ABSTRACT

Printed Electronics (PE) is a growing subfield in the field of electronics manufacturing and material science. It enables the fabrication of electrical and photonic devices using printing techniques such as inkjet, screen printing with conductive inks. PE facilitates the printing of a wide array of electronic components on various substrates, thereby enabling the construction of conventional circuits. The rapid expansion of PE across industrial sectors have sparked significant interest due to its capacity to produce intricate components. A fundamental aspect of PE lies in the application of conductive ink during printing process, which is pivotal in developing flexible electronic circuits and enhancing the communicative capabilities of objects. The selection of appropriate ink is paramount in meeting consumer requirements and ensuring product functionality. Traditionally, ink selection has been a manual task, heavily reliant on the expertise of designers. This conventional approach is time-consuming and may not always yield optimal results. Hence, there is a growing need to design an automated system for ink selection in printing applications.

The fundamental focus of the research work is to build automated systems for choosing conductive ink for PE applications using neural network, metaheuristic algorithm, and deep learning model. The introduced models for conductive ink selection in PE are as follows:

- ❖ An automated system using Multilayer Perceptron Neural Network (MLPNN) and Support Vector Machine (SVM) for conductive ink selection in PE.
- ❖ A conductive ink selection system using Particle Swarm Optimization-MLPNN (PSO-MLPNN)
- ❖ A system to pick a suitable conductive ink for PE applications with the help of Convolutional Neural Network (CNN)

The first phase of this research work deals with the development of an automated system for conductive ink selection using MLPNN. Input data is

normalized into a common range between 0 and 1 using min-max technique. Two models namely MLPNN and SVM are separately designed and trained to capture the intricate relationship between input and output variables. These trained models are used to select the conductive ink based on the input data. Performance of the presented system is analysed by varying number of hidden layers, number of hidden neurons, and number of training and testing samples. Efficacy of the models are evaluated by computing accuracy, recall, precision, F1 score, balance classification rate, and miss classification rate.

The second phase of this research work introduces a novel method for choosing conductive ink for PE employing PSO and MLPNN. In this method, input data is preprocessed using min-max method. A MLPNN is designed and trained using PSO algorithm to learn the relationships between input and output variables. Finally, trained PSO-MLPNN is used to select ink based on input features. Similar to first phase, performance of the presented system is analysed by varying parameters and evaluated using various metrics, and compared with standard MLPNN.

Third phase of this research work builds an automated system to improve accuracy using 1D CNN. Input data is preprocessed with min-max method. A 1D CNN is designed and trained to choose conductive ink for PE applications. Efficacy of the model is evaluated by computing accuracy, recall, precision, F1 score, balance classification rate, and miss classification rate and compared with SVM, MLPNN and PSO-MLPNN.