Fuzzy Project Results

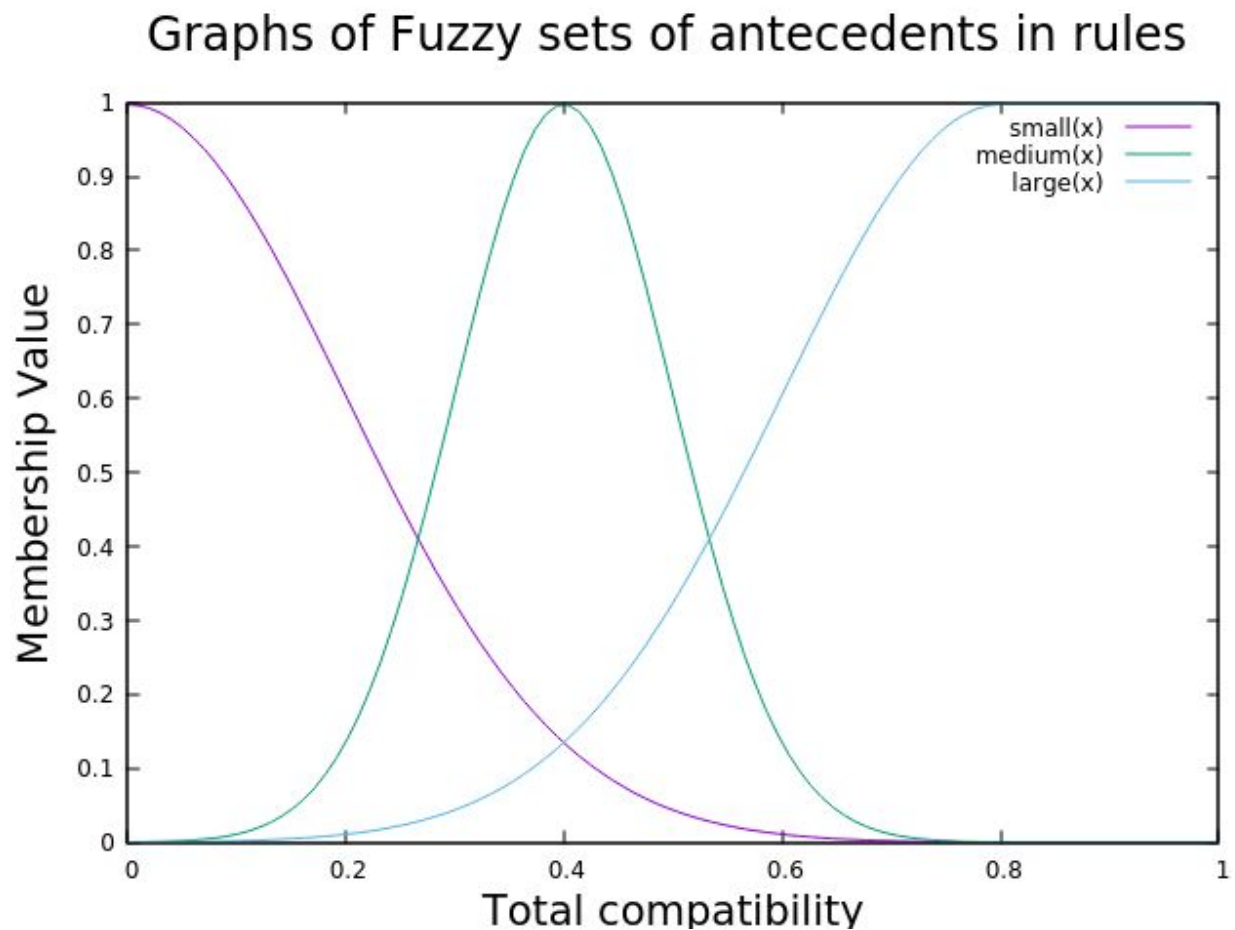## Vaibhav Sinha and Prateek Kumar

CS15BTECH110[34, 31]

Based on

A Robust Approach to Image Enhancement Based on Fuzzy Logic

YoungSik Choi and Raghu Krishnapuram

Graph of Antecedents

Graphs of Fuzzy sets of antecedents in rules

Results

Images used:
- Lena
- Cameraman
- Peppers
- House

Example of Enhanced images by various filters on Lena (with 5% (100 sd) impulsive noise + (15 sd) gaussian noise):

Original Lena:

Noisy Image:

Filter A:

Filter B:

Filter C:

Median Filter:

Fuzzy System R1:

Fuzzy System R2:

Fuzzy System R3:

Fuzzy System R3Crisp:

Fuzzy System R4:

Fuzzy System R4Crisp:

Bilateral Filter:

Gaussian Filter:

LoG filter:

TV Bregman Filter:

TV Chambolle Filter:

Example of Enhanced images by various filters on House (with 5% (100 sd) impulsive noise + (5 sd) gaussian noise):

Original House:

Noisy Image:

Filter A:

Filter B:

Filter C:

Median Filter:

Fuzzy System R1:

Fuzzy System R2:

Fuzzy System R3:

Fuzzy System R3Crisp:

Fuzzy System R4:

Fuzzy System R4Crisp:

Bilateral Filter:

Gaussian Filter:

LoG filter:

TV Bregman Filter:

TV Chambolle Filter:

Results in numbers

Image Enhancement Technique	Lena			Cameraman		
	sd = 5	sd = 10	sd =15	sd = 5	sd = 10	sd =15
Noisy Image	19.91	21.84	24.68	23.12	24.65	27.41
A	18.95	19.61	21.34	23.12	22.88	24.52
B	14.19	14.35	14.77	17.18	17.22	17.44
C	17.25	17.61	17.92	20.75	20.44	21.31
Median	13.18	13.53	14.18	16.78	16.98	17.28
R1	**7.84**	10.83	14.29	**8.94**	11.54	14.61
R2	9.02	9.82	**11.09**	10.64	11.25	**12.13**
R3	19.71	19.65	19.98	23.93	23.36	23.97
R3Crisp	20.72	20.72	21.16	25.35	24.76	25.37
R4	8.51	**9.76**	11.80	10.01	**10.96**	12.43
R4Crisp	9.29	10.68	13.04	11.34	12.22	14.02
LoG	18.08	18.21	18.50	20.09	20.39	20.38
Gauss	16.78	16.80	17.00	19.82	19.84	20.08
TV Chambolle	13.21	13.37	13.62	14.87	14.86	15.33
TV Bregman	14.78	14.84	15.05	16.29	16.29	16.60
BIlateral	15.82	16.10	16.69	17.59	17.36	18.14

Image Enhancement Technique	House			Peppers		
	sd = 5	sd = 15	sd =25	sd = 5	sd = 15	sd =25
Noisy Image	21.72	26.00	32.40	26.25	29.43	34.70
A	20.28	21.99	26.89	26.50	27.42	30.79
B	8.81	9.51	**10.58**	14.50	14.90	15.93
C	18.72	18.90	19.73	22.55	22.99	24.10
Median	8.35	9.80	11.71	12.01	13.12	14.99
R1	6.08	13.32	20.40	**8.53**	14.75	21.15
R2	**5.98**	**8.34**	11.70	8.85	**11.01**	**13.95**
R3	20.23	20.07	20.84	26.12	25.62	26.16
R3Crisp	20.61	20.62	21.86	27.27	26.83	27.53
R4	6.03	9.61	14.89	9.35	12.26	16.54
R4Crisp	6.36	10.60	16.95	10.61	13.78	18.70
LoG	13.27	14.10	14.79	20.58	20.94	21.38
Gauss	12.13	12.33	12.65	20.45	20.76	21.46
TV Chambolle	10.72	11.05	11.64	15.45	16.10	17.28
TV Bregman	10.82	10.96	11.39	16.55	16.97	17.94
BIlateral	15.86	16.22	17.09	20.52	21.08	22.38

Some comments on paper

- RMSE is not an ideal metric.
- R3 is flawed; we propose R4.
- Filter A not really a weighting filter and so generates values out of range.
- Inconsistent formula for filter A in the paper.