A Trapezoid Type Fuzzy Stretching for Automatic Subsurface Damage Detection among Spectacle Lens Products

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I. INTRODUCTION

- Since the quality of lens directly affects human vision, the required precision of such lens manufacturing is very high and the subsurface damage detection and control has been an important issue in optical manufacturing and many techniques are developed [4, 5].
- We need more automatized handy software that can detect small scratches to exclude human inspector subjectivity.
- In this paper, we propose a new fuzzy stretching method that adopts a trapezoid type membership function instead of usual triangle type membership function. The rationale of adopting this trapezoid type membership function is that the usual triangle type function is too much sensitive to separate the background from target object when there is not enough brightness contrast [8] like this lens surface defect detection problem.

II. MODIFIED FUZZY STRETCHING METHOD

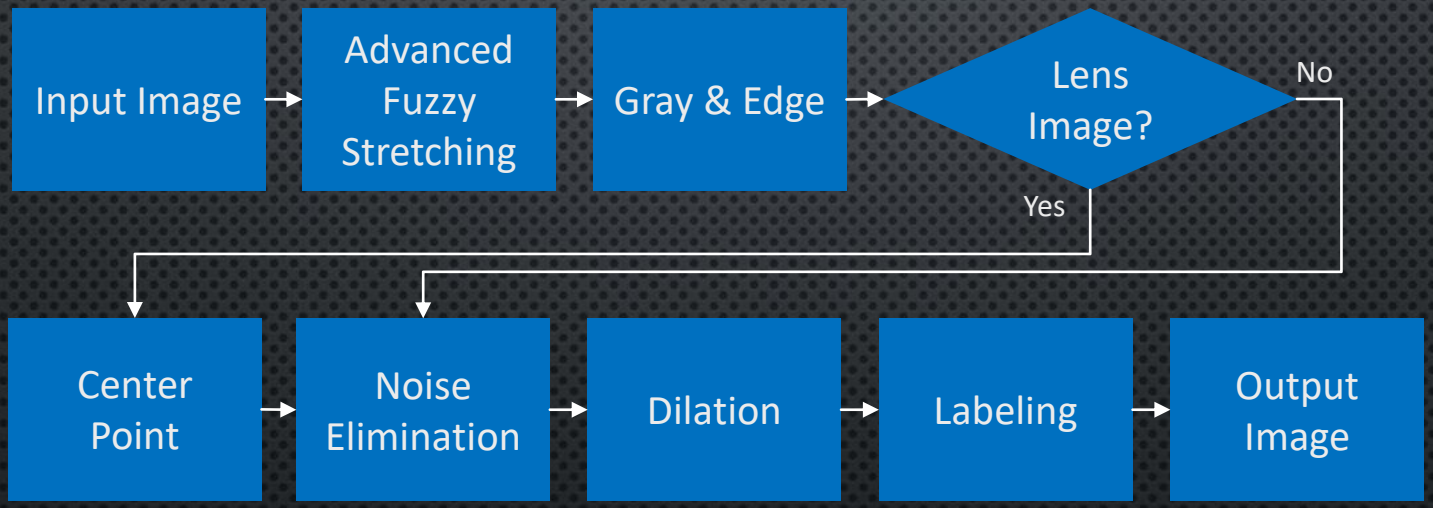


Fig. 1. Automatic Lens Defect Detection Processes

II. MODIFIED FUZZY STRETCHING METHOD

- Fuzzy stretching method

$$G_i = \frac{X_i^r + X_i^g + X_i^b}{3}, \quad G_m = \sum_{i=0}^{M \times N} G_i \times \frac{1}{M \times N}$$

$$G_n = \frac{G_{\max}}{G_{\min}},$$

$$D_{\max} = \left| G_h - G_{\max} \right|, \quad D_{\min} = \left| G_m - G_{\min} \right|,$$

$$I_{\max} = G_m + \gamma, \quad I_{\min} = G_m - \gamma, \quad I_{mid} = \frac{I_{\max} + I_{\min}}{2},$$

$$I_{mid1} = \left| G_m - G_n \right|, \quad I_{mid2} = \left| G_m + G_n \right|$$

G_i: Average brightness

M×N: Image size

G_{min}: Maximum brightness

G_{max}: Minimum brightness

II. MODIFIED FUZZY STRETCHING METHOD

- The fuzzy membership function for image stretching is defined within interval [I_{min}, I_{mid1}, I_{mid2}, I_{max}] shown as Fig. 2.

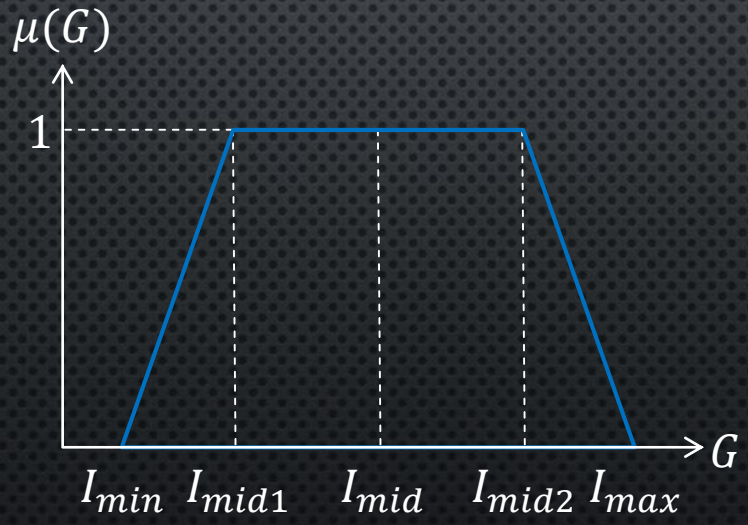
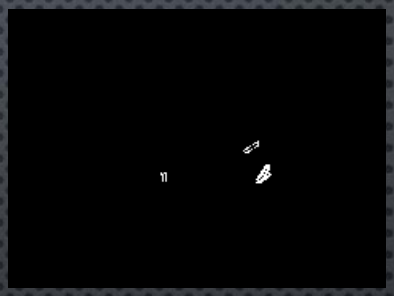


Fig. 2. Proposed Trapezoid Membership Function

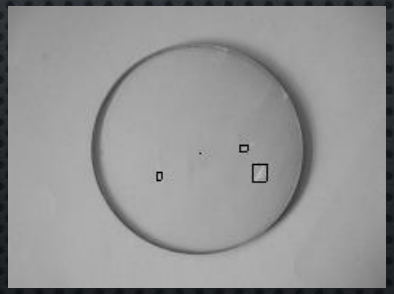
II. MODIFIED FUZZY STRETCHING METHOD

(a) Sobel mask



(b) Noise Removal

(c) Dilation



(d) Labelling

Fig. 3. Defect Detecting Process After Fuzzy Stretching

III. DISCUSSION AND CONCLUSIONS

- The proposed method was implemented with Microsoft Visual Studio .NET 2010 on an IBM-compatible PC with Intel(R) Core(TM) i5 CPU @ 2.80 GHz and 8 GB RAM.
- Thirty digital images of CHEMI MID HL HM sight-corrective dioptric lenses were used in the experiments.

Table 1. Comparison with previous study in scratch detection

	Previous method	**Proposed Method**
lens	7/15	13/15

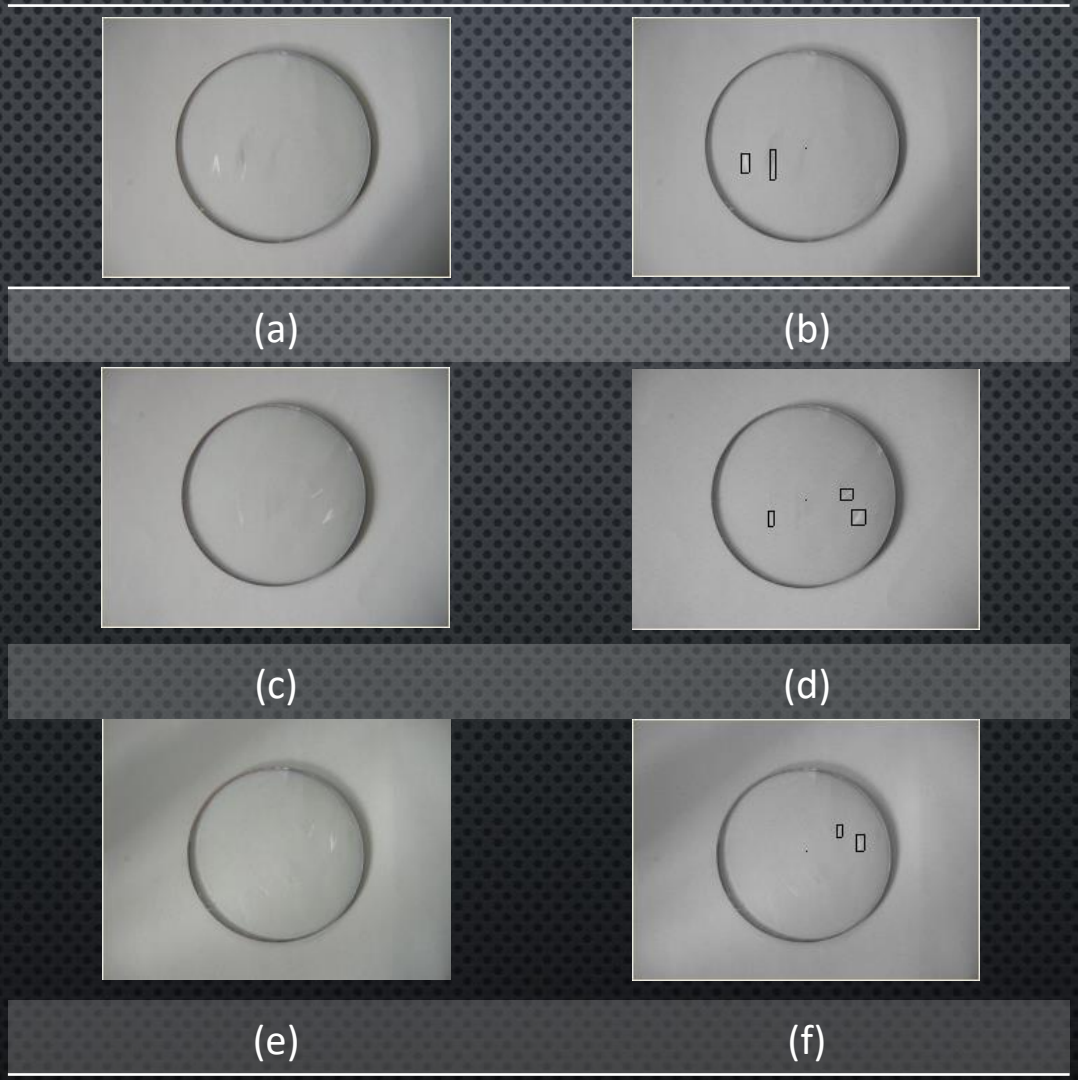


Fig. 4. Defect Detection Results