Pattern Recognition Models: A Study and Review

Alifiya Jahagirdar
Ph.D Student, Department of Computer Science
University of Pune, Pune

Dr. Vrushsen Pawar
Professor and Head, Department of Science
Water and Land Management Institute Aurangabad, India

Abstract: **Pattern recognition has become more popular in the coming years and it's applied in the wider areas of research. The application areas spread into medicine, bioinformatics, data mining, speech recognition, handwriting recognition, face recognition, objects in satellite images and many others. In this paper we have reviewed methods used in pattern recognition. We will be studying different methods used for pattern recognition like statistical and structural techniques, template matching, neural network, fuzzy method and hybrid models.**

Keywords: Pattern recognition, statistical, structural, template matching, neural network, fuzzy, hybrid.

I. INTRODUCTION

Recognizing patterns and Classification have gained interest due to human beings, they have developed skills to observe and take actions by using environment. For example a human can recognizes faces, handwriting without thinking of other properties affecting the objects. When human needs to implement recognition artificially it becomes more complex task. To solve the complexity artificial intelligence is made by using machines which acts like human and is very intelligent to recognize patterns in different environmental conditions. A branch of artificial intelligence is known as pattern recognition. It can be used in many categories like recognition and classification. It is used in different areas like medical, GIS and remote sensing, data mining.

A. Pattern

A pattern is a set of objects or phenomena or concepts where the elements of the set are similar to one another in certain ways or aspects. There are various definitions proposed for the term *pattern.*

[1] 1977(Pavlidis) defined pattern recognition in his book: "the word pattern is derived from the same root as the word patron and, in his original use, means something which is set up as a perfect example to be imitated. Thus pattern recognition means the identification of the ideal which a given object was made after." [2] 1978(Gonzalez,Thomas) defined pattern recognition as a classification of input data via extraction important features from a lot of noisy data. [3] 1985(Watanabe) said that pattern recognition can be looked as categorization problem, as inductive process, as structure analysis, as discrimination method and so on. [4] 1990(Fukunaga) defined pattern recognition as" A problem of estimating density functions in a high-dimensional space and dividing the space into the regions of categories of classes."[5] 1992(Schalkoff) defined PR as" The science that concerns the description or classification (recognition) of measurements"[6] 1993(Srihari,Govindaraju) defined pattern recognition as a discipline which learn some theories and methods to design machines that can recognize patterns in noisy data or complex

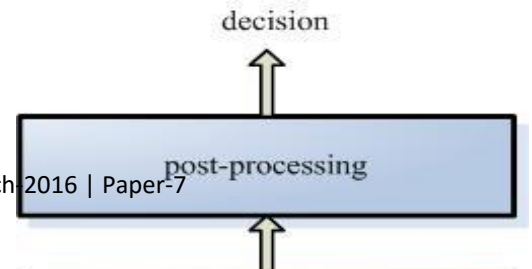
environment. [7] 1996(Ripley) outlined pattern recognition in his book: "Given some examples of complex signals and the correct decisions for them, make decisions automatically for a stream of future examples" [8] 2002 (Robert P.W. Duin) described the nature of pattern recognition is engineering; the final aim of Pattern recognition is to design machines to solve the gap between application and theory. [9] 2003(Sergios Theodoridis,) Pattern recognition is a scientific discipline whose aim is the classification of the objects into a lot of categories or classes. Pattern recognition is also a integral part in most machine intelligence system built for decision making. [10]

B. **Pattern recognition system**

The design model of a pattern recognition system essentially involves the following six steps [1][4]:

1. **Data acquisition and sensing**: Measurements of physical variables, Important issues: bandwidth, resolution, sensitivity, distortion, SNR, latency, etc.
2. **Pre-processing**: Removal of noise in data, Isolation of patterns of interest from the background.
3. **Feature extraction**: Finding a new representation in terms of features.
4. **Model learning and estimation**: Learning a mapping between features and pattern groups and categories.
5. **Classification**: Using features and learned models to assign a pattern to a category.
6. **Post-processing**: Evaluation of confidence in decisions, Exploitation of context to improve performance, Combination of experts.

Block diagram of a pattern recognition system is shown in figure 1.



II. MODELS USED IN PATTERN RECOGNITION

II. Study and review of existing pattern recognition models

A. Statistical model

Statistical model is widely used as it is simplest to use. The statistical patter recognition is mainly based on probabilities and statistics. The pattern is described in terms of feature sets. The feature set is chosen were different patterns occupying non overlapping feature space. Effectiveness of feature set is dependent how the patterns are separated into different classes i.e., proper distance between classes. After performing the analysis of the probability distribution of a pattern belonging to a certain class, a decision boundary is determined [11]. Patterns are provided for some pre-processing operations so that they become suitable for training of the set. On the basis of analysis of training patterns features are determined. The system learns from the training and trains itself to recognize or classify patterns. In the testing phase the feature measurement i.e., distance between the patterns is determined in the

statistical space and feature values are used for learning in the system to perform classification or recognition.

B. Syntactic model

Syntactical model is also termed as structural models used for pattern recognition which is based on relation between features. It is used for more complex relations were patterns are represented by structures. In this model we form a hierarchical structure which comprises of sub-patterns. In this model, the patterns to be recognized are called primitives and the complex patterns are represented by the inter-relationship formed between these primitives and the grammatical rules associated with this relationship [3]. In syntactic pattern recognition, a similarity is associated between the structure of patterns and the syntax of a language. The patterns are the sentences belonging to a language, primitives are the alphabet of the language, and using these primitives, the sentences are generated according to the grammar. Thus, the very complex patterns can be described by a small number of primitives and grammatical rules [12][14]. This approach is considered in pattern recognition because it not only classifies but also provides a description of how from the primitives the given pattern is constructed. This paradigm has been used in situations where the patterns have a definite structure which can be captured in terms of a set of rules [12]. The implementation of a syntactic model approach, however, leads to many difficulties because of the segmentation of noisy patterns (to detect the primitives) and the inference of the grammar from training data. This may yield a combinatorial explosion of possibilities to be investigated, demanding a very large training sets and huge amount of computational efforts [16].

C. Template matching model

Model is widely used in image processing to determine the similarity between two samples, pixels or curves to localize and identify shapes in an image. Each pixel of the template is matched against the stored input image while taking into account all possible position in the input image, each possible rotation and scale changes. In visual pattern recognition, one compares the template to the input image by maximizing the spatial cross-correlation or by minimizing a distance: that provides the matching rate. After calculating the matching rate for every possibility, select the largest one which exceeds a predefined threshold. It is a very expensive operation while dealing with big

templates and using large sets of images. Also it does not work efficiently in the presence of distorted patterns [11][12]. The first figure is the input image and a small portion of it acts as a test template. Then matching is performed and the position of template is marked.

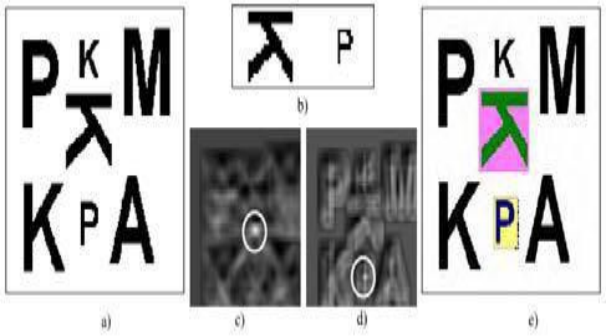


Fig 2.Example of template matching model for pattern recognition [11]

D. Neural network model

Neural network is a self-adaptive trainable process that is able to learn and solve problems based on available knowledge. Neural Network behaves same like biological brain works which are composite of interconnected processing elements that simulate neurons. Through interconnection, each neuron passes information among itself. Artificial Neural network models attempt to use some organizational principles such as learning, generalization, adaptivity, fault tolerance and distributed representation, and computation in the network of weighted directed graphs in which the artificial neurons forms the nodes of the model and the directed edges (with weights) are connections between neuron outputs and neuron inputs[12][14]. The weights applied to the connections results from the learning process and indicate the importance of the contribution of the preceding neuron in the information being passed to the following neuron [11]. The main characteristics of all the neural networks are that they possess the ability to learn complex nonlinear input-output relationships, use sequential training procedures, and adapt themselves to the data. The following diagram is a two layer neural network with one input layer constituting of three neurons and one output layer with two neurons and corresponding weights are assigned in between them.

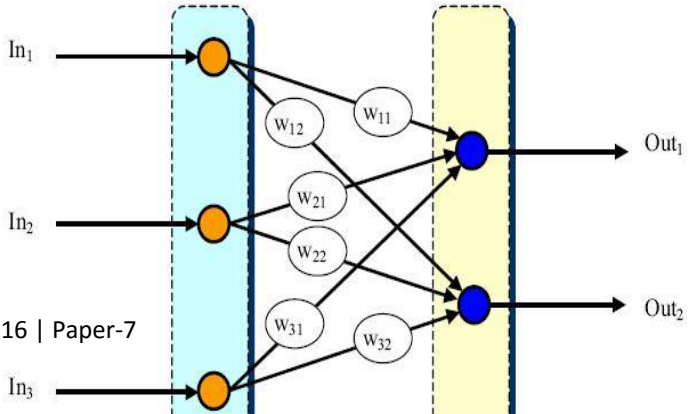


Fig 3.Example of an artificial neural network [17]

III. CONCLUSION

In this paper we have reviewed the existing pattern recognition methods which help in many pattern matching and classification applications. After study of these methods according to our needs we can study the methods and also see the results after implementing on the inputs. Initial phase of this research will focus on comparative study and result analysis of these methods. And base on best result, will pick up appropriate pattern recognition method.

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