جدول5-2. بررسی نقش پارامترهای مختلف $α\_{2}$ و $α\_{1}$ در میزان SNRروش QBEH

|  |  |  |
| --- | --- | --- |
| SNR | α2 | α1 |
| 37.63 | 0.04 | 0.02 |
| 38.94 | 0.03 | 0.01 |
| 38.95 | 0.01 | 0.03 |
| 43.56 | 0.02 | 0.01 |
| 44.44 | 0.02 | 0.02 |
| 50.46 | 0.01 | 0.01 |
| 63.65 | 0.002 | 0.001 |
| 70.46 | 0.001 | 0.001 |

جدول5-3. بررسی نقش پارامترهای $α\_{2}$ و $α\_{1}$ نسبت به $d\_{1}$ و $d\_{0}$ در میزان SNRروش QBEH

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SNR | α2 | α1 | d1 | d0 |
| 37.63 | 0.04 | 0.02 | 4 | 2 |
| 34.97 | 0.04 | 0.02 | 6 | 2 |
| 32.96 | 0.04 | 0.02 | 10 | 2 |
| 44.44 | 0.02 | 0.02 | 4 | 2 |
| 39.65 | 0.02 | 0.02 | 6 | 2 |
| 36.96 | 0.02 | 0.02 | 10 | 2 |
| 64.44 | 0.002 | 0.002 | 4 | 2 |
| 59.65 | 0.002 | 0.002 | 6 | 2 |
| 56.96 | 0.002 | 0.002 | 10 | 2 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| QBEH | QSEH | QLSB[35] | QLSB[36] | cLSQ3 | cLSQ2 | cLSQ1 | Method |
| 70.46 | 61.60 | 41.62 | 58.87 | 44.19 | 51.60 | 55.86 | **Data1** |
| 79.34 | 61.79 | 54.20 | 58.60 | 47.80 | 51.61 | 58.60 | **Data2** |
| 74.87 | 61.72 | 55.12 | 57.46 | 43.87 | 51.44 | 58.13 | **Data3** |
| 75.94 | 61.52 | 56.98 | 58.07 | 46.03 | 54.48 | 57.49 | **Data4** |
| 68.70 | 62.25 | 54.00 | 58.77 | 44.96 | 51.50 | 58.10 | **Data5** |
| 68.44 | 61.76 | 51.61 | 57.63 | 45.59 | 49.65 | 57.63 | **Data6** |
| 67.28 | 61.87 | 55.36 | 57.79 | 45.24 | 53.02 | 56.82 | **Data7** |
| 70.46 | 61.60 | 53.31 | 55.35 | 44.86 | 50.88 | 54.56 | **Data8** |

جدول5-4. مقایسه پارامتر SNR دو رویکرد پیشنهادی با سایر روش های نهان نگاری کوانتومی

جدول5-5.مقایسه نتایج تاثیر flip noise برروی بیت LSB دوررویکرد پیشنهادی باسایرروش­های کوانتومی

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| QBEH | QSEH | QLSB[35] | QLSB[36] | cLSQ3[23] | cLSQ2[23] | cLSQ1[23] | 1-p | DataName |
| 0.000 | 0.000 | 0.006 | 0.006 | 0.000 | 0.000 | 0.011 | 0.01 | Data1 |
| 0.000 | 0.000 | 0.009 | 0.013 | 0.000 | 0.000 | 0.023 | 0.02 |  |
| 0.000 | 0.000 | 0.039 | 0.041 | 0.000 | 0.000 | 0.048 | 0.05 |  |
| 0.000 | 0.000 | 0.085 | 0.085 | 0.000 | 0.000 | 0.092 | 0.1 |  |
| 0.000 | 0.000 | 0.170 | 0.183 | 0.000 | 0.000 | 0.190 | 0.2 |  |
| 0.000 | 0.000 | 0.207 | 0.292 | 0.000 | 0.000 | 0.291 | 0.3 |  |
| 0.000 | 0.000 | 0.003 | 0.007 | 0.000 | 0.000 | 0.006 | 0.01 | Data2 |
| 0.000 | 0.000 | 0.009 | 0.015 | 0.000 | 0.000 | 0.012 | 0.02 |  |
| 0.000 | 0.000 | 0.022 | 0.045 | 0.000 | 0.000 | 0.046 | 0.05 |  |
| 0.000 | 0.000 | 0.046 | 0.080 | 0.000 | 0.000 | 0.088 | 0.1 |  |
| 0.001 | 0.000 | 0.115 | 0.182 | 0.000 | 0.000 | 0.179 | 0.2 |  |
| 0.006 | **0.001** | 0.153 | 0.277 | 0.000 | 0.000 | 0.220 | 0.3 |  |
| 0.000 | 0.000 | 0.003 | 0.007 | 0.000 | 0.000 | 0.009 | 0.01 | Data3 |
| 0.000 | 0.000 | 0.008 | 0.013 | 0.000 | 0.000 | 0.016 | 0.02 |  |
| 0.000 | 0.000 | 0.025 | 0.043 | 0.000 | 0.000 | 0.038 | 0.05 |  |
| 0.000 | 0.0006 | 0.045 | 0.091 | 0.000 | 0.000 | 0.089 | 0.1 |  |
| 0.000 | 0.001 | 0.100 | 0.180 | 0.000 | 0.000 | 0.188 | 0.2 |  |
| 0.000 | 0.005 | 0.153 | 0.296 | 0.000 | 0.000 | 0.276 | 0.3 |  |
| 0.000 | 0.000 | 0.004 | 0.006 | 0.000 | 0.000 | 0.000 | 0.01 | Data4 |
| 0.000 | 0.000 | 0.011 | 0.013 | 0.000 | 0.000 | 0.000 | 0.02 |  |
| 0.000 | 0.000 | 0.025 | 0.040 | 0.000 | 0.000 | 0.000 | 0.03 |  |
| 0.000 | 0.000 | 0.056 | 0.093 | 0.000 | 0.000 | 0.000 | 0.1 |  |
| 0.000 | 0.000 | 0.123 | 0.193 | 0.000 | 0.000 | 0.000 | 0.2 |  |
| 0.000 | 0.000 | 0.182 | 0.294 | 0.000 | 0.000 | 0.000 | 0.3 |  |
| 0.000 | 0.000 | 0.001 | 0.007 | 0.000 | 0.000 | 0.006 | 0.01 | Data5 |
| 0.000 | 0.000 | 0.005 | 0.015 | 0.000 | 0.000 | 0.017 | 0.02 |  |
| 0.000 | 0.000 | 0.025 | 0.035 | 0.000 | 0.000 | 0.043 | 0.05 |  |
| 0.000 | 0.000 | 0.048 | 0.099 | 0.000 | 0.000 | 0.088 | 0.1 |  |
| 0.000 | 0.000 | 0.105 | 0.187 | 0.000 | 0.000 | 0.171 | 0.2 |  |
| 0.000 | 0.000 | 0.161 | 0.280 | 0.000 | 0.000 | 0.285 | 0.3 |  |
| 0.000 | 0.000 | 0.001 | 0.005 | 0.000 | 0.000 | 0.008 | 0.01 | Data6 |
| 0.000 | 0.000 | 0.006 | 0.015 | 0.000 | 0.000 | 0.016 | 0.02 |  |
| 0.000 | 0.000 | 0.018 | 0.044 | 0.000 | 0.000 | 0.043 | 0.05 |  |
| 0.000 | 0.000 | 0.036 | 0.089 | 0.000 | 0.000 | 0.078 | 0.1 |  |
| 0.000 | 0.000 | 0.081 | 0.178 | 0.000 | 0.000 | 0.183 | 0.2 |  |
| 0.000 | 0.000 | 0.122 | 0.275 | 0.000 | 0.000 | 0.278 | 0.3 |  |
| 0.000 | 0.000 | 0.003 | 0.005 | 0.000 | 0.000 | 0.005 | 0.01 | Data7 |
| 0.000 | 0.000 | 0.008 | 0.015 | 0.000 | 0.000 | 0.013 | 0.02 |  |
| 0.000 | 0.000 | 0.023 | 0.046 | 0.000 | 0.000 | 0.043 | 0.05 |  |
| 0.000 | 0.000 | 0.046 | 0.088 | 0.000 | 0.000 | 0.090 | 0.1 |  |
| 0.000 | 0.000 | 0.096 | 0.185 | 0.000 | 0.000 | 0.189 | 0.2 |  |
| 0.000 | 0.000 | 0.153 | 0.278 | 0.000 | 0.000 | 0.278 | 0.3 |  |
| 0.000 | 0.000 | 0.001 | 0.009 | 0.000 | 0.000 | 0.006 | 0.01 | Data8 |
| 0.000 | 0.000 | 0.009 | 0.011 | 0.000 | 0.000 | 0.013 | 0.02 |  |
| 0.000 | 0.000 | 0.026 | 0.047 | 0.000 | 0.000 | 0.041 | 0.05 |  |
| 0.000 | 0.000 | 0.056 | 0.091 | 0.000 | 0.000 | 0.094 | 0.1 |  |
| 0.000 | 0.000 | 0.108 | 0.185 | 0.000 | 0.000 | 0.195 | 0.2 |  |
| 0.000 | 0.000 | 0.185 | 0.286 | 0.000 | 0.000 | 0.279 | 0.3 |  |

جدول 5-6. مقایسه نتایج تاثیر حمله صفربرLSB در دوررویکرد پیشنهادی باسایرروش­های کوانتومی

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| QBEH | QSEH | QLSB[35] | QLSB[36] | cLSQ3[23] | cLSQ2[23] | cLSQ1[23] | 1-p | Data/flipnoise |
| 0.000 | 0.000 | 0.001 | 0.001 | 0.000 | 0.000 | 0.004 | 0.01 | Data1 |
| 0.000 | 0.000 | 0.004 | 0.004 | 0.000 | 0.000 | 0.008 | 0.02 |  |
| 0.000 | 0.000 | 0.011 | 0.014 | 0.000 | 0.000 | 0.017 | 0.05 |  |
| 0.000 | 0.000 | 0.034 | 0.034 | 0.000 | 0.000 | 0.040 | 0.1 |  |
| 0.000 | 0.000 | 0.060 | 0.080 | 0.000 | 0.000 | 0.080 | 0.2 |  |
| 0.000 | 0.000 | 0.091 | 0.086 | 0.000 | 0.000 | 0.117 | 0.3 |  |
| 0.000 | 0.000 | 0.000 | 0.0006 | 0.000 | 0.000 | 0.002 | 0.01 | Data2 |
| 0.000 | **0.000** | 0.001 | 0.007 | 0.000 | 0.000 | 0.005 | 0.02 |  |
| 0.000 | **0.000** | 0.007 | 0.021 | 0.000 | 0.000 | 0.018 | 0.05 |  |
| 0.000 | 0.000 | 0.019 | 0.030 | 0.000 | 0.000 | 0.035 | 0.1 |  |
| 0.000 | **0.000** | 0.033 | 0.073 | 0.000 | 0.000 | 0.076 | 0.2 |  |
| 0.000 | **0.000** | 0.050 | 0.122 | 0.000 | 0.000 | 0.117 | 0.3 |  |
| 0.000 | **0.000** | 0.001 | 0.003 | 0.000 | 0.000 | 0.002 | 0.01 | Data3 |
| 0.000 | **0.000** | 0.005 | 0.009 | 0.000 | 0.000 | 0.004 | 0.02 |  |
| 0.000 | **0.000** | 0.013 | 0.024 | 0.000 | 0.000 | 0.017 | 0.05 |  |
| 0.000 | **0.001** | 0.025 | 0.048 | 0.000 | 0.000 | 0.038 | 0.1 |  |
| 0.000 | **0.008** | 0.053 | 0.114 | 0.000 | 0.000 | 0.080 | 0.2 |  |
| 0.000 | **0.017** | 0.085 | 0.173 | 0.000 | 0.000 | 0.116 | 0.3 |  |
| 0.000 | **0.000** | 0.000 | 0.001 | 0.000 | 0.000 | 0.001 | 0.01 | Data4 |
| 0.000 | **0.000** | 0.003 | 0.008 | 0.000 | 0.000 | 0.004 | 0.02 |  |
| 0.000 | **0.000** | 0.009 | 0.023 | 0.000 | 0.000 | 0.019 | 0.05 |  |
| 0.000 | **0.000** | 0.020 | 0.056 | 0.000 | 0.000 | 0.039 | 0.1 |  |
| 0.000 | **0.000** | 0.041 | 0.115 | 0.000 | 0.000 | 0.078 | 0.2 |  |
| 0.000 | **0.000** | 0.070 | 0.171 | 0.000 | 0.000 | 0.116 | 0.3 |  |
| 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.000 | 0.002 | 0.01 | Data5 |
| 0.000 | 0.000 | 0.001 | 0.005 | 0.000 | 0.000 | 0.015 | 0.02 |  |
| 0.000 | 0.000 | 0.005 | 0.016 | 0.000 | 0.000 | 0.013 | 0.05 |  |
| 0.000 | 0.000 | 0.011 | 0.038 | 0.000 | 0.000 | 0.033 | 0.1 |  |
| 0.000 | 0.000 | 0.027 | 0.086 | 0.000 | 0.000 | 0.078 | 0.2 |  |
| 0.000 | 0.000 | 0.052 | 0.116 | 0.000 | 0.000 | 0.123 | 0.3 |  |
| 0.000 | 0.000 | 0.001 | 0.001 | 0.000 | 0.000 | 0.001 | 0.01 | Data6 |
| 0.000 | 0.000 | 0.002 | 0.005 | 0.000 | 0.000 | 0.003 | 0.02 |  |
| 0.000 | 0.000 | 0.009 | 0.016 | 0.000 | 0.000 | 0.016 | 0.05 |  |
| 0.000 | 0.000 | 0.015 | 0.036 | 0.000 | 0.000 | 0.034 | 0.1 |  |
| 0.000 | 0.000 | 0.031 | 0.075 | 0.000 | 0.000 | 0.083 | 0.2 |  |
| 0.000 | 0.000 | 0.042 | 0.129 | 0.000 | 0.000 | 0.122 | 0.3 |  |
| 0.000 | 0.000 | 0.001 | 0.001 | 0.000 | 0.000 | 0.003 | 0.01 | Data7 |
| 0.000 | 0.000 | 0.002 | 0.004 | 0.000 | 0.000 | 0.004 | 0.02 |  |
| 0.000 | 0.000 | 0.010 | 0.011 | 0.000 | 0.000 | 0.018 | 0.05 |  |
| 0.000 | 0.000 | 0.018 | 0.026 | 0.000 | 0.000 | 0.036 | 0.1 |  |
| 0.000 | 0.000 | 0.056 | 0.060 | 0.000 | 0.000 | 0.083 | 0.2 |  |
| 0.000 | 0.000 | 0.087 | 0.084 | 0.000 | 0.000 | 0.114 | 0.3 |  |
| 0.000 | **0.000** | 0.001 | 0.001 | 0.000 | 0.000 | 0.001 | 0.01 | Data8 |
| 0.000 | 0.000 | 0.003 | 0.004 | 0.000 | 0.000 | 0.007 | 0.02 |  |
| 0.000 | 0.000 | 0.009 | 0.011 | 0.000 | 0.000 | 0.015 | 0.05 |  |
| 0.000 | 0.000 | 0.020 | 0.021 | 0.000 | 0.000 | 0.040 | 0.1 |  |
| 0.000 | 0.000 | 0.060 | 0.056 | 0.000 | 0.000 | 0.066 | 0.2 |  |
| 0.000 | 0.000 | 0.084 | 0.084 | 0.000 | 0.000 | 0.124 | 0.3 |  |

جدول 5-7. مقایسه نتایج تاثیر flip noise در دوررویکرد پیشنهادی باسایرروش­های کوانتومی

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| QBEH | QSEH | QLSB[35] | QLSB[36] | cLSQ3[23] | cLSQ2[23] | cLSQ1[23] | 1-p | DataName |
| 0.021 | **0.0001** | 0.071 | 0.030 | 0.062 | 0.066 | 0.091 | 0.01 | Data1 |
| 0.044 | **0.0006** | 0.076 | 0.061 | 0.120 | 0.130 | 0.158 | 0.02 |  |
| 0.070 | **0.004** | 0.280 | 0.110 | 0.258 | 0.280 | 0.338 | 0.05 |  |
| 0.100 | **0.088** | 0.474 | 0.196 | 0.465 | 0.470 | 0.521 | 0.1 |  |
| 0.130 | **0.106** | 0.531 | 0.268 | 0.590 | 0.601 | 0.620 | 0.2 |  |
| 0.185 | **0.426** | 0.538 | 0.317 | 0.611 | 0.616 | 0.660 | 0.3 |  |
| 0.040 | **0.000** | 0.053 | 0.016 | 0.050 | 0.053 | 0.072 | 0.01 | Data2 |
| 0.058 | **0.001** | 0.118 | 0.028 | 0.094 | 0.120 | 0.131 | 0.02 |  |
| 0.098 | **0.005** | 0.284 | 0.069 | 0.240 | 0.289 | 0.316 | 0.05 |  |
| 0.139 | **0.041** | 0.460 | 0.098 | 0.440 | 0.505 | 0.555 | 0.1 |  |
| 0.185 | **0.229** | 0.686 | 0.100 | 0.723 | 0.781 | 0.817 | 0.2 |  |
| 0.191 | **0.378** | 0.710 | 0.169 | 0.879 | 0.901 | 0.938 | 0.3 |  |
| 0.0006 | **0.000** | 0.060 | 0.011 | 0.049 | 0.050 | 0.068 | 0.01 | Data3 |
| 0.001 | **0.001** | 0.115 | 0.033 | 0.109 | 0.121 | 0.136 | 0.02 |  |
| 0.009 | **0.010** | 0.267 | 0.065 | 0.234 | 0.283 | 0.332 | 0.05 |  |
| 0.010 | **0.065** | 0.479 | 0.099 | 0.448 | 0.494 | 0.550 | 0.1 |  |
| 0.40 | **0.278** | 0.681 | 0.101 | 0.725 | 0.780 | 0.821 | 0.2 |  |
| 0.060 | **0.437** | 0.761 | 0.170 | 0.853 | 0.904 | 0.935 | 0.3 |  |
| 0.070 | **0.00** | 0.060 | 0.016 | 0.048 | 0.059 | 0.065 | 0.01 | Data4 |
| 0.110 | **0.00** | 0.122 | 0.028 | 0.099 | 0.121 | 0.142 | 0.02 |  |
| 0.193 | **0.001** | 0.285 | 0.065 | 0.255 | 0.298 | 0.318 | 0.05 |  |
| 0.211 | **0.031** | 0.501 | 0.096 | 0.448 | 0.494 | 0.550 | 0.1 |  |
| 0.272 | **0.198** | 0.681 | 0.105 | 0.719 | 0.780 | 0.821 | 0.2 |  |
| 0.295 | **0.321** | 0.724 | 0.160 | 0.863 | 0.906 | 0.935 | 0.3 |  |
| 0.010 | **0.000** | 0.052 | 0.015 | 0.045 | 0.050 | 0.061 | 0.01 | Data5 |
| 0.051 | **0.000** | 0.121 | 0.029 | 0.105 | 0.120 | 0.122 | 0.02 |  |
| 0.110 | **0.001** | 0.294 | 0.068 | 0.256 | 0.280 | 0.320 | 0.05 |  |
| 0.154 | **0.035** | 0.486 | 0.092 | 0.443 | 0.517 | 0.543 | 0.1 |  |
| 0.192 | **0.200** | 0.700 | 0.105 | 0.718 | 0.771 | 0.818 | 0.2 |  |
| 0.223 | **0.347** | 0.771 | 0.168 | 0.867 | 0.909 | 0.939 | 0.3 |  |
| 0.001 | **0.000** | 0.061 | 0.014 | 0.050 | 0.062 | 0.066 | 0.01 | Data6 |
| 0.030 | **0.000** | 0.110 | 0.025 | 0.106 | 0.107 | 0.132 | 0.02 |  |
| 0.090 | **0.001** | 0.269 | 0.061 | 0.257 | 0.286 | 0.323 | 0.05 |  |
| 0.152 | **0.033** | 0.451 | 0.096 | 0.445 | 0.509 | 0.550 | 0.1 |  |
| 0.241 | **0.181** | 0.673 | 0.101 | 0.725 | 0.764 | 0.815 | 0.2 |  |
| 0.283 | **0.342** | 0.736 | 0.134 | 0.873 | 0.907 | 0.933 | 0.3 |  |
| 0.006 | **0.000** | 0.065 | 0.016 | 0.052 | 0.054 | 0.068 | 0.01 | Data7 |
| 0.010 | **0.000** | 0.113 | 0.028 | 0.094 | 0.118 | 0.141 | 0.02 |  |
| 0.030 | **0.001** | 0.268 | 0.063 | 0.245 | 0.286 | 0.314 | 0.05 |  |
| 0.053 | **0.030** | 0.479 | 0.092 | 0.465 | 0.499 | 0.545 | 0.1 |  |
| 0.090 | **0.207** | 0.680 | 0.101 | 0.725 | 0.753 | 0.817 | 0.2 |  |
| 0.112 | **0.336** | 0.751 | 0.163 | 0.871 | 0.903 | 0.929 | 0.3 |  |
| 0.010 | **0.00** | 0.062 | 0.013 | 0.048 | 0.055 | 0.069 | 0.01 | Data8 |
| 0.031 | **0.000** | 0.121 | 0.024 | 0.088 | 0.120 | 0.140 | 0.02 |  |
| 0.063 | **0.001** | 0.278 | 0.065 | 0.230 | 0.281 | 0.330 | 0.05 |  |
| 0.100 | **0.035** | 0.475 | 0.105 | 0.448 | 0.508 | 0.553 | 0.1 |  |
| 0.112 | **0.197** | 0.696 | 0.101 | 0.719 | 0.773 | 0.810 | 0.2 |  |
| 0.165 | **0.325** | 0.756 | 0.165 | 0.863 | 0.906 | 0.931 | 0.3 |  |

# 5