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6:  */
7:
8:
9:
10: #pragma once
11: #include <stdint.h>
12: #include <cstdlib>
13:
14: using namespace std;
15:
16: // Data from beans.ppm
17:
18: const uint32_t actualHistBean[256] = {0,0,58,365,639,876,1196,1270,1373,1754,1665,1630,1802,1717,1921,1754
,1699,1844,1721,1668,1639,1587,1611,1520,1508,1483,1497,1473,1395,1367,1398,1310,1282,1223,1258,1306,1289,1293,127
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48,1463,1566,1491,1470,1517,1537,1484,1487,1492,1485,1507,1504,1516,1490,1470,1486,1504,1490,1482,1478,1498,1423,1
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1371,1442,1373,1390,1363,1412,1382,1358,1371,1383,1294,1423,1381,1417,1345,1308,1386,1315,1378,1352,1377,1315,1323
,1379,1409,1306,1324,1331,1360,1320,1318,1282,1269,1317,1285,1307,1311,1347,1354,1339,1320,1341,1304,1280,1341,128
1,1237,1294,1259,1312,1228,1239,1283,1202,1200,1270,1247,1177,1247,1165,1213,1177,1145,1115,1144,1137,1089,1075,10
91,1147,1065,1140,1103,1027,1131,1080,1107,1064,1029,1026,1038,988,992,1043,979,988,972,1012,919,959,966,909,872,9
02,852,822,846,827,799,761,722,725,665,692,659,635,596,593,602,572,570,506,552,499,479,487,434,410,419,321,328,334
,291,207,208,187,151,147,121,106,74,75,60,63,36,26,27,19,18,15,23,15,13,10,9,3,0,0,0};
19: const float actualMeanBean = 104.263387784091;
20: const uchar actualminBean = 2;
21: const uchar actualMaxBean = 252;
22: const float actualStdBean = 61.106823;
23: const uint32_t actualSumBean = 29360570;
24:
25: const uint32_t actualHistBeanMask[256] = {0,0,30,156,238,363,484,509,534,695,651,653,745,708,741,676,611,64
4,648,600,596,590,588,526,559,528,531,556,486,494,524,476,454,475,469,491,455,467,454,457,495,444,463,486,490,521,
490,500,522,554,514,531,528,555,571,533,535,550,522,608,582,596,537,616,577,577,611,599,544,570,592,560,560,565,58
9,575,522,562,591,575,587,561,578,547,539,587,569,582,569,523,541,626,538,597,521,542,557,516,523,505,525,531,528,
560,531,539,539,522,537,510,508,525,530,523,511,504,527,495,503,507,539,511,495,507,502,505,506,545,482,553,525,55
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8,394,408,391,394,376,365,354,354,366,381,347,352,344,312,308,329,312,291,288,299,262,292,255,267,229,276,268,240,
261,230,253,216,223,201,175,171,171,127,122,137,102,86,94,65,63,57,59,41,37,34,24,25,14,12,12,11,8,5,15,8,10,8,5,0
,0,0,0};
26: const float acutalMeanBeanMask = 105.113610746688;
27: const uint32_t actualSumBeanMask = 11377287;
28: const uchar actualminBeanMask = 2;
29: const uchar actualMaxBeanMask = 251;
30: const float actualStdBeanMask = 61.4932556;
31:
32:
```

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6:  */
7:
8:
9:
10: #include <stdint.h>
11: #include <cstdlib>
12:
13: using namespace std;
14:
15: const double meanTestResult = 127.445198;
16: const uint8_t mediaanTestResult = 128;
17: const double stdTestResult = 73.5821;
18: const uint32_t nTestResult = 40000;
19: const uint8_t modeTestResult = 173;
20: const uint8_t rangeTestResult = 255;
21: const uint32_t sumTestResult = 5097808;
22: const uint8_t minTestResult = 0;
23: const uint8_t maxTestResult = 255;
24:
25: const uint8_t histTestResult[256] =
26: { 89, 139, 157, 150, 165, 149, 146, 166, 147, 164, 144, 128, 153, 162, 182, 164, 160, 167, 142, 171, 148, 1
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56, 174, 143, 156, 176, 150, 158, 165, 164, 135, 166, 158, 151, 132, 169, 162, 147, 169, 154, 159, 172, 159, 169,
151, 155, 172, 166, 147, 155, 154, 149, 167, 160, 161, 170, 175, 168, 160, 185, 167, 166, 134, 165, 140, 166, 141,
160, 134, 168, 150, 151, 168, 172, 135, 136, 153, 161, 170, 167, 138, 167, 160, 151, 176, 181, 164, 148, 152, 150
, 167, 151, 152, 163, 151, 133, 138, 147, 174, 151, 150, 155, 149, 158, 159, 171, 163, 164, 144, 145, 164, 149, 17
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43, 134, 156, 155, 148, 148, 86 };
27:
28: const uint8_t testMatrix[200][200] =
29: { { 208, 164, 108, 217, 174, 161, 128, 128, 171, 51, 190, 14, 208, 13, 124, 97, 63, 183, 234, 161, 109, 32,
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106, 215, 168, 39, 163, 152, 211, 208, 105, 34, 213, 242, 205, 148, 31, 71, 110, 161, 60, 161, 24, 163, 56, 87, 24
8, 227, 190, 168, 73, 140, 158, 217, 230, 248, 89, 166, 47, 21, 10, 230, 29, 60, 222, 189, 186, 33, 53, 122, 154,
87, 81, 254, 83, 111, 106, 178, 243, 177, 94, 48, 85, 42, 33, 26, 144, 2, 37, 80, 98, 102, 193, 215, 62, 166, 234,
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30: { 231, 97, 24, 143, 34, 91, 125, 156, 110, 50, 228, 208, 48, 139, 127, 81, 99, 34, 154, 251, 244, 93, 214,
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32: { 233, 136, 120, 178, 28, 57, 90, 136, 65, 224, 33, 177, 209, 82, 99, 183, 212, 130, 190, 153, 148, 96, 131
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33: { 161, 89, 177, 149, 30, 166, 115, 52, 2, 120, 57, 54, 163, 206, 30, 105, 210, 135, 98, 232, 138, 220, 114,
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36: { 139, 140, 9, 252, 167, 36, 248, 246, 241, 247, 237, 244, 131, 204, 214, 163, 236, 205, 120, 244, 200, 172
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27, 89, 60, 64, 109, 224, 21, 186, 237, 87, 175, 159, 185, 37, 221, 24, 134, 187, 243, 244, 243, 239, 45, 40, 22,
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228, 172, 217, 98, 231, 101, 30, 85, 47, 111, 166, 149, 162, 23, 48, 16, 10, 101, 122, 227, 134, 153, 41, 170, 15
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37: { 244, 159, 18, 0, 191, 6, 48, 158, 231, 104, 13, 113, 139, 13, 247, 19, 189, 135, 164, 112, 236, 52, 160,
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133, 65, 48, 175, 70, 239, 104, 21, 101, 39, 189, 90, 113, 168, 157, 181, 62, 118, 85, 12, 188, 42, 19, 116, 89, 3
7, 149, 7, 247, 3, 129, 104, 165, 158, 90, 1, 106, 146, 35, 33, 150, 224, 204, 17, 72, 184, 200, 188, 141, 203, 46
, 115, 243, 18, 241, 142, 109, 237, 222, 238, 139, 104, 186, 197, 95, 186, 149, 32, 232, 253, 119, 62, 60, 59, 160
, 168, 79, 90, 202, 42, 130, 125, 170, 63, 140, 202, 97, 173, 1, 198, 67, 180, 163, 162, 146, 144, 51, 45, 75, 5,
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38: { 246, 150, 81, 221, 149, 107, 170, 177, 100, 215, 151, 22, 155, 72, 55, 31, 188, 244, 71, 153, 2, 221, 46,
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46: { 1.48969760778547, -0.742301837259857, -1.96089999936503, -0.865468030554804, -0.274070229932602, -1.21284719967446, -0.382584802707648, -1.05697274596013, -0.540786416488526, 0.401336339818801, 0.751228984688333, 0.705885019349416, 0.213041698417000, -0.710735074811226, -0.0896224837412097, 0.809972073318538, -0.938301288268817, -0.89950067342813, -0.386234650983645, 0.896747363054464, -0.239731286601329, 0.0512203118444502, 1.81358213090433, -1.03442471723417, 2.28782860567075, 0.303564280841044, 0.433060388963240, 1.13007271999667, 0.0542502285446183, -1.08509809672172, -0.634406535588807, 1.17258993043935, 1.59078797675859, -0.347820318259741, 0.625445779460800, -0.111443964288855, 0.892784163034418, 1.22661722851171, 1.29631036855968, -0.277298794530625, 2.80923185356508, -1.54600257382621, 0.0228442900561173, 0.264136741915250, -1.28741591386074, -0.906881378407088, 0.0243149497110560, -0.190203197452842, -2.86139975927085, -0.212843113131577 },

47: { 1.40903448980048, -1.06158173331999, -0.197698225974150, -0.176534114231451, 1.53007251442410, 0.0661900484246114, 0.64867922048621, -0.284140954626164, -0.308641815280113, 0.942133319236942, 1.7782558929100, 1.41584906843659, 0.879677164233489, 0.777003526719788, 1.02118011801418, 0.173247371832088, 0.161363534650636, -0.285686137601834, 0.525586350117865, 0.504732027944892, 0.180998079792441, -0.774466243939416, 0.914851752841074, 1.33955459790412, 0.166727663349700, -0.790258478597882, -0.0921207484997504, 0.153770741090754, 0.687753654274765, -0.707158590760918, 0.629763180328370, 1.73509586636980, 0.526475048595550, 0.993962534155598, 0.752960417782594, 1.2959578548944, -0.364190188083625, 2.32063532135348, 1.09922948349201, 1.06663077087253, -0.232184861775627, 0.433282396191631, -1.17778858625395, -1.12714618565917, 0.218084852524728, 0.144440606275470, -0.162366873553542, -0.938732410611696, 0.535555296585250, -0.0440345710123355 },

48: { 1.41719241342961, 2.35045722400204, -1.20784548525980, 0.791416061628634, -0.249024742513714, 0.652355888661374, 0.825727149241758, -0.0866902824593051, -1.09659330152547, 0.300485967595730, 1.22306255173381, -1.60451566859706, 2.03887625141404, 0.622393924172013, -0.873979465028903, -0.505542568515379, -0.268182881913388, -0.462421544353747, 1.52326927539060, -0.400897135515841, 0.244249546813347, 0.786781710402895, -0.0570807159144771, -0.969140355828830, -2.15649445075169974, 0.803380232506624, -0.244054937965400, -0.758627156743334, -1.39340730198454, -0.301654545754811, -0.0792337539515894, -0.371696045350843, 0.264818591763603, 0.428436173023810, 0.213483683522705, 1.78129502150358, -0.826188688560360, 0.414497860639019, 0.653223048749175, -2.09923885099037, 0.287032146893391, 0.102954219987465, -0.334578164099747, -0.559175859035221, -1.56656707369580, 1.39640902818180, -0.605661086067383, -0.813462364383170, -0.342037309902017, 0.458181822856723 },

49: { 0.671497133608081, -0.615601881466894, 2.90800803072936, -1.33200442131525, -1.06421341288933, 0.327059967177088, -1.01494364268014, -1.46939507448636, -0.493009815316451, -0.373070658631004, -1.28325610460477, 1.02885306900203, 0.923932448688937, 0.647380884516047, 0.414700293047627, -1.19330579089020, -0.409872647756742, -0.409785214740165, 1.79849445190826, -0.513848012099214, 0.0963928845397177, 1.40890695099350, 1.30936207782942, 0.208715601272198, 1.68939930742667, -1.31990270235869, -0.219188663046641, -0.180163097123277, 1.42536573618701, -1.20044050380044, 1.37694916561229, 1.19286412868397, -0.393597890579411, -1.00418528016197, -0.770234072868573, -0.0656148757390404, 0.276011305268776, 0.211831566780286, -0.505073387271410, 0.638483769418353, -0.464604489893360, -0.570346099876642, -1.82945520860790, -0.808845156537362, 0.783281930836874, -0.189698759604886, 0.271709764009016, -0.583618751528597, -0.597858854736041, -0.441417378808432 },

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52: { 1.63023528916473, 0.888610425420721, -1.05818025798736, 0.333510833065806, -0.229626450963181, -0.650907736597753, -0.291863375753573, -0.0942405879597235, -0.0637831200223327, 0.120205281956355, -1.83563868373519, 1.74625671011842, 0.425485355625296, 0.660707086367175, -0.729247267629503, 0.0464345266878230, -1.84612923609859, 0.610305217573950, 0.817516283237215, 1.18665904286638, -0.174775039544099, -0.176247547257615, 1.41256116072929, 0.0113541711008201, 0.226614480633598, 1.48955304778608, -0.784415293755632, 0.412307702040531, -0.363569288189157, -0.963230982199040, 1.28971939494037, -0.0333563180476360, 0.365328392431846, 0.505707009458752, 0.935251207390719, 0.351756753327098, 0.796122967431404, 1.24160125135253, -0.448304537939442, 0.695348326151247, -0.101778227545497

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, 0.244716707806350, 0.0520315567180542, 1.03749185434765, 0.0429748293046916, -0.199304020638472, 0.1235683182212
31, -0.154843838086042, 0.588137914293571, 2.26519543357233 },
76: { 0.627707287528727, -1.93302291785099, -0.533557109315987, 0.466914435684700, 1.60394635060288, 0.58117232
2675923, 0.327512120829686, 0.607600575846084, 1.63599965727829, -1.74987930638763, -0.865697308360524, 0.55085452
2057470, -0.00222678631383613, -0.249489064473939, 0.404253465109360, -1.60580220462075, -0.286684533211225, 0.392
575281297536, 0.0397401269892484, -0.282763714505208, 2.10662965570578, -1.53218960296576, 1.36231546434230, -0.86
6485025359612, -0.580797689400443, 0.520143592624929, 2.43658435807580, 0.242551659062315, 0.0870459144723551, -0.
233345713757840, -0.925848419891795, -0.261972173055425, -0.426962687763533, -0.831982615393436, -0.07879592366242
87, -0.555661447134641, 0.762849125807182, -0.856837606600554, -0.623493724316681, -0.548901923229815, 1.096594693
34834, -0.118346511075084, 0.877599372594727, -0.0204311926026771, -0.948853230057176, -0.372760077970442, 0.27393
9379550766, 1.18859467046427, 1.37793427720460, -0.0478903304637657 },
77: { 1.09326566903948, -0.438966153934773, -2.00263573588306, -0.209713338388737, 0.0983477746401080, -2.19243
491996591, 0.664734120627595, -0.117798289267962, -0.425058490610031, 0.910482579647112, -1.04310830133763, 0.6829
64276111937, 0.0931087600588035, 0.503744055737328, -0.700620213418206, 0.661536244123409, -0.197342906850919, 1.3
0183950434961, -0.450598603707587, 1.15216580794839, -0.715847393133824, -1.33685240472023, 0.451874567380709, -0.
421846780441972, 0.875135601991687, -1.09224451734164, 0.302407416537707, -0.100647949072058, 0.173593051437428, 0
.403880739292361, 0.00532168979485395, -1.09541491865986, 0.0776686794320303, 0.497899500583305, -0.94179196906103
5, -1.35155634252200, -1.18212703394540, 0.0483900176597465, -1.35010016594322, -0.126011360116434, -0.39816310715
5080, -1.28940788194516, 1.01414104094213, 0.618953085869227, 0.541608366255458, -0.847371160164792, 0.75416580828
2410, -0.414907279235850, 1.85120493279698, -1.55186406853224 },
78: { 1.10927329761440, -1.79467884145512, 0.964229422631628, 0.625190357087626, 0.0413736134896147, -2.3192803
0664330, 0.0851885927211602, 0.699160333644167, 0.589433366718221, 0.867082552947325, -0.270068812648099, 1.170608
66003560, -0.378157056589758, -0.892661403477038, -1.63054289274725, 2.13850225382851, 0.405605372640549, -0.59364
1761840396, 0.109247941665665, -1.14650763211670, -0.280515661741481, -1.47384649800853, 1.64838365704617, -0.9426
66324280616, 1.39544988693277, -0.225794451802544, 0.0583198538886379, -1.62504844947823, 0.453591153371088, 1.192
46859933815, 1.13914949095078, 0.549233489827528, 1.79093025896060, 2.31562610334450, -0.652861505816215, 0.364211
322734809, 0.583847690104213, -0.664853402867584, -1.16224097904506, 0.299580407299929, -0.0854625512885032, 0.057
5636417288340, -0.0843484107867966, 1.80306351071647, -0.821128258718891, 1.33723804312817, 1.52449750573379, -0.6
58616762511396, -1.89766476744468, 0.444083312031626 }};
```

79:

80:

```

1:  /* Copyright (C) Jelle Spijker - All Rights Reserved
2:  * Unauthorized copying of this file, via any medium is strictly prohibited
3:  * and only allowed with the written consent of the author (Jelle Spijker)
4:  * This software is proprietary and confidential
5:  * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6:  */
7:
8:  #define QCLOSE_COMPARE(actual, expected, A) \
9:      QCOMPARE((int64)((actual) / A), (int64)((expected) / A))
10: #define QCLOSE_COMPARE_RANGE(actual, expected, endcount, type) \
11:     count = 0; \
12:     for_each(actual, actual + endcount, \
13:         [&](type & AC) { QCLOSE_COMPARE(AC, (type)expected[count++]); })
14: #define QCLOSE_COMPARE_RANGE(actual, expected, endcount, A, type) \
15:     count = 0; \
16:     for_each(actual, actual + endcount, \
17:         [&](type & AC) { QCLOSE_COMPARE(AC, (type)expected[count++], A); })
18:
19: #include <QString>
20: #include <QtTest>
21:
22: #include <stdint.h>
23:
24: #include <opencv2/core.hpp>
25: #include <opencv2/highgui.hpp>
26:
27: #include "SoilMath.h"
28:
29: #include "StatisticalComparisonDefinition.h"
30: #include "FloatTestMatrix.h"
31: #include "TestMatrix.h"
32: #include "beanhisttest.h"
33:
34: class SoilMath_Test : public QObject {
35:     Q_OBJECT
36:
37: public:
38:     SoilMath_Test();
39:
40: private:
41:     uint32_t count = 0;
42:
43: private Q_SLOTS:
44:     void testCase_Sort();
45:     void testCase_Sort_withKey();
46:
47:     void testCase_Stats_BigNoDiscrete();
48:     void testCase_Stats_Shifted();
49:
50:     void testCase_Mat_Stats();
51:     void testCase_Mat_Stats_Mask();
52:
53:     void testCase_benchmark_roundcast();
54:     void testCase_benchmark_float2intround();
55:
56:     void testCase_quickPow();
57:     void testCase_fastPow();
58:
59:     void testCase_benchmark_quickPow();
60:     void testCase_benchmark_fastPow();
61:     void testCase_benchmark_normalPow();
62: };
63:
64: SoilMath_Test::SoilMath_Test() {}
65:
66: void SoilMath_Test::testCase_Sort() {
67:     uint16_t compArr[10] = {1, 2, 4, 4, 5, 6, 7, 10, 10, 10};
68:     uint16_t startArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
69:     SoilMath::Sort::QuickSort<uint16_t>(startArr, 10);
70:
71:     QCLOSE_COMPARE_RANGE(startArr, compArr, 10, uint16_t);
72:
73:     QBENCHMARK {
74:         uint16_t sArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
75:         SoilMath::Sort::QuickSort<uint16_t>(sArr, 10);
76:     }
77:
78: }
79:
80: void SoilMath_Test::testCase_Sort_withKey() {
81:     uint16_t compArr[10] = {1, 2, 4, 4, 5, 6, 7, 10, 10, 10};
82:     uint16_t compKeyArr[10] = {3, 1, 6, 8, 2, 9, 4, 7, 5, 0};

```

```

84:     uint16_t startArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
85:     uint16_t startKeyarr[10] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9};
86:
87:     SoilMath::Sort::QuickSort<uint16_t>(startArr, startKeyarr, 10);
88:     QCOMPARE_RANGE(startArr, compArr, 10, uint16_t);
89:     QCOMPARE_RANGE(startKeyarr, compKeyArr, 10, uint16_t);
90:
91:     QENCHMARK {
92:         uint16_t sArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
93:         uint16_t sKeyarr[10] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9};
94:         SoilMath::Sort::QuickSort<uint16_t>(sArr, sKeyarr, 10);
95:     }
96: }
97:
98: void SoilMath_Test::testCase_Stats_BigNoDiscrete() {
99:     uint16_t *BigNoTestMatrix = new uint16_t[40000];
100:     uint32_t count = 0;
101:     for (uint32_t i = 0; i < 200; i++) {
102:         for (uint32_t j = 0; j < 200; j++) {
103:             BigNoTestMatrix[count++] = testMatrix[i][j] * 10;
104:         }
105:     }
106:
107:     uint16Stat_t Test(BigNoTestMatrix, 200, 200);
108:
109:     QCOMPARE_RANGE(Test.bins, histTestResult, 255, uint32_t);
110:     QCLOSE_COMPARE(Test.Mean, meanTestResult * 10, 0.01);
111:     QCOMPARE(Test.n, nTestResult);
112:     QCOMPARE((uint64_t)Test.Sum, (uint64_t)(sumTestResult * 10));
113:     QCOMPARE((uint32_t)Test.min, (uint32_t)(minTestResult * 10));
114:     QCOMPARE((uint32_t)Test.max, (uint32_t)(maxTestResult * 10));
115:     QCOMPARE((uint32_t)Test.Range, (uint32_t)(rangeTestResult * 10));
116:     QCLOSE_COMPARE(Test.Std, stdTestResult * 10, 0.025);
117:
118:     delete[] BigNoTestMatrix;
119: }
120:
121: void SoilMath_Test::testCase_Stats_Shifted() {
122:     uint16_t *BigNoTestMatrix = new uint16_t[40000];
123:     uint32_t count = 0;
124:     for (uint32_t i = 0; i < 200; i++) {
125:         for (uint32_t j = 0; j < 200; j++) {
126:             BigNoTestMatrix[count++] = testMatrix[i][j] + 10;
127:         }
128:     }
129:
130:     uint32_t *histTestResultShifted = new uint32_t[266]{};
131:     for (uint32_t i = 10; i < 266; i++) {
132:         histTestResultShifted[i] = histTestResult[i - 10];
133:     }
134:
135:     uint16Stat_t Test(BigNoTestMatrix, 200, 200, 266, 0, 265);
136:
137:     QCOMPARE_RANGE(Test.bins, histTestResultShifted, 266, uint32_t);
138:     QCLOSE_COMPARE(Test.Mean, meanTestResult + 10, 0.01);
139:     QCOMPARE(Test.n, nTestResult);
140:     QCLOSE_COMPARE(Test.Std, stdTestResult, 0.025);
141:
142:     delete[] BigNoTestMatrix;
143: }
144:
145: void SoilMath_Test::testCase_Mat_Stats() {
146:     cv::Mat beans = cv::imread("Images/beans.ppm", 0);
147:     ucharStat_t Test((uchar *)beans.data, beans.cols, beans.rows);
148:     QCLOSE_COMPARE(Test.Mean, actualMeanBean, 0.001);
149:     QCOMPARE_RANGE(Test.bins, actualHistBean, 256, uint32_t);
150:     QCOMPARE(Test.min, actualminBean);
151:     QCOMPARE(Test.max, actualMaxBean);
152:     QCLOSE_COMPARE(Test.Std, actualStdBean, 0.01);
153:     QCOMPARE((uint64_t)Test.Sum, (uint64_t)actualSumBean);
154:
155:     QENCHMARK {
156:         ucharStat_t TestBench((uchar *)beans.data, beans.cols, beans.rows);
157:     }
158: }
159:
160: void SoilMath_Test::testCase_Mat_Stats_Mask() {
161:     cv::Mat beans = cv::imread("Images/beans.ppm", 0);
162:     cv::Mat mask = cv::imread("Images/beansmask.ppm", 0);
163:     ucharStat_t Test((uchar *)beans.data, beans.cols, beans.rows,
164:                     (uchar *)mask.data);
165:     QCLOSE_COMPARE(Test.Mean, acutalMeanBeanMask, 0.001);
166:     QCOMPARE_RANGE(Test.bins, actualHistBeanMask, 256, uint32_t);

```



```

167: QCOMPARE(Test.min, actualminBeanMask);
168: QCOMPARE(Test.max, actualMaxBeanMask);
169: QCOMPARE((uint64_t)Test.Sum, (uint64_t)actualSumBeanMask);
170: QCLOSE_COMPARE(Test.Std, actualStdBeanMask, 0.01);
171: QBENCHMARK {
172:     ucharStat_t TestBench((uchar *)beans.data, beans.cols, beans.rows,
173:         (uchar *)mask.data);
174: }
175: }
176:
177: void SoilMath_Test::testCase_benchmark_roundcast() {
178:     float testf = 254.5;
179:
180:     QBENCHMARK { static_cast<int>(std::round(testf)); }
181: }
182:
183: void SoilMath_Test::testCase_benchmark_float2intround() {
184:     float testf = 254.5;
185:
186:     QBENCHMARK { SoilMath::float2intRound(testf); }
187: }
188:
189: void SoilMath_Test::testCase_quickPow() {
190:     for (int i = -255; i < 256; i++) {
191:         QCLOSE_COMPARE(SoilMath::quick_pow2(i), std::pow(i, 2), 0.0001);
192:     }
193:
194:     QBENCHMARK { SoilMath::quick_pow2(127); }
195: }
196:
197: void SoilMath_Test::testCase_fastPow() {
198:     for (int i = 1; i < 256; i++) {
199:         QCLOSE_COMPARE(SoilMath::fastPow(i, 2), std::pow(i, 2), 1.2);
200:     }
201:
202:     QBENCHMARK { SoilMath::fastPow(127, 2); }
203: }
204:
205: void SoilMath_Test::testCase_benchmark_quickPow() {
206:     QBENCHMARK { SoilMath::quick_pow2(127); }
207: }
208:
209: void SoilMath_Test::testCase_benchmark_fastPow() {
210:     QBENCHMARK { SoilMath::fastPow(127, 2); }
211: }
212:
213: void SoilMath_Test::testCase_benchmark_normalPow() {
214:     QBENCHMARK { std::pow(127, 2); }
215: }
216:
217: QTEST_APPLESS_MAIN(SoilMath_Test)
218:
219: #include "tst_soilmath_test.moc"

```

```
1:  /* Copyright (C) Jelle Spijker - All Rights Reserved
2:  * Unauthorized copying of this file, via any medium is strictly prohibited
3:  * and only allowed with the written consent of the author (Jelle Spijker)
4:  * This software is proprietary and confidential
5:  * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6:  */
7:
8:
9:
10: // Comparison values
11: #define N_MAT 3145728
12:
13: #define L_STD 5.028381605997681
14: #define L_MEAN 80.890745699097508
15: #define L_RANGE 79.936077729332197
16: #define L_MIN 16.742040567344091
17: #define L_MAX 96.678118296676288
18: #define L_SUM 2.544602836865306e8
19:
20: #define A_STD 0.866299119209983
21: #define A_MEAN -3.380512963778564
22: #define A_RANGE 28.974365656143501
23: #define A_MIN -21.293453236190196
24: #define A_MAX 7.680912419953306
25: #define A_SUM -0.106341742845212e8
26:
27: #define B_STD 1.582722966505156
28: #define B_MEAN -14.069966616731605
29: #define B_RANGE 52.152618100375619
30: #define B_MIN -49.577771326645184
31: #define B_MAX 2.574846773730433
32: #define B_SUM -0.442602879453179e8
33:
34: #define X_STD 0.063845026292892
35: #define X_MEAN 0.544538411135235
36: #define X_RANGE 0.783231866666667
37: #define X_MIN 0.019708690196078
38: #define X_MAX 0.802940556862745
39: #define X_SUM 1.712969726983621e6
40:
41: #define Y_STD 0.068325856701040
42: #define Y_MEAN 0.586997317935942
43: #define Y_RANGE 0.894038392156863
44: #define Y_MIN 0.022487607843137
45: #define Y_MAX 0.916526000000000
46: #define Y_SUM 1.846533898955995e6
47:
48: #define Z_STD 0.097003939083143
49: #define Z_MEAN 0.814970278082424
50: #define Z_RANGE 1.032072011764706
51: #define Z_MIN 0.048455952941176
52: #define Z_MAX 1.080527964705882
53: #define Z_SUM 2.563674822931669e6
54:
55: #define RI_STD 0.215470901001717
56: #define RI_MEAN -0.061338583528514
57: #define RI_RANGE 1.861278665280243e2
58: #define RI_MIN -1.210658478499890e2
59: #define RI_MAX 65.062018678035301
60: #define RI_SUM -1.929544996859839e5
```

```

1: #include <opencv2/core.hpp>
2: #include <opencv2/highgui.hpp>
3: #include <QDebug>
4:
5: #include "Vision.h"
6: #include "VisionFunctions.h"
7:
8: void VisionFunctions::CLAHE(Mat &src, Mat &newImage, int GridSize = 3){
9:     // apply the CLAHE algorithm to the L channel
10:    std::vector<cv::Mat> lab_planes(3);
11:    cv::split(src, lab_planes);
12:
13:    // create the CLAHE algorithm and apply it
14:    cv::Ptr<cv::CLAHE> clahe = cv::createCLAHE();
15:    //clahe->setClipLimit(GetThresholdLevel(src, Vision::Segment::Dark, 0, 2));
16:    clahe->setTilesGridSize(cv::Size(GridSize,GridSize));
17:    clahe->apply(lab_planes[0], newImage);
18:
19: };
20:
21: void VisionFunctions::Laplace(Mat &src, Mat &newImage,int kernelSize){
22:    cv::Laplacian(src, newImage, -1, kernelSize); // CV_16S
23: };
24:
25: void VisionFunctions::AdaptiveThreshold(Mat &src, Mat &newImage, uchar kernelSize, Vision::Segment::TypeOfO
bjects Object){
26:
27:     // reset the values in the newImage
28:     newImage = Scalar(0);
29:
30:     // determine the length of an arm of the window
31:     int length = (kernelSize - 1)/2;
32:
33:     for(int i = length; i < (src.cols - length); i++)
34:     {
35:         for(int j = length; j < (src.rows - length) ; j++)
36:         {
37:             /*
38:             // determine the threshold level for a local pixel
39:             //cv::Mat subImage = src.colRange(i-length,i+length).rowRange(j-length,j+length);
40:             //Mat subImage(src, cv::Rect(i - length, j - length, kernelSize, kernelSize));
41:
42:             if (j == length && i == length){
43:                 //imshow("one",subImage);
44:             }
45:
46:             // determine if the local pixel is 0 or 1
47:             if (src.at<uchar>(j,i) < T){
48:                 newImage.at<uchar>(j,i) = 255;
49:             }
50:             else{
51:                 newImage.at<uchar>(j,i) = 0;
52:             }
53:             */
54:         }
55:     }
56: };
57:
58: uint8_t VisionFunctions::GetThresholdLevel(Mat &src, Vision::Segment::TypeOfObjects TypeObject,int threshol
dOffset = 0, int sigma = 2) {
59:     // Calculate the statistics of the whole picture
60:     ucharStat_t OriginalImgStats(src.data, src.rows, src.cols);
61:
62:     // Sets the initial threshold with the mean of the total picture
63:     pair<uchar, uchar> T;
64:     T.first = (uchar)(OriginalImgStats.Mean + 0.5);
65:     T.second = 0;
66:
67:     uchar Rstd = 0;
68:     uchar Lstd = 0;
69:     uchar Rmean = 0;
70:     uchar Lmean = 0;
71:
72:     // Iterate till optimum Threshold is found between back- & foreground
73:     while (T.first != T.second) {
74:         // Gets an array of the left part of the histogram
75:         uint32_t i = T.first;
76:         uint32_t *Left = new uint32_t[i]{};
77:         while (i-- > 0) {
78:             Left[i] = OriginalImgStats.bins[i];
79:         }
80:
81:         // Gets an array of the right part of the histogram

```

```

82:     uint32_t rightEnd = 256 - T.first;
83:     uint32_t *Right = new uint32_t[rightEnd]{};
84:     i = rightEnd;
85:     while (i-- > 0) {
86:         Right[i] = OriginalImgStats.bins[i + T.first];
87:     }
88:
89:     // Calculate the statistics of both histograms,
90:     // taking into account the current threshold
91:     ucharStat_t sLeft(Left, 0, T.first);
92:     ucharStat_t sRight(Right, T.first, 256);
93:
94:     // Calculate the new threshold the mean of the means
95:     T.second = T.first;
96:     T.first = (uchar)(((sLeft.Mean + sRight.Mean) / 2) + 0.5);
97:
98:     Rmean = (uchar)(sRight.Mean + 0.5);
99:     Lmean = (uchar)(sLeft.Mean + 0.5);
100:     Rstd = (uchar)(sRight.Std + 0.5);
101:     Lstd = (uchar)(sLeft.Std + 0.5);
102:     delete[] Left;
103:     delete[] Right;
104: }
105:
106: // Assumes the pixel value of the sought object lies between 2 sigma
107: int val = 0;
108: switch (TypeObject) {
109: case Vision::Segment::Bright: // bright
110:     val = Rmean - (sigma * Rstd) - thresholdOffset;
111:     if (val < 0) {
112:         val = 0;
113:     } else if (val > 255) {
114:         val = 255;
115:     }
116:     T.first = (uchar)val;
117:     break;
118: case Vision::Segment::Dark: // dark
119:     val = Lmean + (sigma * Lstd) + thresholdOffset;
120:     if (val < 0) {
121:         val = 0;
122:     } else if (val > 255) {
123:         val = 255;
124:     }
125:     T.first = (uchar)val;
126:     break;
127: }
128:
129: return T.first;
130: }
131:

```

```

1: #define NO_OF_BLOBS 379
2: #define SMALL_NO_OF_BLOBS 4
3:
4: #include <QString>
5: #include <QtTest>
6: #include <opencv2/core.hpp>
7: #include <opencv2/highgui.hpp>
8:
9: #include "Vision.h"
10:
11: class Vision_Test : public QObject
12: {
13:     Q_OBJECT
14:
15: public:
16:     Vision_Test();
17:
18: private Q_SLOTS:
19:     void TestCase_SimpleLabelBlob();
20:     void TestCase_SingleComplexLabelBlob();
21:     void TestCase_LabelBlobs();
22: };
23:
24: Vision_Test::Vision_Test()
25: {
26: }
27:
28: void Vision_Test::TestCase_SimpleLabelBlob() {
29:     uchar testImgData[100] = { 0, 0, 1, 1, 0, 0, 1, 1, 1, 1,
30:                                0, 0, 0, 1, 0, 0, 0, 1, 1, 1,
31:                                1, 0, 0, 1, 0, 1, 0, 0, 1, 1,
32:                                1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
33:                                1, 1, 0, 0, 0, 0, 1, 0, 1, 1,
34:                                0, 0, 0, 1, 1, 0, 0, 0, 0, 1,
35:                                1, 1, 0, 0, 1, 1, 0, 0, 1, 1,
36:                                1, 1, 1, 0, 0, 1, 1, 0, 1, 1,
37:                                0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
38:                                0, 0, 0, 1, 0, 0, 1, 1, 1, 1};
39:
40:     cv::Mat testImg(10, 10, CV_8UC1, testImgData);
41:     testImg *= 255;
42:     Vision::Segment Segmenter(testImg);
43:     Segmenter.ConvertToBW(Vision::Segment::Bright);
44:     Segmenter.GetBlobList(true);
45:     uint16_t totalNoOfBlobs = Segmenter.MaxLabel;
46:     QCOMPARE(totalNoOfBlobs, uint16_t(SMALL_NO_OF_BLOBS));
47: }
48:
49: void Vision_Test::TestCase_SingleComplexLabelBlob() {
50:     uchar testImgData[100] = { 0, 0, 0, 0, 0, 0, 0, 1, 1, 0,
51:                                0, 0, 0, 0, 0, 1, 1, 1, 1, 1,
52:                                0, 0, 0, 1, 1, 1, 1, 1, 1, 1,
53:                                0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
54:                                1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
55:                                0, 0, 0, 1, 0, 0, 0, 1, 1, 1,
56:                                0, 0, 0, 0, 0, 1, 1, 1, 1, 1,
57:                                0, 0, 0, 1, 1, 1, 1, 1, 0, 0,
58:                                0, 1, 1, 1, 1, 1, 1, 0, 0, 0,
59:                                1, 1, 1, 1, 1, 1, 1, 0, 0, 0};
60:
61:     cv::Mat testImg(10, 10, CV_8UC1, testImgData);
62:     testImg *= 255;
63:     Vision::Segment Segmenter(testImg);
64:     Segmenter.ConvertToBW(Vision::Segment::Bright);
65:     Segmenter.GetBlobList(true);
66:     uint16_t totalNoOfBlobs = Segmenter.MaxLabel;
67:     QCOMPARE(totalNoOfBlobs, uint16_t(1));
68: }
69:
70:
71: void Vision_Test::TestCase_LabelBlobs()
72: {
73:     cv::Mat testImg = cv::imread("42_blobs.ppm", 0);
74:
75:     Vision::Segment Segmenter(testImg);
76:     Segmenter.ConvertToBW(Vision::Segment::Bright);
77:     Segmenter.GetBlobList(true);
78:     std::vector<int> params;
79:     params.push_back(CV_IMWRITE_PXM_BINARY);
80:     params.push_back(0);
81:     cv::Mat temp(Segmenter.LabelledImg.rows, Segmenter.LabelledImg.cols, CV_8UC1);
82:     Segmenter.LabelledImg.convertTo(temp, CV_8UC1);
83:     cv::imwrite("L.pgm", temp, params);

```

```
84:     SHOW_DEBUG_IMG(Segmenter.LabelledImg, uint16_t, uint16_t(-1), "segment labelblobs", true);
85:     uint16_t totalNoOfBlobs = Segmenter.MaxLabel;
86:     QCOMPARE(totalNoOfBlobs, uint16_t(42));
87: }
88:
89: QTEST_APPLESS_MAIN(Vision_Test)
90:
91: #include "tst_vision_test.moc"
```

```

1: #ifndef VISIONFUNCTIONS_H
2: #define VISIONFUNCTIONS_H
3:
4: #include <opencv2/core.hpp>
5: #include <opencv2/highgui.hpp>
6:
7: #include "Vision.h"
8:
9: class VisionFunctions{
10:
11:     public:
12:         void Laplace(Mat &src, Mat &newImage,int kernelSize);
13:         void CLAHE(Mat &src, Mat &newImage, int GridSize);
14:         void AdaptiveThreshold(Mat &src, Mat &newImage, uchar kernelSize, Vision::Segment::TypeOfObjects Ob
ject);
15:
16:     private:
17:         uint8_t GetThresholdLevel(Mat &src, Vision::Segment::TypeOfObjects TypeObject,int thresholdOffset,
int sigma);
18:
19: };
20:
21: #endif // VISIONFUNCTIONS_H

```

```

1:  /* Copyright (C) Jelle Spijker - All Rights Reserved
2:  * Unauthorized copying of this file, via any medium is strictly prohibited
3:  * and only allowed with the written consent of the author (Jelle Spijker)
4:  * This software is proprietary and confidential
5:  * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6:  */
7:
8:
9:  #include <QString>
10: #include <QtTest>
11:
12: class Soil_TestTest : public QObject
13: {
14:     Q_OBJECT
15:
16: public:
17:     Soil_TestTest();
18:
19: private Q_SLOTS:
20:     void testCase1();
21: };
22:
23: Soil_TestTest::Soil_TestTest()
24: {
25: }
26:
27: void Soil_TestTest::testCase1()
28: {
29:     QVERIFY2(true, "Failure");
30: }
31:
32: QTEST_APPLESS_MAIN(Soil_TestTest)
33:
34: #include "tst_soil_testtest.moc"

```



```
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2:  * Unauthorized copying of this file, via any medium is strictly prohibited
3:  * and only allowed with the written consent of the author (Jelle Spijker)
4:  * This software is proprietary and confidential
5:  * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6:  */
7:
8:
9: #define BOOST_TEST_MODULE VSA_UNIT_TESTS
10:
11: // Custom libraries
12: #include "../src/VisionSoilAnalyzer/Vision/Vision.h"
13: #include "../src/VisionSoilAnalyzer/Soil/VisionSoil.h"
14: #include "../src/VisionSoilAnalyzer/SoilMath/SoilMath.h"
15: #include "../src/VisionSoilAnalyzer/SoilPlot/SoilPlot.h"
16:
17: // Test Libraries
18: #include "FloatTestMatrix.h"
19: #include "TestMatrix.h"
20: #include "StatisticalComparisonDefinition.h"
21:
22: #include <boost/test/unit_test.hpp>
23: #include <boost/test/results_reporter.hpp>
24: #include <iostream>
25: #include <fstream>
26: #include <sstream>
27: #include <opencv2/core/core.hpp>
28: #include <opencv2/highgui/highgui.hpp>
29: #include <string>
30: #include <boost/archive/xml_oarchive.hpp>
31: #include <boost/archive/xml_iarchive.hpp>
32: #include <boost/archive/binary_iarchive.hpp>
33: #include <boost/archive/binary_oarchive.hpp>
34: #include <boost/serialization/vector.hpp>
35:
36: // Statistical analysis
37:
38: #include <math.h>
39: #include <cmath>
40: #include <random>
41: #include <sys/time.h>
42:
43: using namespace cv;
44: using namespace std;
45:
46: // Create the Report Redirector
47: struct LogToFile
48: {
49:     LogToFile()
50:     {
51:         std::string logFileName(boost::unit_test::framework::master_test_suite().p_name);
52:         logFileName.append(".log");
53:         logFile.open(logFileName.c_str());
54:         boost::unit_test::unit_test_log.set_stream(logFile);
55:     }
56:     ~LogToFile()
57:     {
58:         boost::unit_test::unit_test_log.test_finish();
59:         logFile.close();
60:         boost::unit_test::unit_test_log.set_stream(std::cout);
61:     }
62:     std::ofstream logFile;
63: };
64: BOOST_GLOBAL_FIXTURE(LogToFile);
65:
66: struct M {
67:     M()
68:     {
69:         BOOST_TEST_MESSAGE("setup fixture");
70:         src = imread("../ComparisionPictures/SoilSampleRGB.ppm");
71:     }
72:     ~M() { BOOST_TEST_MESSAGE("teardown fixture"); }
73:
74:     friend class SoilAnalyzer::Sample;
75:     Mat src;
76:     Mat dst;
77:     Mat comp;
78: };
79:
80: struct B {
81:     B()
82:     {
83:         BOOST_TEST_MESSAGE("Setup fixture");
```

```

84:         src = imread("../ComparisionPictures/BlobTest.ppm", 0);
85:     }
86:     ~B()
87:     {
88:         src.release();
89:         BOOST_TEST_MESSAGE("teardown fixture");
90:     }
91:
92:     Mat src;
93:     Mat dst;
94:     Mat comp;
95: };
96:
97: struct BM {
98:     BM()
99:     {
100:         BOOST_TEST_MESSAGE("Setup fixture");
101:         src = imread("../ComparisionPictures/BlobTestMany.ppm", 0);
102:     }
103:     ~BM() { BOOST_TEST_MESSAGE("teardown fixture"); }
104:
105:     Mat src;
106:     Mat dst;
107:     Mat comp;
108: };
109:
110: struct PM {
111:     PM()
112:     {
113:         BOOST_TEST_MESSAGE("Setup fixture");
114:         checker = imread("../ComparisionPictures/checker.ppm", 0);
115:         std::vector<cv::Mat> RGB;
116:         for (uint32_t i = 0; i < 3; i++)
117:         {
118:             RGB.push_back(checker);
119:         }
120:         cv::Mat alpha(checker.rows, checker.cols, CV_8UC1);
121:         alpha.setTo(255);
122:         RGB.push_back(alpha);
123:         merge(RGB, RGBchecker);
124:     }
125:     ~PM() { BOOST_TEST_MESSAGE("teardown fixture"); }
126:
127:     std::string TestWindow = "SoilPlot Image window";
128:     Mat checker;
129:     Mat RGBchecker;
130:     Mat comp;
131: };
132:
133: //SoilPlot Test
134: BOOST_FIXTURE_TEST_CASE(SoilPlot_Label, PM)
135: {
136:     SoilPlot::Label TestR("RED", "times", 30, cv::Scalar(255, 0, 0, 255), cv::Scalar(0,0,0,0), false, true)
;
137:     SoilPlot::Label TestG("GREEN", "times", 30, cv::Scalar(0, 255, 0, 255), cv::Scalar(0, 0, 0, 0), false,
true);
138:     SoilPlot::Label TestB("BLUE", "times", 30, cv::Scalar(0, 0, 255, 255), cv::Scalar(0, 0, 0, 0), false, t
rue);
139:     SoilPlot::Label TestA("ALPHA", "times", 30, cv::Scalar(255, 125, 0, 10), cv::Scalar(0, 0, 0, 0), false,
true);
140:     namedWindow(TestWindow, cv::WINDOW_NORMAL);
141:
142:     TestR.TopLeftCorner = cv::Point(50, 10);
143:     TestR.Draw();
144:     imshow(TestWindow, TestR.Figure);
145:     cv::waitKey(0);
146:     TestR.DrawOnTop(RGBchecker);
147:     TestG.TopLeftCorner = cv::Point(50, TestR.Figure.rows + 30);
148:     TestG.Draw();
149:     imshow(TestWindow, TestG.Figure);
150:     cv::waitKey(0);
151:     TestG.DrawOnTop(RGBchecker);
152:     TestB.TopLeftCorner = cv::Point(50, TestG.TopLeftCorner.y + TestG.Figure.rows + 20);
153:     TestB.Draw();
154:     imshow(TestWindow, TestB.Figure);
155:     cv::waitKey(0);
156:     TestB.DrawOnTop(RGBchecker);
157:     TestA.TopLeftCorner = cv::Point(50, TestB.TopLeftCorner.y + TestB.Figure.rows + 20);
158:     TestA.Draw();
159:     imshow(TestWindow, TestA.Figure);
160:     cv::waitKey(0);
161:     TestA.DrawOnTop(RGBchecker);
162:

```

```

163:
164:         imshow(TestWindow, RGBchecker);
165:         cv::waitKey(0);
166:     }
167:
168: BOOST_FIXTURE_TEST_CASE(SoilPlot_Lines, PM)
169: {
170:     std::vector<SoilPlot::Line> Lines;
171:     Lines.push_back(SoilPlot::Line(cv::Point(80, 80), cv::Point(150, 150), 1, cv::Scalar(255, 0, 0, 255
)))
172:     Lines.push_back(SoilPlot::Line(cv::Point(80, 80), cv::Point(10, 150), 2, cv::Scalar(0, 255, 0, 255)
)))
173:     Lines.push_back(SoilPlot::Line(cv::Point(80, 80), cv::Point(10, 10), 3, cv::Scalar(0, 0,255, 255)))
;
174:     Lines.push_back(SoilPlot::Line(cv::Point(80, 80), cv::Point(150, 10), 4, cv::Scalar(255, 0, 0, 255)
)))
175:     Lines.push_back(SoilPlot::Line(cv::Point(80, 10), cv::Point(80, 150), 5, cv::Scalar(255, 0, 255, 25
5)));
176:     Lines.push_back(SoilPlot::Line(cv::Point(10, 80), cv::Point(150, 80), 10, cv::Scalar(255, 255, 0, 2
00)));
177:     for_each(Lines.begin(), Lines.end(), [&](SoilPlot::Line &L)
178:     {
179:         L.Draw();
180:         L.DrawOnTop(RGBchecker);
181:     });
182:
183:     namedWindow(TestWindow, cv::WINDOW_NORMAL);
184:     imshow(TestWindow, RGBchecker);
185:     cv::waitKey(0);
186: }
187:
188: BOOST_FIXTURE_TEST_CASE(SoilPlot_Axis, PM)
189: {
190:     std::vector<SoilPlot::Axis> axes;
191:     SoilPlot::Label axisLabel("Horizontal", "times", 30, cv::Scalar(200, 80, 80, 255), cv::Scalar(0, 0,
0, 0), true, true);
192:
193:     std::vector<SoilPlot::Label> Values;
194:     Values.push_back(SoilPlot::Label("1", "times", 16, cv::Scalar(200,80,3,255), cv::Scalar(0,0,0,0), f
alse, true));
195:     Values.push_back(SoilPlot::Label("2", "times", 16, cv::Scalar(200,80,3,255), cv::Scalar(0,0,0,0), f
alse, true));
196:     Values.push_back(SoilPlot::Label("3", "times", 16, cv::Scalar(200,80,3,255), cv::Scalar(0,0,0,0), f
alse, true));
197:
198:     axes.push_back(SoilPlot::Axis(cv::Point(20,140), 120, SoilPlot::Axis::Orientation_enum::Horizontal,
Values, axisLabel, SoilPlot::Axis::ValuePosition::UnderTick, false));
199:     for_each(axes.begin(), axes.end(), [&](SoilPlot::Axis &A)
200:     {
201:         A.Draw();
202:         A.DrawOnTop(RGBchecker);
203:     });
204: }
205:
206:
207: BOOST_AUTO_TEST_CASE(SoilPlot_Bar_Graph)
208: {
209:
210: }
211:
212: // SoilMath Test
213: BOOST_AUTO_TEST_CASE(Vision_Create_Blobs)
214: {
215:     cv::Mat src = imread("../ComparisionPictures/BlobTest.ppm", 0);
216:
217:     Vision::Segment Test(src);
218:     Test.ConvertToBW(Vision::Segment::Bright);
219:     Test.GetBlobList(true);
220:     imwrite("LabeledBlobs.ppm", Test.LabelledImg);
221:     BOOST_CHECK_EQUAL(42, Test.BlobList.size());
222:     for_each(Test.BlobList.begin(), Test.BlobList.end(), [](Vision::Segment::Blob_t &b)
223:     {
224:         stringstream ss;
225:         ss << b.Label << "_few_1nd.ppm";
226:         imwrite(ss.str(), b.Img);
227:     });
228: }
229:
230: BOOST_FIXTURE_TEST_CASE(Vision_Create_Many_Blobs, BM)
231: {
232:     Vision::Segment Test(src);
233:     Test.ConvertToBW(Vision::Segment::Bright);
234:     Test.GetBlobList(true);

```

```

235:         imwrite("LabeledBlobsMany.ppm", Test.LabelledImg);
236:         BOOST_CHECK_EQUAL(370, Test.BlobList.size());
237:         for_each(Test.BlobList.begin(), Test.BlobList.end(), [](Vision::Segment::Blob_t &b)
238:         {
239:             stringstream ss;
240:             ss << b.Label << "_many_.ppm";
241:             imwrite(ss.str(), b.Img);
242:         });
243:     }
244:
245:     BOOST_AUTO_TEST_CASE(SoilMath_Stats_BigNoDiscrete)
246:     {
247:         uint16_t *BigNoTestMatrix = new uint16_t[40000];
248:         uint32_t count = 0;
249:         for (uint32_t i = 0; i < 200; i++)
250:         {
251:             for (uint32_t j = 0; j < 200; j++)
252:             {
253:                 BigNoTestMatrix[count++] = testMatrix[i][j] * 10;
254:             }
255:         }
256:
257:         uint16Stat_t Test(BigNoTestMatrix, 200, 200);
258:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.bins, Test.bins + 255, histTestResult, histTestResult + 255);
259:         BOOST_CHECK_CLOSE(Test.Mean, meanTestResult * 10, 0.0001);
260:         BOOST_CHECK_EQUAL(Test.n, nTestResult);
261:         BOOST_CHECK_EQUAL(Test.Sum, sumTestResult * 10);
262:         BOOST_CHECK_EQUAL(Test.min, minTestResult * 10);
263:         BOOST_CHECK_EQUAL(Test.max, maxTestResult * 10);
264:         BOOST_CHECK_EQUAL(Test.Range, rangeTestResult * 10);
265:         BOOST_CHECK_CLOSE(Test.Std, stdTestResult * 10, 0.01);
266:         delete[] BigNoTestMatrix;
267:     }
268:
269:     BOOST_AUTO_TEST_CASE(SoilMath_Sort)
270:     {
271:         int testDiscrete[] = { 2, 8, 1, 3, 0, 7, 4, 5, 9, 6, 6 };
272:         int ucomp[] = { 0, 1, 2, 3, 4, 5, 6, 6, 7, 8, 9 };
273:         SoilMath::Sort::QuickSort<int>(testDiscrete, 11);
274:         BOOST_CHECK_EQUAL_COLLECTIONS(testDiscrete, testDiscrete + 10, ucomp, ucomp + 10);
275:     }
276:
277:     BOOST_AUTO_TEST_CASE(SoilMath_Stats_ucharStat_t)
278:     {
279:         ucharStat_t Test((uint8_t *)testMatrix, 200, 200);
280:
281:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.bins, Test.bins + 255, histTestResult, histTestResult + 255);
282:         BOOST_CHECK_CLOSE(Test.Mean, meanTestResult, 0.0001);
283:         BOOST_CHECK_EQUAL(Test.n, nTestResult);
284:         BOOST_CHECK_EQUAL(Test.Sum, sumTestResult);
285:         BOOST_CHECK_EQUAL(Test.min, minTestResult);
286:         BOOST_CHECK_EQUAL(Test.max, maxTestResult);
287:         BOOST_CHECK_EQUAL(Test.Range, rangeTestResult);
288:         BOOST_CHECK_CLOSE(Test.Std, stdTestResult, 0.01);
289:     }
290:
291:     BOOST_AUTO_TEST_CASE(SoilMath_Stats_floatStat_t)
292:     {
293:         floatStat_t Test((float *)fTestMatrix, 50, 50);
294:
295:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.bins, Test.bins + 255, fhistTestResult, fhistTestResult + 255);
296:         BOOST_CHECK_CLOSE(Test.Mean, fmeanTestResult, 0.01);
297:         BOOST_CHECK_EQUAL(Test.n, fnTestResult);
298:         BOOST_CHECK_CLOSE(Test.Sum, fsumTestResult, 0.01);
299:         BOOST_CHECK_CLOSE(Test.min, fminTestResult, 0.01);
300:         BOOST_CHECK_CLOSE(Test.max, fmaxTestResult, 0.01);
301:         BOOST_CHECK_CLOSE(Test.Range, frangeTestResult, 0.01);
302:         BOOST_CHECK_CLOSE(Test.Std, fstdTestResult, 0.025);
303:     }
304:
305:     BOOST_AUTO_TEST_CASE(SoilMath_FFT_GetDescriptors)
306:     {
307:         uchar data[] =
308:         { 0, 0, 1, 1, 0, 0,
309:         0, 1, 0, 0, 1, 0,
310:         0, 1, 0, 0, 1, 0,
311:         1, 0, 0, 0, 0, 1,
312:         1, 0, 0, 0, 0, 1,
313:         0, 1, 0, 0, 1, 0,
314:         0, 1, 0, 0, 1, 0,
315:         0, 0, 1, 1, 0, 0 };
316:         cv::Mat src(8, 6, CV_8UC1, &data, 1);
317:         SoilMath::FFT Test;

```

```

318:     ComplexVect_t desc = Test.GetDescriptors(src);
319:     Complex_t desc_exp[] = {
320:         Complex_t(-1.6666667, -6),
321:         Complex_t(2.02375780, -0.16742019),
322:         Complex_t(-3.1094758, -6.13316500),
323:         Complex_t(-1.8036530, 1.023864110),
324:         Complex_t(-0.6666667, -1),
325:         Complex_t(0.04350554, -2.55884126),
326:         Complex_t(-3.0522848, -0.63807119),
327:         Complex_t(-0.7780360, -0.31809187),
328:         Complex_t(-0.3333333, 0),
329:         Complex_t(-1.3856866, -1.43021101),
330:         Complex_t(-1.2238576, 0.466498316),
331:         Complex_t(-0.3295119, 1.459385072),
332:         Complex_t(1.33333331, -1),
333:         Complex_t(-0.3482434, 0.489805636),
334:         Complex_t(0.71895134, 0.304737878),
335:         Complex_t(5.24453433, -0.49849056)
336:     };
337:
338:     BOOST_CHECK_EQUAL(desc.size(), 16);
339:
340:     for (uint32_t i = 0; i < 16; i++)
341:     {
342:         BOOST_CHECK_CLOSE(desc[i].real(), desc_exp[i].real(), 0.0001);
343:         BOOST_CHECK_CLOSE(desc[i].imag(), desc_exp[i].imag(), 0.0001);
344:     }
345: }
346:
347: BOOST_AUTO_TEST_CASE(SoilMath_FFT_GetDescriptors_Non_Continues_Contour)
348: {
349:     uchar data[] =
350:     { 0, 0, 0, 1, 0, 0,
351:       0, 1, 0, 0, 1, 0,
352:       0, 1, 0, 0, 1, 0,
353:       1, 0, 0, 0, 0, 1,
354:       1, 0, 0, 0, 0, 1,
355:       0, 1, 0, 0, 1, 0,
356:       0, 1, 0, 0, 1, 0,
357:       0, 0, 1, 1, 0, 0 };
358:     cv::Mat src(8, 6, CV_8UC1, &data, 1);
359:     SoilMath::FFT Test;
360:     BOOST_CHECK_THROW(Test.GetDescriptors(src), SoilMath::Exception::MathException);
361: }
362:
363: BOOST_AUTO_TEST_CASE(SoilMath_NN_Save_And_Load)
364: {
365:     SoilMath::NN Test(3, 5, 2);
366:
367:     InputLearnVector_t inputVect;
368:     OutputLearnVector_t outputVect;
369:
370:     //Population_t pop;
371:     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
372:     std::default_random_engine gen(seed);
373:     std::uniform_real_distribution<float> dis(0.0, 1.0);
374:
375:     float i1 = 0.0, i2 = 0.0, i3 = 0.0;
376:     float o1 = 0.0, o2 = 0.0;
377:
378:     for (uint32_t i = 0; i < 200; i++)
379:     {
380:         if (dis(gen) > 0.5f) { i1 = 1.0; }
381:         else { i1 = 0.0; }
382:         if (dis(gen) > 0.5f) { i2 = 1.0; }
383:         else { i2 = 0.0; }
384:         if (dis(gen) > 0.5f) { i3 = 1.0; }
385:         else { i3 = 0.0; }
386:
387:         if (i1 == 1.0 && i2 == 1.0 && i3 == 0.0)
388:         {
389:             o1 = 1.0;
390:             o2 = -1.0;
391:         }
392:         else if (i1 == 0.0 && i2 == 0.0 && i3 == 1.0)
393:         {
394:             o1 = 1.0;
395:             o2 = -1.0;
396:         }
397:         else
398:         {
399:             o1 = -1.0;
400:             o2 = 1.0;

```

```

401:         }
402:
403:         ComplexVect_t inputTemp;
404:         inputTemp.push_back(Complex_t(i1, 0));
405:         inputTemp.push_back(Complex_t(i2, 0));
406:         inputTemp.push_back(Complex_t(i3, 0));
407:         inputVect.push_back(inputTemp);
408:
409:         Predict_t outputTemp;
410:         outputTemp.OutputNeurons.push_back(o1);
411:         outputTemp.OutputNeurons.push_back(o2);
412:         outputVect.push_back(outputTemp);
413:     }
414:
415:     Test.Learn(inputVect, outputVect, 0);
416:     Test.SaveState("NN.xml");
417:
418:     SoilMath::NN loadTest;
419:     loadTest.LoadState("NN.xml");
420:
421:     std::vector<float> test_out = Test.Predict(inputVect[0]).OutputNeurons;
422:     std::vector<float> loadtest_out = loadTest.Predict(inputVect[0]).OutputNeurons;
423:
424:     BOOST_REQUIRE_EQUAL_COLLECTIONS(Test.hWeights.begin(), Test.hWeights.end(), loadTest.hWeights.begin(), loadTest.hWeights.end());
425:     BOOST_REQUIRE_EQUAL_COLLECTIONS(Test.iWeights.begin(), Test.iWeights.end(), loadTest.iWeights.begin(), loadTest.iWeights.end());
426: }
427:
428: BOOST_AUTO_TEST_CASE(SoilMath_NN_Prediction_Accuracy)
429: {
430:     SoilMath::NN Test;
431:     Test.LoadState("../ComparisionPictures/NN_Test.xml");
432:
433:     InputLearnVector_t inputVect;
434:     OutputLearnVector_t outputVect;
435:     OutputLearnVector_t outputPredictVect;
436:
437:     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
438:     std::default_random_engine gen(seed);
439:     std::uniform_real_distribution<float> dis(0.0, 1.0);
440:
441:     float i1 = 0.0, i2 = 0.0, i3 = 0.0;
442:     float o1 = 0.0, o2 = 0.0;
443:
444:     for (uint32_t i = 0; i < 10; i++)
445:     {
446:         if (dis(gen) > 0.5f) { i1 = 1.0; }
447:         else { i1 = 0.0; }
448:         if (dis(gen) > 0.5f) { i2 = 1.0; }
449:         else { i2 = 0.0; }
450:         if (dis(gen) > 0.5f) { i3 = 1.0; }
451:         else { i3 = 0.0; }
452:
453:         if (i1 == 1.0 && i2 == 1.0 && i3 == 0.0)
454:         {
455:             o1 = 1.0;
456:             o2 = -1.0;
457:         }
458:         else if (i1 == 0.0 && i2 == 0.0 && i3 == 1.0)
459:         {
460:             o1 = 1.0;
461:             o2 = -1.0;
462:         }
463:         else
464:         {
465:             o1 = -1.0;
466:             o2 = 1.0;
467:         }
468:
469:         ComplexVect_t inputTemp;
470:         inputTemp.push_back(Complex_t(i1, 0));
471:         inputTemp.push_back(Complex_t(i2, 0));
472:         inputTemp.push_back(Complex_t(i3, 0));
473:         inputVect.push_back(inputTemp);
474:
475:         Predict_t outputTemp;
476:         outputTemp.OutputNeurons.push_back(o1);
477:         outputTemp.OutputNeurons.push_back(o2);
478:         outputVect.push_back(outputTemp);
479:
480:         Predict_t outputPredictTemp;
481:         outputPredictTemp.OutputNeurons = Test.Predict(inputTemp).OutputNeurons;

```

```
482:
483:         for (uint32_t j = 0; j < outputTemp.OutputNeurons.size(); j++)
484:         {
485:             BOOST_CHECK_CLOSE(outputPredictTemp.OutputNeurons[j], outputTemp.OutputNeurons[j],
5);
486:         }
487:     }
488: }
489:
490: // Vision Test
491:
492: BOOST_FIXTURE_TEST_CASE(Vision_Convert_RGB_To_Intensity, M)
493: {
494:     // Convert the RGB picture to an intensity picture
495:     Vision::Conversion Test;
496:     Test.Convert(src, dst, Vision::Conversion::RGB, Vision::Conversion::Intensity);
497:
498:     // Read in the Matlab converted intensity picture converted with the Matlab command:
499:     // Matlab_int=0.2126*RGB(:,:,1)+0.7152*RGB(:,:,2)+0.0722*RGB(:,:,3);
500:     comp = imread("../ComparisionPictures/Matlab_int.ppm", 0);
501:
502:     // Calculate the statistics of the two images
503:     ucharStat_t statDst(dst.data, dst.rows, dst.cols);
504:     ucharStat_t statComp(comp.data, comp.rows, comp.cols);
505:
506:     // Simple comparison
507:     BOOST_CHECK_CLOSE(statDst.Mean, statComp.Mean, 0.5);
508:     BOOST_CHECK_CLOSE(statDst.Std, statComp.Std, 0.5);
509:     BOOST_CHECK_CLOSE((double)statDst.Range, (double)statComp.Range, 0.5);
510:     BOOST_CHECK_CLOSE((double)statDst.min, (double)statComp.min, 0.5);
511:     BOOST_CHECK_CLOSE((double)statDst.max, (double)statComp.max, 0.5);
512:     BOOST_CHECK_CLOSE((double)statDst.Sum, (double)statComp.Sum, 0.5);
513: }
514:
515: BOOST_FIXTURE_TEST_CASE(Vision_Convert_RGB_To_CIEXYZ, M)
516: {
517:     // Convert the RGB to an CIElab
518:     Vision::Conversion Test;
519:     Test.Convert(src, dst, Vision::Conversion::RGB, Vision::Conversion::CIE_XYZ);
520:     vector<Mat> LAB = Test.extractChannel(dst);
521:
522:     floatStat_t statDstX((float *)LAB[0].data, src.rows, src.cols);
523:     floatStat_t statCompX;
524:     statCompX.Std = X_STD;
525:     statCompX.n = N_MAT;
526:     statCompX.Mean = X_MEAN;
527:     statCompX.Range = X_RANGE;
528:     statCompX.min = X_MIN;
529:     statCompX.max = X_MAX;
530:     statCompX.Sum = X_SUM;
531:
532:     // Simple comparison
533:     BOOST_CHECK_CLOSE(statDstX.Mean, statCompX.Mean, 0.5);
534:     BOOST_CHECK_CLOSE(statDstX.Std, statCompX.Std, 0.5);
535:     BOOST_CHECK_CLOSE((double)statDstX.Range, (double)statCompX.Range, 0.5);
536:     BOOST_CHECK_CLOSE((double)statDstX.min, (double)statCompX.min, 0.5);
537:     BOOST_CHECK_CLOSE((double)statDstX.max, (double)statCompX.max, 0.5);
538:     BOOST_CHECK_CLOSE((double)statDstX.Sum, (double)statCompX.Sum, 0.5);
539:
540:     floatStat_t statDstY((float *)LAB[1].data, src.rows, src.cols);
541:     floatStat_t statCompY;
542:     statCompY.Std = Y_STD;
543:     statCompY.n = N_MAT;
544:     statCompY.Mean = Y_MEAN;
545:     statCompY.Range = Y_RANGE;
546:     statCompY.min = Y_MIN;
547:     statCompY.max = Y_MAX;
548:     statCompY.Sum = Y_SUM;
549:
550:     // Simple comparison
551:     BOOST_CHECK_CLOSE(statDstY.Mean, statCompY.Mean, 0.5);
552:     BOOST_CHECK_CLOSE(statDstY.Std, statCompY.Std, 0.5);
553:     BOOST_CHECK_CLOSE((double)statDstY.Range, (double)statCompY.Range, 0.5);
554:     BOOST_CHECK_CLOSE((double)statDstY.min, (double)statCompY.min, 0.5);
555:     BOOST_CHECK_CLOSE((double)statDstY.max, (double)statCompY.max, 0.5);
556:     BOOST_CHECK_CLOSE((double)statDstY.Sum, (double)statCompY.Sum, 0.5);
557:
558:     floatStat_t statDstZ((float *)LAB[2].data, src.rows, src.cols);
559:     floatStat_t statCompZ;
560:     statCompZ.Std = Z_STD;
561:     statCompZ.n = N_MAT;
562:     statCompZ.Mean = Z_MEAN;
563:     statCompZ.Range = Z_RANGE;
```



```
564:         statCompZ.min = Z_MIN;
565:         statCompZ.max = Z_MAX;
566:         statCompZ.Sum = Z_SUM;
567:
568:         // Simple comparison
569:         BOOST_CHECK_CLOSE(statDstZ.Mean, statCompZ.Mean, 0.5);
570:         BOOST_CHECK_CLOSE(statDstZ.Std, statCompZ.Std, 0.5);
571:         BOOST_CHECK_CLOSE((double)statDstZ.Range, (double)statCompZ.Range, 0.5);
572:         BOOST_CHECK_CLOSE((double)statDstZ.min, (double)statCompZ.min, 0.5);
573:         BOOST_CHECK_CLOSE((double)statDstZ.max, (double)statCompZ.max, 0.5);
574:         BOOST_CHECK_CLOSE((double)statDstZ.Sum, (double)statCompZ.Sum, 0.5);
575:     }
576:
577:     BOOST_FIXTURE_TEST_CASE(Vision_Convert_RGB_To_CIElab, M)
578:     {
579:         // Convert the RGB to an CIElab
580:         Vision::Conversion Test;
581:         Test.Convert(src, dst, Vision::Conversion::RGB, Vision::Conversion::CIE_lab);
582:         vector<Mat> LAB = Test.extractChannel(dst);
583:
584:         floatStat_t statDstL((float *)LAB[0].data, src.rows, src.cols);
585:         floatStat_t statCompL;
586:         statCompL.Std = L_STD;
587:         statCompL.n = N_MAT;
588:         statCompL.Mean = L_MEAN;
589:         statCompL.Range = L_RANGE;
590:         statCompL.min = L_MIN;
591:         statCompL.max = L_MAX;
592:         statCompL.Sum = L_SUM;
593:
594:         // Simple comparison
595:         BOOST_CHECK_CLOSE(statDstL.Mean, statCompL.Mean, 0.5);
596:         BOOST_CHECK_CLOSE(statDstL.Std, statCompL.Std, 0.5);
597:         BOOST_CHECK_CLOSE((double)statDstL.Range, (double)statCompL.Range, 0.5);
598:         BOOST_CHECK_CLOSE((double)statDstL.min, (double)statCompL.min, 0.5);
599:         BOOST_CHECK_CLOSE((double)statDstL.max, (double)statCompL.max, 0.5);
600:         BOOST_CHECK_CLOSE((double)statDstL.Sum, (double)statCompL.Sum, 0.5);
601:
602:         floatStat_t statDstA((float *)LAB[1].data, src.rows, src.cols);
603:         floatStat_t statCompA;
604:         statCompA.Std = A_STD;
605:         statCompA.n = N_MAT;
606:         statCompA.Mean = A_MEAN;
607:         statCompA.Range = A_RANGE;
608:         statCompA.min = A_MIN;
609:         statCompA.max = A_MAX;
610:         statCompA.Sum = A_SUM;
611:
612:         // Simple comparison
613:         BOOST_CHECK_CLOSE(statDstA.Mean, statCompA.Mean, 0.5);
614:         BOOST_CHECK_CLOSE(statDstA.Std, statCompA.Std, 0.5);
615:         BOOST_CHECK_CLOSE((double)statDstA.Range, (double)statCompA.Range, 0.5);
616:         BOOST_CHECK_CLOSE((double)statDstA.min, (double)statCompA.min, 0.5);
617:         BOOST_CHECK_CLOSE((double)statDstA.max, (double)statCompA.max, 0.5);
618:         BOOST_CHECK_CLOSE((double)statDstA.Sum, (double)statCompA.Sum, 0.5);
619:
620:         floatStat_t statDstB((float *)LAB[2].data, src.rows, src.cols);
621:         floatStat_t statCompB;
622:         statCompB.Std = B_STD;
623:         statCompB.n = N_MAT;
624:         statCompB.Mean = B_MEAN;
625:         statCompB.Range = B_RANGE;
626:         statCompB.min = B_MIN;
627:         statCompB.max = B_MAX;
628:         statCompB.Sum = B_SUM;
629:
630:         // Simple comparison
631:         BOOST_CHECK_CLOSE(statDstB.Mean, statCompB.Mean, 0.5);
632:         BOOST_CHECK_CLOSE(statDstB.Std, statCompB.Std, 0.5);
633:         BOOST_CHECK_CLOSE((double)statDstB.Range, (double)statCompB.Range, 0.5);
634:         BOOST_CHECK_CLOSE((double)statDstB.min, (double)statCompB.min, 0.5);
635:         BOOST_CHECK_CLOSE((double)statDstB.max, (double)statCompB.max, 0.5);
636:         BOOST_CHECK_CLOSE((double)statDstB.Sum, (double)statCompB.Sum, 0.5);
637:     }
638:
639:     BOOST_FIXTURE_TEST_CASE(Vision_Convert_LAB_To_RI, M)
640:     {
641:         // Convert the RGB to an CIElab
642:         Vision::Conversion Test;
643:         Test.Convert(src, src, Vision::Conversion::RGB, Vision::Conversion::CIE_lab);
644:
645:         Test.Convert(src, dst, Vision::Conversion::CIE_lab, Vision::Conversion::RI);
646:     }
```



```

647:         floatStat_t statDstRI((float *)dst.data, src.rows, src.cols);
648:         floatStat_t statCompRI;
649:         statCompRI.Std = RI_STD;
650:         statCompRI.n = N_MAT;
651:         statCompRI.Mean = RI_MEAN;
652:         statCompRI.Range = RI_RANGE;
653:         statCompRI.min = RI_MIN;
654:         statCompRI.max = RI_MAX;
655:         statCompRI.Sum = RI_SUM;
656:
657:         // Simple comparison
658:         BOOST_CHECK_CLOSE(statDstRI.Mean, statCompRI.Mean, 1.25);
659:         BOOST_CHECK_CLOSE(statDstRI.Std, statCompRI.Std, 1.25);
660:         BOOST_CHECK_CLOSE((double)statDstRI.Range, (double)statCompRI.Range, 1.25);
661:         BOOST_CHECK_CLOSE((double)statDstRI.min, (double)statCompRI.min, 1.25);
662:         BOOST_CHECK_CLOSE((double)statDstRI.max, (double)statCompRI.max, 1.25);
663:         BOOST_CHECK_CLOSE((double)statDstRI.Sum, (double)statCompRI.Sum, 1.25);
664:     }
665:
666:     BOOST_AUTO_TEST_CASE(Vision_CopyMat_3_Uchar_Channel_With_Mask)
667:     {
668:         Mat RGB_crop = imread("../ComparisionPictures/RGB_crop.ppm", 1);
669:         Mat mask = imread("../ComparisionPictures/mask.ppm", 0);
670:         Mat RGB_res = imread("../ComparisionPictures/RGB_res.ppm", 1);
671:
672:         Mat copiedMat = Vision::ImageProcessing::CopyMat<uchar>(RGB_crop, mask, CV_8UC1);
673:
674:         BOOST_CHECK_EQUAL_COLLECTIONS(copiedMat.begin<cv::Vec3b>(), copiedMat.end<cv::Vec3b>(), RGB_res.begin
in<cv::Vec3b>(), RGB_res.end<cv::Vec3b>());
675:         cv::imwrite("Copy_with_Mask.ppm", copiedMat);
676:     }
677:
678:     BOOST_AUTO_TEST_CASE(Vision_CopyMat_1_Uchar_Channel_With_Mask)
679:     {
680:         Mat Int = imread("../ComparisionPictures/RGB_crop.ppm", 0);
681:         Mat mask = imread("../ComparisionPictures/mask.ppm", 0);
682:         Mat Int_res = imread("../ComparisionPictures/RGB_res.ppm", 0);
683:
684:         Mat copiedMat = Vision::ImageProcessing::CopyMat<uchar>(Int, mask, CV_8UC1);
685:
686:         BOOST_CHECK_EQUAL_COLLECTIONS(copiedMat.begin<uchar>(), copiedMat.end<uchar>(), Int_res.begin<uchar
>(), Int_res.end<uchar>());
687:         cv::imwrite("Copy_with_Mask.ppm", copiedMat);
688:     }
689:
690:     BOOST_AUTO_TEST_CASE(Vision_CopyMat_1_Float_Channel_With_Mask)
691:     {
692:         Mat floatTest = (Mat_<float>(5, 5) <<
0.1, 0.2, 0.3, 0.4, 0.5,
1.1, 1.2, 1.3, 1.4,
1.5,
2.1, 2.2, 2.3, 2.4,
2.5,
3.1, 3.2, 3.3, 3.4,
3.5,
4.1, 4.2, 4.3, 4.4,
4.5,
5.1, 5.2, 5.3, 5.4,
5.5);
693:
694:
695:
696:
697:
698:
699:         Mat mask = (Mat_<float>(5, 5) <<
0, 0, 0, 0, 0,
0, 1, 1, 0, 0,
1, 1, 1, 1, 0,
0, 0, 0, 1, 1,
0, 0, 0, 0, 0,
0, 0, 0, 0, 0);
700:
701:
702:
703:
704:
705:
706:         Mat floatres = (Mat_<float>(5, 5) <<
0, 0, 0, 0, 0,
0, 1.2, 1.3, 0, 0,
2.1, 2.2, 2.3, 2.4,
0,
0, 0, 0, 3.4, 3.5,
0, 0, 0, 0, 0,
0, 0, 0, 0, 0);
707:
708:
709:
710:
711:
712:         Mat copiedMat = Vision::ImageProcessing::CopyMat<float>(floatTest, mask, CV_32F);
713:         BOOST_CHECK_EQUAL_COLLECTIONS(copiedMat.begin<float>(), copiedMat.end<float>(), floatres.begin<float
t>(), floatres.end<float>());
714:     }
715:
716:     BOOST_AUTO_TEST_CASE(Vision_CopyMat_With_LUT)
717:     {
718:         Mat BW_res = imread("../ComparisionPictures/mask.ppm", 0);
719:         Mat Label = imread("../ComparisionPictures/label.ppm", 0);
720:         uint8_t *LUT = new uint8_t[300]{};

```

```

721:         LUT[255] = 1;
722:
723:         Mat copiedMat = Vision::ImageProcessing::CopyMat<uint8_t, uint8_t>(Label, LUT, CV_8UC1);
724:         imwrite("copiedMat.ppm", copiedMat);
725:         BOOST_CHECK_EQUAL_COLLECTIONS(copiedMat.data, copiedMat.data + (copiedMat.rows * copiedMat.cols), B
W_res.data, BW_res.data + (BW_res.rows * BW_res.cols));
726:         delete[] LUT;
727:     }
728:
729:     BOOST_AUTO_TEST_CASE(Vision_RemoveBorder)
730:     {
731:         cv::Mat Border = imread("../ComparisionPictures/Border.ppm", 0);
732:         cv::Mat noBorderComp = imread("../ComparisionPictures/noBorder.ppm", 0);
733:
734:         Vision::Segment Test(Border);
735:         Test.RemoveBorderBlobs(1);
736:         imwrite("noBorder.ppm", Test.ProcessedImg);
737:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.data, Test.ProcessedImg.data + (Test.ProcessedImg.r
ows * Test.ProcessedImg.cols), noBorderComp.data, noBorderComp.data + (noBorderComp.rows * noBorderComp.cols));
738:     }
739:
740:     BOOST_AUTO_TEST_CASE(Vision_RemoveBorder_Chain_Event)
741:     {
742:         cv::Mat Border = imread("../ComparisionPictures/Border.ppm", 0);
743:         cv::Mat noBorderComp = imread("../ComparisionPictures/noBorder.ppm", 0);
744:         Border *= 255;
745:
746:         Vision::Segment Test(Border);
747:         Test.ConvertToBW(Vision::Segment::Bright);
748:         Test.FillHoles(true);
749:         Test.RemoveBorderBlobs(1, true);
750:         imwrite("noBorder.ppm", Test.ProcessedImg);
751:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.data, Test.ProcessedImg.data + (Test.ProcessedImg.r
ows * Test.ProcessedImg.cols), noBorderComp.data, noBorderComp.data + (noBorderComp.rows * noBorderComp.cols));
752:     }
753:
754:     BOOST_AUTO_TEST_CASE(Vision_MorphologicalFilter_Erode)
755:     {
756:         cv::Mat FilterImg = imread("../ComparisionPictures/FilterImg.ppm", 0);
757:         cv::Mat ErosionComp = imread("../ComparisionPictures/erodedResult.ppm", 0);
758:         Mat mask = imread("../ComparisionPictures/MorphMask.ppm", 0);
759:         Vision::MorphologicalFilter Test(FilterImg);
760:         Test.Erosion(mask);
761:
762:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.begin<uchar>(), Test.ProcessedImg.end<uchar>(), Ero
sionComp.begin<uchar>(), ErosionComp.end<uchar>());
763:     }
764:
765:     BOOST_AUTO_TEST_CASE(Vision_MorphologicalFilter_Dilate)
766:     {
767:         cv::Mat FilterImg = imread("../ComparisionPictures/FilterImg.ppm", 0);
768:         cv::Mat DilateComp = imread("../ComparisionPictures/DilatedResult.ppm", 0);
769:         Mat mask = imread("../ComparisionPictures/MorphMask.ppm", 0);
770:         Vision::MorphologicalFilter Test(FilterImg);
771:         Test.Dilation(mask);
772:
773:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.begin<uchar>(), Test.ProcessedImg.end<uchar>(), Dil
ateComp.begin<uchar>(), DilateComp.end<uchar>());
774:     }
775:
776:     BOOST_AUTO_TEST_CASE(Vision_MorphologicalFilter_Open)
777:     {
778:         cv::Mat FilterImg = imread("../ComparisionPictures/FilterImg.ppm", 0);
779:         cv::Mat OpenComp = imread("../ComparisionPictures/openResult.ppm", 0);
780:         Mat mask = imread("../ComparisionPictures/MorphMask.ppm", 0);
781:         Vision::MorphologicalFilter Test(FilterImg);
782:         Test.Open(mask);
783:
784:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.begin<uchar>(), Test.ProcessedImg.end<uchar>(), Ope
nComp.begin<uchar>(), OpenComp.end<uchar>());
785:     }
786:
787:     BOOST_AUTO_TEST_CASE(Vision_MorphologicalFilter_Close)
788:     {
789:         cv::Mat FilterImg = imread("../ComparisionPictures/FilterImg.ppm", 0);
790:         cv::Mat CloseComp = imread("../ComparisionPictures/closeResult.ppm", 0);
791:         Mat mask = imread("../ComparisionPictures/MorphMask.ppm", 0);
792:         Vision::MorphologicalFilter Test(FilterImg);
793:         Test.Close(mask);
794:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.begin<uchar>(), Test.ProcessedImg.end<uchar>(), Clo
seComp.begin<uchar>(), CloseComp.end<uchar>());
795:     }
796:

```

```
797: BOOST_AUTO_TEST_CASE(Vision_Segment_GetEdgesByErosion)
798: {
799:     cv::Mat BlobImg = imread("../ComparisionPictures/FilterImg.ppm", 0);
800:     cv::Mat EdgeComp = imread("../ComparisionPictures/BlobTestEdgeResult.ppm", 0);
801:
802:     Vision::Segment Test(BlobImg);
803:     Test.GetEdgesEroding();
804:     BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.begin<uchar>(), Test.ProcessedImg.end<uchar>(), Edg
eComp.begin<uchar>(), EdgeComp.end<uchar>());
805: }
806:
807: // Soil Test
808:
809: BOOST_FIXTURE_TEST_CASE(Soil_Particle_Analyze, M)
810: {
811:     SoilMath::NN nn;
812:     nn.LoadState("../ComparisionPictures/NN_Test.xml");
813:
814:     SoilAnalyzer::Sample Test(src);
815:     Test.Analyse(nn);
816:
817:     std::string filename = "SoilSample.vsa";
818:     Test.Save(filename);
819:
820:     imwrite("BW.ppm", Test.BW);
821:     // imwrite("Edge.ppm", Test.Edge);
822:
823:     //uint32_t i = 0;
824:     //for_each(Test.Population.begin(), Test.Population.end(), [&](SoilAnalyzer::Particle &p)
825:     //{
826:     //    stringstream ss_edge;
827:     //    stringstream ss_RGB;
828:     //    ss_edge << i << "_edge.ppm";
829:     //    ss_RGB << i << "_RGB.ppm";
830:     //    imwrite(ss_edge.str(), p.Edge);
831:     //    imwrite(ss_RGB.str(), p.RGB);
832:     //});
833: }
834:
835: BOOST_FIXTURE_TEST_CASE(Soil_Sample_Save_And_Load, M)
836: {
837:     SoilAnalyzer::Sample Test(src);
838:     std::string filename = "SoilSample.vsa";
839:     Test.Save(filename);
840:
841:     SoilAnalyzer::Sample TestLoad;
842:     TestLoad.Load(filename);
843:
844:     BOOST_CHECK_EQUAL_COLLECTIONS(Test.OriginalImage.data, Test.OriginalImage.data + 1000, TestLoad.Ori
ginalImage.data, TestLoad.OriginalImage.data + 1000);
845: }
846:
847: BOOST_FIXTURE_TEST_CASE(Soil_Sample_Analyze, M)
848: {
849:     //SoilAnalyzer::Sample Test(src);
850:     //Test.Analyse();
851:
852:     //imwrite("A_BW.ppm", Test.BW);
853:     //imwrite("A_Edge.ppm", Test.Edge);
854:     //imwrite("A_Int.ppm", Test.Intensity);
855:     //
856:     //for (uint32_t i = 0; i < Test.Population.size(); i++)
857:     //{
858:     //    std::stringstream ss;
859:     //    ss << i << "_BW.ppm";
860:     //    imwrite(ss.str(), Test.Population[i].BW);
861:     //    std::stringstream sss;
862:     //    sss << i << "_Edge.ppm";
863:     //    imwrite(sss.str(), Test.Population[i].Edge);
864:     //    std::stringstream ssss;
865:     //    ssss << i << "_RGB.ppm";
866:     //    imwrite(ssss.str(), Test.Population[i].RGB);
867:     //}
868: }
869:
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6:  */
7:
8:
9:
10: #include <stdint.h>
11: #include <cstdlib>
12:
13: using namespace std;
14:
15: const double meanTestResult = 127.445198;
16: const uint8_t mediaanTestResult = 128;
17: const double stdTestResult = 73.5821;
18: const uint32_t nTestResult = 40000;
19: const uint8_t modeTestResult = 173;
20: const uint8_t rangeTestResult = 255;
21: const uint32_t sumTestResult = 5097808;
22: const uint8_t minTestResult = 0;
23: const uint8_t maxTestResult = 255;
24:
25: const uint8_t histTestResult[256] =
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28: const uint8_t testMatrix[200][200] =
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44: { -0.204966058299775, 0.0859311331754255, 0.124049800003193, 0.307535159238252, -1.17421233145682, -1.6702069785047, -0.504586405514010, 0.308623139948530, 0.818551368521001, -0.723631125289073, 0.541334435719376, 0.648940737363587, 0.244474675589888, 0.317851419059697, 0.779567428734972, 0.970447788354572, 0.477227285007673, -1.22939364899916, -0.774513104760749, 0.883617136720828, 1.03928933984721, 0.194551374026050, -0.536821821287498, -0.482230718469758, 0.949274703601312, 1.58262066304722, 0.568393573839513, 0.00485442371891243, 1.14580629896864, -1.41300117247607, 0.967982891147789, 0.0939167564889651, 0.494840747422341, -0.551190610935942, 1.00482816344250, 1.08214445191656, 0.195826852819803, 0.264142905788656, 0.384828570751979, 0.550139249522149, -2.34190519391168, 1.86315963313024, -1.52064632561286, -1.62796673299559, 0.126440831034675, -0.239781704489258, 1.32309337684571, 2.05781063406419, 0.219462388420982, 0.663561179344313 },

45: { -0.124144348216312, -1.49159031063761, 1.43669662271894, -1.25711835935205, -0.192239517539275, 0.471634326416303, -1.27059444980866, -0.233860042129153, -0.292588130834394, -0.593250315010804, 0.389266203843264, -0.360076301153972, 0.808438803176791, 0.138047974449526, 0.439411111553712, -0.568569570389605, -0.0713196500274540, -0.270965129963311, -1.39327258405515, 0.435944182163725, 0.910896579458498, 0.279784956482345, -0.302032298446366, 0.647448206700766, 0.717441409444788, 2.72923012321038, -1.20602925424890, 0.436918628028167, 0.181169289545898, -0.515985900361916, 0.270145532752676, -0.951181464851560, -1.21584898482425, -0.0874088682817872, -1.92012580512738, 0.982434080192891, -0.151132402938184, 3.15852807293036, 0.325697632239670, 1.85514736069923, 1.24809514455416, 0.134026621818908, 0.671841600663500, 1.61730243170781, 0.680867794187540, 0.920985453809901, -0.517358965637976, -0.374535035425795, -0.878201101512337, 0.225782139434436 },

46: { 1.48969760778547, -0.742301837259857, -1.96089999936503, -0.865468030554804, -0.274070229932602, -1.21284719967446, -0.382584802707648, -1.05697274596013, -0.540786416488526, 0.401336339818801, 0.751228984688333, 0.705885019349416, 0.213041698417000, -0.710735074811226, -0.0896224837412097, 0.809972073318538, -0.938301288268817, -0.89950067342813, -0.386234650983645, 0.896747363054464, -0.239731286601329, 0.0512203118444502, 1.81358213090433, -1.03442471723417, 2.28782860567075, 0.303564280841044, 0.433060388963240, 1.13007271999667, 0.0542502285446183, -1.08509809672172, -0.634406535588807, 1.17258993043935, 1.59078797675859, -0.347820318259741, 0.625445779460800, -0.111443964288855, 0.892784163034418, 1.22661722851171, 1.29631036855968, -0.277298794530625, 2.80923185356508, -1.54600257382621, 0.0228442900561173, 0.264136741915250, -1.28741591386074, -0.906881378407088, 0.0243149497110560, -0.190203197452842, -2.86139975927085, -0.212843113131577 },

47: { 1.40903448980048, -1.06158173331999, -0.197698225974150, -0.176534114231451, 1.53007251442410, 0.0661900484246114, 0.64867922048621, -0.284140954626164, -0.308641815280113, 0.942133319236942, 1.77825589929100, 1.41584906843659, 0.879677164233489, 0.777003526719788, 1.02118011801418, 0.173247371832088, 0.161363534650636, -0.285686137601834, 0.525586350117865, 0.504732027944892, 0.180998079792441, -0.774466243939416, 0.914851752841074, 1.33955459790412, 0.166727663349700, -0.790258478597882, -0.0921207484997504, 0.153770741090754, 0.687753654274765, -0.707158590760918, 0.629763180328370, 1.73509586636980, 0.526475048595550, 0.993962534155598, 0.752960417782594, 1.2959578548944, -0.364190188083625, 2.32063532135348, 1.09922948349201, 1.06663077087253, -0.232184861775627, 0.433282396191631, -1.17778858625395, -1.12714618565917, 0.218084852524728, 0.144440606275470, -0.162366873553542, -0.938732410611696, 0.535555296585250, -0.0440345710123355 },

48: { 1.41719241342961, 2.35045722400204, -1.20784548525980, 0.791416061628634, -0.249024742513714, 0.652355888661374, 0.825727149241758, -0.0866902824593051, -1.09659330152547, 0.300485967595730, 1.22306255173381, -1.60451566859706, 2.03887625141404, 0.622393924172013, -0.873979465028903, -0.505542568515379, -0.268182881913388, -0.462421544353747, 1.52326927539060, -0.400897135515841, 0.244249546813347, 0.786781710402895, -0.0570807159144771, -0.969140355828830, -2.156494075169974, 0.803380232506624, -0.244054937965400, -0.758627156743334, -1.39340730198454, -0.301654545754811, -0.0792337539515894, -0.371696045350843, 0.264818591763603, 0.428436173023810, 0.213483683522705, 1.78129502150358, -0.826188688560360, 0.414497860639019, 0.653223048749175, -2.09923885099037, 0.287032146893391, 0.102954219987465, -0.334578164099747, -0.559175859035221, -1.56656707369580, 1.39640902818180, -0.605661086067383, -0.813462364383170, -0.342037309902017, 0.458181822856723 },

49: { 0.671497133608081, -0.615601881466894, 2.90800803072936, -1.33200442131525, -1.06421341288933, 0.327059967177088, -1.01494364268014, -1.46939507448636, -0.493009815316451, -0.373070658631004, -1.28325610460477, 1.02885306900203, 0.923932448688937, 0.647380884516047, 0.414700293047627, -1.19330579089020, -0.409872647756742, -0.409785214740165, 1.79849445190826, -0.513848012099214, 0.0963928845397177, 1.40890695099350, 1.30936207782942, 0.208715601272198, 1.68939930742667, -1.31990270235869, -0.219188663046641, -0.180163097123277, 1.42536573618701, -1.20044050380044, 1.37694916561229, 1.19286412868397, -0.393597890579411, -1.00418528016197, -0.770234072868573, -0.0656148757390404, 0.276011305268776, 0.211831566780286, -0.505073387271410, 0.638483769418353, -0.464604489893360, -0.570346099876642, -1.82945520860790, -0.808845156537362, 0.783281930836874, -0.189698759604886, 0.271709764009016, -0.583618751528597, -0.597858854736041, -0.441417378808432 },

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51: { 0.717238651328839, -0.192418510588264, 1.37897197791661, -1.44909729283874, 1.23467914689078, 1.00607711081905, 0.137024874130050, -0.822293276290175, 0.0458411057137050, 0.798886992156716, 0.901931466951714, 0.0474713232748285, 0.641661506421779, 1.04858076053644, 0.349254416663714, -0.353622599299341, 0.0614454835840975, 1.23329711264414, -0.320196186885630, -0.671190164007305, -0.352252185662263, 1.92775842981169, -0.348266810335265, 0.512015643736454, -0.582630964347252, 0.271866921602583, -0.320804325089082, 0.896745287933842, 0.0377646999541895, 0.340370564189367, 0.141231683307765, -1.41504453500076, -1.19565443202559, -1.04570999122494, 0.093186527774352, 0.404638157039467, -0.217506670385249, -0.527776960816186, -2.05156142183125, -0.374179299914121, -0.379827523353313, -0.707513213507977, -0.173993462313665, 0.592105269146540, 0.655324411572857, 1.94343804984731, -0.352315122780687, -0.390419817771038, -0.689680720773709, -0.155584259505827 },

52: { 1.63023528916473, 0.888610425420721, -1.05818025798736, 0.333510833065806, -0.229626450963181, -0.650907736597753, -0.291863375753573, -0.0942405879597235, -0.0637831200223327, 0.120205281956355, -1.83563868373519, 1.74625671011842, 0.425485355625296, 0.660707086367175, -0.729247267629503, 0.0464345266878230, -1.84612923609859, 0.610305217573950, 0.817516283237215, 1.18665904286638, -0.174775039544099, -0.176247547257615, 1.41256116072929, 0.0113541711008201, 0.226614480633598, 1.48955304778608, -0.784415293755632, 0.412307702040531, -0.363569288189157, -0.963230982199040, 1.28971939494037, -0.0333563180476360, 0.365328392431846, 0.505707009458752, 0.935251207390719, 0.351756753327098, 0.796122967431404, 1.24160125135253, -0.448304537939442, 0.695348326151247, -0.101778227545497

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63: { -2.94428416199490, -0.804465956349547, 0.281984063670556, 0.552783345944550, -0.507817550278174, 0.929789458557716, -0.0208576177016003, -1.03598477851339, -2.18602161274824, 1.04683278430523, 0.316500360797716, -0.760089998635267, -0.181843218459334, -0.895113135482436, -1.08695922946133, 0.497980623046732, -0.0809780150606096, 1.56508398508243, -1.23681835282285, 2.61733491205073, -1.08469845223762, -0.167559322169704, 0.636139891402968, 0.652124811269931, -0.854933633648374, 1.33728872704226, 0.598015714251220, 0.560490613996136, 0.219159093583546, 0.565059812252813, -0.838170422573186, -0.660738591146436, 0.0524291487772232, -0.386241663817012, 2.48682132029734, -0.155099375334764, -0.240370839253825, -0.222782007935513, -1.12049669501273, -0.489477981932457, -0.380699996153992, 0.494943144464081, -0.672560081842942, 2.47390028937627, -1.58682139990345, 0.0284089339182698, -0.436415217054889, 0.317575756440424, 0.00650927822731750, -0.926951533232400 },

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65: { 0.325190539456198, 0.835088165072682, -1.33367794342811, -1.11763868326521, 0.0124690413616180, -0.690361103111226, 2.17777870918415, 0.940704403352132, -1.44101359763891, 0.327678163907201, -1.03218434407217, 0.51972888133619, -0.0375331888191716, -0.160886766738443, -1.01445076770532, 0.727572036915723, -1.26256484462796, -0.449397359860250, 2.01077176753361, 0.294203684446698, 1.09892920248474, 0.717253725490156, -0.898377114100747, 0.245191593724021, -0.0909672511936310, 0.0540457844376036, -1.78073717512705, -0.153945389665798, -0.950982653969911, 2.2332772023387, 3.56986777687433, 1.50812707914556, 0.565420571160198, -0.796464226593885, -0.415927944852021, 2.24606514978483, -1.51625365102634, -1.16853089383044, 0.739062644702988, -0.622585356871510, 1.63587024814945, -1.15421883476858, -1.06996069280028, -0.822480553830570, -1.38523374102593, 0.941136788326655, 0.0846058871809478, 1.15911590583064, 0.652821094952842, 1.78482983886684 },

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67: { 1.37029854009523, 0.215670086403744, 0.350179410603312, 0.660143141046978, -0.457014640871583, 1.19210187053127, -2.49688650318450, -0.875874261956672, 1.47020128084852, 0.229596893220314, -0.418903195029849, -1.15552936828724, -2.12797676818267, -0.952635997119978, -0.325347780360491, 0.836633754476153, -0.989562679068364, -1.9919717760327, 0.308299436246859, -1.06493009609004, 2.29566581301284, -1.00586895174408, 1.59725391127757, -2.27510154234740, 1.19482381863413, -0.632706740469993, -1.71359529882238, 0.241120454779083, 0.0714298098874079, -0.0460029344953983, 1.14691785982515, -0.959284630503597, 0.0807011876263225, 0.417806430208596, 0.0892519475074891, -2.06764536263329, 0.782392865209733, -2.09947869962566, -1.53121827215908, 0.961148926751320, 0.563637584407024, 1.45253241673925, 0.411882595255150, -1.00705252750908, -0.601120319370960, -0.338241647272311, 0.900753095645828, 1.03945813330173, 0.884584173475766, 0.940411654286259 },

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75: { -0.164879019209038, -0.0824944253709554, -1.15640165566400, 1.52697668673337, -0.0845394798177242, -2.486
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.180257693987047, 0.787066676357980, 0.310508318600499, 0.853086767518578, 0.929660284419656, 0.626278997699139, -
1.16872284991455, -1.15600108495170, 0.164010316907443, 0.0781888950833453, 1.63205721592088, 0.460789425007212, -
0.725798166048959, 1.34115381887992, 0.433986613232231, 0.782334970498853, -0.534204178984686, 0.277457471578041,
2.37424855083501, -0.340284725667614, -0.535212822136925, -1.03603143787954, -0.827086376299091, -1.56502465785673
, -1.00159245598463, 0.578937985821923, -0.688841182918157, 1.63449867890992, 0.777789285588373, 0.370962258011913
, 0.244716707806350, 0.0520315567180542, 1.03749185434765, 0.0429748293046916, -0.199304020638472, 0.1235683182212
31, -0.154843838086042, 0.588137914293571, 2.26519543357233 },
76: { 0.627707287528727, -1.93302291785099, -0.533557109315987, 0.466914435684700, 1.60394635060288, 0.58117232
2675923, 0.327512120829686, 0.607600575846084, 1.63599965727829, -1.74987930638763, -0.865697308360524, 0.55085452
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575281297536, 0.0397401269892484, -0.282763714505208, 2.10662965570578, -1.53218960296576, 1.36231546434230, -0.86
6485025359612, -0.580797689400443, 0.520143592624929, 2.43658435807580, 0.242551659062315, 0.0870459144723551, -0.
233345713757840, -0.925848419891795, -0.261972173055425, -0.426962687763533, -0.831982615393436, -0.07879592366242
87, -0.555661447134641, 0.762849125807182, -0.856837606600554, -0.623493724316681, -0.548901923229815, 1.096594693
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9379550766, 1.18859467046427, 1.37793427720460, -0.0478903304637657 },
77: { 1.09326566903948, -0.438966153934773, -2.00263573588306, -0.209713338388737, 0.0983477746401080, -2.19243
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0183950434961, -0.450598603707587, 1.15216580794839, -0.715847393133824, -1.33685240472023, 0.451874567380709, -0.
421846780441972, 0.875135601991687, -1.09224451734164, 0.302407416537707, -0.100647949072058, 0.173593051437428, 0
.403880739292361, 0.00532168979485395, -1.09541491865986, 0.0776686794320303, 0.497899500583305, -0.94179196906103
5, -1.35155634252200, -1.18212703394540, 0.0483900176597465, -1.35010016594322, -0.126011360116434, -0.39816310715
5080, -1.28940788194516, 1.01414104094213, 0.618953085869227, 0.541608366255458, -0.847371160164792, 0.75416580828
2410, -0.414907279235850, 1.85120493279698, -1.55186406853224 },
78: { 1.10927329761440, -1.79467884145512, 0.964229422631628, 0.625190357087626, 0.0413736134896147, -2.3192803
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66003560, -0.378157056589758, -0.892661403477038, -1.63054289274725, 2.13850225382851, 0.405605372640549, -0.59364
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66324280616, 1.39544988693277, -0.225794451802544, 0.0583198538886379, -1.62504844947823, 0.453591153371088, 1.192
46859933815, 1.13914949095078, 0.549233489827528, 1.79093025896060, 2.31562610334450, -0.652861505816215, 0.364211
322734809, 0.583847690104213, -0.664853402867584, -1.16224097904506, 0.299580407299929, -0.0854625512885032, 0.057
5636417288340, -0.0843484107867966, 1.80306351071647, -0.821128258718891, 1.33723804312817, 1.52449750573379, -0.6
58616762511396, -1.89766476744468, 0.444083312031626 }};

79:

80:


```
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6:  */
7:
8:
9:
10: // Comparison values
11: #define N_MAT 3145728
12:
13: #define L_STD 5.028381605997681
14: #define L_MEAN 80.890745699097508
15: #define L_RANGE 79.936077729332197
16: #define L_MIN 16.742040567344091
17: #define L_MAX 96.678118296676288
18: #define L_SUM 2.544602836865306e8
19:
20: #define A_STD 0.866299119209983
21: #define A_MEAN -3.380512963778564
22: #define A_RANGE 28.974365656143501
23: #define A_MIN -21.293453236190196
24: #define A_MAX 7.680912419953306
25: #define A_SUM -0.106341742845212e8
26:
27: #define B_STD 1.582722966505156
28: #define B_MEAN -14.069966616731605
29: #define B_RANGE 52.152618100375619
30: #define B_MIN -49.577771326645184
31: #define B_MAX 2.574846773730433
32: #define B_SUM -0.442602879453179e8
33:
34: #define X_STD 0.063845026292892
35: #define X_MEAN 0.544538411135235
36: #define X_RANGE 0.783231866666667
37: #define X_MIN 0.019708690196078
38: #define X_MAX 0.802940556862745
39: #define X_SUM 1.712969726983621e6
40:
41: #define Y_STD 0.068325856701040
42: #define Y_MEAN 0.586997317935942
43: #define Y_RANGE 0.894038392156863
44: #define Y_MIN 0.022487607843137
45: #define Y_MAX 0.916526000000000
46: #define Y_SUM 1.846533898955995e6
47:
48: #define Z_STD 0.097003939083143
49: #define Z_MEAN 0.814970278082424
50: #define Z_RANGE 1.032072011764706
51: #define Z_MIN 0.048455952941176
52: #define Z_MAX 1.080527964705882
53: #define Z_SUM 2.563674822931669e6
54:
55: #define RI_STD 0.215470901001717
56: #define RI_MEAN -0.061338583528514
57: #define RI_RANGE 1.861278665280243e2
58: #define RI_MIN -1.210658478499890e2
59: #define RI_MAX 65.062018678035301
60: #define RI_SUM -1.929544996859839e5
```

```

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5:  * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6:  */
7:
8:
9:  #include "testparticlegenerator.h"
10:
11:
12:  TestParticleGenerator::TestParticleGenerator()
13:  {
14:  }
15:
16:  cv::Mat TestParticleGenerator::GenParticle(uint32_t size, float ellipseratio, cv::Vec3b meanColor, cv::Vec3
f stdColor, float roughness, float angle)
17:  {
18:      uint32_t height, width;
19:      height =
20:          cv::Mat img(x ? x : y, );
21:          cv::ellipse(img, cv::Point(img.cols/2, img.rows/2), cv::Size(size, size * ellipseratio), angle, 0 360,
cv::Scalar(1,1,1), -1);
22:
23:  }
```

```

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6:  */
7:
8:
9:
10: #ifndef TESTPARTICLEGENERATOR_GLOBAL_H
11: #define TESTPARTICLEGENERATOR_GLOBAL_H
12:
13: #include <QtCore/qglobal.h>
14:
15: #if defined(TESTPARTICLEGENERATOR_LIBRARY)
16: #   define TESTPARTICLEGENERATORSHARED_EXPORT Q_DECL_EXPORT
17: #else
18: #   define TESTPARTICLEGENERATORSHARED_EXPORT Q_DECL_IMPORT
19: #endif
20:
21: #endif // TESTPARTICLEGENERATOR_GLOBAL_H

```

```

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5:  * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6:  */
7:
8:
9:
10: #ifndef TESTPARTICLEGENERATOR_H
11: #define TESTPARTICLEGENERATOR_H
12:
13: #include "testparticlegenerator_global.h"
14: #include <opencv2/core.hpp>
15: #include <vector>
16: #include <stdint.h>
17:
18: class TESTPARTICLEGENERATORSHARED_EXPORT TestParticleGenerator
19: {
20:
21:
22: public:
23:     std::vector<cv::Mat> particles;
24:     TestParticleGenerator();
25:     cv::Mat GenParticle(uint32_t size, float ellipseratio, cv::Vec3b meanColor, cv::Vec3f stdColor, float roughness, float angle);
26: };
27:
28: #endif // TESTPARTICLEGENERATOR_H

```