## Objects Properties

| Properties | Ball | Bat | Table | Arm and Hand |
|---|---|---|---|---|
| Composition | One single group of pixels | 2 groups of pixels | 2 groups of pixels | Multiple groups of pixels |
| Size | Small/Medium | Medium | Large | Large and Small |
| Orientation | Multiple | Multiple | Straight | Multiple |
| Elongation | Not elongated | Long | Very long | Multiple |
| Intensity | Values close to 0 | High values near 1 | Contrasted 0/1 | Contrasted 0/1 |
| Contrast with background | Very high | High | Very high | Very high |
| Shape | Round | Round and Straight | Straight | Complex |
| Colour | White | Red on top but the side is black | Green but the edges are white | Red, black and skin-like colour |

## Ball and Bat positions - Test Results

| | Images | X-Estimated Positions | Y-Estimated Positions | X-Real Positions | Y-Real Positions | X Error (%) | Y Error (%) |
|---|---|---|---|---|---|---|---|
| Ball | 0 | 145 | 55 | 143 | 55 | 0.57% | 0% |
| | 1 | 143 | 40 | 142 | 42 | 0.29% | 0.83% |
| | 2 | 143 | 29 | 141 | 31 | 0.57% | 0.83% |
| | 3 | 140 | 23 | 140 | 24 | 0% | 0.42% |
| | 4 | 138 | 21 | 140 | 21 | 0.57% | 0% |
| | 5 | 138 | 23 | 139 | 23 | 0.29% | 0% |
| | 6 | 137 | 29 | 137 | 30 | 0% | 0.42% |
| | 7 | 136 | 40 | 136 | 42 | 0% | 0.83% |
| | 8 | 134 | 56 | 134 | 59 | 0% | 1.25% |
| | 9 | 133 | 77 | 133 | 81 | 0% | 1.67% |
| | 10 | 133 | 102 | 131 | 112 | 0.57% | 4.17% |
| | 11 | 131 | 130 | 131 | 135 | 0% | 2.08% |
| | 12 | 133 | 100 | 132 | 105 | 0.29% | 2.08% |
| | 13 | 132 | 74 | 131 | 79 | 0.29% | 2.08% |
| | 14 | 132 | 52 | 133 | 55 | 0.29% | 1.25% |
| | 15 | 135 | 34 | 134 | 36 | 0.29% | 0.83% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 16 | 134 | 21 | 135 | 22 | 0.29% | 0.42% |
| | 17 | 137 | 12 | 135 | 13 | 0.57% | 0.42% |
| | 18 | 137 | 8 | 135 | 9 | 0.57% | 0.42% |
| | 19 | 134 | 9 | 136 | 9 | 0.57% | 0% |
| | 20 | 137 | 12 | 136 | 13 | 0.29% | 0.42% |
| Bat | 0 | 111 | 151 | 111 | 149 | 0% | 0.83% |
| | 1 | 111 | 153 | 111 | 149 | 0% | 1.67% |
| | 2 | 111 | 159 | 113 | 153 | 0.57% | 2.5% |
| | 3 | 112 | 164 | 113 | 159 | 0.29% | 2.08% |
| | 4 | 113 | 168 | 115 | 163 | 0.57% | 2.08% |
| | 5 | 113 | 173 | 115 | 167 | 0.57% | 2.5% |
| | 6 | 112 | 175 | 113 | 171 | 0.29% | 1.67% |
| | 7 | 110 | 175 | 111 | 171 | 0.29% | 1.67% |
| | 8 | 108 | 174 | 109 | 169 | 0.29% | 2.08% |
| | 9 | 106 | 169 | 107 | 165 | 0.29% | 2.5% |
| | 10 | 104 | 163 | 105 | 159 | 0.29% | 2.5% |
| | 11 | 103 | 154 | 103 | 151 | 0% | 1.25% |
| | 12 | 102 | 148 | 103 | 143 | 0.29% | 2.08% |
| | 13 | 101 | 143 | 103 | 139 | 0.57% | 1.67% |
| | 14 | 101 | 143 | 103 | 139 | 0.57% | 1.67% |
| | 15 | 102 | 145 | 103 | 141 | 0.29% | 1.67% |
| | 16 | 102 | 152 | 105 | 147 | 0.86% | 2.08% |
| | 17 | 103 | 158 | 105 | 153 | 0.57% | 2.08% |
| | 18 | 105 | 164 | 105 | 161 | 0% | 1.25% |
| | 19 | 105 | 171 | 105 | 165 | 0% | 2.5% |
| | 20 | 106 | 174 | 107 | 169 | 0.29% | 2.08% |

**Ball:**

Total Error in X = 0.29%

Total Error in Y = 1.02%

**Bat:**

Total Error in X = 0.37%

Total Error in Y = 1.98%

—> with Total Error = Sum/21

$$S = \sqrt{(V_x)^2 + (V_y)^2} \times 0.248 \times 25$$

Distance = $(coordinate_{i+1} - coordinate_i) * (68.47/18.02) = (coordinate_{i+1} - coordinate_i) * 3.8$

$$\text{Error in X} = \frac{X_{\text{real position}} - X_{\text{estimated position}}}{X_{max}} \times 100$$

$$\text{Error in Y} = \frac{Y_{\text{real position}} - Y_{\text{estimated position}}}{Y_{max}} \times 100$$

| | Images | X-Estimated Positions | Y-Estimated Positions | X-Real Positions | Y-Real Positions | X Error (%) | Y Error (%) |
|---|---|---|---|---|---|---|---|
| Ball | 21 | 141 | 28 | 140 | 30 | 0.284 | 0.833 |
| | 22 | 141 | 42 | 140 | 43 | 0.284 | 0.417 |
| | 23 | 142 | 61 | 141 | 61 | 0.284 | 0.000 |
| | 24 | 142 | 85 | 142 | 85 | 0.000 | 0.000 |
| | 25 | 143 | 114 | 142 | 115 | 0.284 | 0.417 |
| | 26 | 144 | 142 | 143 | 144 | 0.284 | 0.833 |
| | 27 | 143 | 116 | 142 | 116 | 0.284 | 0.000 |
| | 28 | 143 | 92 | 143 | 91 | 0.000 | 0.417 |
| | 29 | 143 | 72 | 142 | 72 | 0.284 | 0.000 |
| | 30 | 143 | 57 | 142 | 58 | 0.284 | 0.417 |
| | 31 | 143 | 46 | 142 | 48 | 0.284 | 0.833 |
| | 32 | 143 | 40 | 142 | 41 | 0.284 | 0.417 |
| | 33 | 143 | 38 | 142 | 40 | 0.284 | 0.833 |
| | 34 | 143 | 40 | 142 | 42 | 0.284 | 0.833 |
| | 35 | 143 | 47 | 142 | 48 | 0.284 | 0.417 |
| | 36 | 143 | 57 | 142 | 57 | 0.284 | 0.000 |
| | 37 | 143 | 71 | 142 | 71 | 0.284 | 0.000 |
| | 38 | 143 | 88 | 143 | 88 | 0.000 | 0.000 |
| | 39 | 144 | 108 | 143 | 108 | 0.284 | 0.000 |
| | 40 | 144 | 131 | 143 | 132 | 0.284 | 0.417 |
| | 41 | 144 | 128 | 144 | 128 | 0.000 | 0.000 |
| | 42 | 145 | 108 | 144 | 107 | 0.284 | 0.417 |
| | 43 | 146 | 91 | 145 | 91 | 0.284 | 0.000 |
| | 44 | 146 | 78 | 145 | 78 | 0.284 | 0.000 |
| | 45 | 147 | 69 | 146 | 70 | 0.284 | 0.417 |
| | 46 | 147 | 63 | 145 | 59 | 0.568 | 1.667 |
| | 47 | 148 | 61 | 147 | 62 | 0.284 | 0.417 |
| | 48 | 148 | 61 | 147 | 62 | 0.284 | 0.417 |
| | 49 | 148 | 65 | 148 | 66 | 0.000 | 0.417 |
| | 50 | 149 | 71 | 148 | 72 | 0.284 | 0.417 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 51 | 149 | 80 | 149 | 80 | 0.000 | 0.000 |
| 52 | 150 | 91 | 149 | 91 | 0.284 | 0.000 |
| 53 | 151 | 104 | 149 | 104 | 0.568 | 0.000 |
| 54 | 161 | 122 | 150 | 118 | 3.125 | 1.667 |
| 55 | 158 | 126 | 149 | 131 | 2.557 | 2.083 |
| 56 | 161 | 124 | 148 | 130 | 3.693 | 2.500 |
| 57 | 164 | 123 | 152 | 131 | 3.409 | 3.333 |
| 58 | 165 | 122 | 154 | 130 | 3.125 | 3.333 |
| 59 | 167 | 123 | 156 | 128 | 3.125 | 2.083 |
| 60 | 166 | 122 | 156 | 126 | 2.841 | 1.667 |
| 61 | 169 | 119 | 159 | 123 | 2.841 | 1.667 |
| 62 | 167 | 116 | 160 | 120 | 1.989 | 1.667 |
| 63 | 162 | 113 | 161 | 115 | 0.284 | 0.833 |
| 64 | 163 | 109 | 161 | 107 | 0.568 | 0.833 |
| 65 | 165 | 100 | 163 | 100 | 0.568 | 0.000 |
| 66 | 167 | 92 | 166 | 92 | 0.284 | 0.000 |
| 67 | 176 | 85 | 169 | 85 | 1.989 | 0.000 |
| 68 | 182 | 82 | 171 | 82 | 3.125 | 0.000 |
| 69 | 175 | 79 | 173 | 79 | 0.568 | 0.000 |
| 70 | 176 | 78 | 175 | 79 | 0.284 | 0.417 |
| 71 | 178 | 79 | 177 | 80 | 0.284 | 0.417 |
| 72 | 180 | 82 | 179 | 83 | 0.284 | 0.417 |
| 73 | 182 | 86 | 181 | 87 | 0.284 | 0.417 |
| 74 | 183 | 92 | 182 | 92 | 0.284 | 0.000 |
| 75 | 185 | 99 | 184 | 99 | 0.284 | 0.000 |
| 76 | 186 | 107 | 184 | 107 | 0.568 | 0.000 |
| 77 | 177 | 117 | 172 | 119 | 1.420 | 0.833 |
| 78 | 158 | 129 | 152 | 132 | 1.705 | 1.250 |
| 79 | 158 | 129 | 138 | 143 | 5.682 | 5.833 |
| 80 | 158 | 129 | 114 | 161 | 12.500 | 13.333 |
| 81 | 158 | 129 | 98 | 156 | 17.045 | 11.250 |
| 82 | 158 | 129 | 78 | 152 | 22.727 | 9.583 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 83 | 158 | 129 | 60 | 151 | 27.841 | 9.167 |
| | 84 | 158 | 129 | 46 | 152 | 31.818 | 9.583 |
| | 85 | 158 | 129 | 21 | 155 | 38.920 | 10.833 |
| | 86 | 158 | 129 | 10 | 157 | 42.045 | 11.667 |
| | 87 | 158 | 129 | Out of Screen | Out of Screen | Out of Screen | Out of Screen |
| | 88 | 158 | 129 | Out of Screen | Out of Screen | Out of Screen | Out of Screen |
| Bat | 21 | 152 | 176 | 146 | 169 | 1.7 | 2.9 |
| | 22 | 153 | 177 | 145 | 170 | 2.3 | 2.9 |
| | 23 | 151 | 177 | 144 | 169 | 2.0 | 3.3 |
| | 24 | 152 | 174 | 143 | 168 | 2.6 | 2.5 |
| | 25 | 154 | 170 | 142 | 164 | 3.4 | 2.5 |
| | 26 | 155 | 165 | 143 | 157 | 3.4 | 3.3 |
| | 27 | 154 | 159 | 144 | 151 | 2.8 | 3.3 |
| | 28 | 153 | 155 | 143 | 147 | 2.8 | 3.3 |
| | 29 | 152 | 154 | 144 | 147 | 2.3 | 2.9 |
| | 30 | 154 | 155 | 145 | 149 | 2.6 | 2.5 |
| | 31 | 155 | 159 | 146 | 152 | 2.6 | 2.9 |
| | 32 | 155 | 162 | 148 | 156 | 2.0 | 2.5 |
| | 33 | 156 | 165 | 148 | 159 | 2.3 | 2.5 |
| | 34 | 157 | 167 | 149 | 161 | 2.3 | 2.5 |
| | 35 | 157 | 168 | 149 | 162 | 2.3 | 2.5 |
| | 36 | 157 | 167 | 149 | 162 | 2.3 | 2.1 |
| | 37 | 156 | 166 | 149 | 161 | 2.0 | 2.1 |
| | 38 | 156 | 164 | 148 | 159 | 2.3 | 2.1 |
| | 39 | 156 | 162 | 147 | 156 | 2.6 | 2.5 |
| | 40 | 156 | 157 | 146 | 152 | 2.8 | 2.1 |
| | 41 | 161 | 152 | 147 | 147 | 4.0 | 2.1 |
| | 42 | 164 | 147 | 148 | 141 | 4.5 | 2.5 |
| | 43 | 164 | 143 | 153 | 137 | 3.1 | 2.5 |
| | 44 | 165 | 140 | 157 | 136 | 2.3 | 1.7 |
| | 45 | 181 | 146 | 161 | 137 | 5.7 | 3.8 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 46 | 193 | 154 | 167 | 143 | 7.4 | 4.6 |
| 47 | 193 | 154 | 175 | 151 | 5.1 | 1.3 |
| 48 | 190 | 169 | 184 | 159 | 1.7 | 4.2 |
| 49 | 190 | 169 | 188 | 166 | 0.6 | 1.3 |
| 50 | 198 | 174 | 193 | 172 | 1.4 | 0.8 |
| 51 | 203 | 175 | 197 | 174 | 1.7 | 0.4 |
| 52 | 218 | 170 | 204 | 175 | 4.0 | 2.1 |
| 53 | 218 | 171 | 206 | 176 | 3.4 | 2.1 |
| 54 | 231 | 163 | 201 | 174 | 8.5 | 4.6 |
| 55 | 231 | 163 | 209 | 171 | 6.3 | 3.3 |
| 56 | 226 | 164 | 212 | 168 | 4.0 | 1.7 |
| 57 | 227 | 161 | 215 | 164 | 3.4 | 1.3 |
| 58 | 228 | 157 | 217 | 159 | 3.1 | 0.8 |
| 59 | 219 | 152 | 219 | 151 | 0.0 | 0.4 |
| 60 | 221 | 143 | 221 | 142 | 0.0 | 0.4 |
| 61 | 223 | 135 | 222 | 132 | 0.3 | 1.3 |
| 62 | 226 | 127 | 225 | 123 | 0.3 | 1.7 |
| 63 | 229 | 120 | 229 | 117 | 0.0 | 1.3 |
| 64 | 224 | 93 | 228 | 97 | 1.1 | 1.7 |
| 65 | 226 | 87 | 227 | 87 | 0.3 | 0.0 |
| 66 | 228 | 83 | 229 | 83 | 0.3 | 0.0 |
| 67 | 228 | 79 | 228 | 79 | 0.0 | 0.0 |
| 68 | 227 | 76 | 227 | 76 | 0.0 | 0.0 |
| 69 | 226 | 75 | 225 | 74 | 0.3 | 0.4 |
| 70 | 222 | 75 | 222 | 76 | 0.0 | 0.4 |
| 71 | 218 | 78 | 218 | 78 | 0.0 | 0.0 |
| 72 | 213 | 82 | 213 | 82 | 0.0 | 0.0 |
| 73 | 208 | 87 | 208 | 86 | 0.0 | 0.4 |
| 74 | 203 | 92 | 202 | 92 | 0.3 | 0.0 |
| 75 | 196 | 99 | 197 | 99 | 0.3 | 0.0 |
| 76 | 190 | 107 | 190 | 107 | 0.0 | 0.0 |
| 77 | 183 | 118 | 182 | 117 | 0.3 | 0.4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 78 | 178 | 126 | 178 | 125 | 0.0 | 0.4 |
| 79 | 179 | 129 | 178 | 130 | 0.3 | 0.4 |
| 80 | 179 | 128 | 179 | 128 | 0.0 | 0.0 |
| 81 | 185 | 126 | 181 | 125 | 1.1 | 0.4 |
| 82 | 182 | 122 | 182 | 122 | 0.0 | 0.0 |
| 83 | 184 | 118 | 184 | 118 | 0.0 | 0.0 |
| 84 | 187 | 115 | 186 | 115 | 0.3 | 0.0 |
| 85 | 192 | 115 | 189 | 113 | 0.9 | 0.8 |
| 86 | 191 | 112 | 191 | 114 | 0.0 | 0.8 |
| 87 | 192 | 113 | 192 | 114 | 0.0 | 0.4 |
| 88 | 194 | 115 | 194 | 115 | 0.0 | 0.0 |
| | | | | **Error Ball** | 3.7 | 1.8 |
| | | | | **Error Bat** | 1.8 | 1.6 |

| | Images | Areas (pixels) | Perimeter (pixels) |
|---|---|---|---|
| Bat | 21 | A = 358 | P = 183 |
| | 22 | A = 360 | P = 180 |
| | 23 | A = 348 | P = 183 |
| | 24 | A = 308 | P = 175 |
| | 25 | A = 273 | P = 175 |
| | 26 | A = 262 | P = 170 |
| | 27 | A = 263 | P = 171 |
| | 28 | A = 316 | P = 169 |
| | 29 | A = 321 | P = 167 |
| | 30 | A = 316 | P = 165 |
| | 31 | A = 300 | P = 162 |
| | 32 | A = 287 | P = 163 |
| | 33 | A = 283 | P = 160 |
| | 34 | A = 286 | P = 163 |
| | 35 | A = 274 | P = 153 |
| | 36 | A = 254 | P = 155 |
| | 37 | A = 230 | P = 144 |
| | 38 | A = 221 | P = 140 |
| | 39 | A = 195 | P = 134 |
| | 40 | A = 179 | P = 128 |
| | 41 | A = 125 | P = 105 |
| | 42 | A = 130 | P = 101 |
| | 43 | A = 136 | P = 115 |
| | 44 | A = 151 | P = 103 |
| | 45 | A = 291 | P = 155 |
| | 46 | A = 114 | P = 70 |
| | 47 | A = 19 | P = 20 |
| | 48 | A = 78 | P = 82 |

| | | |
|---|---|---|
| 49 | A = 922 | P = 344 |
| 50 | A = 168 | P = 102 |
| 51 | A = 190 | P = 113 |
| 52 | A = 503 | P = 169 |
| 53 | A = 606 | P = 215 |
| 54 | A = 1128 | P = 267 |
| 55 | | |
| 56 | A = 1197 | P = 290 |
| 57 | A = 1191 | P = 240 |
| 58 | A = 1042 | P = 205 |
| 59 | A = 666 | P = 94 |
| 60 | A = 592 | P = 101 |
| 61 | A = 396 | P = 83 |
| 62 | A = 176 | P = 56 |
| 63 | Bracelet is closer | |
| 64 | Bracelet is closer | |
| 65 | A = 105 | P = 37 |
| 66 | A = 151 | P = 45 |
| 67 | A = 158 | P = 49 |
| 68 | A = 148 | P = 50 |
| 69 | A = 142 | P = 58 |
| 70 | A = 116 | P = 43 |
| 71 | A = 133 | P = 46 |
| 72 | A = 143 | P = 45 |
| 73 | A = 146 | P = 46 |
| 74 | A = 162 | P = 47 |
| 75 | A = 185 | P = 51 |
| 76 | A = 182 | P = 66 |
| 77 | A = 232 | P = 94 |
| 78 | A = 355 | P = 67 |
| 79 | A = 409 | P = 95 |
| 80 | A = 382 | P = 76 |

| | | |
|---|---|---|
| 81 | A = 442 | P = 133 |
| 82 | A = 335 | P = 69 |
| 83 | A = 336 | P = 76 |
| 84 | A = 331 | P = 72 |
| 85 | A = 401 | P = 145 |
| 86 | A = 324 | P = 67 |
| 87 | A = 312 | P = 67 |
| 88 | A = 265 | P = 56 |