CHAPTER - I

INTRODUCTION

1.0 PATTERN RECOGNITION AND ITS SCOPE

With the advent of the digital computers, there has been a considerable growth of interest in the challenging task of building machines that can perceive, learn, think and take decisions. The ability to do such things had hitherto been considered to be an exclusive privilege of the intelligent beings and hence the name artificial intelligence was given to this new branch of computer applications. In one such application called the pattern recognition, automatic recognition of the patterns is sought to be done by the machine. Here, the word pattern has the same meaning as in the common usage. It may be an abstract thing like a pattern of the thought process or a tangible thing like a pattern of the heartbeat. In short, it may be defined as a meaningful regularity. Pattern recognition (PR) is a subject dealing with the methods of designing or programming machines to recognize these meaningful regularities in noisy or complex environments.

The problem of character recognition is one of the earliest to receive the attention of the researchers in the field of pattern recognition. In this problem, each character, despite its variations due to the writing styles of different individuals, constitutes a distinct pattern class as distinguishable from the other classes of patterns. So, it is

required here to identify the class membership of a given character on the basis of its similarities with respect to the members of its own class or its dissimilarities with respect to the members of the other classes. The initial interest in the research on character recognition stemmed from the urge for developing computers that can directly read manuscripts rather than the coded data from the peripheral devices like the card readers and the cathode-ray tube terminals. This interest continued possibly due to two reasons :(i) the ease with which data may be collected, (ii) the prospect of getting good market for the commercialised products. Now, after more than two decades, the character recognition problem is still receiving as much attention as it was receiving earlier. But there has been a considerable expansion in the field of PR applications. The problems of system identification, finger print identification, scene analysis, speech analysis, speaker identification, prediction of the future behaviour of management or economic systems (e.g., sales or demand forecasting, forecasting of inflationary trends), weather forecasting from meteorological data, prediction of earthquakes from seismological data, identification of natural resources from satellite data, radar and sonar signature analysis, cell tissue analysis, sleep state recognition from EEG data, recognition of cardiovascular activities from ECG data may be cited as a few typical PR applications. The present day pattern recognition methodologies are also much wide ranged. These methodologies are developed by borrowing concepts from varied disciplines like statistics,

switching theory, communication theory, control theory, biological modelling, formal language theory, psychology and so on. This is what makes this subject at once intricate and fascinating.

1.1 APPROACHES TO PATTERN RECOGNITION

There are three basic approaches to pattern recognition: 1) Numerical, 2) Structural or linguistic, 3) Fuzzy set theoretic.

In the numerical approach, each pattern is represented by an n-dimensional pattern vector $[x_1, x_2, \ldots x_n]^t$ where x_1, x_2, $\ldots$ x_n denote the numerical values of the independent variables(usually referred to as measurements) characterizing the pattern. For example, in a typical weather forecasting problem, the temperature and the humidity may be the components of the pattern vector. The abstract model of the PR system using this approach is called the classification model. It contains three parts : (i) a transducer which senses the input and converts it into a form suitable for machine processing (ii) a feature extractor to extract from these raw measurements the relevant information, (iii) a classifier which uses this information to assign the input data to one of the finite number of prespecified categories. Most of the methods used for feature extraction and classification are **statistical**, though some nonstatistical methods like the perceptron algorithm for classification find place in the literature. For problems involving costly measurements, a special type of numerical approach called the sequential

measurement approach is used. Here the measurements are taken sequentially according to some order till a satisfactory system performance is obtained.

The numerical approach is often criticised for two reasons : (i) It is mainly concerned with manipulation of numbers rather than providing a description of the pattern which seems fundamental to the recognition process. (ii) It is based on the methodologies which compress the data severely and hence is not equipped with the means for generating patterns of a particular class. In order to overcome these shortcomings, the structural or descriptive approach is developed for the analysis of the scenes like the photographs of the industrial objects. Here, each scene is divided into subscenes which can easily be recognized. The total scene is recognized by means of the structural relationship between the subscenes. For example, in a character recognition problem, the subscenes may be strokes, cusps, etc; once they are recognized, the character may easily be recognized by means of the relative positions of these primitives. In this approach, the scene may be viewed as a statement in a language whose grammar defines the allowed structural relations. The picture grammars for parsing the scenes are developed borrowing the concepts extensively from the theory of the formal languages.

Though the above two approaches seem to be radically different, their similarities on a philosophic plane cannot be overlooked. Both the approaches consist of three fundamental aspects, namely, characterization, abstraction and

generalization. Characterization is nothing but the selection of the measurements for representing the pattern in case of the numerical pattern recognition. In the structural approach, it is the selection of the primitives like the strokes, cusps and so on. The choice of the decision rule to classify the patterns and the selection of the language to describe the scene represent the abstraction phases in these two approaches. Then the ability of the classifier to correctly classify an unknown pattern or the capability of a language to describe a new scene appropriately is known as generalization. All these three aspects are interdependent. Choice of improper features (primitives) may necessitate the design of a complex classifier (language structure) and the ability of correct classification (description) may be used to choose effective features (primitives) or decision rules (languages). To be more specific, the analysis of the PR problem, or simply pattern analysis, may be carried out using the intuitive ideas about the pattern environment, the investigations into the nature of the data obtained from the measurement process and the feed back from the feature extraction (primitive selection) and classification (description) stages. This pattern analysis may, in turn, be helpful in providing the guidelines for the modification of the measurement process for a better system performance. The generalized model incorporating all these concepts is shown in Fig.1.1. However, it may be mentioned here that most of the present day techniques of the linguistic approach are heuristic and ad hoc.