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A Study on Applications of Machine Learning Concepts in Textile Industry

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Abstract *— Textile industry has been one of the major contributing sector towards growth of the nation and towards increasing employment since clothing has been as basic need. Textile industry all over the world has been a labour requiring and is highly fragmented. This industry is dominated by small, unorganised and medium industries which requires lot sum of investments in labour and a time requiring process. Automation of cutting and stitching process has made the entire process more efficient, by reducing errors in cutting when done manually and made the process more efficient. The machines are trained to learn designs that are given as inputs and cut the running clothes accordingly. This report details the improvement and comparison of using automated tools over manual process and implementation in various countries.*

Keywords *– machine learning, automation, textile industry and efficiency.*

I.INTRODUCTION

Textile industry is one of the most vital industries that outperform when implemented efficiently in more planned and organised way. There are industries that are moving from manual process of cutting, stitching, knitting, and quality assurance into automation where systems that are trained with machine learning algorithms. These algorithms help the system learn the input design and aid in bringing down the time spent on manual process and reduce the risk of errors and wastage from the errors. Time efficiency is more important because of the increased competition from both domestic and international markets. However, with a reservoir of experience and expertise within the industry, it could re-establish itself as a forceful industry with an ability to challenge competitors both domestically and internationally through a focus on added value, exceptional quality, and the effective application of all resources through technological innovation.

Issues that influence the clothing and textile industry include mechanisation and automation, research and development, the expertise and skills base, quality orientation and, above all, the eradication of import quotas. Other factors influencing the decline in the clothing industry in India include:

- An inability to adjust to the changes in the industry
- Possible lack of effective performance management and leadership qualities
- Family-owned businesses that were operated conservatively with low investment and a lack of managerial qualities
- Lack of knowledge, skills, and training strategies in the industry
- Lack of strategic thinking and positioning
- A pressurised industry
- Working in manual environment
- Lack of efficient communication
- Internal politics in organisations

The research methodology adopted in this investigation included a literature review of available documents on the industry, and interviews and discussions with organisational staff and leadership in a case study context.

II.OBJECT RECOGNITION AND CNN

AlexNet is a convolutional neural network architecture and consists of eight learning, five convolutional, and three fully connected layers. Usually, the convolutional layers include a convolution step, pooling step, and activation functions. Specifically, the convolution step is a set of learnable filters that are responsible for extracting features from the input image. AlexNet involves 60 million parameters and a neural network with 650,000 neurons consisting of five convolutional layers, some of which consist of three fully connected layers with a maximum pooling layer followed by the last 1000-way softmax. To make training faster, unsaturated neurons and highly efficient Graphic Processing Unit (GPU) convolution operations have been used. To reduce overfitting on fully connected layers, a normalization method called "dropout" was used, and the top test error rate of 15.3% was achieved and compared to the error rate of 26.2% achieved by a variant of this model presented in the ILSVRC 2012 competition.

AlexNet has five convolutional layers, three fully connected layers, three max-pooling layers, two cross-channel normalization layers, two dropout layers, and seven rectified linear unit (ReLU) layers. The first layer learns the first-order features, such as colour and edges. The second layer learns the corners. The third layer learns about small patches or textures. The fourth and fifth layers learn the higher-order features of the input space. Then, the final-layer features are fed into a supervised layer to complete the task, such as regression. The transfer-learned AlexNet predicts the demonised image from the features learned from the hidden layers.

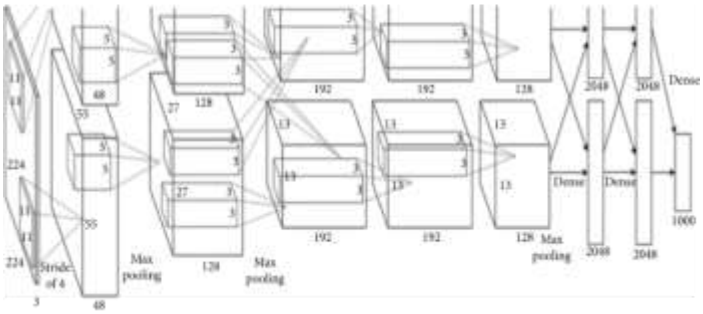

Fig 1: AlexNet Architecture

III.AUTOMATION IN MANUFACTURING INDUSTRIES

Factory automation refers to a system that automates the entire unmanned factory and manufacturing process using automatic equipment, such as computers and robots. In contrast, smart factories give each function to various objects related to manufacturing. Each of these objects is a factory that communicates to each other through internet of things (IoT) devices and can autonomously connect, collect, and analyse data. Smart factory and automation systems can enable the development of a fashion system based on the product quantities that are better balanced with market demand, more consistent with the customers' needs, highly customized, and transparent for their entire lifecycle. Focusing on the 4.0 smart factory, the garment manufacturing industry needs to be transformed into an automated manufacturing process through several technologies such as computer systems and digital facilities because of the limitations of the relocation of the production base and the needs of customers.

The complete automation of garment manufacturing is impossible because a human force is still needed to control the direction and position of the sewn fabric during the sewing process. Regardless of how much technology develops, more than 95% automation appears impossible because garment styles change very quickly, and its forms are so numerous. Nevertheless, partial automation is being realized gradually. Research on automation is aimed at automatically and easily manufacturing garments and textiles for sale rather than prototypes. Therefore, a future garment manufacturing system is expected to be a smart factory. This is because the production costs are increasing gradually, and reactive and local production according to customization needs is required.

IV.CASE STUDY OF MANUFACTURING PROCESS AUTOMATION IN CLOTHING AND TEXTILE FIELDS

Existing systems include

- A robot-based sewing system named SEWBO (Sewbo, Inc., Seattle, WA, USA) sewed all the necessary seams of a T-shirt automatically using an industrial robot arm.
- Within the project speed factory of Adidas, a new sewing system to sew two layers of textiles automatically has been developed by the Institute Textiletechnik of the RWTH Aachen University. The system consists of two transport rollers to guide textiles with different contours through the sewing process individually.
- Philipp Moll proposed an innovative concept for garment manufacturing. The concept comprised a holistic, general production line from cutting, and transport to the sewing process with the following three parts: fast automated single-ply cutting, automatic robotic pick-up of fabric parts and transfer to an automatic hanging transport system, and sewing process with a traditional sewing technique and robotic 3D assembling.

This paper proposes a system to establish an automated process for garment manufacturing with various machines and technologies. To this end, the currently developed automated sewing system was examined, and a new automatic manufacturing process for smart clothing was proposed. Smart clothing is a new clothing concept with the convergence of information and communication technology (ICT). Therefore, the material constituting it is relatively limited compared to that generally required to produce fashion clothing, and the design is also simple. For these reasons, smart clothing was selected as the target item for establishing an automated process for manufacturing garments. For this purpose, the 2D–3D computer aided design (CAD) system, technical embroidery technology, robot-based gripping system, and automatic sewing system were used to connect the process and analyse the correlation between textile and process conditions at each stage. Through this, the production system for a sports bra with a light-emitting diode (LED) system was optimized.

V. VISION BASED SHAPED RECOGNITION MODULE

The vision-image processing technique was applied to recognize the shape of a fabric object automatically and to make a proper decision for optimal gripping of the object. The vision camera (CAM) was attached below the gripper jig structure with a flashlight. OpenCV, the most popular and powerful open-source computer vision library, was used to construct the vision-based shape recognition algorithm.

The final vision-based recognition module has two functions: marker recognition and shape recognition. The marker recognition was required to determine whether to start the automatic fabric handling processes, including gripping, transferring, and releasing steps. The speed-up robust features (SURF) algorithm was used to detect the pre-specified marker in a fabric object in a real-time manner with a CAM image at a rate of 30 frames per second (fps). The next step begins once the SURF-based algorithm confirms the marker position for two seconds (60 frames) within the CAM screen.

The second step is to match the real-time CAM images with the pre-designed CAD pattern (2D) images. As a second step in the vision system, the fabric shape-recognition algorithm works by matching the pre-designed CAD pattern image to real-time vision CAM images. To increase the recognition accuracy, several types of image features were considered and tested, such as the contour, edges, and corner, and the corner-based features were finally chosen as the features of the CAM images.

VI. DATA COMMUNICATION MODULE AND TOTAL SYSTEM DEVELOPMENT

The heterogeneous communication network environment for the robot, AC servomotors, and grippers should be established to transfer the information obtained from the shape recognition module.

- PC to Robot: Transmits the x, y coordinates of the target's center point by Ethernet-based socket communication.
- PC to Grippers: Transfers the specified stroke length of needle gripper using Ethernet/IP communication.
- PC to Jig (AC servomotors): Sends the determined gripper positions through Ethernet for control automation technology(EtherCAT) communication.

The processed data from the vision-based shape recognition module and data 2 were transferred to the PC, and the data on the robot movement, needle stroke, and gripper position were generated and given to each device: the robot arm, grippers, and AC servomotors. The 6-DOF robot equipped with the gripping sub-system could grasp the fabric at its optimal points and move it to the target position precisely. To estimate the transferring accuracy, the difference between the target position and actual position capture by the CAM was calculated by considering the pixels of the entire fabric (cloth) area. The final accuracy was calculated to be 96.64%.

VII.GARMENTS CLASSIFICATION USING ALGORITHMS

Building an effective classification functions or systems is central to data mining. Provided a partial observation and a classification, a system can statistically identify the unobserved attribute. There are various kinds of techniques used for classification such as Decision Trees, Gradient Boost, Naïve Bayes, ensemble Learning methods, etc. However, this study employs two techniques: Naïve Bayes, Bayesian Forest.

1. Naïve Bayes classifier

It is a probabilistic machine-learning model, which is a collection of classification algorithms based on Bayes' Theorem. It is considered fast, efficient, and easy to implement. It assumes that the predictive features are mutually independent given the class. In this study, the Bernoulli Naïve Bayes algorithm is used, where each feature is supposed to be a binary-valued variable. Assuming that we have an object F represented by a given feature vector of m-dimensions, i.e., Fi = (f1, f2, . . . ,fm) i , which is a Boolean expressing absence or presence of the ith feature. Based on the features, the object can be classified into a class ci in C = (c1, c2, . . . ,cw).

2. Bayesian Forest

A Bayesian Forest is another ensemble learning method where the decision tree formation relies on the Bayesian statistics. In RF, the training of the multiple random trees takes place and the appropriate tree configuration is selected, which results in the best classification. In a Bayesian-based random forest method, the Bayesian statistics are used for the selection of random decision trees from a collection of trees. The Bayesian approach starts with a prior distribution. Subsequently, it estimates a likelihood function for each set of data in a decision tree. Bayesian forest draws the weights of the trees from an exponential distribution and the prediction is an approximate posterior mean.

VIII. CONCLUSION

The paper aims at describing the pros and advantages gained over using an automate or a semi-automated system over the manual old process of clothe manufacturing. This suggests he best way to use automation in industry and the technique involved, as a testing phase this can be implemented in a small unit of the entire production which can be later implemented in large scale. The garment industry in India has been going through a remarkable phase of growth and restructuring over the last 15years and still boosted by the invention of deep learning and machine learning fields which help in even faster growth.

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