Table 1. Overview of mainstream models

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Network structure** | **Representative model** | **Advantage** | **Shortcoming** | **Dataset** | **Result(MAE)** |
| Single branch structure | CrowdCNN | Can handle scenes with varying densities | Limited adaptability to density variations. | WorldExpo'10 | 12.9 |
|  | MCNN | Multi-column architecture can handle various density changes. | High number of parameters and complex training. | ShanghaiTechPartB | 26.4 |
| Multi-branch structure | CP-CNN | Combines contextual information, leading to high accuracy. | High computational complexity. | ShanghaiTechPartB | 20.1 |
|  | Switch-CNN | Dynamically switches sub-networks to handle different density scenes. | Complex switching mechanism and diHicult training. | ShanghaiTechPartA | 90.4 |
|  | CSRNet | Uses dilated convolutions to efficiently capture muki-scalc infonnation. | Highly dependent on training data. | ShanghaiTechPartA | 68.2 |
| Special structure | ACSCP | Adaptive scheme, effective in high-density crowd scenarios. | Poor real-time performance. | UCF.CC.50 | 291.0 |
|  | GauNct | Uses Gaussian filters to improve density estimation accuracy. | Sensitive to outliers, less robust. | UCF.CC.50 | 186.3 |

Table 2. Overview of the four datasets

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Dataset** | **Resolution** | **Number of pictures** | **Number of training images** | **Number of test images** | **Maximum count** | **Minimum count** | **Average count** | **Total count** |
| Shanghai Tech PartA | Different | 482 | 300 | 182 | 3139 | 33 | 501.4 | 241677 |
| Shanghai Tech ParlB | 768x1024 | 716 | 400 | 316 | 578 | 9 | 123.6 | 88488 |
| UCF.CC.50 | Different | 50 | 40 | 10 | 4543 | 94 | 1279.5 | 63974 |
| UCF-QNRF | Different | 1535 | 1201 | 334 | 12865 | 49 | 815.4 | 12511642 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Methods | Shanghai B | | Shanghai A | | UCF-QNRF | | UCF\_CC\_50 | |
| MAE | MSE | MAE | MSE | MAE | MSE | MAE | MSE |
| MCNN (2016) | 26.4 | - | 110.2 | - | - | - | 337.6 | - |
| CSRNet (2018) | 10.6 | 16 | 68.2 | 115 | 120.3 | 208.5 | 266.1 | 397.5 |
| SANet (2018) | 8.4 | 13.6 | 67 | 104.5 |  |  | 258.4 | 334.9 |
| CAN (2019) | 7.8 | 12.2 | 62.3 | 100 | 107 | 183 | 212.2 | 243.7 |
| LSC-CNN (2019) | 8.1 | 12.7 | 66.4 | 117 | 120.5 | 218.2 | 225.6 | 302.7 |
| DensityCNN (2020) | 9.1 | 16.3 | 63.1 | 106.3 | 101.5 | 186.9 | 244.6 | 341.8 |
| SDANet (2020) | 7.8 | **10.2** | 63.6 | 101.8 | - | - | 227.6 | 316.4 |
| FusionCount (2022) | **6.9** | 11.8 | 62.2 | 101.2 | - | - | - | - |
| OrdinalEntropy (2023) | 9.1 | 14.5 | 65.6 | 105 | - | - | - | - |
| NDConv (baseline) | 7.8 | 13.8 | 61.4 | 104.1 | 91.2 | 165.6 | 167.2 | 240.6 |
| SPCANet | 7.3 | 12.5 | **60.9** | **99.9** | **90.8** | **158.7** | **161.1** | **228.8** |

**Table 3.** Comparisons of four Mainstream datasets

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Strip Pooling | Baselinc(NDConv) | | Ours(SPCANet) | |
| MAE | MSE | MAE | MSE |
| 1 | **61.4** | 104.1 | 62.2 | 105.3 |
| 2 | 61.9 | **103.8** | **60.9** | **99.9** |
| 3 | 63.7 | 111.2 | 62.9 | 110.7 |
| 4 | 64.6 | 108.3 | 62.6 | 107.9 |

**Table 4.** Influence of the Number of Strip Pooling on Shanghai Part A

**Table 5.** Effect of ECA on Further Model Improvements

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Methods | Shanghai B | | Shanghai A | | UCF\_QNRF | | UCF\_CC\_50 | |
| MAE | MSE | MAE | MSE | MAE | MSE | MAE | MSE |
| baseline | 7.8 | 13.8 | 61.4 | 104.18 | 91.2 | 165.6 | 167.2 | 240.6 |
| baseline+Strip Pooling | 7.8 | 12.9 | **60.6** | 102.81 | **89.4** | 160.9 | 165.1 | 253.3 |
| baseline+Strip Pooling+ECA | **7.3** | **12.5** | 60.9 | **99.9** | 90.8 | **158.7** | **161.1** | **228.8** |

**Table 6.** Effect of the Weight of λ On Shanghai Tech Part A and Part B

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Dataset** | **Metrics** | **λ(super-parameter)** | | | |
| 1e-1 | 1e-2 | 1e-3 | 1e-4 |
| Shanghai Tech Part A | MAE | 63.1 | 62.7 | **60.9** | 61.4 |
|  | MSE | 100.1 | 99.6 | 99.9 | **98.6** |
| Shanghai Tech Part B | MAE | 7.6 | 7.4 | **7.3** | 7.7 |
|  | MSE | 14.7 | **12.2** | 12.5 | 12.8 |

**Table 7**. Effect of Optimizer and BatchSize On UCF-QNRF and UCF\_CC\_50

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Dataset** | **Metrics** | **Optimizer & BatchSize** | | | | | |
| Adam | | | SGD | | |
| 4 | 8 | 16 | 4 | 8 | 16 |
| UCF-QNRF | MAE | 91.1 | **90.8** | 92.3 | 93.7 | 95.6 | 94.1 |
|  | MSE | **157.9** | 158.7 | 161.3 | 165.4 | 165.2 | 167.9 |
| UCF\_CC\_50 | MAE | **161.1** | 175.2 | 182.4 | 167.2 | 187.2 | 189.5 |
|  | MSE | 228.8 | 238.7 | 283.1 | 240.6 | **227.5** | 240.6 |