm based on the three methods based on a factor, the most important influence in the shadow of the moving target detection and segmentation, but also do the detail, and gives a common method of removing shadow.

CONCLUSION

The IP camera system of CMOS image sensor will soon become the choice of commercial security applications. We will provide some general views on commercial security monitoring, from the closed circuit television system based on CCD to the IP system based on CMOS for the whole system, such as low cost, low power consumption and increase the CMOS sensor performance. The paper presents the algorithm of detection and statistical pedestrian in motion target based on CMOS image sensor. In probability theory, the statistical characteristics of mean is a description of the main central position, the standard deviation is a "subject" and "tail" separate statistical characteristics, as the statistics (function of the statistical characteristics mean and standard deviation), can be very good expression of the overall distribution of information. Pedestrians in the statistical system, we determine the adaptive threshold method has achieved better effect.

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