CHAPTER 1

Introduction

1.1 Introduction

In the era of the uncertainty of tropical conditions the rainfall forecasting is becoming very crucial. The success of forecasting solely depends upon the exactness of the model. There are many experiments carried out to develop appropriate model using various techniques [1], [2], [3], [4], [5], [6]. The monsoon governs the every pulse of life in India. It is no wonder, therefore, that the public and particularly the media are very much concerned about the shortfall in monsoon rainfall. In 2002, the rainfall during the first half of the summer monsoon season (June and July) had been much less than the average and fears were being expressed of a possible drought situation. The rainfall since then has been reasonable and at some place it was more than average.

Tropically the rainfall regions are categorized as North West India, Peninsula and North East India for the study of rainfall [2].

The Northwest India region consist of following states, Uttar Pradesh, Haryana, Chandigarh, Delhi, Punjab, Himachal Pradesh, Jammu & Kashmir and Rajasthan. The peninsula consists of Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Lakshadweep. The Northeast India consists of Andaman and Nicobar Islands, Arunachal Pradesh, Assam and Meghalaya, Nagaland, Manipur, Mizoram, Tripura, Sikkim, West Bengal, Orissa and Bihar. In recent years, long range monsoon rainfall forecast based on the Neural Network model has been more precise [1].

The normal monsoon implies, the rainfall equal to the long period average. Some of the parts receive excess rainfall and some of them receive deficient rainfall. The averages of smaller areas are not same as the national average.

Rainfall forecasting is a challenging task especially in the modern world facing the problem of global warming. In general, climate and rainfall are highly non-linear phenomena in nature exhibiting what is known as the "butterfly effect". While some regions of the world are noticing a systematic decrease in annual rainfall, others notice increases in flooding and severe storms [3].
Accurate and long-range forecast of rainfall patterns continue to be a major challenge and preoccupation for the scientific community. In view of the tremendous impact of rainfall patterns in areas like agricultural planning, accurate and long-range forecast of rainfall certainly requires persistent effort and a multi-pronged strategy using different techniques and methodologies. One such promising forecasting tool is the neural network.

An in-depth analysis of the information available and the experiences of researchers tell that the rainfall data is a chaotic time series and it is very sensitive to the initial conditions [7].

1.2 Motivation

At the time of independence India was mainly known as agriculture base developing country. The national gross domestic product (GDP) growth was dependent on the agricultural produce. The agriculture industry in India mainly depends on the monsoon. Over the period, the national GDP growth is not solely dependent on the agriculture produce; however around 70% population depends on the agriculture. In view of the impact of rainfall patterns in agricultural planning, accurate and long range forecast of rainfall is vary vital.

Fortunately, Indian Meteorological Department (IMD) has a rich data set of meteorological observations from which the nature of variability of the summer monsoon (June – September) rainfall is easily known. A number of different NN architectures and learning methods have been applied to the time series forecasting problem with varying degrees of success. However, there still exists a need for satisfactory guidelines while choosing a model size for a particular forecasting problem. This has motivation to propose the methodology for average rainfall forecasting using the historical data of the rainfall. The objective of NN predictor training is to minimize the cost function of the difference between desired and calculated values [6].

Existing forecasting of rainfall in India is mainly for the large area i.e. for country as a whole, or subdivision wise like North East India, North West India or Peninsula or region wise like Madhya Maharashtra, Marathwada, Vidarbha, and Kokan. However, the forecasting of small areas like station level (small region) or a couple of stations is to be carried out for the benefit of local farmers. This has lead to a strong motivation to work in this vital area.
The field of neural network approach deals with pattern recognition, system modeling and forecasting. System-modeling capability of neural network approach is explored. System modeling approach has certain advantages in design, problem solving and approximation of the mapping. By using neural network, it is possible
(i) to work without the knowledge of the physical process, assuming the internal parameters or boundary conditions,
(ii) to train neural network itself by using massive amount of the data, and
(iii) to use a complex non-linear mapping, such as precipitation phenomena [4].

1.3 Aims and objectives

The main focus of this research is broadly divided in two categories

Aims

i. To collect the data from data base,

ii. To interpolate the data set,

iii. Study of various models of Artificial Neural Network (ANN) for rainfall forecasting of Western Maharashtra and find the appropriate model.

Objectives

i. Change the various parameters of the networks like momentum, step size, number hidden layers, number of processing elements in each hidden layer, number of epoch and runs to optimize the network,

ii. Identify the optimized network, and

iii. Suggest new models for rainfall forecasting in meteorological station area.

The study is based on the meteorological parameters of Western Maharashtra. The Maharashtra state has been divided in four parts by the meteorological department viz. Madhya Maharashtra, Marathwada, Vidarbha, and Kokan. These parts are too big to study the meteorological events. The accuracy of forecasting may increase, if the area of study is comparatively smaller. Thus, an attempt has been made to forecast the rainfall for Western Maharashtra. It is a part of Madhya Maharashtra region of meteorology. The data set required for the study is collected from IMD, Pune. The data set is then converted to excel format. The missing values are traced. These missing values have been calculated by geometric mean. Twelve parameters and the previous rainfall data are used as input to neural networks. The multilayer perceptron
(MLP), radial basis function (RBF), and time lagged recurrent neural (TLRN) networks are used in this study. One optimized configuration from each network topology is found out.

1.4 Scope of the thesis

The geographical configuration of India basically consists of three oceans, namely Indian Ocean, Bay of Bengal and the Arabian Sea bordering the peninsula. This gives out the climate system with two monsoon seasons and two cyclones interspersed with hot and cold weather seasons [8]. However in the state of Maharashtra, the major rainfall is the summer monsoon (June to September). Thus, the scope of the thesis is limited to summer rainfall hence the parameters considered are for the period of June to September. The study is restricted to the rainfall forecasting of Pune meteorological station a small part of western Maharashtra using the local parameters only.

1.5 Outline of the thesis

The report is structured such that the focus on development remains on forefront. Chapter 2 covers detailed survey of work done in the area of use of ANN in rainfall forecasting. The traditional methods of rainfall forecasting are also reviewed. The published work forms basis for the study. The basics of neural network, various topologies and terminologies used are included in Chapter 3. The types of learning methods and learning rules used are discussed. The various neural network paradigms are tested and tabulated for a typical data set. This work of testing various ANN topologies has given thorough understanding about the Neural Network. The training reports, testing reports with performance parameters of multilayer perceptron network using momentum, delta bar delta, Levenberg Marquardt, conjugate gradient, and quickprop learning rules with tanh, linear tanh, sigmoid and linear sigmoid activation functions are presented and discussed in Chapter 4. Chapter 5 deals with results obtained by radial basis function network using momentum, delta bar delta, Levenberg Marquardt, conjugate gradient, and quickprop learning rules with tanh, linear tanh, sigmoid and linear sigmoid activation functions. The results obtained by time lagged recurrent network using TDNN axon, Gamma axon, and Laguerre axon are presented and discussed in Chapter 6 with same learning rules and activation functions. The thesis is concluded with the inferences drawn, recommendations for continuing work and experts comments in Chapter 7. The references are enlisted.