EDGE DETECTION USING DIFFERENCE EQUATIONS

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ABSTRACT

We propose an alternate approach to edge detection using difference equations. The employed difference equation places a greater weight on edges in rapidly changing areas based on context. Our experimental results show that this approach helps to suppress patterns.

Index Terms— edge detection, computer vision, difference equation, recurrence relation

1. INTRODUCTION

Edge detection is import in the field of computer vision because it allows an objects to be separated from their backgrounds. This is useful for automated tracking, feature detection, and digital art.

The standard convention for edge detection uses a gradient of an image to determine how abruptly the image changes, the more abrupt, the more likely it is to be an edge [1][3]. In this paper we propose to use a difference equation to place a greater weight on the context in which the edge occurs. Edges in rapidly changing areas are less likely to be considered significant and edges in gradually changing areas are more likely to be considered significant. The remainder of the paper is organized as follows: section 2 presents the algorithm for edge detections. Section 3 demonstrates how it compares to other common edge detection methods. Section 4 concludes with the use of this edge detector.

2. THE DIFFERENCE EQUATION

In order to soften small details and remove compression artifacts a 3x3 Gaussian filter with a sigma of 0.5 is first applied to the image. Each image is then evaluated as a series of 3x3 overlapping grids. Each pixel in a grid is compared to the average value of that grid. If the pixel varies by an amount greater than an acceptable difference, the pixel is marked as an edge. The assumption is that when an edge pixel first appears in a given grid it will exceed the acceptable difference. The acceptable difference is determined by the equation

$$A_{n+1} = W*A_n + (1-W)(\sigma *C)$$

Where A is the acceptable difference; W is the weight constant; σ is the standard deviation of the grid; and C is a constant multiplier. We empirically determined that W= 0.95 C=2.0 are good choices for the edge detection task. A_n is the acceptable difference and A_{n+1} is the updated acceptable difference. The nature of this detection scheme makes thicker lines at more significant edges.

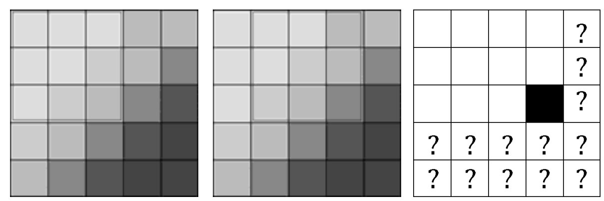

Figure 1: After coming from a region of little variation (left) the acceptable difference is low. When a pixel is greater than that acceptable difference from the mean (bottom right pixel in middle image) that pixel is marked as an edge in a matrix with the same dimensions as the image.

Since this process is dependent on the order in which grids are evaluated, two passes are made. One steps through horizontally (as pictured) and a second steps through vertically. The union of the two resulting images produces the output.

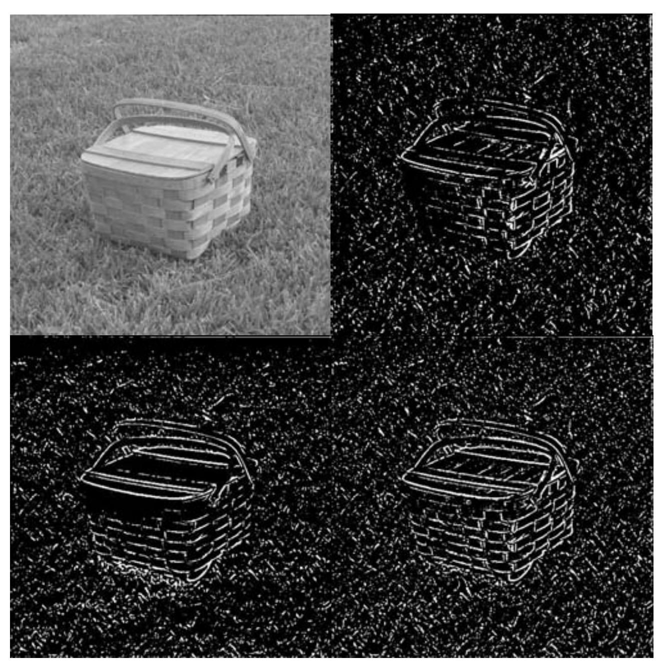

Figure 1: (Top left) original image; (top right) horizontal detection; (bottom left) vertical detection; (bottom right) union of the two detection results. Original image from [3]

3. EVALUATION

The pixels are grouped into connected segments and any group containing less than a threshold is removed. We use an automatic threshold of 1/100 of the image height.

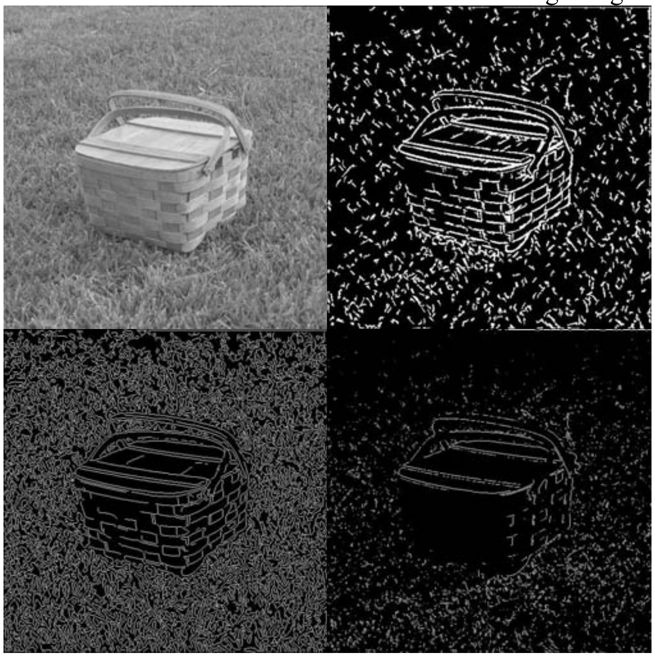

Figure 2: Comparison of the difference filter edge detection to other popular edge detection methods. (Top left) original image[3]; (top right) difference filter; (bottom left) Canny; (bottom right) Sobel.

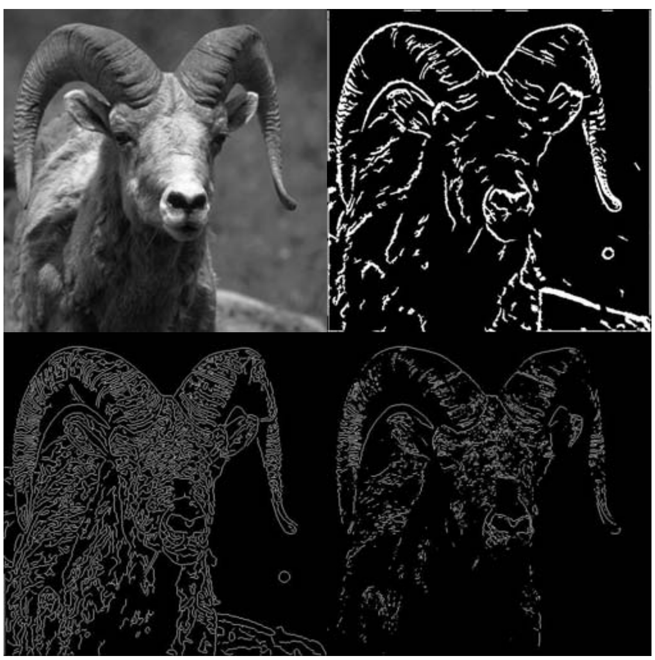

Figure 3: Comparison of the difference filter edge detection to other popular edge detection methods. (Top left) original image[3]; (top right) difference filter; (bottom left) Canny; (bottom right) Sobel.

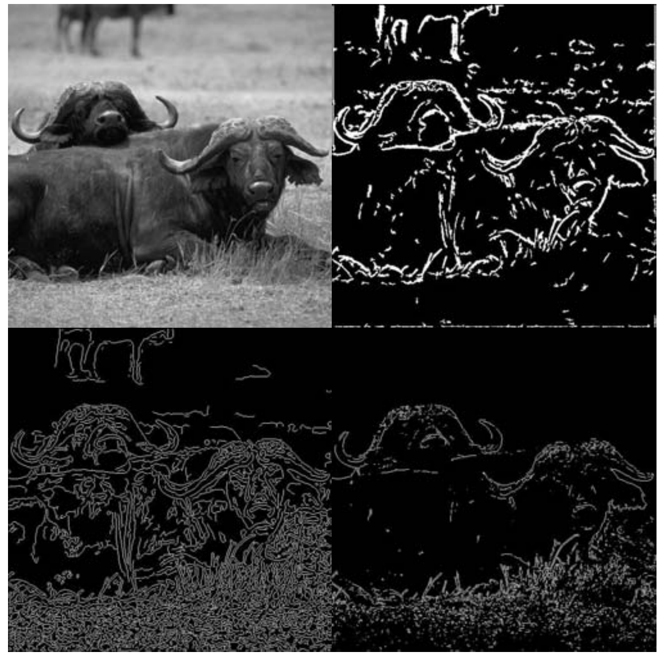

Figure 2: Comparison of the difference filter edge detection to other popular edge detection methods. (Top left) original image[3]; (top right) difference filter; (bottom left) Canny; (bottom right) Sobel.

The difference equation edge detection method detects the shadow region of the basket unlike the Sobel method, and it has a far less cluttered grass area than the Canny method. Similarly, compared to the Sobel image of the buffalo, it captures more significant details on the buffalo, without picking up the noise of the grass.

4. CONCLUSION

Using a difference equation for edge detection is a new method that often produces results comparable to other popular edge detection methods. In certain instances, where patterns can produce confusing outputs or a thicker line is desired, this method may produce better results.

5. REFERENCES

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