ABSTRACT
The primary goal of pattern recognition is supervised or unsupervised classification. Among the various frameworks in which pattern recognition has been traditionally formulated, the statistical approach has been most intensively studied and used in practice. More recently, neural network techniques and methods imported from statistical learning theory have deserved increasing attention. The design of a recognition system requires careful attention to the following issues: definition of pattern classes, sensing environment, pattern representation, feature extraction and selection, cluster analysis, classifier design and learning, selection of training and test samples and performance evaluation. The general problem of recognising complex pattern with arbitrary patterns with arbitrary orientation, location and scale remains unsolved. New and emerging application, such as data mining, web searching, retrieval of multimedia data, face recognition and cursive handwriting recognition, require robust and efficient pattern recognition techniques. The objective of this review paper is to summarise and review some of the well-known methods used in various stages of a pattern recognition system and identify research topics and applications which are at the forefront of this exciting and challenging field. In the literature, Pattern recognition frameworks have been drawn closer by different machine learning strategies. This part reviews 33 related examinations in the period between 2014 and 2017.

1. Introduction

Data Mining includes various systems for preprocessing, analysing and interpreting data. These strategies fall fundamentally in two fields: Pattern Recognition and Machine Learning. The objective of pattern Recognition is the recognisable proof of verifiable items and relations, i.e. the extraction of patterns from the input data. These procedures are mostly related with image analysis despite the fact that this isn’t the main sort of application.

Machine Learning procedures are for the most part connected to extract generalised knowledge from information (including images) that will be additionally utilised for prescient errands [1]. A few arrangements have been proposed to defeat the Pattern Recognition issue. Among this strategy, much interest has been focused on the machine
learning strategies. These incorporate rule based learning, Naive Bayes classifier, decision trees, support vector machines (SVMs). These methodologies share the same underlying principle that they don’t require determining any rules expressly [2]. Machine learning strategies can be characterised by the input data: supervised and unsupervised classification. In directed classification approach, classes are characterised by the pre-stored learning information with pre-characterised classes for every component of the information. Nonetheless, in unsupervised order conspire, the classes are resolved utilising the likeness of classes and the input pattern is allotted as needs be [3].

Many supervised learning methods such as Transfer learning, Multi-instance learning, and the new trends in deep learning techniques were used for the formulation of solutions to the pattern recognition problem for example, in drug activity prediction, text classification, image classification, object detection, and visual tracking [4]. The radiation of solar can be predicted efficiently using this machine learning techniques mainly with Artificial Neural Networks (ANN) which involves the frequently used technique such as SVM, Support Vector Regression (SVR) and K-mean methods as well as the rarely used methods such as Boosting, Regression Tree and Random Forest [5]. In the field of medical imaging, the performance of the Convolutional Neural Networks (CNNs) for nodule detection in medical image analysis tasks can be improved by presenting the new approach for eliminating the hand-crafted features called Massive-Training Artificial Neural Networks (MTANNs). Without using any high level semantic features, this model can detect and classify the focal defects [6].

Apart from various pattern recognitions such as face recognition, speech recognition, handwritten word recognition and fingerprint recognition the iris matching recognition is one of the peculiar solution to the biometric services since the features from iris images are highly distinctive and stable regardless of the age of the person [7].

Pattern recognition is concerned with the design and development of systems that recognise patterns in data. The purpose of a pattern recognition programme is to analyse a scene in the real world and to arrive at a description of the scene which is useful for the accomplishment of some task. The real world observations are gathered through sensors and pattern recognition system classifies or describes these observations. A feature extraction mechanism computes numeric or symbolic information from these observations. These extracted features are then classified or described using a classifier. The process used for pattern recognition consists of many procedures that ensure efficient description of the patterns. So there is a need of ensured and knowledge technique for pattern recognition for improving the recognition rate or accuracy. In order to analyse the better pattern recognition method a review paper is designed out which analyses the machine learning based Pattern Recognition using different recent technologies to improve the performance, accuracy of the best solutions for the problems involved in data mining and other related fields. Various pattern recognition models are shown in Table 1.

2. Review on Pattern Recognition

Automatic (machine) recognition, description, classification, and grouping of patterns are critical issues in an assortment of building and logical teaches, for example, as biology, psychology, medicine, marketing, computer vision, artificial intelligence, and remote sensing.
Table 1. Pattern recognition models.

| Approach                  | Representation          | Recognition function          | Typical criterion          |
|---------------------------|-------------------------|------------------------------|----------------------------|
| Template matching         | Samples, pixels, curves | Correlation, distance measure | Classification error       |
| Statistical               | Features                | Discriminant function        | Classification error       |
| Syntactic or structural   | Primitives              | Rules, grammar               | Acceptance error           |
| Neural networks           | Samples, pixels, features | Network function              | Mean square error           |

A pattern is as the inverse of a turmoil it is a substance, dubiously characterised, that could be given a name. For instance, a pattern could be a fingerprint image, a handwritten cursive word, a human face, or a speech signal. Given a pattern, its recognition or classification may comprise of one of the accompanying two tasks (1) supervised classification (e.g. discriminant examination) in which the input pattern is recognised as an individual from a predefined class, (2) unsupervised classification (e.g. clustering) in which the pattern is appointed to an until now obscure class. Note that the recognition issue here is being acted like a classification or categorisation task, where the classes are either characterised by the framework planner (in supervised classification) or are educated in light of the similitude of patterns (in unsupervised classification). These applications incorporate data mining (recognising a pattern, e.g. correlation, or an anomaly in a large number of multidimensional patterns), document classification (proficiently seeking content archives), monetary determining, association and recovery of interactive media databases, and biometrics (individual distinguishing proof in view of different physical properties, for example, face and fingerprints).

D’Addona DM et al. have displayed a tool-wear prediction and pattern-recognition utilising artificial neural network (ANN) and DNA-based computing (DBC). Overseeing tool-wear was a critical issue related with all material expulsion forms. This paper manages the utilisation of two nature-inspired computing systems, to be specific, ANN and DBC for dealing with the tool-wear. Test information has been utilised to prepare the ANN and, at that point, to play out the DBC. It was exhibited that the ANN can foresee the level of tool-wear from an arrangement of tool-wear images handled under a given technique while the DBC can distinguish the level of similitude/different among the prepared images. Additionally, study can be completed while tackling other complex issues coordinating ANN and DBC where both prediction and pattern-recognition were two critical computational issues that should be understood all the while [8]. Table 2 shows some examples of pattern recognition application.

Gao G et al. have depicted a technique by abusing the low-rankness of both the information portrayal and every impediment initiated error image all the while, by which the worldwide structure of information together with the error image can be very much caught. For robust face recognition errands, we especially concentrate on the omnipresent situations where both training and testing images were tainted because of impediments. To take in more discriminative low-rank portrayals, we define our target to such an extent that the scholarly portrayals were ideal for classification with the accessible administered data and near an ideal-code regularisation term. With solid structure data saving and segregation capacities, the learned robust and discriminative low-rank representation (RDLRR) works extremely well on face recognition issues, particularly with face images defiled by constant impediments. Together with a straightforward direct classifier, the approach was appeared to beat a few other state-of-the-art face recognition strategies on databases with an assortment of face varieties [9].
Table 2. Examples of pattern recognition application.

| Problem domain          | Application                          | Input pattern                  | Pattern classes                                      |
|-------------------------|--------------------------------------|--------------------------------|------------------------------------------------------|
| Bioinformatics          | Sequence analysis                    | DNA/Protein sequence           | Known types of genes/patterns                        |
| Data mining             | Searching for meaningful patterns     | Points in multidimensional space| Compact and well separated clusters                  |
| Document classification | Internet search                      | Text document                  | Semantic categories (e.g. business, sports, etc.)     |
| Document image analysis | Reading machine for the blind         | Document image                 | Alphanumeric characters, words                       |
| Industrial automation   | Printed circuit board inspection      | Intensity or range image       | Defective/non defective nature of product            |
| Multimedia database retrieval | Internet search                      | Video clip                     | Video genres (e.g. action, dialogue, etc.)            |
| Biometric recognition   | Personal identification               | Face, iris, fingerprint        | Authorized users for access control                  |
| Remote sensing          | Forecasting crop yield                | Multispectral image            | Land use categories, growth pattern of crops         |
| Speech recognition      | Telephone directory enquiry without operator assistance | Speech waveform               | Spoken words                                         |

Iwana BK et al. have examined a dynamic time warping (DTW) based DSE with the end goal of the classification of monstrous arrangements of fleeting patterns. Dissimilarity space embedding (DSE) presents a strategy for speaking to information as vectors of dissimilarities. This portrayal was intriguing for its capacity to utilise a dissimilarity measure to implant different patterns into a vector space. Be that as it may, utilising extensive informational indexes presents the issue of requiring a high computational cost. To address this, we consider a prototype selection approach. A vector space made by DSE offers us the capacity to regard its autonomous measurements as features taking into consideration the utilisation of feature selection. This strategy abuses this and decreases the quantity of prototypes required for exact classification. To approve this technique, they utilise two-class classification on an informational index of written by hand on-line numerical digits. The recreation comes about demonstrate that by utilising DSE with group classification, high accuracy 96.67 ± 4.38% classification was conceivable with not very many prototypes [10].

Mage L et al. have enhanced predictive modelling of decomposition characteristics got from Differential Scanning Calorimetry (DSC), through the execution of pattern recognition as an essential classification. With regards to process and item outline, predictive models were progressively utilised. Decomposition properties of chemicals might be tentatively decided through calorimetric estimations, and a couple of molecular structure-based models-which connect the molecular structure of mixes with their decomposition properties were likewise accessible. For this reason, the whole decomposition pinnacles of the atoms were spoken to and treated with image processing algorithms to recognise the diverse patterns. Predictive modelling was then performed inside the classifications and contrasted with a worldwide model forecast [11]. Table 3 shows the links between the statistical and neural network methods.

Naz S et al. have designed a cross breed approach in light of explicit feature extraction by combining convolutional and recursive neural networks for feature learning and classification of cursive Urdu Nastaliq script. Late advancements in acknowledgment of cursive scripts depend on understood feature extraction strategies that give better outcomes when
Table 3. Links between the statistical and neural network methods.

| Statistical pattern recognition                      | Artificial neural networks                      |
|------------------------------------------------------|-------------------------------------------------|
| Linear discriminant function                        | Perception                                      |
| Principle component analysis                        | Auto associative network, and various PCA networks|
| A posteriori probability estimation                  | Multilayer perception                            |
| Nonlinear Discriminant analysis                     | Multilayer perception                            |
| Parzen window density based classifier               | Radial basis function network                   |
| Edited K-NN rule                                     | Kohonen’s LVQ                                    |

contrasted with customary high-quality feature extraction approaches. The primary layer separates low-level translational invariant features utilising Convolutional Neural Networks (CNN) which were then sent to Multi-Dimensional Long Short-Term Memory Neural Networks (MDLSTM) for contextual feature extraction and learning. Trials were completed on the freely accessible Urdu Printed Text-line Image (UPTI) dataset utilising the proposed progressive mix of CNN and MDLSTM. An acknowledgment rate of up to 98.12% for 44-classes was accomplished beating the state-of-the-art comes about on the UPTI dataset [12].

Uhlmann E et al. have clarified a plausibility of pattern recognition utilising an alternate historical process and sensors data from a SLM machine to enhance the analysis. Selective Laser Melting (SLM) was an added substance producing process, in which the examination has been expanding in the course of recent years to meet client particular prerequisites. In this way, new assembling parameters have been observed raising the quantity of sensors in the machines. Thus, it prompts a greater measure of data and troubles to perform manual data analysis. The outcomes were assessed utilising a clever apparatus for calculations setup and data analysis created [13].

Peralta D et al. have displayed a way to deal with fingerprint classification utilising convolutional neural networks, which stay away from the need of an explicit feature extraction process by fusing the image processing inside the preparation of the classifier. Fingerprint classification was standouts amongst the most widely recognised ways to deal with quicken the ID in huge databases of fingerprints. Fingerprints were assembled into disjoint classes, so an info fingerprint was contrasted just with those having a place with the predicted class, lessening the infiltration rate of the inquiry. The classification methodology more often than not starts by the extraction of features from the fingerprint image, much of the time in view of visual characteristics. This could foresee a class notwithstanding for low-quality fingerprints that were dismissed by ordinarily utilised calculations, for example, Finger Code. The examination gives exceptional significance to the robustness of the classification for various impressions of a similar fingerprint, expecting to limit the infiltration in the database. In tests, convolutional neural networks yielded preferred precision and infiltration rate over state-of-the-art classifiers in view of explicit feature extraction. The tried networks likewise enhanced the runtime, because of the joint optimisation of both feature extraction and classification [14].

Chatterjee A et al. have demonstrated an anti-spoof touch less 3D fingerprint detection system utilising a blend of single shot fringe projection and bio speckle analysis. Fingerprint was a one of a kind, un-alterable and effectively gathered biometric of a person. Despite the fact that it was a 3D biological characteristic, conventional techniques were intended to give just a 2D image. This touch-based mapping of 3D shape to 2D image misfortunes data and prompts nonlinear distortions. In addition, as just topographic subtle elements
were caught, traditional systems were conceivably defenceless against spoofing materials. For fingerprint detection utilising fringe projection, light from a low power LED source enlightens a finger through a sinusoidal grating. The fringe pattern regulated due to features on the fingertip was caught utilising a CCD camera. Fourier transform technique based recurrence sifting was utilised for the remaking of 3D fingerprint from the caught fringe pattern. In the following stage, for spoof detection utilising bio speckle analysis a visuono numeric algorithm in light of the altered basic capacity and non-normalized histogram was discussed. High activity bio speckle patterns were produced on account of cooperation of collimated laser light with inward fluid flow of the genuine finger test [15].

Peralta D et al. have portrayed a complete identification system with a hierarchical classification structure that circuits the data of multiple feature extractors. Fingerprint recognition has been a hot research theme along the most recent couple of decades, with numerous applications and consistently developing populaces to distinguish. The need of adaptable, quick identification systems was therefore patent in such circumstances. In this unique situation, fingerprint classification was usually used to enhance the speed of the identification. A feature determination was connected to enhance the classification precision. At last, the distributed identification was done with an incremental inquiry, investigating the classes as indicated by the likelihood arrange given by the classifier. A single parameter tunes the trade-off between identification time and exactness. This technique was assessed more than two NIST databases and a vast synthetic database, yielding penetration rates near the ideal estimates that can be come to with classification, prompting low identification times with little or no precision misfortune [16].

Zeng Y et al. have clarified a novel traffic sign recognition approach based on the examination on the impact that colour spaces have on the portrayal learning of the convolutional neural system. A DP-KELM was examined utilising a kernel-based extreme learning machine (KELM) classifier with profound perceptual features. Traffic sign recognition assumes a vital part in self-sufficient vehicles and in addition propelled driver help systems. Albeit different methods have been created, it was as yet troublesome for the state-of-the-art algorithms to get high recognition exactness with low computational expenses. Dissimilar to the past methodologies, the portrayal learning process in DP-KELM was executed in the perceptual Lab colour space. Based on the adapted profound perceptual feature, a kernel-based ELM classifier was prepared with high computational effectiveness and speculation execution. Through the analyses on the German traffic sign recognition benchmark, this method was exhibited to have higher exactness than a large portion of the state-of-the-art approaches. In particular, when contrasted and the hinge loss stochastic gradient descent method which has the highest exactness, this method can accomplish an equivalent recognition rate with significantly less computational expenses [17].

3. Review on Machine Learning

Machine learning is the investigation of rousing PCs to act without being unequivocally redone. In the earlier decade, machine learning has given us self-driving vehicles, sensible pattern recognition, fruitful web administrations, and an incomprehensibly upgraded understanding of the human genome. Various Researchers similarly think it is the best way to deal with pick up change towards human-level Artificial Intelligence. Some of the research papers related to the Machine Learning techniques are described below:
Muhammad Jamal Afridi et al. have researched the chance of suddenly positioning source Convolutional Neural Networks (CNNs) going before to utilising them for the goal work. In particular, they have exhibited a data theoretic structure to welcome the source-target relationship and considered that as an establishment to determine the system to mechanically rank source CNNs in efficient, zero-shot form. The ongoing adequacy of the approach was efficiently evaluated utilising the Places-MIT dataset, MNIST dataset and a certifiable MRI database. The exploratory outcomes were approved the effectiveness of the proposed positioning strategy for transfer learning [18].

Olfa Ben Ahmed et al. have concentrated on the combination of integral data and proposed a Multiple Kernel Learning (MKL) structure for the acknowledgment of Alzheimer's disease (AD). In their work, they have proposed the strategy for extraction of the nearby picture got biomarkers from Diffusion Tensor Imaging (DTI) which was another methodology giving reciprocal data and Structural Mild Cognitive Impairment (SMCI) to develop multimodal AD marks. Their proposed strategy was tested and assessed on a subset from the Alzheimer's malady Neuroimaging Initiative (ADNI) dataset. The accomplished outcomes assign that their multimodal approach delivered the generous upgrade in precision over utilising every last single methodology independently [19].

Zeyad Hailat et al. have concentrated on the Face Recognition Problem by building up the hand-created and Unsupervised Learning strategies. They have demonstrated the diverse modalities to exchange various data. In their work, they have proposed a profound element learning based Multi-Channel Multi-Model Feature Learning (McMmFL) framework to decide the discriminative highlights in question acknowledgment issues. They have proposed an Auto-Encoder (AE) for improvement that fuses the Alternating Direction Method of Multipliers (ADMM). Their proposed technique used the advantage of K-means Clustering and Histogram of Gradients (HOG) to build the acknowledgment rates. The proposed work has actualised three benchmark facial informational collections that incorporate AR, Yale, and PubFig83 with various acknowledgment rates, separately [20].

Rana Aamir Raza Ashfaq et al. have proposed Fuzziness based Semi-Supervised Learning Approach (FSSLA) by utilising unlabelled examples bolstered with Supervised Learning Algorithm (SLA) to build up the execution of the classifier for the Intrusion Detection Systems (IDSs). They have composed a Single Concealed Layer Feed-forward Neural Networks (SLFN) to yield a fuzzy membership vector, and to acquire low, high, centre level fuzziness classifications on unlabelled specimens was refined utilising the fuzzy amount. Their proposed interruption recognition system was probed on the NSL-KDD dataset. The exploratory results exhibit that unlabelled specimens be suitable to low and high fuzziness bunches make significant impacts to enhance the execution of classifier [21].

Philippe Burlina et al. have itemised the system for Application of Machine Learning Approach utilising Deep Learning for the issue of Automated Retinal Image Analysis (ARIA) and Age-related Macular Degeneration (AMD) examination. They have set up the cautious checking to recognise the beginning and provoke treatment of the neo-vascular shape and additionally dietary supplementation could lessen the danger of vision misfortune from AMD examination, consequently, they have suggested some favoured practice designs for distinguishing people with the middle of the road organise in an opportune way. They have tended to the important 4-class, 3-class, and 2-class AMD brutality order issues. Their proposed structure was investigated the NIH AREDS dataset utilising 5664 shading fundus
pictures and the outcomes gave the enhanced precision of grouping issue for both machine
and doctor reviewing [22].

James H Cole et al. have perceived the capabilities of ‘brain predicted age’ as a biomarker
of individual contrasts in the cerebrum maturing process. They have proposed a Predic-
tive Modelling Approach in light of Deep Learning, and particularly Convolutional Neural
Networks (CNNs), and connected to both pre-handled and crude T1-weighted informa-
tion. They have approved the precision of CNN mind anticipated age utilising a substantial
dataset of solid grown-ups (N = 2001). On all datasets, they have produced the CNN cere-
brum anticipated ages and contrasted with a Gaussian Process Regression (GPR) approach.
The proposed display was investigated BAHC dataset. In their proposed work age forecasts
can be unequivocally delivered on crude T1-weighted information, altogether diminishing
calculation time for novel information, conveying the procedure nearer to giving ongoing
data on cerebrum wellbeing in clinical settings [23].

Xieping-Gao et al. have connected the Hidden Markov Tree model of Dual-Tree Complex
Wavelet Transform (DTCWT-HMT) for smaller scale calcification determination in advanced
mammography. Their proposed DTCWT-HMT could proficiently catch the relationship
between various wavelet coefficients. They have enhanced the highlights of DTCWT-HMT
and DTCWT by utilising Genetic Algorithm (GA). Their proposed demonstrate have utilised
the Extreme Learning Machine (ELM), a proficient learning hypothesis was utilised as the
classifier to analyse the kind and harmful small scale calcifications. Their proposed strategy
was probed the Nijmegen, MIAS and DDSM datasets utilising Area under Curve (AUC) of
Receiver Operating Characteristic (ROC). The test comes about demonstrated the adequacy
of the proposed strategy as far as the precision and steadiness [24].

Janani Kalyanam et al. have concentrated on the patterns in Non-Medical Use of Pre-
scription Medications/Drugs (NMUPD) conduct to build up the procedures in the field
of Digital Epidemiology (DE). They have coordinated the examination of the well-known
small scale blogging website Twitter. In their proposed work, they have separated the
undesirable tweets for regularly manhandled solution opioid pain-relieving drugs Perco-
cet, OxyContin, and Oxycodone from the 11 million gathered tweets. The got undesirable
tweets were done in three ensuing rounds of Unsupervised Machine Learning meth-
ods. Almost 2.3 million tweets were distinguished that contained substance important to
pain-relieving NMUPD. Their proposed approach could be utilised as a part of enormous
information substance manhandle observation, information gathering, and examination
in contrast with different systems that rely on content investigation and human coding
plans [25].

Mohamed Layounit et al. have concentrated on the acknowledgment of signs gath-
ered from the attractive sweeps of metal-misfortune surrenders have particular examples in
Magnetic Flux Leakage (MFL) outputs of pipelines, and utilised them to depict the imperfec-
tion sorts erosion, breaks, gouges, and so on and they have evaluated the lengths and pro-
fundities of deformities. They have tended to the real weight to the human administrator
because of the examination of huge measure of information. In their work, they have pro-
posed an answer for mechanise the investigation of MFL signals. Their proposed arrange-
ment utilised the Pattern-Adapted Wavelets (PAW) to recognise and decide the length of
metal-misfortune abandons. Also, to gauge the profundity of the metal-misfortune sur-
renders, the piece of attractive motion spillage signals equal to the deformities which
were disengaged and the Artificial Neural Networks (ANN) were utilised. At long last their
proposed procedure was tested utilising MATLAB apparatus and the re-enactment comes about were acquired to exhibit the exactness [26].

David M Schnyer et al. have proposed the system for measuring Magnetic Resonance Imaging (MRI) of the human cerebrum White Matter (WM) for the characterisation of grown-ups through Major Depressive Disorder (MDD) and Healthy Controls (HC). In their proposed structure, they have connected the Support Vector Machine Learning (SVML) to the Diffusion Tensor Imaging (DTI) determined Fractional Anisotropy (FA) maps which could be delegated MDD versus HC. The proposed structure was tested by foreseeing best dataset with Right Hemisphere Whole Brain FA Map with eight fundamental datasets and the precision comes about at specific specificity and affectability were gotten [27].

Sanchez et al. described a new model of a Modular Neural Network (MNN) optimised with hierarchical genetic algorithms is proposed. The model uses a granular approach based on the database complexity. In this case the proposed method is tested with the problem of human recognition based on the face information. The ORL and the ESSEX face databases are used to test the effectiveness of the proposed method. To compare with other related works using the same databases, four cases are established (3 for the Essex Database and 1 for the ORL Database). The results using the proposed method are better than the results achieved by other works, and this affirmation is based on a statistical comparison of results. The main idea is to design the architectures of modular neural networks using a Hierarchical Genetic Algorithm (HGA). The distribution of persons in each granule is determined by an initial analysis, resulting in a grouping of data with the same complexity [28].

Castillo et al. explained a new optimisation method for modular neural network (MNN) design using granular computing and a firefly algorithm is proposed. This method is tested with human recognition based on benchmark ear and face databases to verify the effectiveness and the advantages of the proposed method. Nowadays, there are a great number of optimisation techniques, but it is very important to find an appropriate one that allows for better results depending on the area of application. For this reason, a comparison of techniques is presented in this paper, where the results achieved for ear recognition and face recognition by the proposed method are compared against a hierarchical genetic algorithm in order to know which of these techniques provides better results when a modular granular neural network is optimised and applied to pattern recognition mainly for human recognition. The parameters of modular neural networks that are being optimised are: the number of modules (or sub granules), percentage of data for the training phase, learning algorithm, goal error, number of hidden layers and their number of neurons [29].

Melin et al. performs optimal granulation of data and design of modular neural networks architectures to perform human recognition, and to prove its effectiveness benchmark databases of ear, iris, and face biometric measures are used to perform tests and comparisons against other works. The design of a modular granular neural network (MGN) consists in finding optimal parameters of its architecture; these parameters are the number of sub granules, percentage of data for the training phase, learning algorithm, goal error, number of hidden layers, and their number of neurons. Nowadays, there is a great variety of approaches and new techniques within the evolutionary computing area, and these approaches and techniques have emerged to help find optimal solutions to problems or models and bioinspired algorithms are part of this area. In this work a grey wolf optimiser
is proposed for the design of modular granular neural networks, and the results are compared against a genetic algorithm and a firefly algorithm in order to know which of these techniques provides better results when applied to human recognition [30].

From the Table 4 we can clearly understand the performance of the existing pattern Recognition system. In this table some machine learning technique achieved maximum accuracy. The overall processing time also minimised. However, this existing pattern recognition system having some limitation.

4. Review on Pattern Recognition Application

Abeni et al. [31] proposed a face recognition system based on one-class Support Vector Machines for mobile devices running the Symbian Operating System. In the evaluation, the recognition system was tested on a Nokia 6680 mobile phone and the results indicated that an EER of 7.92% and 3.95% could be achieved according to a global threshold and an individual threshold respectively.

Hadid et al. [32] proposed an approach of analysing a face authentication scheme using Haar-like features with Ad-aBoost for face and eye detection. The obtained results were very promising and indicated the feasibility of face authentication on mobile phones. The achieved average authentication rates are 82% for small-sized faces (40 × 40 pixels) and 96% for faces of 80 × 80 pixels respectively.

Tao and Veldhuis [33] developed a low-cost biometric authentication system for mobile devices from face detection, registration, illumination normalisation, verification, to information fusion. Their system could be able to achieve an equal error rate of 2% in the experiment.

Xi et al. [34] proposed a hierarchical correlation based face authentication (HCFA) scheme for mobile devices, which could analyse the relationship between each cross-correlation output peak generated from selected sub-regions of a face. They further implemented the scheme on Nokia S60 CLDC emulator using Java ME and the experimental results showed that the scheme suited resource-constrained mobile computing environment due to the low memory and storage demand. By testing on the Yale Face dataset B, their scheme could achieve an EER of 3.58%.

Findling and Mayrhofer [35] proposed a pan shot face unlock method: a mobile device unlock mechanism using all information available from a 180-degree pan shot of the device around the user’s head. For face recognition, they evaluated different support vector machines and neural networks, and the results demonstrated the feasibility of their approach.

Chen et al. [36] proposed a sensor-assisted facial authentication method, which used motion and light sensors to defend against 2D media attacks and virtual camera attacks. The experimental results showed that the approach could achieve 95–97% detection rate and 2–3% false alarm rate over 450 trials in real-settings.

Rubio et al. [37] explained widespread interest in applying pattern recognition methods to anatomical neuroimaging data, but so far, there has been relatively little investigation into how best to derive image features in order to make the most accurate predictions. In this work, a Gaussian Process machine learning approach was used for predicting age, gender and body mass index (BMI) of subjects in the IXI dataset, as well as age, gender
| Reference            | Reference | Technique                                                                 | System requirement       | Results                                                                 | Conclusion                                                                 |
|----------------------|-----------|---------------------------------------------------------------------------|---------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------|
| D’Addona DM et al. [8]|           | Artificial neural network (ANN) and DNA-based computing                   | MATLAB                    | The error is a bit more than 1% for the 5GB image set                  | ANN and DBC, can be used to reduce unnecessary time and volume of information while solving complex computation problems |
| Gao G et al. [9]     |           | Robust and discriminative low-rank representation (RDLRR) with a simple linear multi-classifier | Yale B data base, Multi-PIE database | Occlusion level is 40%. RDLRR always achieves stable performance when α varies from 0.1 to 1 average of 96.67 ± 4.38% | RDLRR was robust to corruptions: illumination changes, real disguise and block occlusion, and yielded better performances |
| Iwana BK et al. [10] |           | dynamic time warping (DTW) based Dissimilarity space embedding (DSE)       | UNIPEN on-line handwriting data set | DTW-based distance measure can be classified with a high accuracy and low prototype count | DTW-based distance measure can be classified with a high accuracy and low prototype count |
| Mage L et al. [11]   |           | Hierarchical clustering; classification tree                              | 197 DSC curves            | 85% of critical compounds were correctly identified                    | The combination of CNN and MDLSTM proved to be an effective feature extraction method |
| Naz S et al. [12]    |           | CNN and MDLSTM                                                           | UPTI dataset              | recognition rate is 98.12%                                            | The combination of CNN and MDLSTM proved to be an effective feature extraction method |
| Uhlmann E et al. [13]|           | SLM machine. Nearest Neighbour, Bayes Classifier, Neural Network, and Support Vector Machine (SVM), k-mean algorithms | CMT tool                  | The Bayes Classifier, due to the achieved accuracy of 63%              | The result showed that an automatic classification for the SLM machine is possible |
| Peralta D et al. [14]|           | CNN, DNN                                                                 | Intel Core i7-3820 processor (3.60 GHz) and 24GB RAM. The CNNs were run on a single Nvidia GeForce GTX TITAN GPU (2688 cores, 6144 MB GDDR5 RAM). | the proposed network obtains 99.60% accuracy                           | The robustness experiments also showed that the deep learning strategy was able to obtain a very high test accuracy |
| Chatterjee A et al. [15]|        | bio speckle analysis, visuo-numeric algorithm, 3D sensor, MSF* and non-normalized histogram techniques | MATLAB                    | –                                                                       | Overall the proposed technique is very simple, fast, low cost and full field |

(continued)
Table 4. Continued.

| Reference | Technique | System requirement | Results | Conclusion |
|-----------|-----------|--------------------|---------|------------|
| Peralta et al. [16] | AFIS with hierarchical classification | SFinGe, NIST-SD4, NIST-SD14 | Classification accuracy  
For Segmented 0.9376  
For Not segmented 0.9189 | The results obtained over  
several databases highlight  
the very good classification  
accuracy obtained by the  
proposal, while eliminating  
the rejection rate |
| Zeng et al. [17] | DP-KELM, kernel-based extreme learning machine (KELM) classifier with deep perceptual features | 8 Intel(R) Xeon(R) E5-2643  
CPUs (3.30 GHz), 12 GB DDR4 | Recognition rate is 99.54% | The proposed method  
uses a relatively simple architecture that reduces  
the computation cost |
| Muhammad A. Afridi et al. [18] | Deep Learning Technique in Convolutional Neural Networks | Standard MNIST, Places-MIT Databases | Performance percentage is  
60.1% with 5% of selected training data | The Efficiency of ranking  
source CNNs was improved by proposed Information Theoretic Framework |
| Olfa Ben Ahmed et al. [19] | Multiple Kernel Learning Technique | ADNI Datasets | Classification accuracies for AD  
versus NC-90.2%, MCI versus NC-79.42% and AD versus  
MCI-76.63% | Substantial enhancement of  
accuracy could be achieved for recognition of AD by MKL |
| Zeyad Hailat et al. [20] | Unsupervised machine learning with McMmFL method | Benchmark Facial Datasets  
includes AR, Yale, PubFig83 Datasets | Recognition percentage for  
AR-95.04%, Yale-98.97%,  
PubFig83-95.85% | The discriminative features in  
object recognition problems were determined and the  
recognition rates could be improved by McMmFL method |
| Rana Aamir Raza Ashfaq et al. [21] | Fuzziness Based Semi-Supervised Machine Learning Technique | NSL-KDD Dataset | Testing accuracies for KDD  
test+ = 84.12%, KDD test  
test- = 68.82% | The performance of the  
classifier for Intrusion Detection system could be improved by FSSLA |

(continued)
| Reference               | Technique                                      | System requirement                | Results                                                                 | Conclusion                                                                                       |
|------------------------|------------------------------------------------|-----------------------------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Philippe Burlina et al. [22] | Transfer Learning in associate with Deep Learning technique | NIH-AREDS Dataset                | Accuracy (i) for Machine Class 4-79.4%, class 3-81.5%, class 2-93.4% (ii) for physician grading Class 4–75.8%, class 3–85%, class 2–93.4% | The accuracy of the Classification problem of ARIA and AMD analysis were improved using the application of transfer learning technique |
| James H Cole et al. [23] | Predictive Modelling Approach Based on Deep Learning | Large, multi-site BAHC dataset   | RMS Error for Gray Matter (GM) – 5.31, White Matter (WM)-6.54, GM + WM-5.67, Raw-6.46 | The accuracy of CNN brain-predicted age with reduced computation time could be achieved using PMA |
| Xieping-Gao et al. [24] | Hidden Markov Tree Model of Dual-tree Complex Wavelet Transform with Genetic Algorithm | Nijmegen, MIAS, DDSM Datasets     | AUC for Nijmegen-0.9856, MIAS-0.9941, DDSM-0.9168                         | The accuracy and stability could be improved by DTCWT-HMT using Genetic Algorithm for Microcalcification Diagnosis problem |
| Janani Kalyanam et al. [25] | Unsupervised Machine Learning Technique        | TwitterSpherePublic API           | Totally 84.2% of tweets are observed and tested                          | The process of carrying out the unwanted tweets from the TwitterSphere Public API could be achieved by proposed method |
| Mohamed Layounit et al. [26] | Pattern Adapted Wavelets for the detection and sizing of metal-loss defects | MATLAB                           | Length Prediction Accuracy-90%                                         | The estimation of length and depth of metal-loss defects could be achieved with high accuracy using PAW |
| David M Schnyer et al. [27] | Support Vector Machine Learning Technique       | Right Hemisphere Whole Brain FA map with eight datasets | Total Accuracy-74.0% with 80% Specificity and 68% Sensitivity             | The classification of adults with MDD and HC could be achieved by SVML with high accuracy |
and diagnostic status using the ABIDE and COBRE datasets. MRI data were segmented and aligned using SPM12.

5. Future Direction

In current years, deep artificial neural networks have won numerous contests in pattern recognition and machine learning. This review suggests several directions for fruitful research in pattern recognition such as Face Recognition, Handwritten cursive word Recognition, Speech Signal Recognition, Iris Recognition and Fingerprint Recognition. We can use Machine learning technique to analyse high dimensional data with unknown statistical characteristics for precision crop protection by learning the model structure directly from training data.

6. Conclusion

Pattern Recognition is a develop yet energising and quick creating field, which supports for the improvements in related fields, for example, Computer Vision, Content (text) and Record Examination, Radar Processing, Speech Recognition, Text Classification, Image Processing and Neural Network Systems. It is firmly likened to Machine Learning, and furthermore discovers applications in quick rising ranges, for example, Biometrics, Bioinformatics, Big Data Analysis and most of the recently developed data science. It is the way toward grouping input information into items or classes depends upon the key highlights. Hence, this review paper has been analysed various recent Pattern Recognition Methodologies using different Machine Learning techniques. Machine learning is so unavoidable today that we presumably utilise it many times each day without knowing it. Machine learning techniques are frequently sorted as being supervised or unsupervised. In this supervised methodology, the algorithm expects people to give both information and wanted yield, not with-standing outfitting input about the exactness of forecasts throughout the preparation. When preparing is finished, the calculation will apply what was found out to new information. In Unsupervised methodology, the algorithm should not be prepared with wanted result information. Rather, they utilise an iterative approach called Deep Learning to audit information and reach at conclusions. Unsupervised learning methods are utilised for more unpredictable tasks than the supervised machine learning frameworks. Here, the recent Pattern Recognition methodologies with the different solutions for different classification problems have been demonstrated and reviewed researches focused on this Machine Learning Techniques particularly. Also the review paper has analysed the Pattern Recognition includes the Face Recognition, Handwritten cursive word Recognition, Speech Signal Recognition, Iris Recognition and Fingerprint Recognition.

From this carried out review, it is also found that invariant pattern recognition is desirable in many applications such as character and face recognition. Early research in statistical pattern recognition did emphasise extraction of invariant features which turns out to be a very difficult task. Recently there has been some activity in designing invariant recognition methods which do not require invariant features. For example, the nearest neighbour classifier using tangent distance and deformable template matching. These approaches only achieve invariance to small amounts of linear transformations and nonlinear deformations. Besides, they are computationally very intensive. Simard et at. Proposed an algorithm
named tangent-prop to minimise the derivative of the classifier outputs with respect to distortion parameters, that is to improve the invariance property of the classifier to the selected distortion. This makes the trained classifier computationally very efficient. In future in order to achieve better accurate in both identity and verification tasks of pattern recognition in various application we can use some adaptive or hybrid machine learning technique.

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