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Fabric Defect Detection using Deep Learning

Vijaya saradhi[1], Kolluri Sahaja [2], Dasari Vani [3], Alisha Begum[4]

[1]Professor, Department of Computer Science and Engineering

[2,3,4]B.TECH Scholars, Department of Computer Science and Engineering

Sreenidhi Institute of Science & Technology, Hyderabad, India

Abstract*: Fabric defect detection is very significant in textile manufacturing. Inspecting the quality of raw materials is considered to be one of the most crucial aspects behind any production unit. Its significance in the textile industry is even more as most of the time different fabrics are combined together to form a finished fabric and defect found in any one of the fabric can halt the entire production assembly resulting in huge financial losses for large manufacturing unit. In general the valuation of the fabric gets reduced in between 40 to 60 percent depending upon the nature of the defect found in the fabric. Most of the defects in fabrics also known as flaws, on the surface results either from wear and tear of machines, improper stocking or other miscellaneous activities like stain spills or scratches etc. Therefore the main aim is to develop model that maximize the machine's detection efficiency by minimizing its misclassification rate*

Keywords: Fabric defect detection, deep learning **,** Inception V3, Deep Convolutional neural Network (DCNN).

I. INTRODUCTION

The textile industry is a rising sector .In the textile industry, fabric defect detection is a critical step in ensuring the quality of fabrics produced. The traditional method of inspection is time-consuming, labor- intensive, and prone to errors. The advancements in computer vision and deep learning, automated fabric defect detection has become possible. In this, we propose a system for fabric defect detection using the Inception V3 model. Fabric defect detection is an important task in the textile industry to ensure that the final product meets quality standards. Manual inspection of fabrics can be time-consuming and prone to errors. Machine learning models can be used to automate and improve the accuracy of defect detection. In this, we will use Inception V3, a pre-trained deep learning model, to detect defects in fabrics.

Fabric defect detection is a quality assurance process that has to ensure the identification of defects present in the textile fabric. These defects can reduce the textile fabric price as much as 45% to 65%. A traditional inspection system is composed of manual workers/operators. Their job is to detect the defects while the fabric is being moved by a machine. Therefore, traditional systems can only achieve 65% to 70% accuracy, even though they have very slow speed compared to production rate. As a result, automatic visual inspection systems ensure the high quality fabric.

II. LITERATURE SURVEY

Fabric defect detection in digital image process has received tidy attention throughout the past 2 decades and diverse approaches are projected in the literature. Most prominent approach in automated fabric fault detection is, fabric defect detection using morphological filters proposed by P.Peng, K.F.C. Yiu. Defect detection system is based on morphological filters and proposed to handle the problem of automated defect detection for woven fabrics. Proposed scheme extracts texture features of the textile fabric using a pre- trained Gabor wavelet network. These texture features are then used to facilitate the construction of structuring elements in subsequent morphological processing to remove the fabric background and isolate the defects. By Xie Xianghua et al the techniques used to examine textural abnormalities are mentioned in four categories, applied math approaches, structural approaches, filter primarily based ways, and model primarily based approaches. This paper focuses on the recent developments in vision primarily based on image process techniques, particularly people who are supported texture analysis ways. Due to rising demand and observe of color texture analysis in application to visual scrutiny, those works that are dealing with color texture analysis are mentioned on an individual basis.

A. Origin of the Proposal

Fabric Defects makes the major wastages in the textile manufacturing process in the form of resources and as well as product quality. This Fabric Defect Detection will reduce such type of wastages for textile industries. In general textile fabric defects refer to defects on the surface of the fabric. There are many types of fabric defects, most of which are caused by process problems and machine malfunctions. Artificial Intelligence algorithms are used to solve the industrial problems and improves the efficiency and security of the manufacturing industries.

Textile manufacturing is a large scale and complicated industry, this process consists of a series of complex and orderly processes, mainly including spinning, weaving, dyeing, printing and finishing and garments manufacturing. The Stability and Quality of fabric will depend on whole production line.

The factors that will affect the final products in textile industries will mainly include material quality, mechanical factors, dye type, yarn size and human factors. It is a challenging task in the fabric industry because of the complex shapes and large variety of fabric defects. Man methods have been proposed to solve this problem, but their detection speed and accuracy were very low. Fabric Defect detection is an important step in the fabric production process .Human Inspection with eyes for fabric defects is the traditional method is used in fabric industry and visual inspections can identify and locate the defects. In the process of fabric manufacturing, the defects in the previous stage will affect the later stage. Therefore, effective fabric defects can reduce the loss of enterprises earlier and faster. Therefore, effective fabric defect detection of the key measures for modern fabric manufacturers to control cost and enhance product value and core competence. Previously, Manual human efforts are applied in textile industry to detect the defects in the fabric production process. Lack of concentration, human fatigue, and time consumption are the main drawbacks associated with the manual fabric defect detection process. Applications based on computer vision and digital image processing can address the mentioned limitations and drawbacks. In modern textile manufacturing, automatic fabric defect is an important way to ensure the textile quality. The core of a complete online textile fabric defect detection system is the detection algorithms. The influence of artificial intelligence on industrial field has far exceeded our expectations. The vast number of researchers and engineers are constantly accelerating the development of industrial intelligence. Industrial Artificial Intelligence is typical cross disciplinary, which combines knowledge of mechanical, Data science, network, communication etc.

B. International Status

Deep Convolutional neural Network (DCNN) based algorithms have achieved satisfactory results on visual tasks and have been widely used in industrial scenarios. Liu is a researcher who worked on this project based on DCNN to detect fabric defects with complicated textures. This approach is particularly designed for real textile production environment with limited resources. A series of improvements have been done to make the detection more effective. Zhou proposed an efficient DCNN architecture focusing on the problem of fabric defect detection, Called Efficient Defect Detectors (EDDs). To extract more low-level features, EDDs adjust the input resolution, depth, and width using a scaling strategy. The improvement proved to be effective when compared with existing fabric defect detection algorithms.

The updated usage of these algorithms was proposed by other researcher with a novel detection network named de-deformation defect detection network(D4Net). This Model is composed of reference generation, de-deformation network and marginal loss. Putting this researching forward Peng, a Researcher was used Prior Anchor Convolutional Neural Network (PRAN-Net) to fix this problem. Feature pyramid Network (FPN) is utilized to selected multiscale feature maps and then sparse priori anchors are generated based on truth boxes.

Two-Stage Detection Algorithms. Regarding two-stage detectors, a sparse set of proposals is generated int the first stage and int the second stage, the features of generated proposals are sent into DCNN for prediction results. In recent years, Generative Adversarial Networks (GANs) have attracted a lot of attention. These algorithms are widely used in a range of computer vision and computer graphics applications, such as image synthesis and video generation.

Hardware selection of Detection: The basic components of image acquisition system are very important for the deployment work and therefore the hardware selection is critical for subsequent detection work. Hardware such as cameras, lens, lights and frame grabber is an important factor. For instance, one of the researchers proposed a new fabric defect detection method for using a thermal camera. These images obtained by the thermal imaging camera have their own image characteristics. The algorithm can be designed utilizing thermal differences between defect and defect-

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free areas and to improve the detection accuracy and efficiency while reducing the cost. Different from visual inspection systems, Fang introduce a tactile inspection system design is mainly based on a visual tactile sensor, which consists of several LEDs a camera and an elastic sensing layer.

C. National Status

Fabric Defect detection algorithms are roughly divided into two categories like traditional algorithms and learning based algorithms. Traditional algorithms mainly involve statistical algorithms this approach utilizes the spatial distribution of gray values in images such as gray- level co-occurrence matrices (GLCM), autocorrelation analysis, and fractal dimension features. Raheja present an automated fabric defect detection system utilizing GLCM.In this approach, a signal graph is constructed with GLMC statistics and interpixel distance. Then a comparison between non defective image and test image is made. The conclusion made that GLCM based algorithms generate higher detection accuracies and less computational complexity.

National status of this detection mainly using the statistical approaches. Anand a researcher was combined the GLCM and curvelet transform by extracting the eigenvector of the defect which makes the fabric defect features more evident. The experiments show the effectiveness of the proposed algorithm with comparison to GLCM and wavelet-based methods respectively. Kumar designed a statistical approach for identifying defects in fabric images using eigenvalues. Using the coefficient of variation, defective portions of the fabric images are identified. This method is simple and easy to use according to the experiments in the work.

Dictionary learning Based algorithms: Many researchers have validated the effectiveness of dictionary learning based algorithms dealing with textile fabric defect detection problems. Similarly, we have other traditional based algorithms like deep learning algorithms. This type of algorithms was used by many researchers. At present, the deep learning-based objects detector can be classified as one-stage detectors and two stage detectors. In general, one stage detectors have fast detection speed to meet the requirements of online detection, but the detection accuracy usually fails to meet requirements.

CNN based algorithms for on- loom fabric defect inspection. This proposed algorithm introduces dynamic activation layer utilizing the defect probability information with a pairwise potential function to a CNN. This algorithm obtains good results dealing with the unbalanced data classification problem. CNN algorithm has achieved satisfactory results on visual tasks and have been widely used in industrial scenarios. In addition, the conveying cloth on the production line will also affect the image tasking speed. Therefore, the hardware selection of the entire system needs to be considered.

III. SCOPE OF THIS DOCUMENT AND PROJECT

To improve the efficiency and effectiveness of the system, the following recommendations can be put into consideration. Quality of the fabric can be identified, can perform segregation on good and bad fabric, 3D cameras can be used to achieve better fault identification .The manual inspection leads to lower productivity and higher market losses. In this study, automated fabric defect detection methods are discussed in 11 groups .There are many different types of fabrics and defects, a single method that can run on all fabric types and contain these defects has not been found. Each method has its strengths and weaknesses that are discussed in subsequent sections. In the vast majority of the methods examined, the authors have created their own database under different lighting conditions. Since a large number of fabric defect detection methods exist in the literature, their comparison is helpful for researchers to find the optimal method depending on fabric type and defect. However, it should be considered that the studies are conducted using different databases, different parameters, and varied imaging systems, hence making the validity and reliability of methods far from objectivity. This covers the research on textile fabric defect detection methods, and it is thought that comprehensive studies similar to this one will contribute significantly to the textile industry. For future research, there is a critical need for some common publicly available fabric image databases that will open up new directions for the researchers in textile industry. Hybrid approaches with a combination of deep features with other visual features are also considered as a promising direction for future research.

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IV. EXISTING SYSTEM

There are several existing systems for fabric defect detection. These systems can be categorized into rule-based systems, traditional machine learning-based systems, and deep learning-based systems. Rule-based systems use predefined rules to detect defects, while traditional machine learning-based systems use handcrafted features and classifiers. Deep learning-based systems, on the other hand, learn features automatically from data. Some of the existing systems for fabric defect detection are:

SVM-based system: This system uses a support vector machine (SVM) classifier with handcrafted features to detect fabric defects.

GAN-based system: This system uses a generative adversarial network (GAN) to generate realistic images of defective fabrics and detect defects in real fabric images.

V. PROPOSED METHOD

The proposed system is divided into several processes. First, the image acquisition system captures the fabric image, which is then pre-processed, with histogram equalization, to enhance the defective region. Then, image analysis is performed to detect the fabric defect. A customized CNN architecture was used for the defect detection process, in order to create a robust and computationally effective defect detection system. If this system detects a possible defect in the fabric roll, the system's activity is stopped, and the nearby operator is informed. After that the operator confirms or reverses the system evaluation and gives the authorization for the system to proceed the operation and continue to the next fabric image. Furthermore, the defect type, location and other characteristics can be documented for later research. In the following subsections, the system processes as well as the CNN architecture and false negative reduction methods are described.

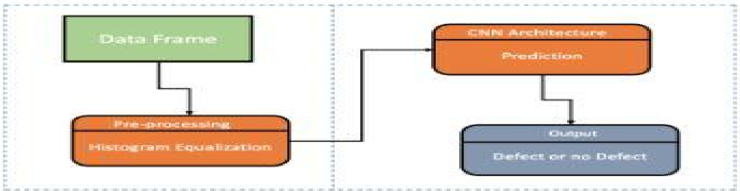

FIGURE 2: Fabric defect detection system block diagram.

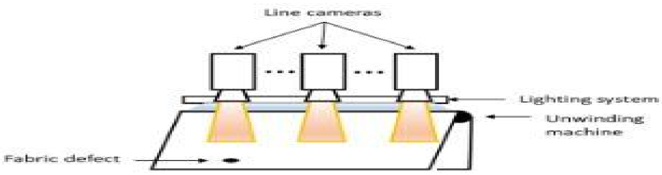

FIGURE 3: Structure of the visual inspection system.

IMAGE ACQUISITION

In order to have a fast RGB (Red, Green, Blue) image acquisition system with low noise and high resolution images, a series of line scan CMOS (Complementary Metal- Oxide Semiconductor) sensors cameras can be used. These cameras capture less blurry images and have more speed and range of motion then other scan cameras. To capture the entire width of the inspected fabric with good resolution, this system uses a row of line cameras, jointly with the lighting system, while the fabric roll is unwind by a machine, as illustrated in Figure.

VI. METHODOLOGY

6.1 Preprocessing of Fabric Images

To make our approach generalize to types of defects and multiple fabric groups, we first use a fixed-size square slider to crop the original image to a certain step and regularity. In this paper, we use a square slider with the size of 224x224. To enhance the contrast of the image without causing intensity saturation and detail corrosion, this paper applies histogram equalization (HE) method for effective and efficient mean brightness preservation and contrast enhancement.

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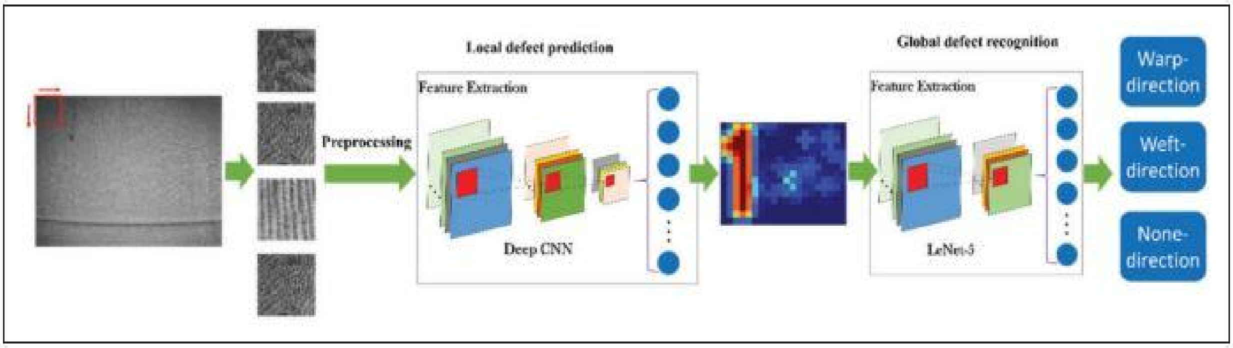
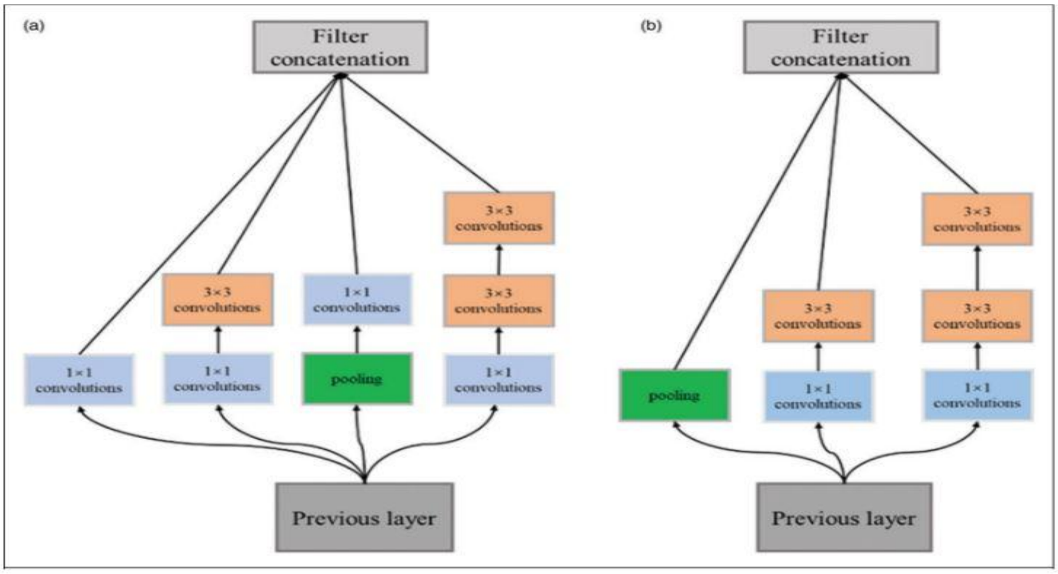
The method first separates the histogram of the input image into two sub-histograms. Then the sub histograms are modified by the plateau limits, which are calculated from the respective sub- histograms. Finally, HE is performed on the modified sub-histograms respectively. The method of image enhancement consists of three main steps: histogram segmentation, histogram modification and histogram transformation.



6.2 Working

1. Preprocessing of fabric images in which we first use a fixed-size square slider to crop the original image to a certain step and regularity. In this paper, we use a square slider with the size of 224x224. To enhance the contrast of the image without causing intensity saturation and detail corrosion
2. Local Defect Detection does a Significant progress has been made on image recognition by moving from the early low-level feature-based algorithms to deep learning-based frameworks. The advancement of deep learning, this approach applies a sparse CNN using an Inception module30 to predict the possibility of defects in the image.
3. Global defect detection, After all box-images have been predicted, we can obtain a feature map for the input image. Then a simple CNN is applied to recognize the defect type based on the feature map with a size of 32x24. Firstly, the feature map is normalized into a square of size 32x32, by way of zero padding. The proposed method applies INCEPTION-v5 to recognize the feature map.



6.3 Evaluation Metrics

In this study, we use the following evaluation metrics to appraise the performance of defect detection models. The evaluation metrics are detection rates (DR), false alarm rates (FR), area under the curve (AUC) and detection success rates (also known as detection accuracy and called DACC), all of which are expressed as percentages. Their definitions are as follows

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$$D_R = \frac{TP}{M}$$

$$F_R = \frac{FP}{N}$$

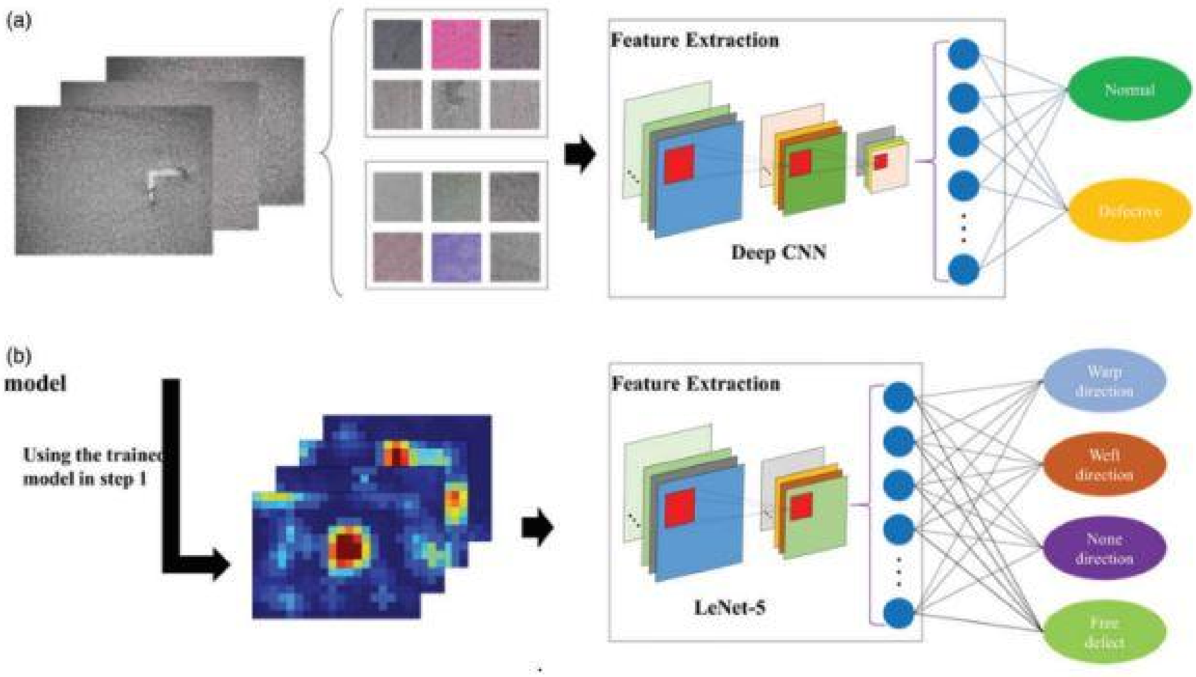
$$AUC = \frac{\sum_{i \in positive} rank_i - \frac{M \times (M+1)}{2}}{M \times N}$$

$$D_{ACC} = \frac{TP + TN}{FP + FN + TN + FP}$$

where, M and N respectively denote the total number of defect and defect-free images. The definitions of TP, FP, FN and TN can be seen in Table. If we sort all the verification samples from small to large according to the probability, then rank represents the serial number of the positive sample.

Metrics	Without pre-processing	With grayscale stretching	With proposed equalization
Precision			
Normal	92.5%	92.7%	93.7%
No direction	93.3%	93.5%	93.8%
Warp direction	88.6%	91.1%	91.7%
Weft direction	87.6%	89.2%	90.4%
AUC	0.895	0.907	0.912
D_R	90.8%	91.2%	92.1%
F_R	8.6%	6.9%	5.7%
D_{ACC}	91.1%	92.5%	93.2%

6.4 Experimental Details



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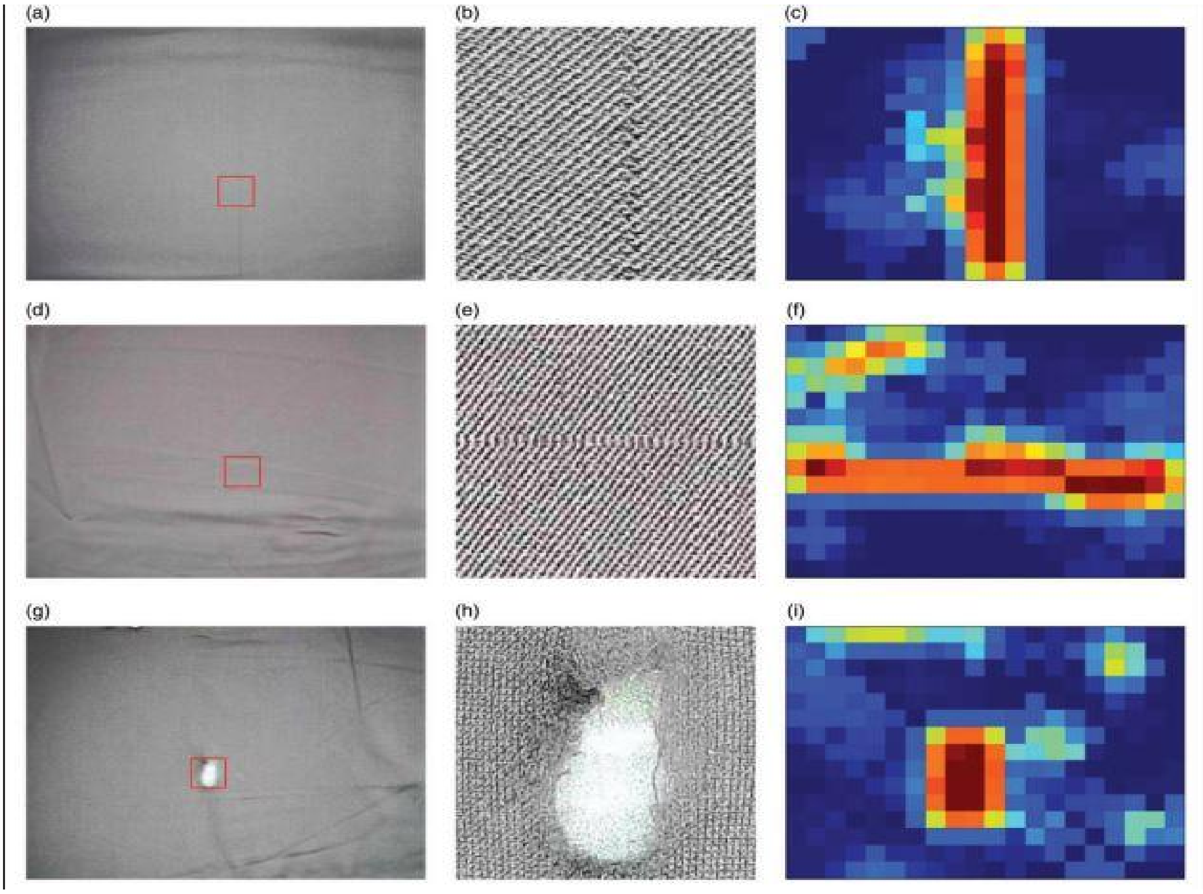

VII. CONCLUSION

In this project, we proposed a system for fabric defect detection using Inception V3. Over all this system shows the potential of operator-assisted systems, which may be easier to implement, low- cost and better to tackle realistic scenarios. In this work, a new CNN based fabric defect detection system, suited for a realistic scenario, was proposed. The CNN method provides good feature detection, as it can be confirmed in Section V-C. This system has the possibility of being operator- assisted whom may confirm or reverse the system evaluation when a possible defect is detected. This increases the system accuracy by reducing the number of FP examples. Therefore, two FN reduction methods were studied. To obtain a reliable dataset that could represent most of the fabric defect types found in the literature, a new dataset was created. In total four different datasets were used to train and test the proposed methods. An average of 75% accuracy was observed in the test datasets when the system was in automatic mode. Therefore, this system outperforms human inspection systems even in automatic mode. When the false negative reduction method was applied, together with the operator intervention, an average of 95% accuracy was attained in the same datasets. These results show that the proposed system achieves better performance when compared to traditional systems and others found in literature, in addition to being much faster, cheaper and easier to maintain. Plus, the time spent by the operator in this system will always be much shorter than in a traditional inspection system. As future work, it would be of interest to develop a larger dataset, with more real-world examples that would allow to train and implement a more complex defect detection system. A larger dataset would allow the use of more complex models, such as Long Short-Term Memory (LSTM) and Transformer networks. To improve the FN reduction functionality, more robust methods that can be executed during training, such as a custom loss function, could be tested. As a final objective, the developed system should be implemented in a real-world environment, to test and compare it to a traditional inspection system.

REFERENCES

[1]. Y. Y. Liu, ‘‘Research on fabric defect detection method based on deep learning,’’ M.S. thesis, Dept. Control Sci. Eng., Harbin Inst. Technol., Harbin, 2020.

[2]. K. Yıldız, Ö. Demir, and E. E. Ülkü, ‘‘Fault detection of fabrics using image processing methods,’’ Pamukkale Univ. J. Eng. Sci., vol. 23, no. 7, pp. 841–844, 2017.

[3]. W. Wong and J. Jiang, “Computer vision techniques for detecting fabric defects,” in *Applications of Computer Vision in Fashion and Textiles*, Elsevier, Amsterdam, Netherlands, 2018.

[4]. T. Czimmermann, G. Ciuti, M. Milazzo et al., “Visual-based defect detection and classification approaches for industrial applications-a survey,” *Sensors*, vol. 20, no. 5, p. 1459, 2020.

[5]. M. F. Nisha, P. Vasuki, and S. M. M. Roomi, “Survey on various defect detection and classification methods in fabric images,” *Journal of Environmental Nanotechnology*, vol. 6, no. 2, pp. 20–29, 2017.

[6]. M. Li, S. Wan, Z. Deng, and Y. Wang, “Fabric defect detection based on saliency histogram features,” *Computational Intelligence*, 2019.

[7]. W. Ouyang, B. Xu, J. Hou and X. Yuan, "Fabric defect detection using activation layer embedded convolutional neural network", *IEEE Access*, vol. 7, pp. 70130-70140, 2019.

[8]. L. Li, "Research on fabric defect detection method based on convolutional neural network", 2019.

[9]. H. P. Liu, "Research on nonwoven fabric defect online detection system using machine vision", 2015.

[10]. W. J. Liu, H. Liu, Z. R. Li and D. Y. Lai, "A fabric defect detection algorithm based on image enhancement and CNN", *Comput. Technol. Develop.*, vol. 31, pp. 90-95, Jan. 2021.