UPOV
International Union for the Protection of New Varieties of Plants

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Technical Working Party on Testing Methods and Techniques **TWM/2/10**

Second Session
Virtual meeting, April 8 to 11, 2024

Original: English
Date: March 19, 2024

A METHOD FOR CALIBRATION OF SIZE AND COLOR USED IN IMAGE ANALYSIS

Document prepared by an expert from China

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The annex to this document contains a copy of a presentation “a method for calibration of size and color used in image analysis”, to be made by an expert from China, at the second session of the Technical Working Party on Testing Methods and Techniques (TWM).

[Annex follows]

A METHOD OF CALIBRATION FOR SIZE AND COLOR USED IN IMAGE ANALYSIS

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TWM2, Virtual meeting, April 8 to 12, 2024

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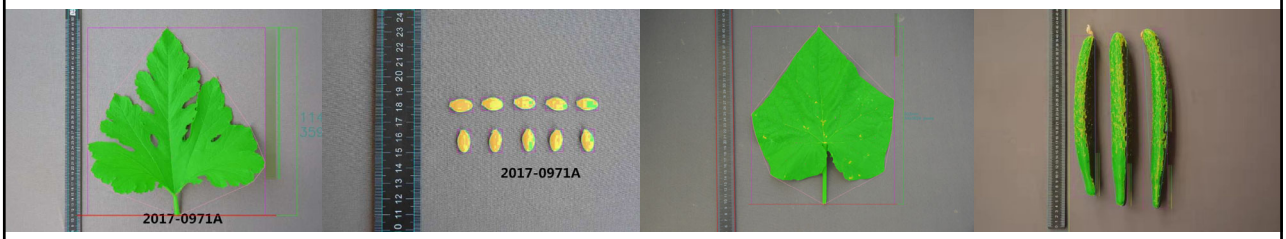
BACKGROUND

We started to apply image analysis technology in Squash and Cucumber in 2021.



leaf of squash | seed of squash | leaf of cucumber | fruit of cucumber

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BACKGROUND

We developed a image analysis function in DUSCEL in 2021.

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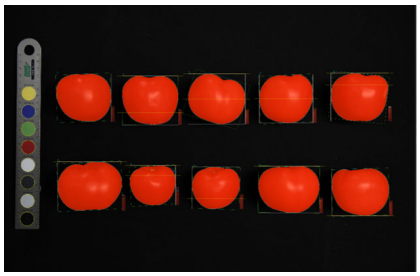
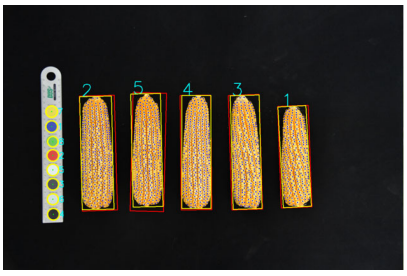
BACKGROUND

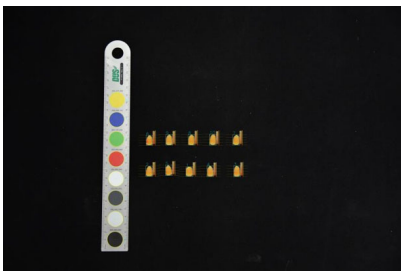
We developed new image analysis algorithms by new ruler in tomato and maize in 2023.



fruit of tomato



ear of maize



kernel of maize

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PROBLEM

- Old ruler and one color background couldn't give a right calibration of size and color.
- New ruler could give a right calibration of size, but failed to give a right color back because of poor manufacture for color coin.

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PROBLEM

Light has significant influence in color. RGB distance between two color could be bigger than 25.

Ruler	IMA1	IMA2	IMA3	IMA4	IMA5	IMA6	VO
yellow	153D	8A	2B	154B	154B	160A	153D
blue	95B	99B	N95D	96B	96B	N95B	94A
green	143A	135C	140C	140B	140B	141D	140A
red	45A	45A	43C	42C	42B	175B	45A
white	198D	155A	69D	192D	192D	112D	155A
dark grey	203D	202B	189A	N92D	N137A	N92A	202B
light grey	201D	202D	97D	202D	202D	190C	202D
black	202A	202A	203D	203C	203D	202A	202A

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RHS COLOR DISTANCE

RHS	R	G	B
1A	235	224	67
1B	232	225	87
1C	236	232	144
1D	241	234	164
2A	246	225	59
2B	241	227	91
2C	243	236	149
2D	244	234	174
3A	250	226	64
3B	245	228	85
3C	246	232	128
3D	248	237	157

RHS1	RHS2	DIST
1A	1B	20.24846
1A	1C	77.42093
1A	1D	97.69852
1A	2A	13.63818
1A	2B	24.91987
1A	2C	83.25863
1A	2D	107.8425
1A	3A	15.42725
1A	3B	20.97618
1A	3C	62.498
1A	3D	91.85859
1A	4A	29.22328
1A	4B	60.06663
1A	4C	87.04596
1A	4D	124.8038
1A	5A	12.40967
1A	5B	16.88194
1A	5C	50.35871
1A	5D	90.21641
1A	6A	24.39262
1A	6B	19.05256
1A	6C	32.44996
1A	6D	81.31421
1A	7A	33.61547
1A	7B	20.61553
1A	7C	24.83948

RHS1	RHS2	RGB DIST	GROUP DIST
22B	23C	1	2
203C	203D	1.732050808	0
17A	21A	2	0
17D	18A	2.236067977	0
62D	65D	2.236067977	0
8D	159D	25	33
14B	17A	25	0
22D	28D	25	1
45A	53B	25	3
45D	53C	25	0
10C	23C	45	4
13D	155D	45	9
15D	160A	45	33
18C	193D	45	37
29C	73C	45	3
19B	25C	75	2
23A	30C	75	8
26D	76C	75	16
32C	62A	75	26
34D	169B	75	0
2A	94C	195	22
3A	58A	195	16
21B	106D	195	21
N57B	198D	195	25
N57D	114D	195	15
N81A	110D	195	9

Minimum Distance =25

RGBDIST=sqr(R1-R2)^2+(G1-G2)^2+(B1-B2)^2)

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NEW METHOD

- We could consider an actual color in certain light as standard color.
- We developed a new algorithm to produce a perfect corrected rate by white and black colors in new calibration ruler.
- We could correct the color by the perfect corrected rate when we use the same calibration ruler.

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NEW METHOD

too dark | standard light | too light

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NEW METHOD

color	white	yellow	light grey	green	red	blue	dark grey	black
standard R	197	205	173	99	152	49	53	27
standard G	198	180	173	149	47	55	47	24
standard B	193	80	175	78	41	115	49	19
1 actual R	254	249	239	152	230	100	98	59
1 actual G	252	231	239	217	96	107	96	56
1 actual B	254	148	241	126	85	195	101	51
2 actual R	225	232	213	133	196	71	78	52
2 actual G	229	212	214	187	78	82	76	50
2 actual B	230	115	216	109	74	162	79	46
3 actual R	138	147	111	54	96	27	27	19
3 actual G	141	129	118	99	26	30	26	15
3 actual B	151	48	126	42	28	85	31	16

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NEW METHOD

White balance value=r * 0.299 + g * 0.587 + b * 0.114
197 * 0.299 + 198 * 0.587 + 193 * 0.114 = 197.131

standard wb	197.131	176.075	173.228	125.956	77.711	60.046	49.022	24.327
1 actual wb	252.826	226.92	239.228	187.191	134.812	114.939	97.168	56.327
2 actual wb	227.918	206.922	213.929	161.962	112.826	87.831	76.94	50.142
3 actual wb	141.243	125.148	116.819	79.047	47.158	35.373	26.869	16.31
1 perfect rate	0.7797102	0.7759342	0.7241126	0.6728742	0.5764398	0.5224162	0.5045077	0.4318888
2 perfect rate	0.8649207	0.8509245	0.8097453	0.7776886	0.6887685	0.6836538	0.6371458	0.4851621
3 perfect rate	1.3956869	1.4069342	1.4828752	1.5934318	1.6478858	1.6975094	1.8244817	1.4915389

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NEW METHOD

rc = ra * ((wswb / wawb - bswb / bawb) * (ra - bawb) / (wawb - bawb) + bswb / bawb)

ra: actual red value

rc: corrected red value

wswb: white balance value of standard white color

wawb: white balance value of actual white color

bswb: white balance value of standard black color

bawb: white balance value of actual black color

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NEW METHOD

Corrected color

color	white	yellow	light grey	green	red	blue	dark grey	black
standard R	197	205	173	99	152	49	53	27
standard G	198	180	173	149	47	55	47	24
standard B	193	80	175	78	41	115	49	19
1 corrected R	198.57421	192.46151	180.50161	91.388302	170.04039	50.919403	49.554077	25.760595
1 corrected G	196.11851	171.18858	180.50161	155.43598	48.202912	55.809561	48.202912	24.153358
1 corrected B	198.57421	87.935452	182.86527	69.95727	41.024625	132.0838	51.607377	21.545435
2 corrected R	193.20466	202.6846	177.44038	88.067328	156.16078	37.609995	42.484368	25.434819
2 corrected G	198.59614	176.15446	178.73057	145.39497	42.484368	45.363715	41.070328	24.24294
2 corrected B	199.95469	71.726584	181.32378	66.587276	39.673378	117.30567	43.197796	21.910451
3 corrected R	192.94815	204.51668	157.49681	78.981594	137.31826	40.050106	40.050106	28.300027
3 corrected G	196.81814	181.25532	166.79531	141.38159	38.586717	44.431068	38.586717	22.38816
3 corrected B	209.61835	70.426823	177.3301	61.816812	41.511961	122.30123	45.888319	23.868428
1 RGB distance	6.0901571	17.257643	13.206466	12.808015	18.080464	17.210334	4.4855093	2.8352926
2 RGB distance	7.945291	9.4126854	9.6201137	16.210177	6.2819522	15.096568	13.394219	3.3135384
3 RGB distance	17.145962	9.6672204	16.860505	26.845341	16.929232	15.65602	15.753274	5.2905286

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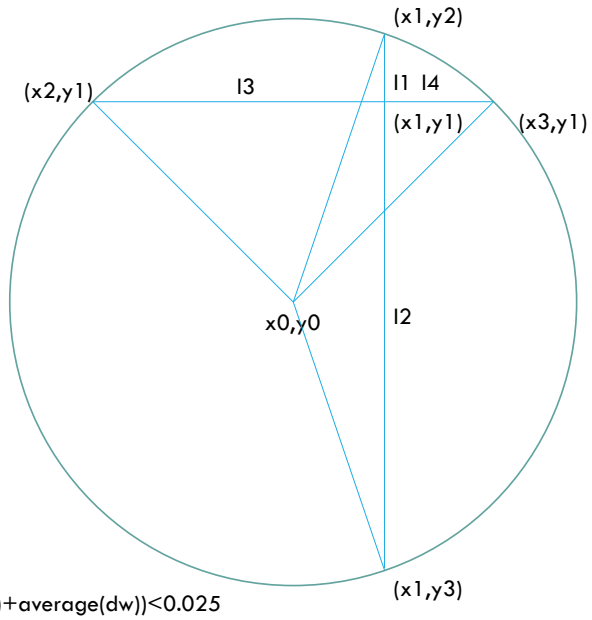
NEW METHOD



x0=x1+(l4-l3)/2
y0=y1+(l1-l2)/2

Dw1=sqr((x2-x0)^2+(y1-y0)^2)=2cm
Dw2=sqr((x1-x0)^2+(y2-y0)^2)=2cm
Dw3=sqr((x3-x0)^2+(y1-y0)^2)=2cm
Dw4=sqr((x1-x0)^2+(y3-y0)^2)=2cm

Db1=sqr((x2-x0)^2+(y1-y0)^2)=2cm
Db2=sqr((x1-x0)^2+(y2-y0)^2)=2cm
Db3=sqr((x3-x0)^2+(y1-y0)^2)=2cm
Db4=sqr((x1-x0)^2+(y3-y0)^2)=2cm

(max(dw)-min(dw))/max(dw)<0.05
(max(db)-min(db))/max(db)<0.05
abs(average(db)-average(dw))/(average(db)+average(dw))<0.025

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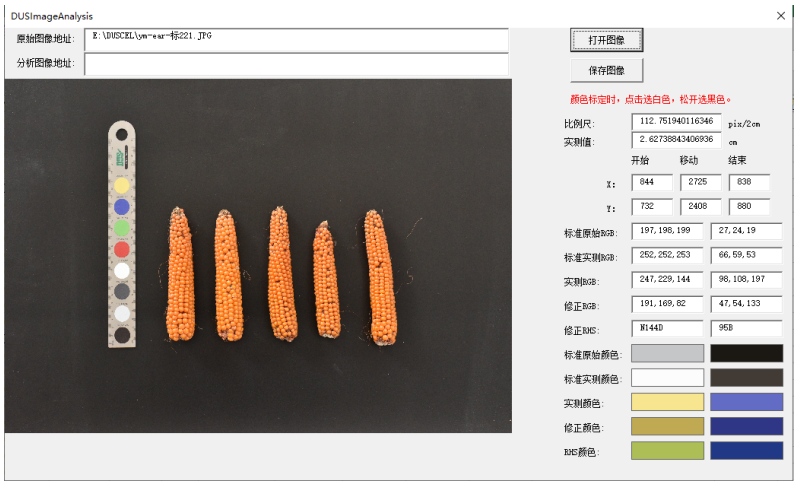
NEW METHOD



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original images

corrected images

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FUTURE

1. Try to get real color in calibration ruler by other tool.
2. Verify new method in different light or camera.
3. Use calibration ruler to check image deformation.

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THANK YOU FOR YOUR ATTENTION!

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[End of Annex and of document]