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EFFECTIVE STEREO MATCHING METHODOLOGIES FOR STEREO VISION APPLICATION

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Abstract:
Stereo vision is the process of extracting 3D information from multiple 2D views of a scene. The 3D information can be obtained from a pair of images, also known as a stereo pair, by estimating the relative depth of points in the scene. These estimates are represented in a stereo disparity map, which is constructed by matching corresponding points in the stereo pair. Stereo images are rectified to simplify matching, so that a corresponding point in one image can be found in the same row in the other image. This reduces the 2D stereo correspondence problem to a 1D problem. Stereo image rectification is achieved by determining a set of matched interest points, estimating the fundamental matrix, and then deriving two projective transformations.

Keywords: Stereo vision, 3D information, 2D views of a scene and 2D stereo correspondence problem

1. INTRODUCTION

Approaches to the correspondence problem can be broadly classified into two categories: the intensity-based matching and the feature-based matching techniques. In the first category, the matching process is applied directly to the intensity profiles of the two images, while in the second, features are first extracted from the images and the matching process is applied to the features.

2. Intensity-based stereo matching

As shown in the previous section, the epipolar lines coincide with the horizontal scan lines if the cameras are parallel, the corresponding points in both images must therefore lie on the same horizontal scan line. Such stereo configurations reduce the search for correspondences from two-dimensions (the entire image) to one-dimension. In fact, a close look at the intensity profiles from the corresponding row of the image pair reveals that the two intensity profiles differ only by a horizontal shift and a local foreshortening. Fig. depict the images taken with a camera that undergoes a displacement in the horizontal direction, the image pair therefore corresponds to a parallel camera set up. Two black lines are marked at rows 80 and 230 in both images. Fig. show the intensity profiles of row 80 and row 230 of the two images.

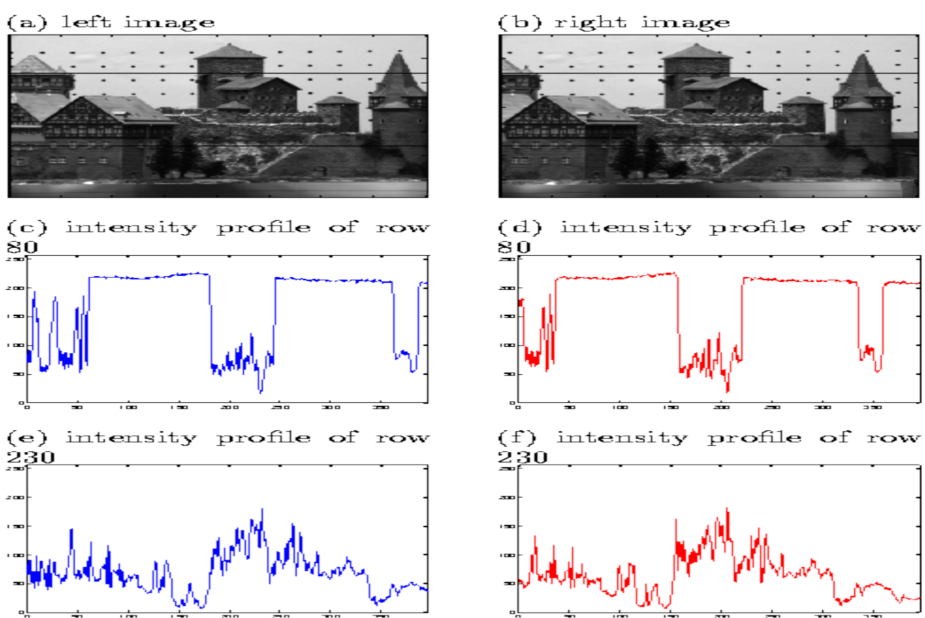

Figure 1: A comparison of the intensity profiles of two images from a parallel stereo configuration. The image pair shown above is retrieved via ftp from the Calibrated Imaging Laboratory of CMU.

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3. Applications

- 3D Facial Recognition
- Military/Law Enforcement
- Industrial/Professional
- Consumer Applications
- Robotics
- Medical

4. Algorithm

The Proposed Growing Algorithm

Require:

Rectified images Il, Ir, initial correspondence seedsS, image similarity threshold τ, and margin μ. Compute image similarity for all seeds s∈S.

Initialize matching table T := ∅, and auxiliary arrays Cbest(: , :) :=−∞, C0best(: , :) :=−∞.

repeat

Draw the seed s = (x,x0,y) ∈ S of the best image similarity simil(s).

For each of the four best neighbors qi = (u,u0,v) = argmax t∈Ni(s) simil(t), i ∈{1,2,3,4} do 2.6: c :=simil (qi).

if c ≥ τ and qi /∈T and c + μ ≥minCbest(u,v), C0best(u0,v)then

Update the matching tableT :=T ∪{qi},

the seed queueS :=S∪{qi},

and the best image similarities Cbest(u,v):=maxc, Cbest(u,v) , C0best(u0,v):=maxc, C0best(u0,v) .

end if

endf or

until S is empty.

return table T with traced-out disparity components.

5. Methodology

1. Using Stereo vision technology the distance between the objects will be calculated effectively.
2. The disparity between the two object is calculated using 3D vision.
3. In this method the computation speed is calculated.
4. This method can cope with much more difficult cases like repetitive patterns, complex scene, etc.
5. This algorithm is proposed to visits small fraction of disparity space in order to find the disparity map.
6. This method can be easily adapted for multi-image matching.
7. Accurate matching on 2-megapixel images of complex scenes is routinely obtained in a few seconds with minimal seed without limiting the disparity search range.

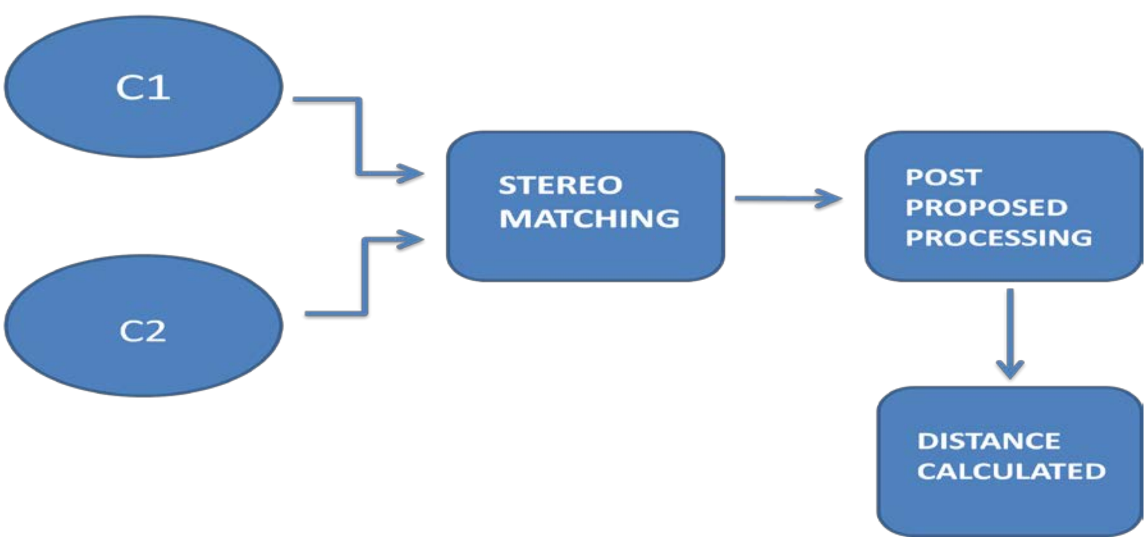


Figure 2:

6. Related works using stereo matching

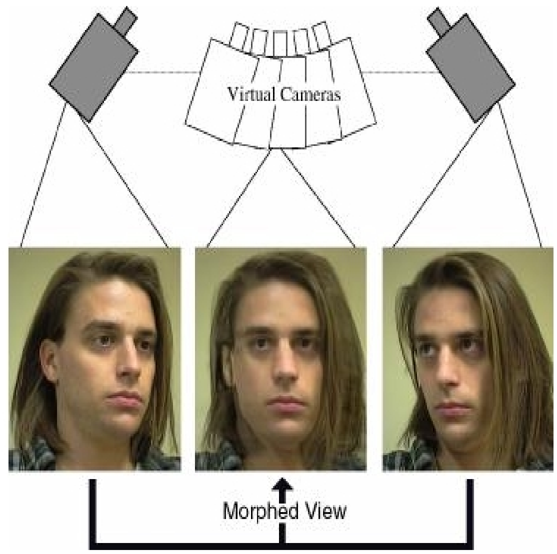
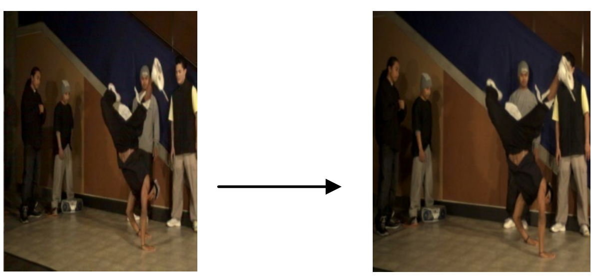
View Interpolation	**View Morphing**
Given two images with correspondences, *morph* (warp and cross-dissolve) between them [Chen & Williams, SIGGRAPH’93] input depth image novel view 	Morph between pair of images using epipolar geometry [Seitz & Dyer, SIGGRAPH’96] 
Video view interpolation  	**The LittleDog robot, designed and built by Boston Dynamics, Inc.**   

Figure 3:

7. LittleDog robot equipped with a Tyzx DeepSea stereo camera.

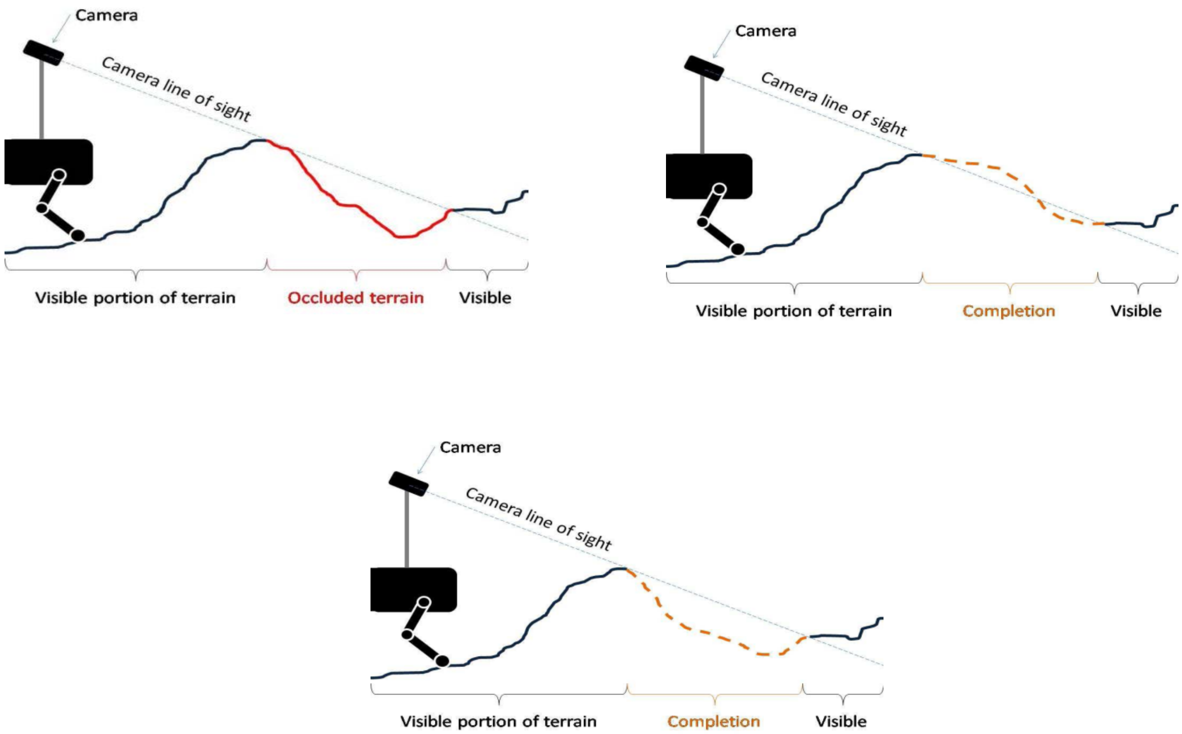


Figure 4:

8. Terrain Modeling

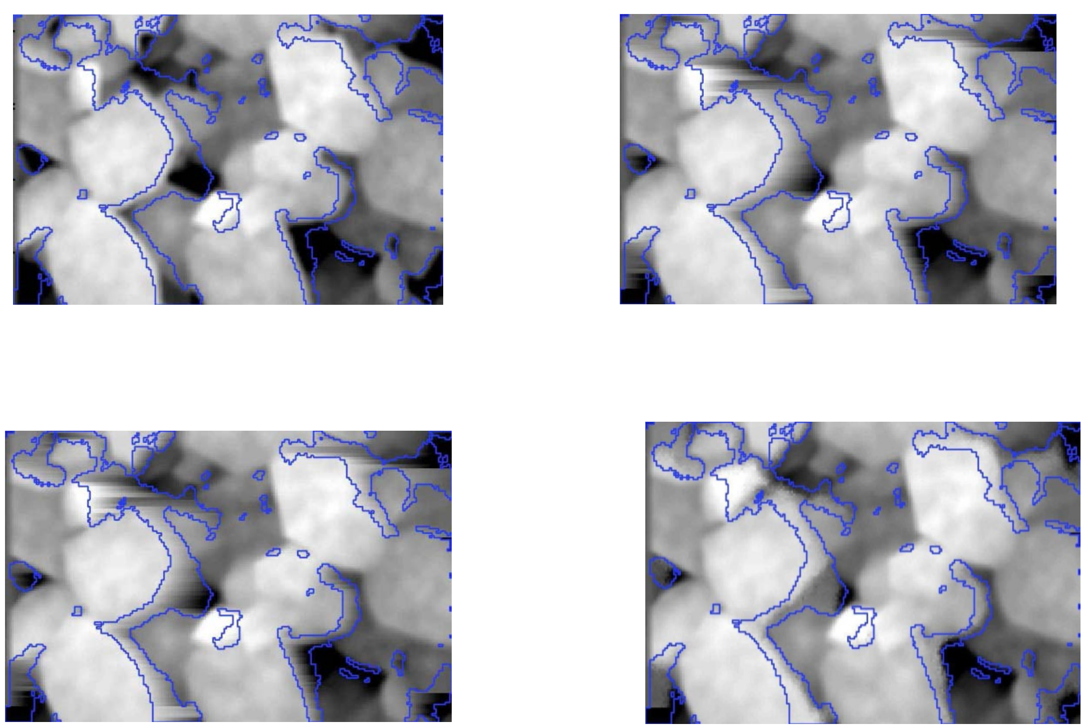


Figure 5:

9. Recent Works

1. 3D VuCAM™ Digital Binoculars - 3D Facial Recognition

Stereo Vision Imaging, has recently successfully completed their second military contract in 2009 developing advanced state-of-the-art 3D and 2D facial recognition algorithms for stand-off detection addressing military reconnaissance missions and requirements.

Custom FPGA-based stereo camera (under development)

- Real-time depth maps
- Xilinx Spartan 6 FPGA
- USB 2.0/3.0 and Gigabit Ethernet

Stereo matching process is a very difficult search procedure. In order to minimum false matches, some matching constraints must be imposed. Below is a list of the commonly used constraints.

- **Similarity** (or **compatibility** Grimson, 1981). For the intensity-based approach, the matching pixels must have similar intensity values (i.e. differ lower than a specified threshold) or the matching windows must be highly correlated. For the feature-based approach, the matching features must have similar attribute values.
- **Uniqueness** Marr and Poggio, 1979. Almost always, a given pixel or feature from one image can match *no more than one* pixel or feature from the other image.

As noted earlier, the uniqueness constraint may not be applicable to the line segment-based approach. This constraint can also fail if transparent objects are present in the scene. Furthermore, given a pixel or feature *m* in one image, its ``corresponding'' pixel or feature may be occluded in the other image. In this case, no match should be assigned to *m*.

- **Continuity** Marr and Poggio, 1979. The cohesiveness of matters suggests that the disparity of the matches should vary smoothly almost everywhere over the image.

This constraint fails at discontinuities of depth, for depth discontinuities cause an abrupt change in disparity.

- **Ordering** Baker and Binford, 1981. If $m \leftrightarrow m'$ and $n \leftrightarrow n'$ and if *m* is *to the left* of *n* then *m*' should also be *to the left* of *n*' and vice versa. That is, the ordering of features is preserved across images.

The ordering constraint fails at regions known as *the forbidden zone* (Fig.).

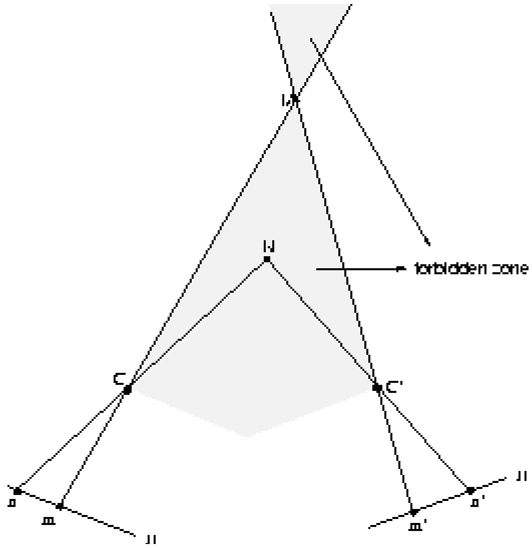


Figure 2: The ordering constraint fails if a given 3-D point (*N* here) falls onto the forbidden zone of another 3-D point (*M*). In the left image (Π), *m* is to the right of*n*, but in the right image (Π'), this ordering is reversed.

10. Conclusion

In many respects feature based algorithms are established as the most robust way to implement stereo vision algorithms for the class of problems defined above as being industrial stereo problems. The advantages offered by using features are that feature based representations contain desirable statistical properties and provide algorithmic flexibility to the programmer. The flexibility being that algorithmic constraints can be applied explicitly to the data structures rather than implicitly as with area based correlation techniques. In particular the use of edge-string based representations leads to algorithms which are as locally accurate as the precision to which the edges can be extracted.

Determination of three dimensional data from images is of central importance in the field of machine vision. One of the most direct way of achieving this from image data is stereo vision. Stereo vision has a wide range of potential application areas including; three dimensional map building data visualization and robot pick and place. A variety of constraints may be used to guide the correspondence solution depending upon the properties of the data. This is reflected in the broad range of algorithms that have been developed. For example, if camera calibration is available epi-polar constraints can be used. The absence of transparent objects allows the use of disparity gradient limits. The absence of occlusion can permit strong surface smoothness constraints. If the images are generated under constrained lighting conditions the images may display photo-metric properties allowing direct pixel matching. All of these factors can have a strong influence on the quantity and reliability of data recovered by an algorithm. Consequently, it is not fair to expect any one algorithm to be capable of making the best of an arbitrary set of data.

References

1. Konstantin Schauwecker, Sandino Morales, Simon Hermann, and Reinhard Klette, Computer Science Department, The University of Auckland Private Bag 92019, Auckland 1142, New Zealand - An Study of stereo Algorithms .
2. E. Trucco, A. / Verri, Introductory Techniques for 3-D Computer Vision, Prentice Hall, 1998.
3. R.I. Hartely, A. / Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press 2000.
4. V. Kolmogorov and R. Zabih, Computing Visual correspondence with occlusions using graphs cuts, ICCV 2001.
5. Christos Georgoulas, Georgios Ch. Sirakoulis and Ioannis Andreadis , Laboratory of Electronics, Democritus University of Thrace Xanthi, Greece – In Real Time Stereo Vision Applications.
6. Mathias J.P.M. Lemmens, Delft University, Institute of Fotogrammetry and Remote Sensing Thijssweg, A Survery On Stereo Matching Techniques.
7. Stephen T. Barnard Artificial Intelligence Center SRI International 333 Ravenswood Avenue Menlo Park, California - A STOCHASTIC APPROACH TO STEREO VISION
8. Forsyth and Ponce, “Computer Vision – A Modern Approach”, Pearson Education.

9. O. Faugera, “Three Dimensional Computer Vision: A Geometric view point”, The MIT Press, Cambridge, 1993.
10. R.A. Lane and N.A. Thacker, A Tutorial view of Stereo Matching Research, 1998.
11. Carlos D. Castillo and David w. Jacobs, Computer Science Department, University of Maryland, College Park, - 3D Recognition using Stereo Matching.
12. A.C. Berg, T.L.Berg, and J. Malik, Shape matching and Object recognition using low distortion correspond-dences, IEEE Computer Society., 2
13. M. Gerrits and P. Bekaert., Local Stereo Matching with Segmentation-based Outlier Rejection In Proc. Canadian Conf. on Computer and Robot Vision (CRV 2006).