Master's Thesis Information Showcase
Spring Semester-2024
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Department: Telecommunications Engineering
Programme: Masters of Science
Specialization: Telecommunication System

1	**Title of the Thesis** **Fabric Defect Detection and Identification using LSTM-CNN network**
2	**Abstract** (min 300 to 500 words) The fabrication process of the garments from the fabrics requires to check the fabric for any defects so as to keep the final product defect free. Similarly, the fabric manufacturing from the yarns also requires to have a check on the manufactured fabric for defects. Presently these defects are mostly observed by the staff manually. However, an AI based fabric defect detection can have many advantages such as increase in speed and efficiency, improved accuracy and consistency, cost savings and data driven insights. In present studies some studies have used CNN for the automatic defect identification and reported good accuracy. However, not all the defects have been covered in these studies. Therefore, here an integration of CNN and LSTM networks for an efficient defect detection with improved accuracy and its classification in all possible defects. The proposed model combines properties of both networks. In sequential data LSTM is applied to capture long term dependencies while in hierarchal data CNN is used to extract spatial features. The proposed scheme is tested over two datasets both dataset, that have different type of fabrics like Plain, textured, weaved, woven, printed fabrics and denim etc. The proposed model showed 78.24% accuracy with 78.20% average F1 score over validation dataset. This study includes comparison of performance between modified LSTM-CNN and CNN-LSTM network and shows that modified LSTM-CNN model performance is batter then CNN-LSTM model for fabric defect detection and classification
3	**Impact on SDG#__"** (min 500 words) (Please mention the impact of the relevant attained SDG) The proposed research on **fabric defect detection using a hybrid Long Short-Term Memory–Convolutional Neural Network (LSTM-CNN)** contributes directly to **United Nations Sustainable Development Goal (SDG) 9: Industry, Innovation and Infrastructure**, which aims to build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. The textile industry is one of the largest manufacturing sectors worldwide and plays a vital role in the economic development of many countries, including Pakistan. However, maintaining consistent fabric quality remains a major challenge due to the limitations of traditional manual inspection systems, which are often time-consuming, subjective, labor-intensive, and prone to human error. The proposed intelligent defect detection framework addresses these limitations by introducing an automated, accurate, and efficient quality inspection system. The developed LSTM-CNN model combines the spatial feature extraction capability of Convolutional Neural Networks (CNNs) with the sequential learning capability of Long Short-Term Memory (LSTM) networks. This hybrid architecture enables the model to

identify subtle texture variations and complex defect patterns that may not be easily detectable using conventional computer vision techniques or manual inspection. By automatically detecting defects such as holes, stains, broken threads, and damaged fabric with high accuracy, the proposed system significantly improves the reliability of industrial quality control processes.

One of the primary contributions of this research toward SDG 9 is the promotion of **industrial innovation** through the adoption of Artificial Intelligence (AI) and Deep Learning technologies. The textile manufacturing sector is gradually moving toward Industry 4.0, where intelligent automation plays a central role in increasing productivity and operational efficiency. Integrating an AI-based inspection system into textile production lines enables manufacturers to monitor product quality in real time, reduce dependency on manual inspection, and minimize production interruptions. Such technological advancements enhance industrial competitiveness while supporting sustainable manufacturing practices.

The proposed framework also contributes to the development of **smart manufacturing infrastructure**. Automated defect detection systems can be deployed alongside modern textile machinery, enabling continuous monitoring of fabric production without interrupting manufacturing operations. Real-time quality assessment allows defective products to be identified immediately, preventing faulty fabric from progressing through subsequent manufacturing stages. Consequently, manufacturers can reduce production losses, optimize resource utilization, and improve overall operational efficiency.

Another important contribution of this research is the enhancement of **manufacturing productivity and economic performance**. Manual inspection often suffers from fatigue, inconsistency, and reduced inspection accuracy during long production shifts. In contrast, the proposed LSTM-CNN model maintains consistent performance throughout continuous operation, resulting in faster inspection speeds and improved defect detection accuracy. Increased automation reduces labor costs associated with repetitive inspection tasks while allowing skilled workers to focus on higher-value technical activities such as system monitoring, maintenance, and production optimization.

The proposed system also supports **sustainable industrialization** by minimizing material waste. Defective fabrics detected at an early stage can be removed before additional processing, dyeing, finishing, or packaging. Early identification prevents unnecessary consumption of raw materials, water, chemicals, and energy during downstream production processes. As a result, manufacturers can significantly reduce production waste and improve resource efficiency, supporting environmentally sustainable manufacturing practices. This contribution aligns not only with SDG 9 but also indirectly supports **SDG 12 (Responsible Consumption and Production)** through efficient utilization of industrial resources.

Furthermore, improved product quality enhances customer satisfaction and strengthens the global competitiveness of textile manufacturers. Countries with large textile export industries can benefit from AI-driven quality assurance systems by consistently meeting international quality standards, reducing product returns, and improving export reliability.

	The adoption of intelligent inspection technologies therefore contributes to economic growth and industrial modernization while encouraging continuous innovation within the textile sector. The proposed research also establishes a foundation for future intelligent textile manufacturing systems. The developed LSTM-CNN framework can be extended by integrating Internet of Things (IoT) devices, edge computing platforms, cloud-based monitoring systems, or robotic automation for fully autonomous textile inspection. Such future developments would further strengthen smart factory initiatives and accelerate the digital transformation of manufacturing industries. In conclusion, the proposed AI-based fabric defect detection system represents a significant contribution toward achieving **SDG 9: Industry, Innovation and Infrastructure** by promoting intelligent industrial automation, improving manufacturing efficiency, reducing operational costs, enhancing product quality, and encouraging technological innovation within the textile sector. Additionally, by minimizing material waste and improving resource utilization, the research indirectly supports **SDG 12 (Responsible Consumption and Production)** and contributes to **SDG 8 (Decent Work and Economic Growth)** through increased industrial productivity and sustainable economic development. Therefore, this research demonstrates how advanced deep learning technologies can play a vital role in building smarter, more efficient, and more sustainable textile manufacturing systems.
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5	**Supervisor & Co-supervisor Name** (along with contact details) **Supervisor:** Dr. Rizwan Aslam Butt **Co-supervisor:** Dr. Amir Qureshi
6	**Graphical Abstract**

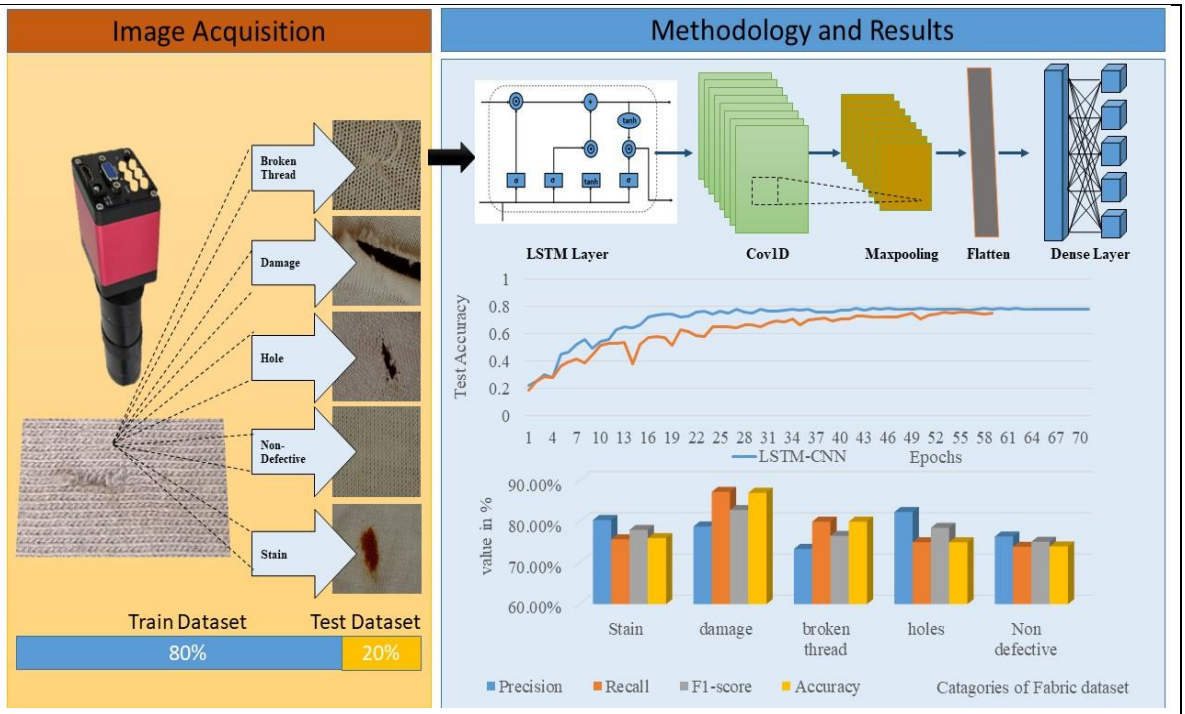
Image Acquisition
Broken Thread
Damage
Hole
Non-Defective
Stain
Train Dataset
Test Dataset
80%
20%
Methodology and Results
LSTM Layer
Cov1D
Maxpooling
Flatten
Dense Layer
Test Accuracy
1
0.8
0.6
0.4
0.2
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70
LSTM-CNN
Epochs
value in %
90.00%
80.00%
70.00%
60.00%
Stain
damage
broken thread
holes
Non defective
Precision
Recall
F1-score
Accuracy
Catagories of Fabric dataset