A NOVEL TOOL FOR STEREO MATCHING OF IMAGES

B.Harika[1], N. Raghava Rao[2], R.V.Krishnaiah[3]

[1]M.Tech Student, [2]Associate Professor, Dept. of CSE, [3]Prinicipal, DRKIST, Hyderabad, AP, India
harika_honey16@yahoo.co.in, raghavarao.n@gmail.com, r.v.krishnaiah@gmail.com

Abstract

Stereo matching techniques play an important role in many real world applications like robot stereo vision and image sequence analysis. From given pair of stereo pairs of images, it is possible to have matching techniques to obtain image descriptors or phenomena to compare the images. The goal of stereo matching can be achieved using either relational matching or feature or signal. However, the signal approach is most widely used. Recently Lemmens [10] provided a comprehensive review of many stereo matching techniques. In this paper we implement the techniques that can help in the real world. We build a prototype application that demonstrates the proof of concept. The empirical results revealed that the proposed application has good utility.

Keywords *– Stereo images, stereo matching,*

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1. INTRODUCTION

Image processing has been around for long time. Working with images has many real world utilities. A picture speaks thousand words. Pictures convey more meaning than text. Extraction of automatic digital information from images is very important activity. There are many techniques for this. However we can't find a single best technique to do so. The techniques work based on the problem area. For instance vision problems can be solved with some technique which is not efficient for other problems. Therefore many diverse approaches came into existence causing confusion among the users of the techniques. Therefore this paper is aimed at reviewing the diversity in the existing scenarios. Provided this, matching is a common approach to compare two or more image sets. It is also known stereo matching.

For each pair of stereo descriptors are different. Therefore it is important to extract image descriptors at runtime without prior information of the images. In real world matching applications it is required that application should be able to match a sequence of images on the fly. In order to extract 3-D information there are many passive methods. These methods are known as shading, focusing and texture. Recently laser and radar are also used for active ranging. However, they are not in the present scope. From conjugate image pairs surface recovery 3-D object space is the purpose of stereo vision. For the purpose of image analysis 3-D surface description provides details of whole objects which may cause processing bottleneck at runtime. Instead Digital Elevation Models are extracted using digital photogrammetry and matching techniques.

2. STEREO MATCHING TECHNIQUES

Before describing stereo matching techniques we would like to provide the steps of stereo analysis first. In the first step descriptors and tokens of both images are extracted. In the second step, phenomena selection, and corresponding object spaces are selected. In the third step, interpolation is made in order to arrive at 3-D surface description. The three stages are illustrated in figure 1.

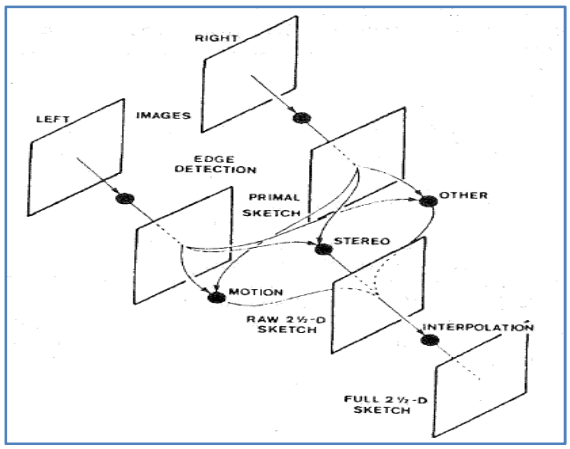

Fig. 1: Illustrates three stages of the solution

As can be seen in figure 1, it is evident that there are three phases in solving the problem. In the first phase extraction of phenomena is done. In the second phase, selection of corresponding phenomena is made, and in the final phase, interpolation is made in order to get descriptions of full 3-D surface. For the purpose of matching three types can be considered. They include signal matching, feature matching

and relational matching. In all the techniques, it is important to analyze structures of images as they can be described.

3. FEATURE MATCHING TECHNIQUES

Features are in every digital image. The features might be points, lines and areas. There are many detectors to find characteristics of stereo images. They include Marr-Hildreth, Moravec, Dreschler and Forstner operator. Matching can be influenced strongly by three features of images. They include discreteness, similarity and consistency. Points that will help in distinction with neighborhood can be stated as discreteness. The resemblance measures of two points are known as similarity. Consistency refers to the conformity of matches based on some object model with consistent surface in the images. These features can lead to the three stages namely selection of distinct features, selection of candidate features and thinning of the candidate points. First of all point matching is explored with similarity measures. Then consistency techniques are focused. Finally edge detection is shape description and vectorization is made. Invariance refers to the localization and selection of the points that should remain intact towards radiometric and geometric distortions. Stability refers to having high probability that appears in stereo images. Seldomness refers to the avoidance of the features obtained from repetitive structures.

4. RELATIONAL MATCHING

Relational matching is one of the stereo matching techniques that take attributes and also relationships between phenomena into account. They consider regions, fragments, lines, blobs, points obtained besides the attributes like gray value, shape, area, length and so on for the processing. Relationships reveal spatial connections and also corresponding properties. When there are two entities, reliable mapping of primitives of one entity with that of another one is important to known the relationships and characteristics. In graph theory entity description concept is included. The description contains many details. Search algorithms are used in order to map the entities correctly. As there are many view points of stereo images, the object structure is different from different images. Matching procedures should be aware of these differences and tolerate them in order to perform well. Graph representation structures are proposed by Shapiro and HaraUck as relational matching is complex and it is in its initial stage in the development and representation of structures. Relational matching of complex scenes cannot be tolerated here. More on relational matching can be found in [10] and expositions in advance form are in [11] and [12].

5. SIGNAL MATCHING

In this approach, pixels of neighborhood are considered. Based on the gray value of pixels resemblance is computed. Statistical measure like cross-correlation is used as seen in figure 2.

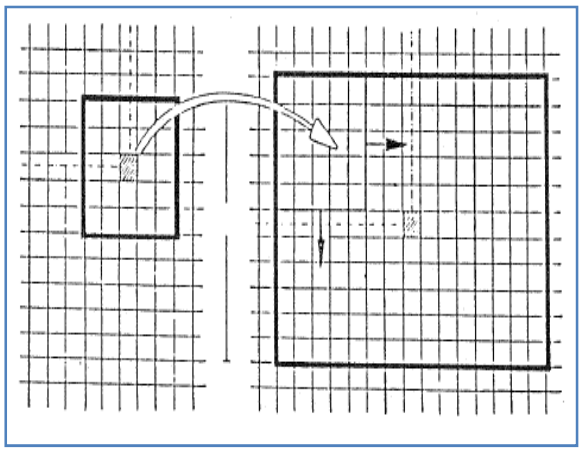

Fig. 2: Illustrates signal matching

To define coordinates which are not known is computed as follows.

$$g_t(x_t, y_t) = g_s(x_s, y_s) + n(x, y)$$

With given coordinates of the target area, the corresponding coordinates are added to the additive noise. The equation is used to compute approximate values. There are some refinements introduced in LSM. Geometric constraints were used to have multiple views. Rosenholm introduced another kind of matching known as multiple point matching. For gray value correlation discrete correlation is used generally.

$$R^1_{ts} = \sum_i g_i^t \cdot g_i^s$$

When sample means and second moments are used together, the cross correlation is computed as follows.

$$R^4_{ts} = \frac{\sum_i (g_i^t - \bar{g}^t)(g_i^s - \bar{g}^s)}{\sqrt{\sum_i (g_i^t - \bar{g}^t)^2 \cdot \sum_i (g_i^s - \bar{g}^s)^2}}$$

In order to find best solution the measures given above are to be maximized.

6. RESULTS

Stereo matching technique has been implemented using Java platform. We built a prototype application to dedemonstrate

the concept of stereo matching. The environment used to build the application includes a PC with 4GB RAM, core 2 dual process running Windows 7 operating system. The main application is as shown in figure 3.

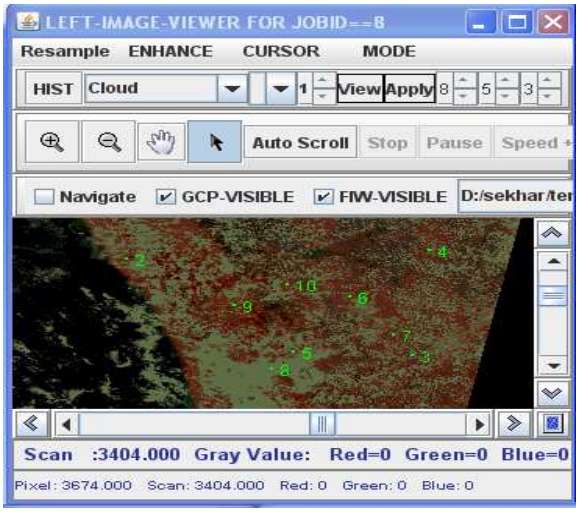

Fig. 3: Input image shown on the screen with points

As can be seen in figure 3, an input iage is taken from end user. The image is presented with a scrollbar using which users can navigate to and fro. The image has certain points that can be considered for matching. The identified points are presented in the figure. The image gray values and the number of pixels in the iamge are also presented. In the next step, another image is taken and the points are considered. The figure 4 shows the same.

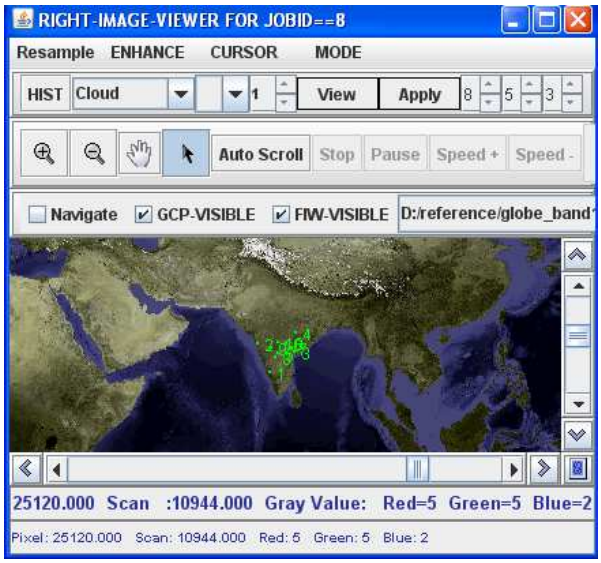

Fig. 4: Illustrates image with points

As seen in figure 4, the image is shown with points and they are matched with other image points. This kind of comparison is made using the techniques described in this paper. The points are useful in performing stereo matching. The screen also shows the statistics about the image including RGB values and pixels present in the image.

Fig. 5: Shows identified points in tabular format

As can be seen in figure 5, the identified points are presented in tabular format. For each scan all statistics are provided including the pixels present. It also has provision for performing swipe operation. The resultant image along with intermediate results is presented in figure 6.

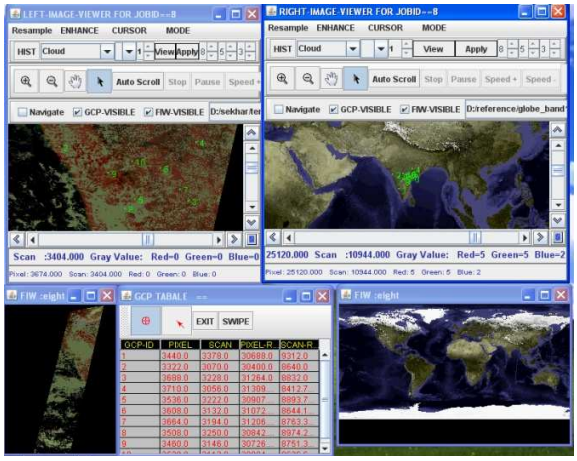

Fig. 6: Illustrates the whole process

As can be seen in figure 6, it is evident that the images considered for stereo matching are preened along with point details in tabular format. The swiping results are also presented in the figure. Another example on swipe with overlapped image is presented in figure 7.

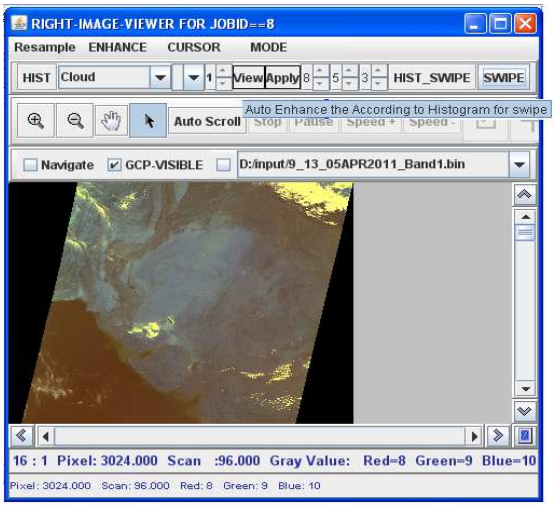

Fig. 8: Illustrates another example

As seen in figure 8, it is evident that the results of overlapping of images as result of stereo matching are presented. The screen also shows the RGB values along with other statistics like scan and number of pixels. Thus the results revealed that the proposed technique is useful in real world applications. The usage trend of the three stereo matching techniques is presented in figure 9.

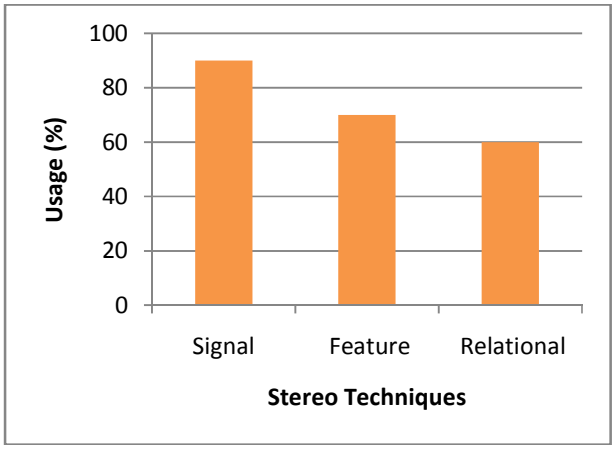

Fig. 9: Usage trend of stereo techniques

As can be seen in figure 9, the signal technique is most widely used.

CONCLUSIONS

In this paper we implement a prototype application with user-friendly interface which demonstrates the usefulness of stereo matching techniques besides making a review of them. Two stereo images are compared pixel by pixel in order to obtain dense surface description. The gray values do not have necessary information to reveal the reliable matches. This causes ambiguities. Using neighbor pixels ambiguity can be avoided to some extent. The reason behind this is the presence of occlusions and geographic differences. Present computer vision applications cannot scale to the level of using all objects and the relationships in the given scenarios. Extraction of radiometric independent phenomena or features is the technique which lies between relational matching and also signal. Instead of course grained strategy, fine grained strategy is preferred to have reliable matches. In this paper we implemented stereo matching techniques that help in real world applications. The empirical results revealed that the application is useful.

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BIOGRAPHIES

B. Harika has completed B.Tech (C.S.E), from DRK College of Engineering and Technology, JNTU, Hyderabad, Andhra Pradesh, India, and pursuing M.Tech (C.S.E) in DRK Institute of Science and Technology, JNTUH, Hyderabad, Andhra Pradesh, India. Her research interest includes Computer Networks and Databases, Software Engineering, Data Mining, Compiler Design and DAA.

Dr. R. V. Krishnaiah, did M.Tech (EIE) from NIT Waranagal, M.Tech (CSE) form JNTU, Ph.D, from JNTU Ananthapur, He has memberships in professional bodies MIE, MIETE, MISTE. His main research interests include Image Processing, Security systems, Sensors, Intelligent Systems, Computer networks, Data mining, Software Engineering, network protection and security control. He has published many papers and Editorial Member and Reviewer for some national and international journals.

N. Raghava Rao is working as an Associative Professor in DRK Institute of Science and Technology, JNTU, Hyderabad, Andhra Pradesh, India. He has received M.Tech (CS) degree from JNTUH; His main research interest includes Data Mining, Compiler Design and DAA.