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DETECTION OF SCENE CHANGES FOR EFFICIENT IMAGE TRANSMISSION FROM A MOVING CAMERA

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ABSTRACT

In this paper a new approach on scene change detection is provided in order to improve the efficiency for digital image transmission even if the camera is moving. This application shows the results obtained with an unchanging scene seen from a mechanically unstable (due to atmospheric conditions and other disturbances) camera.

The work is applied to the transmission of moving objects on a railway crossing, so the railway driver can see what is happening at the crossing a long time before arriving there.

The vision system presented is able to recognize some scene features, which can provide the necessary information about object movement in spite of the possible camera movement.

Keywords: Motion, Color, Line correspondences.

INTRODUCTION

The paper is organized as follows: Firstly, the general problem is introduced and an overview of motion detection is presented. Secondly, how to estimate motion from vertical straight lines (VSL) are described, including the detection by hue and luminance components. Thirdly, the real-time Vision System Architecture used on the application is described and finally the algorithm for line correspondences and the results obtained are listed.

The motion estimation problem has been studied from several years ago by a large number of scientists. Solving the motion analysis problem usually requires three different steps: feature detection, correspondence of primitives and motion parameters estimation.

To do the feature extraction involves the detection for the moving objects of a large number of characteristics such as points, line segments, vertices, corners, straight lines, etc... To take scene features as reference is also a very common topic for image subtraction and motion detection.

In addition, the problems of a moving camera and an unstable background have been studied. A.V.Brandt and K-P Karmann [1,2] present a motion estimation based on a model of camera dynamics and a algorithm based on a Kalmann filter using adaptative reference images.

Algorithms and architectures for edge detection have been an essential part for many computer vision systems. In [3] K.Kories and G.Zimmermann present a summary on feature detectors for motion detection. Also, several methods have been proposed to compute the motion parameters using optical flow. Because this is an unconstrained problem, all motion estimation algorithms involve additional assumptions about the structure and stereo images. In these cases, video-rate operation is not possible and the polynomial solutions require initial guesses, high computing cost, and usually more than two frames. C.Jerian and R.Jain [4] make use on polynomial methods for solving the structure from motion problem.

We focus on the line correspondences problem which is a very common topic on motion detection. In this way the works made by Y.Liu and T.S.Huang [5,6] have a special relevance.

Most of the real cases it is possible to get many straight lines from horizontal gradients, which are associated to color and luminance changes.

The results of R. Nevatia (7) indicate that luminance and chromatic edges tend to be highly correlated.

On the other hand, scenes with low illumination levels have chromatics edges much more contrasted than the image luminance component. This caracteristic gives robustness to the vision system under illumination changes and low illumination levels. Then, the color can be used to significantly improve the capabilities of a vision system.

The choice of color coordinates for edge extraction was initially presented by G.S.Robinson [8].

In this paper, we make use of V.S.L. associated to horizontal gradients color components, in addition to luminance gradients.

PROBLEM DESCRIPTION

The target of this work is provide useful information about motion detected in an outdoor scene.

In (Fig.1) two differents perspectives of the same scene are showed. Our major interest is on the vertical edges associated to wall corners, many-branched lampposts, publicity pannels, catenaries, etc.

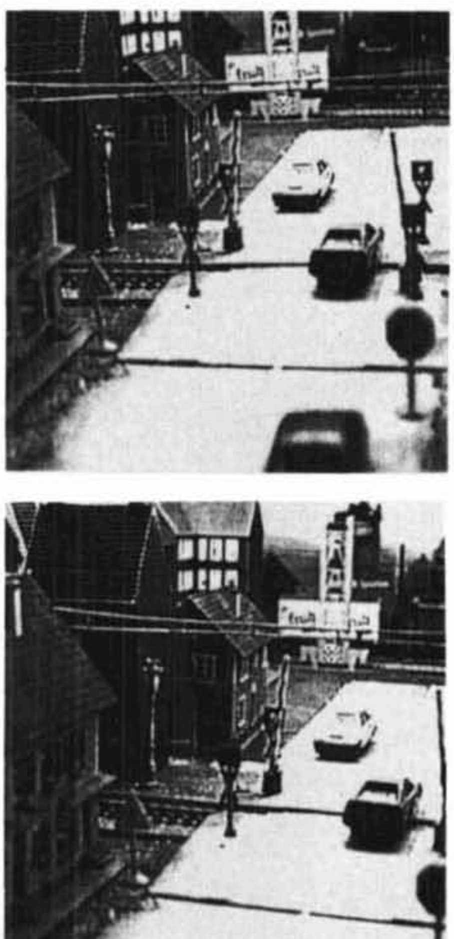

Fig.1 Perspective of the observed scene, with Δx, Δy and a small rotation

VSL, the most common technique used on structured environments, has the additional advantatge that is almost invariant for a wide range of movements of camera.

The verticality is therefore a feature that has no dependence from x,y movement and also from small rotations.

Our application is intended to detect moving objects on a railway crossing and to send this information to the railway driver (fig.2). There are a lot of possibles causes that can modify the camera's point of view. As we would be expected, the simple differencing technique is not at all appropriate for solving this particularity.

Fig.2 Railway driver and monitor

In addition, a great reduction on data transmission can be achieved sending only information about changes in the scene instead of sending again all the scene information. This is used on videophone and video-conferencing applications together with image data compression.

Also there ara some matching methods for motion detection avaiable, but it results too costly (time and computing support).

In order to perform the object motion detection, it is necessary to find the common area in their two visual fields and then estimate the sensor movement.

This problem is solved by finding the relative x and y shift and the small rotation between two consecutive frames, extracted by means of correspondences between VSL of the static scenery.

A R C H I T E C T U R E

In (fig.3) the real time architecture used for motion detection is drawn.

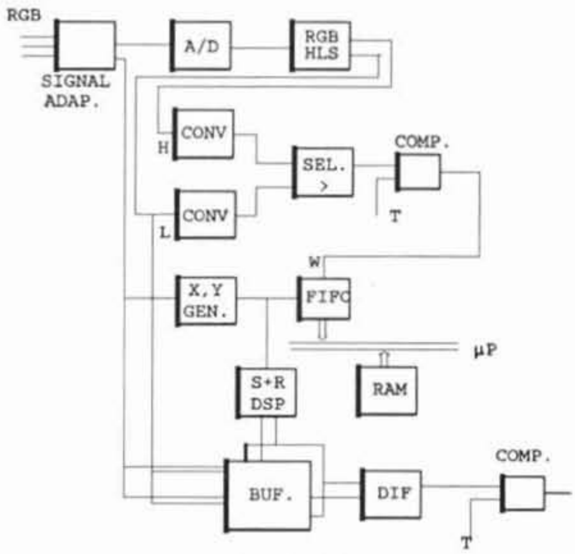

Fig.3 Architecture

A standard RGB video signal comes to the inputs provided by the camera. After its traitement by an A/D converter, a real time module converts this RGB digital input signal to HLS digital values. This RGB/HLS module is controlled and programmed by the microprocessor system. This feature easily allows to change the mathematical conversion.

The (figs. 4) show the most outstanding components on hue (4a) and luminance (4b) gradients for a railway crossing.

Fig. 4a Hue component for a railway crossing

Fig. 4b Luminance for a railway crossing

A real time window operator is applied over the hue and the luminance. The window dimension is defined by its 7 rows and 3 columns, and has been chosen looking for a balance between the information on the verticality feature and the hardware complexity. After applying this operator over the picture each pixel is set to the maximun gradient value among the two convolutioned images.

By using an adaptive thresholding a binary image is obtained which now contains the vertical straight lines detected.

In order to save time during the searching lines process, during the conversion to binary images and during its parametric treatment, only the V.S.L. coordinates are stored in a FIFO memory. This process has the main advantatge that classifies the data in such a way that it is very easy when reading the FIFO to separate the coordinates points from differents lines.

For every two consecutives frames, the microprocessor takes information about VSL from the FIFO memories. An algorithm from line correspondences finds the x and y displacement and the rotation detected in 2D ortographic projection.

The S&R DSP applies shift and rotation over the pixels of t-2t frame. The module DIF is able to compute substraction over t-dt and t-2dt frames. Motion detection can be done by thresholding the difference image.

I M A G E   A L G O R I T H M

The line to line correspondence for a couple of frames can give deceitful results.

For finding V.S.L. correspondences belonging to an environment with unknown structure a new image algorithm has been developped. Given two sets of primitives

(V.S.L.) observed that belong to two consecutive frames, the target is to establish a correspondence between them. We take into account only the more outstanding lines.

Besides, the problem that the number of V.S.L. which belongs to every frame is not the same, has been reviewed.

The algorithm is based on the idea that it must apply the stiffness constraints to every possible triplets of V.S.L. segments detected. The number of possible V.S.L. triplets by frame i is expressed by the equattion $Ti = \binom{N_i}{3}$, where N_i is the number of segments.

For each triplet the algorithm computes the three distances between center points of segments of the triangle associated to these three distances. (fig.5).

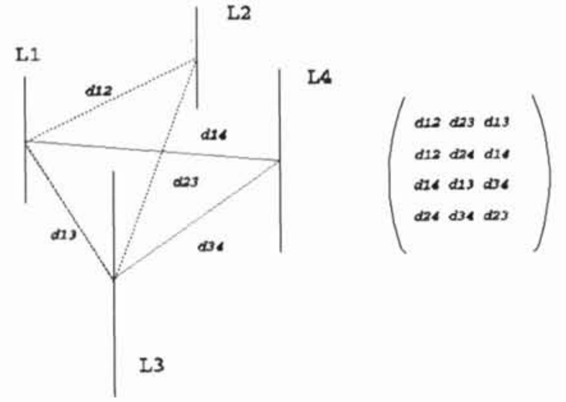

Fig. 5 The way of grouping VSL triplets on frame t

Every triplet of V.S.L. has associated a set of three numeric values. Therefore for every frame the algorithm is able to generate a matrix M_i with a dimension T_i x 3

In the case showed in Fig. 5 the matrix has a dimension 4 x 3.

In frame t+dt (fig.6), a new line (labeled as L5) has appeared and the line labeled as L1 has disappeared. Fig-7 shows the matrix M_j which is associated to the frame t+dt, with a dimension T_jx3.

In this exemple it is possible to find correspondences between 3 rows of these matrices, with a knowm tolerance. An easy algorithm to find correlations between rows has been implemented.

For each correspondence we know the associated VSL and can take out information about shift and rotation.

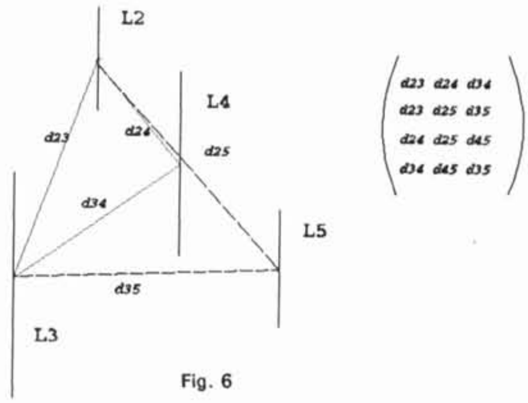

Fig. 6

R E F E R E N C E S

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