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Foreword

The Sixth International Conference on Software in Telecommunications and Computer Networks SoftCOM'98 was held from 14 to 17 October 1998 in the pleasant ambience of the luxury ship Marko Polo on the route Split-Barša-
Dubrovnik. It was organized by the University of Split (Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture), HPT-TKC
(Croatian Post and Telecommunications) Split, WTC (World Trade Center)
Split and Technology center Split. The Conference was sponsored by the
Ministry of Science and Technology of the Republic of Croatia, the University
of Split and by the IEEE Communications Society (COMSOC) Technical
Committee of Communications Software.

The papers submitted for presentation at SoftCOM'98 have been reviewed by
recognized scientists from universities, institutes and companies from Croatia,
Italy, USA, Slovenia, and UK. Each paper has been reviewed by three
reviewers and all submitted papers have been carefully selected based on
their contribution, relevance, conceptual clearness and overall quality. Nearly
80% of papers have been recommended for presentation within the technical
program. We believe that reviewers’ suggestions and comments to authors,
have considerably contributed to the quality of the SoftCOM'98 Proceedings.
We would like to thank them all for their very well done job.

The papers accepted for presentation were classified into 7 groups: Software
Architecture, Design and Applications; ATM Networks, Wireless
Communications, Advanced Services; Network Design, Management and
Control; Signal Processing and Coding; Circuit Design and Electromagnetic
Compatibility. The whole technical program was held through 9 sessions. The
Technical Committee has also invited several outstanding experts both from
Croatia and abroad to present the state of the art in the most interesting areas
such as trends in development of telecommunication systems and services,
new directions in network management, re-inventing the communication
structure, universal and satellite communications, spoken queries systems in
European languages and quantum mind networks. In addition, five tutorials
were held by well known experts. We believe that themes of tutorials such as
software architecture in digital cellular systems, high bandwidth access to the
home, multimedia applications on Internet, quantum mind networks and an
overview of EU R&D projects, could find a great interest of professionals
engaged in development and design of advanced communication systems and
services. The SoftCOM'98 Conference days also include a group of panel
discussions in the framework of the Professional Circle session.

This year we continue with a practice of organizing some events related to
SoftCOM. This year we organize two workshops dealing with recently really hot
topics: intelligent transport systems and communication/information systems in
healthservice and telemedicine.

We believe that the Conference help all of us to keep step with a very dynamic
and complex development of modern communications, software architectures,
software services and related technologies.

Split, October 1998

N. Rozić
measures in compression system which removes temporal redundancy between frames. In compressed video system, which removes temporal redundancy, distortion is a function of picture content. In this system quality measurements using test waveforms do not characterise the picture degradation due to compression and temporal characteristics of the system are not explored. But objective measures have good correlation with subjective results in compressed video system, which reduce only spatial redundancy within single frame. Objective measurements are repeatable and do not depend on viewing conditions or the mood of the viewers.

In real video sequences many picture defects are hidden by the picture transition or content with which they are associated. Therefore subjective measures are needed. But, subjective measures of picture quality depend on viewing conditions. The measurement takes a large amount of time and resources and the results are not always repeatable. Ideally, a combination of subjective and objective test methods is the most effective way to test video compression system.

REFERENCES


IMAGE DISPLACEMENT VECTOR DETERMINATION BY FUZZY SET COMPARATOR

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Abstract: Principles of digital picture analysis and image understanding techniques make computer vision system applicable. Abundance in interpretation of analysed information involved by presence of noise, absence of contrast, sensor distortion etc., can be avoided using principles of Fuzzy Set Theory.

In this paper FSC (Fuzzy Set Comparator) is used for object displacement vector determination. 2D fuzzy set of displaced images: up, down, right, left and centre, are defined in learning process from one image of a scene. The displacement vector is determined on the basis of the differences between new scene and defined fuzzy set of displaced scenes. The displacement vector is determined.

Theoretical results are evaluated experimentally using "off-line" mode of FSC digital image processing.

KEYWORDS: displacement vector, pattern recognition, fuzzy set theory

INTRODUCTION

A mapping between one frame from an image sequence and the preceding or following frame can be represented as a displacement vector field [1], or as Weng defined [2], the displacement vectors between the corresponding image points are the results of image matching, used as input for 3D motion estimation. Based on existing techniques for image matching, which roughly fall into two categories: continuous and discrete [2], the displacement vectors appropriately model the scene structure.

In the continuous approaches, the interframe motion is approximated by motion velocity and, therefore, to achieve for such an approximation to be reasonable the interframe motion must be very small and the intensity function is smooth and well behaved [3]. The displacement vectors are given as optical flow.

The discrete approach techniques treat the images as samples of the scene taken at discrete times, and select discrete features as tokens that are to be matched. For example, points with high grey value variation can be defined as
matching tokens [4]. Other features used for matching include edges for stereo matching [5], lines for stereo matching, correlation of intensity patterns [6], etc. Generally speaking, discrete approaches allow either small motion or relatively large motion and more accurately models which actually happen than the continuous approach.

As the concept of fuzzy sets fits very naturally in the framework of discrete image matching techniques, in this work FSC (Fuzzy Set Comparator) is used for object vector displacement determination. 2D fuzzy set of displaced images: up, down, right, left and centre are defined in learning process from one image of a scene. Based on differences between new scene and defined fuzzy set of displaced scenes, the displacement vector is determined. Theoretical results are evaluated experimentally using "off-line" mode of FSC digital image processing.

1. THE LEARNING PROCEDURE AND A DISPLACEMENT VECTOR DETERMINATION

The displacement vector determination is usually based on sophisticated procedures for overlapping recognised shapes in a sequence of analysed images [8], [9]. Fuzzy set comparator board (Fig.1) enables hardware comparison for patterns that are stored in the available memories without prior image shape identification. The results of the comparison are stored in registers accompanied to the memories and could be sent to the neural net gate which is responsible for finding the winning memory pattern, i.e. it makes the decision which of the memory patterns is the most similar to the referent one. Also, the degrees of similarity are determined, too. Defining a unit step characteristic function (Fig.2) whose values \( E_i \) are equal for all patterns in appropriate video memories damps the influence of noise on input data.

![Diagram of FSC board](image)

Fig.1. Schematic representation of the FSC board

The size of each FSC video memory is adapted to the NTSC standard. For continuous video input from camera, only the even field of video is used, and only 192x132 pixels are saved. Each pixel is represented by two bits, so a total of four grey levels can be achieved.

![Error threshold characteristic function](image)

Fig.2. The shape of the error threshold characteristic function

In the learning process, the image of monitored scene has to be processed to define 2D fuzzy sets of displaced images named: up, down, left, rights and centre. Those fuzzy sets are stored in five external pattern memories as fuzzy matrices with appropriate pixel grey values. The characteristic function of those fuzzy sets is also 2D function with the same values scaled to \([0,1]\) interval. The data from the new image of a scene is entered serially into the FSC device, where it is formatted into bit fields and compared, one field at a time, with data stored in external pattern memories. The result is an accumulation of errors across all of the fields. These error sums represent a set of closeness values. If the smallest closeness value of a particular comparison is also less than a characteristic function threshold value, then the best match is found between the known and unknown image of a scene patterns. The displacement vector is determined by the four-step procedure. The first one is calculation of the degrees of fulfilment. Each displacement has its own degree of fulfilment, which is reciprocal to the error sums. If an error sum is equal to zero, than the stored pattern is identical to the compared one. Therefore, the degree of fulfilment has maximum value, which is equal to 1. Contrary, the highest value of an error sum means the weakest match between grabbed and stored patterns resulting with zero degree of fulfilment. Consequently, the degree of fulfilment is a vector, whose each element is calculated by the formula:

\[
\begin{align*}
\text{if } E_i &= \text{maxErr} & \lambda_i &= 0 \\
\text{else if } E_i &= \text{minErr} & \lambda_i &= 1 \\
\text{else } \lambda_i &= \frac{\text{maxErr} - \text{minErr}}{\text{maxErr}} \cdot E_i
\end{align*}
\]
where maxErr is the maximal error sum. Similarly minErr is minimal error sum between compared new image of a scene and stored pattern memories, $E_i$ is appropriate error sum, and "i" represents the i-th element of the fuzzy vector.

The second step is determination of the output fuzzy set

$$d^* = \gamma_l \wedge d^*$$

where $d^*$ are fuzzy sets of displacement depicted on Fig.3b.

![Diagram of directions](image)

Fig.3a. Defining the meaning of the direction fuzzy sets

![Diagram of mapping functions](image)

Fig.3b. Mapping functions of the direction fuzzy sets

The third stage is interpretation of the output fuzzy set resulting with displacement vector direction. Its crisp value is calculated using centre of gravity method

$$d^* = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} d_{ij} \cdot d^*_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{m} d^*_{ij}}$$

The final stage is determinated by displacement vector magnitude. The idea was based on the following procedure: the higher the degrees of fulfilment are, the displacement vector looks more like the displacement created and stored in the pattern memories during the learning phase. It is important that only two displacements are relevant which have maximum values of degrees of fulfilment. For example depicted on Fig 3a, it is displacement "down" and "left".

As the image of a scene is always compared with a image patterns constructed partly with the moving object interesting part (etc. "up" part - symbolising move in the down direction; "right" part - symbolising move in the left direction and similar) and with a background, this method would perform in the same way using different (non-uniform and/or textured) background or texture covered object.

The same considerations probably could not be applied to big oscillations in size/size of the object but described experiment is performed having in mind that the same techniques will be applied for final positioning of the robot manipulator where oscillations in size of the image objects are neglected.

This method for displacement vector determination could be applied in a control algorithm, because the obtained results are quite satisfactory as the experiment, described in the next section, will show.

2. EXPERIMENTAL RESULTS

The experimental results were obtained "off line" as the camera standard (CCIR) and used FSC board (NTSC) were incompatible. The images grabbed with camera MICAM HRS were stored in the additional frame buffer, which belongs to the system CYCLOPE 2-1. There, the image was processed and adapted for comparison on the FSC. Afterwards, the 2D fuzzy sets of displacement vectors were established and stored in appropriate memories. Its absolute values of grey level are visible on the Fig 4a, 4b, 4c, 4d and 4e. The new grabbed image with displaced object was compared with the stored patterns and the comparison results appeared on the screen. The object was moved to the right, so the error sum of the fifth pattern memory had the lowest value and consequently $\lambda_2 = 1$.

3. CONCLUSIONS

Comparing the known image patterns with the new image of a scene, it is possible to define the object displacement vector. Although the results were obtained only "off line", the speed and precision in displacement vector determination were respectable and indicated that the described method applied on compatible equipment has to be seriously considered in real time detection, tracking and/or control of a moving object.
The special advantage of this method is that the obtained displacement vector could be directly used as an input to control algorithm. Typical applications could be the control of a robot manipulator, mentioned before, or the control of the camera movement to keep the object in the image center all the time.

4. LITERATURE


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Fig. 4. Images captured by CCIR camera and adapted to the NTSC standard; the images of the defined displacement: center 4a, up 4b, down 4c, right 4d and left 4e; the image of the moved object 4f.