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Research Article

SEPERATION OF IMPULSE NOISE FOR CATTLE IDENTIFICATION USING FUZZY METHODS

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ABSTRACT

Muzzle patterns of cattle are uneven features of their skin surface. They are different from each other like finger prints of human. Hence these muzzle patterns can be used to identify cattle. Noise is any unwanted component in an image. It is important to eliminate noise in the images before some sub-sequent processing such as edge detection, image segmentation and pattern recognition. This paper proposes a method for salt and pepper noise removal based on mathematical methods using fuzzy rules from muzzle images. The proposed Fuzzy operator consists of two modules viz. Detection module and Adaptation module. For fuzzy reasoning, a triangular shaped fuzzy set described by a two parameter membership function is used. For each pixel element 13 fuzzy rules are applied and an output □ is produced in detection module. In adaptation module □ is further reduced and it is added with input pixel value to get output pixel value. The proposed method is able to perform a very strong noise cancellation while preserving muzzle image details. The Fuzzy Filter is compared with other non-linear filters such as Median Filter, SDROM Filter, PSM Filter and is getting better results in terms of PSNR values and SSIM Values.

INTRODUCTION

Muzzle (viz. snout or nose) patterns of cattle are uneven features of their skin surface. Muzzle print or nose print, was investigated as distinguished pattern for cattle since 1922 (Barry, 2007). The arrangement and distribution of ridges and valleys are responsible for the formation of pattern on the muzzle. The pattern of cattle muzzle is highly hereditary and the asymmetry between muzzle halves is significant. Since the muzzle pattern is consistent over time and individualistic like human fingerprints, it is used as a form of permanent identification (Lin, ?). Digital images are systematically affected by noise during their acquisition, transmission or recording. This is a major problem for many image processing techniques since they cannot work in the noisy environment. The noise removal comprise the effective suppression of the noise while preserving the fine texture and edges. There exist different noise types which can affect an image. The most well-known and noise types are the additive noise, the multiplicative noise and impulse noise. Impulse noise (Alan C Bovik, 2005), refers to a wide variety of processes that result in some basic muzzle image degradation. The effect is similar to sprinkling white and black dots - salt and pepper - on the image. One example where impulse noise arises is, in transmitting images over noisy digital links.

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Impulse noise is an example of (very) heavy-tailed noise. In this paper a modified fuzzy operator is presented for the removal of impulse noise; this operator is based on the method proposed in (Russo, 1994), and is able to perform a very strong noise reduction, while preserving image details. This higher performance is obtained by using suitably implementing fuzzy reasoning at two different stages.

Impulse noise model

Impulse noises are often caused by errors during the muzzle image acquisition or transmission of digital images through communication channels. The noisy muzzle image $P(i,j)(1 \le i \le X: 1 \le j \le Y)$ is defined by

$$P(i,j) = \begin{cases} P_0 \; with \; probability \; 1 - p_1 - p_2 \\ h_1 \; with \; probability \quad p_1 \\ h_2 \; with \; probability \quad p_2 \end{cases}$$

Where $P_0(i,j)$ is the original image; h_1 is equal to or near the maximum intensity as a positive impulse; and h_2 is equal to or near the minimum intensity as a negative impulse.

The filter structure

The modified fuzzy Filter is composed of two subunits called

- Detection module.
- Adaptation Module.

In Detection module noise pulses are detected by using luminance differences among neighboring pixels for getting a correction term. As a result, a possible correction term is selected. In Adaptation module, value of this correction term is modified for detail preservation.

Detection Module

Let x_0 and y_0 be the pixel in the input image and the corresponding one in the output image respectively, define the neighborhood

$$\begin{matrix} x_1 & x_2 & x_3 \\ x_4 & x_0 & x_5 \\ x_6 & x_7 & x_8 \end{matrix}$$

The proposed operator is applied recursively to the data. Its input variables are the luminance differences.

$$d_j = \begin{Bmatrix} y_j - x_0 \ , j = 1,2,3,4 \\ x_j - x_0 \ , j = 5,6,7,8 \end{Bmatrix} \quad (1)$$

The output variable y is the correction term which could be added to each of input pixel value to cancel the noise. Here we are using two parameter triangular shaped membership function for fuzzy reasoning.

$$\mu(d) = \begin{Bmatrix} 0 & d \le e - z \\ (z - |d - c|)/_z & e - z < d < e + z \\ 0 & d \ge e + z \end{Bmatrix} \quad (2)$$

Where e represents the center of the isosceles fuzzy set, and z represents its half width. Using this membership function two fuzzy sets labeled positive (P O) and negative (N E) are defined. If L represents number of gray levels in the image, then the fuzzy set parameters are given as

$$C_{PO} = L - 1$$

$$C_{NE} = -L + 1$$

$$W_{PO} = W_{NE} = 2(L - 1)$$

Fuzzy rules are used for detecting noise pulses. Fuzzy rules are formed by using neighboring pixel value differences. For Rule1, $(R_1) = \{2, 5, 7\}$, a pair of fuzzy rules for R_I is given as

$$\alpha_{PO}(1) = Min\,[\mu_{PO}(2)\,, \mu_{PO}(5)\,, \mu_{PO}(7)\,] \quad (3)$$

$$\alpha_{NE}(1) = Min\,[\mu_{NE}(2)\,, \mu_{NE}(5)\,, \mu_{NE}(7)\,] \quad (4)$$

Here we can see that $Rule\ 1(R_1)$, defined by is using $eqn(1)$, to identify the noise pulse in the position x_0. α_{PO} & α_{NE} detects the presence of negative noise pulse and positive noise pulse in location x_0 respectively. In order to deal with the presence of noise pulses in different locations, 13 different rules that of one given in $eqn(3)$ & $eqn\ (4)$ are defined for each pixel.

$R_1 = \{2\,,5\,,7\,\}$,$R_2 = \{5\,,7\,,4\,\}$,$R_3 = \{7\,,4\,,2\,\}$,
$R_4 = \{4\,,2\,,5\,\}$, $R_5 = \{1\,,3\,,8\,,6\,\}$,
$R_6 = \{1\,,2\,,3\,,5\,\}$, $R_7 = \{2\,,3\,,5\,,8\,\}$,
$R_8 = \{3\,,5\,,8,7\,\}$, $R_9 = \{5\,,8\,,7\,,6\,\}$,
$R_{10} = \{8\,,7\,,6\,,4\,\}$, $R_{11} = \{7\,,6\,,4\,,1\,\}$,
$R_{12} = \{6\,,4\,,1\,,2\,\}$, $R_{13} = \{4\,,1\,,2\,,3\,\}$

Using these 13 combinations, totally 26 fuzzy rules analogues to eqn (3) & eqn (4) are obtained. After defining $Fuzzy\ Rule\ Base\ 'y'$ is obtained as an output of inference process. In our method $'y'$ is obtained by using following relation

$$\beta_1 = Max[\,\alpha_{PO}(i)]\ : i = 1,2, \dots 13$$

$$\beta_2 = Max[\,\alpha_{NE}(i)]\ : i = 1,2, \dots 13$$

$$\beta_0 = Max[\,0\,, 1 - \beta_1 - \beta_2\,]$$

$$y = \frac{(L-1)(\beta_1 - \beta_2)}{(\beta_1 + \beta_2 + \beta_0)}$$

Adaptation Module

The purpose of this module is to improve the quality of fine details by avoiding unwanted pixel corrections. Basic idea of this step is that, if absolute value of $'\boldsymbol{y}'$ is small further reduce it. i.e. output $\boldsymbol{y}'$ is given by

$$y' = y(1 - \mu_{SM}(|y|))$$

where μ_{SM} is the membership value of fuzzy set $small(SM)$

$$\mu_{SM}(d) = \begin{cases} 1 & d \le a \\ (a + b - d)/_b, & a \le d \le a + b \\ 0 & d > a + b \end{cases}$$

The parameters a & b are selected as $a = 41\,, b = 33$.The output pixel is given as $x_0 + y'$.

ANALYSIS AND RESULTS

The detection and adaptation of a pixel to be a noisy pixel is done as described in section 3. The results are given in Fig.1 with comparison to median filter. This method accurately restores the images with noise. The result of Fuzzy Filter (two iterations) with a=41, b=33 is shown in Fig.1. Here we can see that, this method has higher performance than median filter. Figure 1 shows the. Muzzles images for comparison of median filtering, iterative median filtering, PSM filtering[13], SDROM filtering[6], and proposed Fuzzy filtering techniques. To prove the efficiency of proposed algorithm an average plot among these images are required. It is given in Figure 2. Proposed Fuzzy filter is compared with other salt and pepper noise removal methods for 10% to 70% values of noise ratios, with extremely different noisy test images. The parameters are selected as, for PSM Filter N_D = 3; W_F = 3; T_R = 25; a = 65; b = 50; T 1 = 40 for SDROM Filter T 1 = 8; T 2 = 25; T 3 = 40; T 4 = 50 and for Fuzzy Filter two iterations with a = 41; b = 33. Here we can see that the proposed filter has higher performance than other methods like median filter, iterative median filter, PSM filter and SDROM filter. From Figure 2 some inferences using PSNR values are given below,

- Proposed filter (Fuzzy filter) has higher performance than other methods.

- The PSM filter shows higher performance at low noise ratios and lower performance at high noise ratios.
- The SDROM filter has just reverse performance as that of PSM filter.

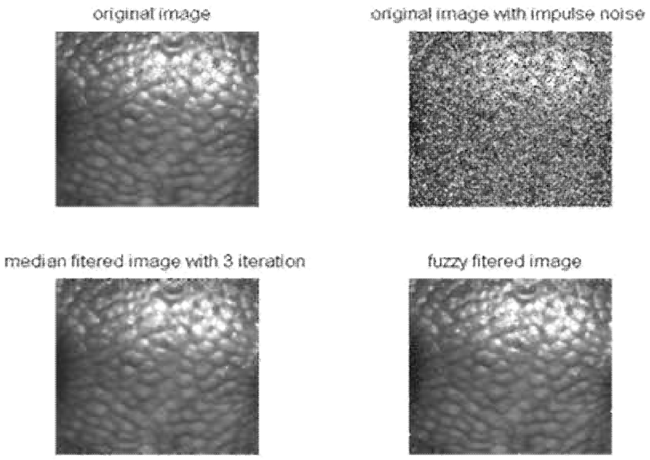

Figure 1. Various filters in Muzzle image

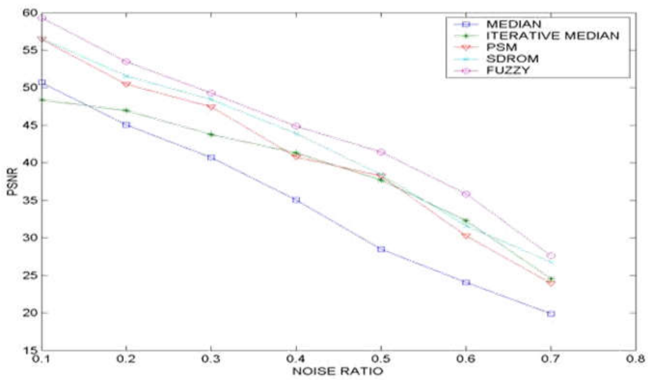

Figure 2. Average plot of comparison of different noise removal methods on muzzle images

From the noise ratio 0:16 onwards iterative median has higher performance than median filter

Conclusion

In this work a fuzzy filter that can remove salt and pepper noise effectively while preserving details of the image is discussed. It is compared with conventional methods such as median, iterative median and well known methods such as PSM Filter, SDROM Filter. Here we can see that the Fuzzy Filter has higher performance than these methods in terms of PSNR and SSIM index Values[12] .

The advantages of the Fuzzy method are:-

- It drastically reduces Impulse noise.
- It helps in preserving edge sharpness.
- It does not introduce blurring in comparison to other methods.

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