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## **TABLE 1**

Sample distribution of benign and malignant images in the breakhis dataset with respect to the different magnification factors

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Class** | **40X** | **100X** | **200X** | **400X** |
| **Benign** | 625 | 644 | 623 | 588 |
| **Malignant** | 1370 | 1437 | 1390 | 1232 |
| **Total No of Images (7909)** | 1995 | 2081 | 2013 | 1820 |

## **TABLE 2**

Performance Evaluation of VGG16, GoogLeNet, and ResNet-50 with the Modified VGG16 Architecture and the Proposed Approach on BreakHis Dataset

**40X Magnification**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Technique** | **Accuracy** | **F1** | **IBA** | **GMean** |
| VGG16 | 0.8531 | 0.8952 | 0.6329 | 0.8105 |
| GoogLeNet | 0.8748 | 0.9100 | 0.6934 | 0.8433 |
| ResNet50 | 0.7095 | 0.8214 | 0.1062 | 0.3597 |
| Modified VGG16 w/ Single Dense Layer | 0.8681 | 0.9067 | 0.6577 | 0.8221 |
| **Modified VGG16 w/ Inception Block w/ Single Dense Layer** | **0.8982** | **0.9264** | **0.7535** | **0.8748** |

**100X Magnification**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Technique** | **Accuracy** | **F1** | **IBA** | **GMean** |
| VGG16 | 0.8754 | 0.9122 | 0.6730 | 0.8301 |
| GoogLeNet | 0.8498 | 0.8929 | 0.6275 | 0.8081 |
| ResNet50 | 0.7125 | 0.8189 | 0.1443 | 0.4346 |
| Modified VGG16 w/ Single Dense Layer | 0.8626 | 0.9029 | 0.6460 | 0.8163 |
| **Modified VGG16 w/ Inception Block w/ Single Dense Layer** | **0.8658** | **0.9034** | **0.6759** | **0.8347** |

**200X Magnification**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Technique** | **Accuracy** | **F1** | **IBA** | **GMean** |
| VGG16 | 0.8692 | 0.9082 | 0.6542 | 0.8197 |
| GoogLeNet | 0.8411 | 0.8873 | 0.6017 | 0.7938 |
| ResNet50 | 0.7053 | 0.8231 | 0.0570 | 0.2524 |
| Modified VGG16 w/ Single Dense Layer | 0.8742 | 0.9112 | 0.6732 | 0.8308 |
| **Modified VGG16 w/ Inception Block w/ Single Dense Layer** | **0.8742** | **0.9100** | **0.6909** | **0.8421** |

**400X Magnification**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Technique** | **Accuracy** | **F1** | **IBA** | **GMean** |
| VGG16 | 0.8462 | 0.8906 | 0.6061 | 0.7939 |
| GoogLeNet | 0.8352 | 0.8822 | 0.5869 | 0.7847 |
| ResNet50 | 0.6905 | 0.8124 | 0.0517 | 0.2486 |
| Modified VGG16 w/ Single Dense Layer | 0.8516 | 0.8941 | 0.6232 | 0.8037 |
| **Modified VGG16 w/ Inception Block w/ Single Dense Layer** | **0.8370** | **0.8802** | **0.6224** | **0.8080** |

**Table 3**  
Comparison of the Proposed Approach with the State-of-the-Art Approaches on BreakHis Dataset Based on Mean Accuracy Across Different Magnification Factors

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Technique** | **40X** | **100X** | **200X** | **400X** |
| Spanhol et al. [8] | 0.8960 ± 0.0650 | 0.8500 ± 0.0480 | 0.8400 ± 0.0320 | 0.8080 ± 0.0310 |
| Spanhol et al. [39] | 0.8460 ± 0.0290 | 0.8480 ± 0.0420 | 0.8420 ± 0.0170 | 0.8160 ± 0.0370 |
| Bayramoglu et al. [10] | 0.8300 ± 0.0300 | 0.8310 ± 0.0350 | 0.8460 ± 0.0270 | 0.8210 ± 0.0440 |
| Zhu et al. [40] | 0.8570 ± 0.0190 | 0.8420 ± 0.0320 | 0.8490 ± 0.0220 | 0.8010 ± 0.0440 |
| Gupta et al. [41] | 0.8674 ± 0.0237 | 0.8856 ± 0.0273 | 0.9031 ± 0.0376 | 0.8831 ± 0.0301 |
| Deniz et al. [17] | 0.9096 ± 0.0159 | 0.9058 ± 0.0196 | 0.9137 ± 0.0172 | 0.9130 ± 0.0740 |
| Song et al. [42] | 0.9002 ± 0.0302 | 0.9120 ± 0.0440 | 0.8780 ± 0.0530 | 0.8740 ± 0.0720 |
| Gupta et al. [18] | 0.9471 ± 0.0088 | 0.9590 ± 0.0420 | 0.9676 ± 0.0109 | 0.8911 ± 0.0012 |
| **VGGIN-Net** | **0.9588 ± 0.0033** | **0.9657 ± 0.0087** | **0.9500 ± 0.0122** | **0.9315 ± 0.0034** |
| **VGGIN-Net (with fine-tuning)** | **0.9710 ± 0.0046** | **0.9705 ± 0.0022** | **0.9716 ± 0.0033** | **0.9368 ± 0.0053** |
| **Ours** | **0.8407 ± 0.0698** | **0.8332 ± 0.0611** | **0.8328 ± 0.0705** | **0.8121 ± 0.0659** |

## **Table 4**

Performance Evaluation of the Proposed Approach with Undersampling and Oversampling Techniques on BreakHis Dataset

(i) 40X, (ii) 100X, (iii) 200X, (iv) 400X

**40X**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sampling Technique** | **Accuracy** | **F1 Score** | **G-Mean** | **Informedness (IBA)** |
| Undersampling | 0.8590 | 0.8602 | 0.8590 | 0.7181 |
| Oversampling | 0.9015 | 0.9287 | 0.8805 | 0.7641 |
| None | 0.8982 | 0.9264 | 0.8748 | 0.7535 |

**100X**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sampling Technique** | **Accuracy** | **F1 Score** | **G-Mean** | **Informedness (IBA)** |
| Undersampling | 0.8282 | 0.8232 | 0.8277 | 0.6564 |
| Oversampling | 0.8738 | 0.9093 | 0.8435 | 0.6932 |
| None | 0.8658 | 0.9034 | 0.8347 | 0.6759 |

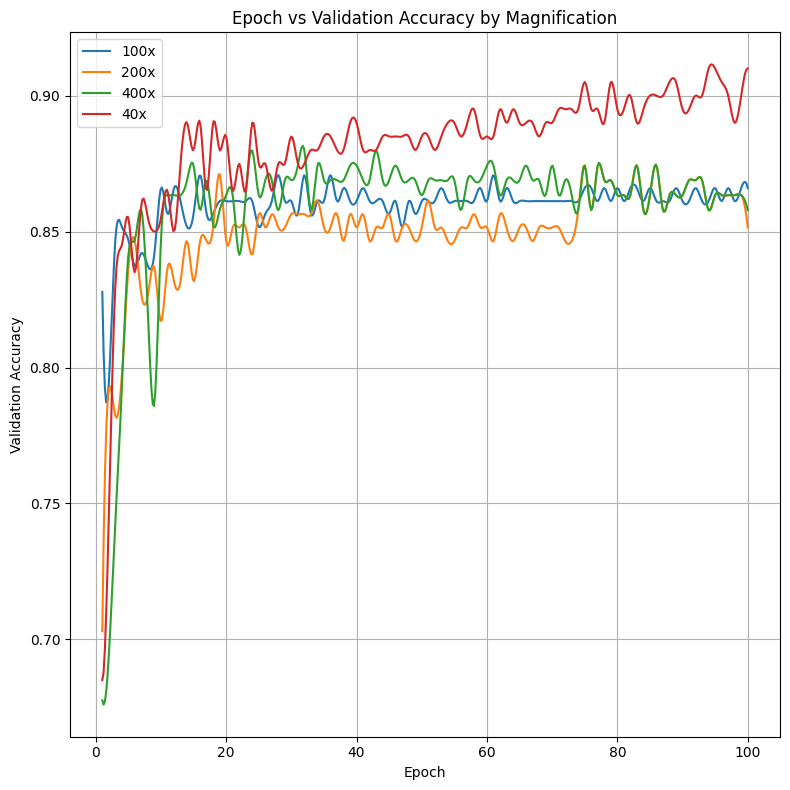
**200X**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sampling Technique** | **Accuracy** | **F1 Score** | **G-Mean** | **Informedness (IBA)** |
| Undersampling | 0.8449 | 0.8449 | 0.8449 | 0.6898 |
| Oversampling | 0.8808 | 0.9149 | 0.8483 | 0.7035 |
| None | 0.8742 | 0.9100 | 0.8421 | 0.6909 |

**400X**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sampling Technique** | **Accuracy** | **F1 Score** | **G-Mean** | **Informedness (IBA)** |
| Undersampling | 0.8442 | 0.8433 | 0.8442 | 0.6884 |
| Oversampling | 0.8571 | 0.8963 | 0.8234 | 0.6551 |
| None | 0.8370 | 0.8802 | 0.8080 | 0.6224 |

## **Graphs**



A graph of a graph

AI-generated content may be incorrect.