

CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

This chapter provides a brief overview of the research carried out in the area under consideration. A variety of methods have been established to improve the quality and reproducibility of PE.

2.2 REVIEW OF RELATED WORKS ON PE

Kamyshny et al. (2011) provides a comprehensive review of metal-based inkjet inks for PE, especially those containing complexes, metal-organic compounds, and metal nanoparticles. The authors detail the process for manufacturing these inks and creating conductive patterns using various sintering techniques. There are also many uses for metal-based inks and inks.

Brunton A et al. (2015) utilized the error-diffusion halftone technique to facilitate the printing of tonal representations which might be clean, in particular for colouring restricted through available inks and materials. Although effective for representing colours, this method may have drawbacks in accurately reproducing fine details or subtle color gradients due to inherent constraints in ink and material limitations. Rama et al. (2015) explored the steps involved in creating conductive inks and how they are used in flexible electronics and PE. It is showed that the chemical methods for synthesizing silver ink.

Matsuhisa et al. (2015) suggested a cutting-edge method for creating high-conductive printed elastic conductors that are appropriate for use in electronic textiles. The authors discussed about the materials, performance characteristics, potential applications, and future prospects of these conductive materials in the field of wearable electronics.

Huang et al. (2015) created a cost-effective and highly conductive material that can be used in printed Radio Frequency (RF) devices. The authors

discussed the fabrication process of the graphene laminate, emphasizing the elimination of binders to improve conductivity. They also discussed the electrical properties of graphene parts, such as their level of conductivity and efficiency in RF applications.

Ostfeld et al. (2015) showed that low-temperature printing techniques can be used to integrate various electronic devices. These methods can be used to create many types of electronic systems, such as power supplies and power consumption devices. The authors showed how to fabricate RLC circuits and screen-print passive components on flexible plastic substrates. The results demonstrate the feasibility of using printed passive components for flexible electronic systems. By emphasizing the potential in equipment production.

Li et al. (2016) offered a new way to design multi-color displays and touch interfaces. The production process is discussed. This involves placing light patterns on various functional materials. to create different colours, print and transfer to stretchable substrates. This allows multiple colours to be combined in a single stretched display. This improves visibility. The paper also discusses the mechanical properties of stretchable displays. Emphasis is placed on the ability to withstand stretching and bending without compromising functionality. The touch interface indicates that the device can also provide interactive input. which increases flexibility in use.

He et al. (2019) introducing a new graphene Nano platelet-based ink for future PE, the authors report that the graphene ink is highly conductive, economical, and highly flexible. Screen printing on plastic and paper surfaces using ink has proven effective. Using post-printing techniques such as compression ironing and heat annealing. The printed graphene patterns display impressive properties such as high electrical conductivity and good flexibility.

Jansson et al. (2022) integrated flexographic screen printing has been used to evaluate the printability and metal conductive layer performance of

various paper-based (SP) printed materials, but this method cannot address durability. The long-term or environmental impact of these printed conductive layers is fully realized.

Kwon et al. (2022) proposed a method for developing recyclable PE for applications such as biosensors and wearable electronics. This approach not only meets the growing demand for sustainable materials; But it also meets the unique needs of emerging technologies. Even though there are new innovations challenges may include optimizing the balance between recyclability and material performance in electronic applications.

Htwe and Mariatti (2022) assorted with other substances in flowable inks. The authors provide an overview of previous studies on the preparation of flowable inks and their application in PE. They also carried out a review of various printing methods. comprehensively used for depositing conductive ink and examine various post-printing techniques to improve efficiency.

2.3 REVIEW OF RELATED WORKS BASED ON ANN

Vahabli E et al. (2016) investigated the use of a radial basis function (RBF) network to predict surface roughness in manufactured parts via fused deposition modeling (FDM). The RBF network is trained using the input parameters. various Including FDM settings, material properties and part geometry to predict surface roughness. The simulation results show that the model improves the surface quality of FDM parts by accurately predicting and controlling the surface roughness.

Yao et al. (2017) a hybrid model for design feature recommendation that combines SVM and Hierarchical Clustering (HC) is proposed to identify suitable design elements for automotive components. Our method uses HC to classify design features and SVM to improve classification results. However, this method may have limitations in handling large datasets or complex design spaces, as HC

may struggle with high-dimensional data and SVM. It may require extensive tuning for optimum performance.

The creation of dots in printing may affect printing accuracy. To solve this problem, Shi J et al. (2018) introduced a ML model called learning-based cell injection control (LCIC). The LCIC model assumes the piezoelectric effect inverse and the simulated data is used to build and train an MLP that simulates a piezoelectric print head using computational fluid dynamics. This trained MLP is then used to adjust its parameters. Automatic typing optimization based on classification performance the results showed that the MLP method significantly improved the printing efficiency.

Wu and Xu (2018) use a neural network (NN) to predict the amount and rate of ink shedding. After training, the NN model predicts the drop velocity and ink volume based on three input features such as pulse length, rise time, and voltage but the model needs extensive training data to capture the full range of printing conditions, and possible inaccuracies in predicting highly dynamic inkjet behavior.

Guo et al. (2018) Investigated how various factors affect the ejection quantity of printing using ML algorithm. Authors focused on ink residences and method parameters to apprehend their effect at the printing process. Experiments have been carried out the use of exceptional sorts of inks and varied method parameters inclusive of voltage, nozzle diameter, and distance among the nozzle and the substrate. Results showed that the modifications in procedure parameters and substrate motivated ejection quantity with higher voltage and shorted distances leading to larger droplet volumes.

Kamyshny and Magdassi (2019) presented a discussion of recent advances in the use of conductive inks in printed flexible electronic devices. Basic characteristics of nanomaterials, dispersion stability, preparation of conductive

ink, steps after printing and methods of various printing technologies were mentioned in the review.

Matsui et al. (2019) discussed advances and applications in flexible printable organic transistors. This article covers various aspects related to these transistors from the materials used in production to the development of integrated circuits. It highlights the potential of these transistors to revolutionize the electronics industry through the use of lightweight, cost-effective devices.

Qi et al. (2019) provided a detailed and comprehensive summary of the current status, challenges, and future trends of the use of NN-based ML techniques in PE applications, contributing to the advancement of this rapidly developing field.

Leng et al. (2019) discussed the development of conductive ink using screen-printed graphite Nano sheets. This ink is used in ML this paper explores the use of this ink in building sensors that can transmit data wirelessly and were trained to recognize specific patterns with ML algorithms, and highlighting the potential applications of such sensors in areas such as healthcare and smart manufacturing, Shi L et al. (2018) proposed a novel ML-based algorithm for droplet velocity optimization. Authors sought to improve the bio printing process using a fully connected neural network (FCNN) to simultaneously optimize multiple objectives. It can also increase printing speed, accuracy, and material efficiency.

An innovative algorithm for selecting inks for spectral generation was presented by Ansari et al. (2020). This method uses mixed integer programming to analyze images and select the best ink for spectral generation. To increase the accuracy of ink selection, they incorporated a NN which was not only designed and trained for the specific task of selection. This shows the novelty in spectral creation. But it also reveals the synergy between traditional and ML methods to achieve accurate, high-quality color reproduction. Despite this ability limitations

also include the complexity of the optimization process and the need for comprehensive training data to ensure accurate ink selection for spectral generation.

Neto et al. (2021) developed a model to study the characteristics of ceramic insulators using MLP. To classify them in this model, MLP is designed with an input layer, two hidden layers and an output layer. Results showed that the MLP based model attained highest classification accuracy compared to statistical methods.

Nagasawa et al. (2021) introduced line spread function and NN skin color and translucency estimate. This method calculated the line spread function, created multi-layered human skin color patches, and utilized NN to predict layout. This method yielded close-to-target color and translucency. While the outcomes are better, challenges may arise in accurately capturing the full range of skin tones and translucency levels across different lighting conditions.

Zhang and Moon (2021) discussed the growing interest in employing ML model to improve the writing process with noncontact direct ink. Authors pointed out that noncontact ink writing offers benefits such as cost-efficiency and customization for device applications. Despite these benefits, printing quality continues to be the limiting factor in microelectronics' electrical performance. The authors emphasize the need for ML techniques to improve printing speed, accuracy, and material characterization. They also discuss the basic considerations, motivating parameters, and limitations of direct inking methods. Non-contact moreover, they identify the main drawbacks, difficulties, and future directions for creating ML techniques for optimizing non-contact direct inking processes.

Kim et al. (2022) presented an approach for optimizing drive waveforms for ink printing. This is important to ensure reliable printing based on ink and fluid properties. The author uses different types of ink. Each type of ink is

injected using a variety of wave-shaped designs. They evaluated and compared five ML models, including SVM, KNN, RF, MLP, and Extreme Gradient Boosting (XGBoost), to predict jet injection behavior. Among all the ML models, MLP's prediction accuracy was the best.

Brishty et al. (2022) studied how to use machine learning (ML) techniques to classify printer ink based on spray patterns. They were compared with three ML algorithms: K- Nearest Neighbor (KNN), Decision Tree (DT) and Neural Network (NN). Comparing the performance of the ML algorithms, the results proved that the NN classifier it has higher accuracy than KNN and DT classifiers. Disadvantages of this study may include the need for significant computational resources when dealing with large amounts of data. The possibility of overfitting when using the NN model.

Chen et al. (2023) created a random forest (RF) prediction model that accurately predicts extraction cycle times and droplet sizes. It uses experimental data obtained under different printing conditions. Comparison between the prediction accuracy of the RF method and other machine learning (ML) techniques such as classification regression trees (CART) supported vector regression (SVR). The results show that the model RF simulations provide an efficient way to estimate both the duration of the ejection cycle and the droplet diameter. Therefore, it contributes to the advancement of printing to achieve perfect precision.

Mouleeshuwarappabu and Kasthuri (2023) examined the potential of MLP in classifying electroencephalography (EEG) signals to diagnose epilepsy was analyzed. The EEG signals were pre-processed. The features are then calculated, and then the obtained features are applied to the MLP to classify signals.

2.4 REVIEW OF RELATED WORKS BASED ON HYBRID APPROACH

Adhikari and Agrawal (2013) developed two hybrid models for forecasting time series data. Two networks such as MLP and Elman ANN were designed and trained to anticipate time series data. Results clearly demonstrated the superior forecasting of PSO-MLP over its Back Propagation (BP) counterpart for both MLP and Elman ANN models. Garro and Vazquez (2015) developed an ANN model for data classification. Authors trained the ANN using three algorithms such as PSO, LM, and BP individually. Results of the models PSO-ANN, BP-ANN and LM-ANN were compared to find out the better model. PSO-ANN provided better results than BP-ANN and LM-ANN.

Neha and Vashishtha (2016) proposed a novel algorithm for feature selection in 1D data categorization utilizing PSO algorithm. The proposed methods optimized the selection of features for training an ANN and improve classification rate compared to standard algorithms.

ANNs are often applied to data categorization due to their ability to capture relationship between input and output variables via training process. A novel method by combining ANN and PSO algorithm was described by Tarkhaneh.O and Shen.H (2019). Authors adopted PSO algorithm for tuning the parameters of ANN. Results revealed the PSO-ANN significantly outperformed compared to its counterpart.

Qtest.H and Awad.M (2021) constructed an algorithmic method for the automatic categorization of diabetes. MLPNN training and determination of the optimal weights of the trained network are completed by PSO method. The results show that PSO-MLPNN outperforms MLPNN in terms of classification rate.

2.5 REVIEW OF RELATED WORKS BASED ON DEEP LEARNING

Caggiano et al. (2019) discussed ML approaches for real-time error detection using image processing techniques. This approach focuses on the detection of material defects caused by process distortions in selective laser melting of metal powders. A bimodal CNN is used to analyze the images. The method automatically detects and fuses features to identify patterns associated with defect states in selective laser melting. The results show that the ML method effectively detects errors caused by process irregularities.

Huang et al. (2020) implemented unsupervised ML algorithms for jetting prediction. An unsupervised learning method is implemented using Deep Recurrent Neural Network (DRNN). The model's unsupervised method allows the identification of features and combinations of data. They do not require external labelling. However, unsupervised algorithms may encounter problems in interpretation and may require further investigation to ensure reliable predictions in typing situations.

Lall et al. (2022) presented application of deep learning models in the field of inkjet printing. The precise objective of the deep learning model is to establish a connection between the printing parameters and the obtained electrical performance. Including geometric prediction of inkjet substructure. This method not only demonstrates the integration of advanced computational methods. But it also reveals its power to optimize and predict key performance indicators. Potential challenges in generalizing the model to a formula.

Liu and Si (2022) created a 1D CNN deep learning model for financial chart pattern classification. SVM, LSTM, and Extreme Learning Machine (ELM) models are compared and contrasted with 1D CNN models as compared to other methods. Out of which 1D CNN was evaluated as the most accurate, according to the data, connecting your device to the internet is essential in your daily life. It supports a wide range of web applications in fields such as healthcare,

engineering, and business. These applications support a large user base this makes security a key focus in academia and industry. Advances in deep learning have expanded the field of research. Especially in detecting network intrusions where hackers exploit to gain unauthorized access to sensitive systems, Kazi et al (2022) introduced a 1D CNN based architecture for entry detection four dimensional network. The results show the highest classification accuracy in infiltration detection.

Mattioli et al. (2022) presented a novel approach that classifies five different brain states using a ten-level one-dimensional convolutional neural network (CNN) using data enhancement techniques and a limited set of EEG signals. Tested using EEG motor movement data, the 1D CNN surpassed the current best approaches by achieving the maximum accuracy at the group level.

ML and deep learning techniques have been progressively used to address intricate challenges in many domains of knowledge. Krohling B A and Kronhling R A (2023) developed a 1D CNN to evaluate the analytical performance of spectral data acquired via spectroscopy. Input signals were preprocessed to remove discard noise and then applied as input for the 1D CNN. Results showed that the 1D CNN performed well compared to ML algorithms.

2.6 RESEARCH GAPS IDENTIFIED

- Previous methods have struggled with limited datasets, which affects training and validation of the models.
- Existing approaches might not have focused on the real world data implementation and scalability of neural networks.
- Very few works have used neural network for conductive ink selection. However, these works might not have explored the optimization of neural network parameters for better predictive performance in conductive ink selection.

- Existing methods may not be able to compare deep learning models with machine learning models in the case of conductive ink selection.

2.7 CHAPTER SUMMARY

This chapter presented a detailed review of methods previously used in printed electronic devices. The analysis focuses on the type of ink used. Configuration of deep neural networks and metaheuristic algorithms. It is also used to tune neural network parameters from these research results. The appropriate conductive ink can be selected using an artificial neural network.