CHAPTER 7

OVERALL PERFORMANCE ANALYSIS

7.1 INTRODUCTION

This chapter delves into the evaluation of methodologies introduced for conductive ink selection in printed electronics applications with machine learning and deep learning methods. Based on accuracy, recall, precision, F1-score, BCR, and MCR, respectively, the built models' performance is assessed.

7.2 SIMULATION RESULTS AND DISCUSSION

This research work introduced three distinct methodologies for conductive ink selection in printed electronics applications. To provide a comprehensive perspective, an in-depth comparison was conducted among these three methods. The following sub sections compare the performance of the developed models.

7.2.1 Accuracy

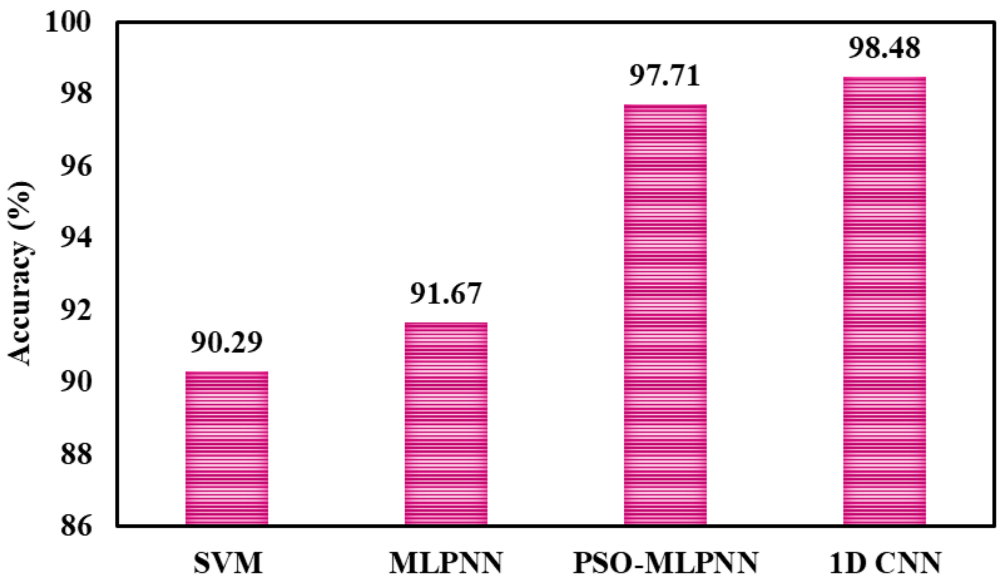

Figure 7.1 Performance comparison in terms of accuracy

Figure 7.1 graphically compares the performance of the developed models such as SVM, MLPNN, PSO-MLPNN, and 1D CNN. As shown in Figure 7.1, the SVM, MLPNN, PSO-MLPNN, and 1D CNN models achieved an accuracy values of 90.29%, 91.67%, 97.71%, and 98.28%, respectively. The deep learning model demonstrated superior accuracy, followed by PSO-MLPNN, MLPNN, SVM. Remarkably, the deep learning model exhibited a 7.99%, 6.81%, and 2.1% improvement in accuracy compared to SVM, MLPNN and PSO-MLPNN models, respectively.

7.2.2 Recall

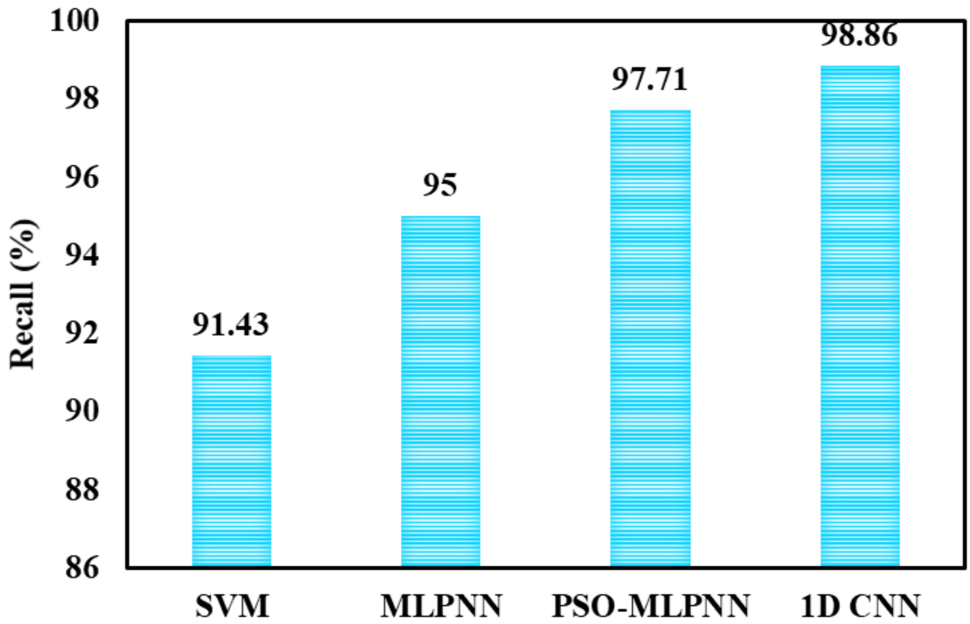

Figure 7.2 Performance comparison in terms of recall

Figure 7.2 visually depicts the efficacy of the developed models such as SVM, MLPNN, PSO-MLPNN, and 1D CNN. As depicted, the SVM yielded recall of 91.43%, MLPNN of 95%, PSO-MLPNN of 97.71%, and 1D CNN of 98.86%. Upon analysis, it became apparent that the 1D CNN model showed an improvement of 7.43%, 3.86% and 1.15% in recall compared to the SVM, MLPNN, and PSO-MLPNN models, respectively. The findings underscore the efficacy of the 1D CNN model in recalling instances relevant to conductive ink selection in PE applications and highlighting the importance of using sophisticated architecture for improved performance in complex tasks.

7.2.3 Precision

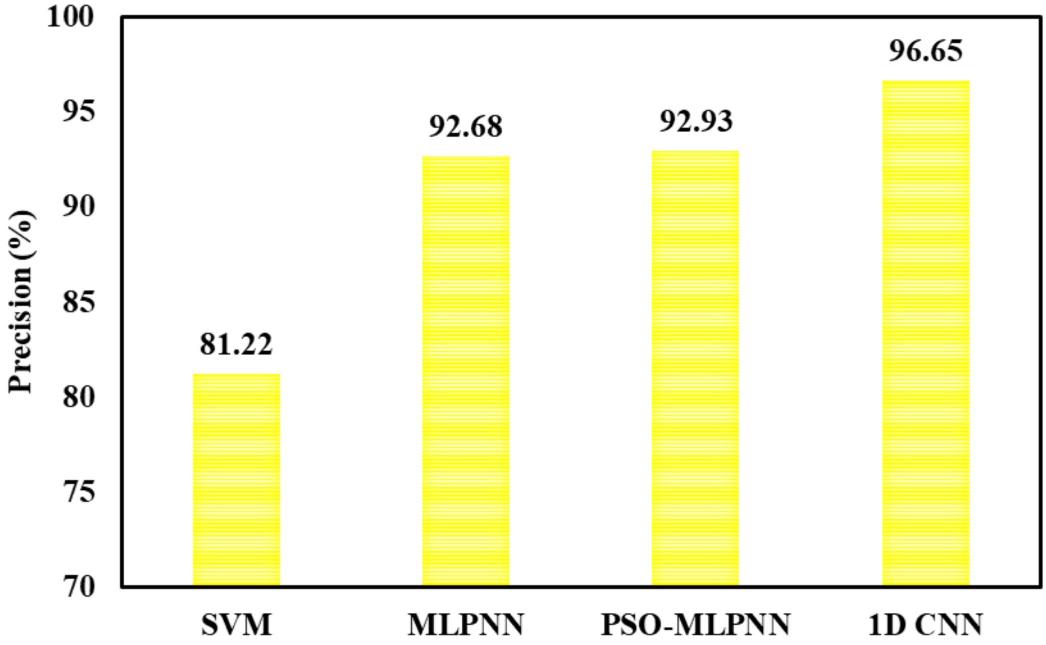

Figure 7.3 Performance comparison in terms of precision

Figure 7.3 provides a visual representation of the effectiveness of the developed models, namely SVM, MLPNN, PSO-MLPNN, and 1D CNN. From Figure 7.3, it is found that SVM, MLPNN, PSO-MLPNN and 1D CNN achieved accuracy values of 81.22%, 92.68%, 92.93% and 96.65%, respectively shown. The increased accuracy of the 1D CNN model highlights its effectiveness in facilitating better performance compared to other methods to accurately identify relevant instance.

7.2.4 F1-score

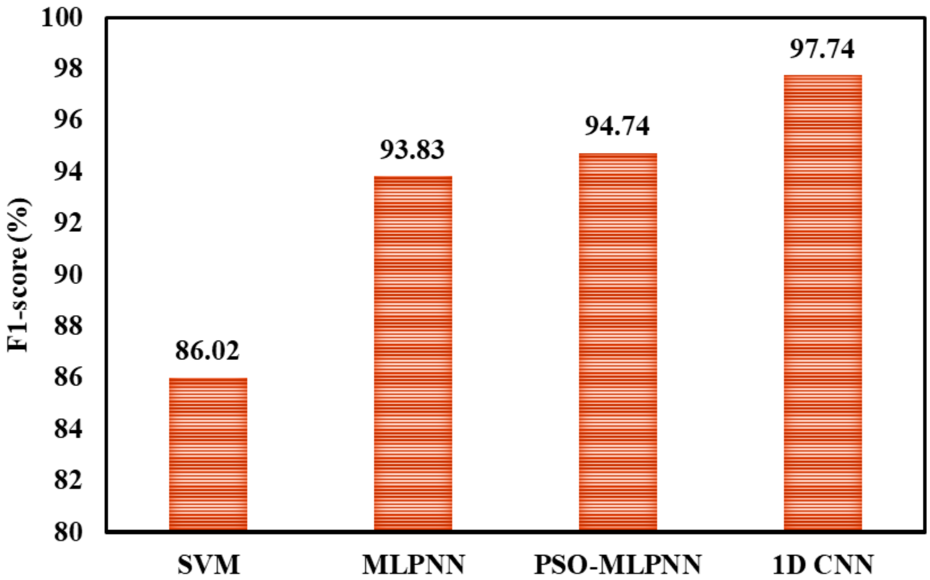

Figure 7.4 Performance comparison in terms of F1-score

Figure 7.4 shows the performance of the model in terms of F1 score. By inspecting Figure 7.4, the SVM, MLPNN, PSO-MLPNN, and 1D CNN models obtained F1 score values of 86.02%, 93.83%, 94.74%, and 97.74. % respectively - reveals remarkable improvement scores with increases of 11.72%, 3.91 % and 3 % compared to SVM, MLPNN and PSO-MLPNN.

7.2.5 BCR

The performance of different models based on their BCR values is graphically compared in Figure 7.5. Upon analysing Figure 7.5, it can be observed that the SVM, MLPNN, PSO-MLPNN, and 1DCNN models yielded BCR values of 84.43%, 90.15%, 97%, and 98.57%, respectively. This assessment emphasized the significant increase in BCR value exhibited by the 1DCNN model, with improvements of 14.14%, 8.42%, and 1.57% compared to the SVM, MLPNN, and PSO-MLPNN.

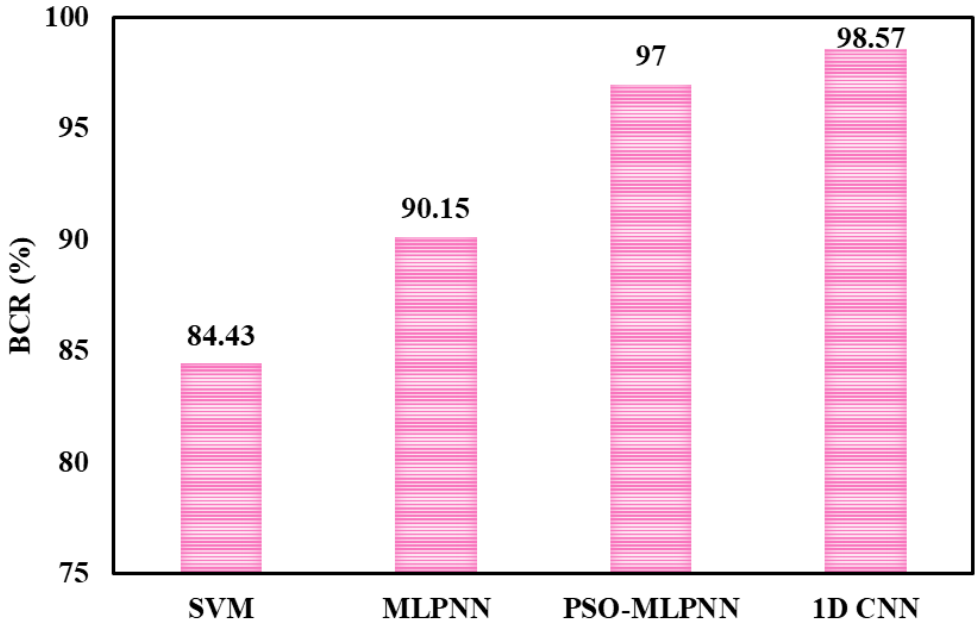

Figure 7.5 Performance comparison in terms of BCR

7.2.6 MCR

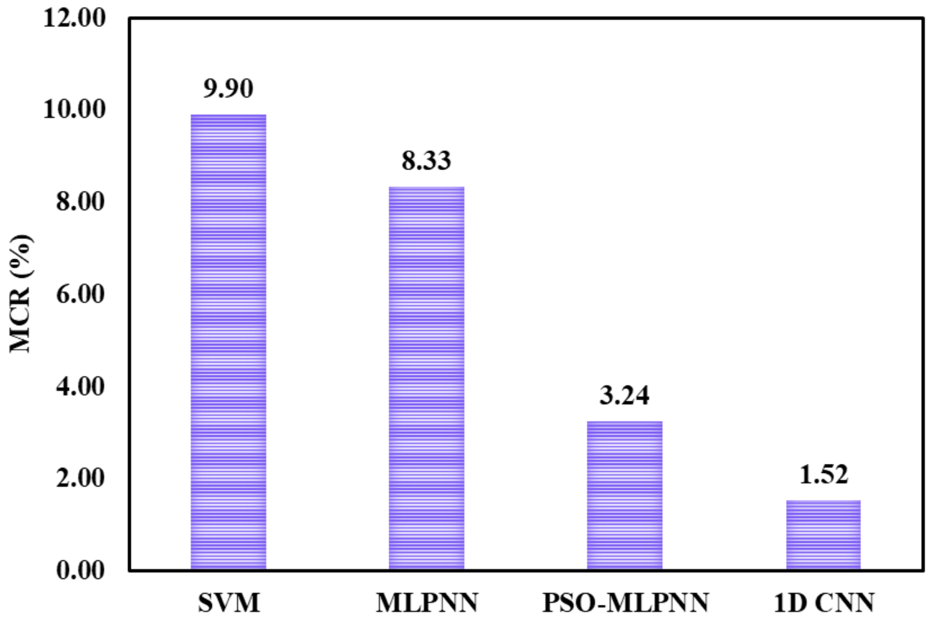

Figure 7.6 Performance comparison in terms of MCR

Pictorial representation of various models performance based on their MCR values is depicted in Figure 7.6. Analysis of the Figure 7.6 revealed that the SVM attained MCR value of 9.90%, MLPNN of 8.33%, PSO-MLPNN of

3.24%, and 1D CNN of 1.52%. The designed showed excellent performance by reporting lower MCR value compared to other models.

The rationale behind the varying metrics such as accuracy, recall, precision, and F1-score values of each model can be attributed to the respective architectures and training methodologies. The 1D CNN model, known for its capability to capture spatial dependencies with the data, likely excelled in discerning intricate patterns in the data, thereby achieving the highest accuracy. On the other hand, the PSO-MLPNN model incorporated PSO algorithm to optimize the parameters of the MLPNN and showed improved metrics compared to the MLPNN model. This finding suggests that the optimization method contributed to refining the models' performance. Additionally, the MLPNN showed lesser values compared to other methods. These lower values reflect its inherent ability to learn and generalize from the data. The superior accuracy of each model can be attributed to their unique architectural features and optimization methods, which enabled them to effectively learn and capture the underlying patterns in the dataset.

7.2.7 Computation time

Effectiveness of the developed models are assessed by computing computation time. Computation time analysis is a process of evaluating and comparing the time taken by models to complete a task. The execution time increase with the size of the input data. Computation time plays pivotal role in determining the performance a system. Standard MLP required 7.8 seconds for classification, PSO-MLPNN required 7 seconds for classification, and 1D CNN required 9 seconds for classification. The computation time of the developed models can be ranked as follows: PSO-MLPNN<MLPNN<1D CNN. This notable improvement can be attributed due to the utilization of optimization algorithm in the MLPNN. This is not only underscores the performance of the models but also emphasizes its potential in real-time applications.

7.3 CHAPTER SUMMARY

The thorough analysis of the results above conclusively demonstrated that the 1D CNN model surpassed its counterparts such as MLPNN and PSO-MLPNN across all metrics. In the field PE, the proposed deep learning model has proved as the most effective model for conductive ink selection. The heightened evaluation metrics values observed in the 1D CNN model signifies its remarkable ability to accurately identify instances within the data. This enhancement plays a pivotal role in distinguishing the 1D CNN model as the optimal choice for conductive ink selection in PE purposed. By precisely detecting patterns and instances, the 1D CNN model not only showed efficacy but also offers promising prospects for practical implementation.