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"Fuzzy based approach for weather advisory system"

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Abstract: *In this paper, we propose study of weather advisory system development by using Fuzzy Logic based approach. Agricultural productivity largely depends upon weather. Weather forecasts in all temporal ranges are desirable for effective planning and management of agricultural practices. The development of response strategy helped farmers realize the potential benefits of using weather-based agro meteorological information in minimizing the losses due to adverse weather conditions, thereby improving yield, quantity and quality of agricultural productions. The nature of weather is uncertain and viable we are using Fuzzy approach for the development of system.*
Keywords: *Fuzzy Logic, Weather data, Weather Advisory System*

I. Introduction

1.1 Background and Motivation

Some of the early works that appeared in the late 1960s concentrated on effectiveness of agro meteorological information. Studies have also been carried out to determine the potential benefits in agricultural farm decisions from long-range weather predictions. This can be done if the scientific methods to be used for weather-based advisories have a direct relationship with the traditional knowledge of the farmers. Agriculture in India depends heavily on weather and climate conditions. Weather forecasts are useful for decisions regarding crop choice, crop variety, planting/harvesting dates, and investments in farm inputs such as irrigation, fertilizer, pesticide, herbicide etc. Hence, improved weather forecast based agromet advisory service greatly helps farmers to take advantage of benevolent weather and mitigate the impacts of malevolent weather situation [1].

Medium range weather forecast based agro-meteorological advisory service of NCMRWF strives to improve and protect agricultural production, which is crucial for food security of the country. The weather forecast and advisories have been helping the farming community to take advantage of prognosticated weather conditions and form the response strategy. On many occasions Agro-Meteorological Field Units have reportedly saved the crop from unfavorable weather condition. Also the service, on many instances, helped farmers over different regions to minimize crop losses as a result of extreme weather conditions. Such reports were included in the Annual Progress Reports submitted by the Agro-Advisory Service (AAS) units as well as discussed during different review meetings of the project. But these were sporadic cases and could not be inter-compared mainly due to non uniform use of the methodology. Hence, a project entitled "Economic Impact of AAS of NCMRWF" was formulated and launched in November 2003 to assess the use and value of the service, with a view not only to assess the economic impact of the service but also to assess its usage pattern and identify strengths and weaknesses to further improve it [2].

Long range forecast or a weather forecast at least one year in advance would help in crop planning and yield forecast assessment. Even a seasonal forecast would be of great help. However, since efforts in this direction are yet to yield a reliable result, short and medium range weather forecasts can be utilized for yield assessment. Dynamic crop-weather simulations should be used for this purpose through in-season use of the models with real time data. Both current and normal weather data will be the input and as crop growth progresses, period of normal data gets decreased.

The quality and the reliability of long range forecast and extended range forecast are to be improved for preparation and improved weather based agro-advisories. Early drought warnings and their management strategies are to be expended to district level. For monitoring crop growth I any current season, for each crop species, preparation of crop weather diagrams or calendars depicting current events of crop growth is advisable. Development of weather based forewarning systems is the need of the hour in limiting possible excessive usage of insecticides, pesticides and fungicides [3].

Weather and climatic information plays a major role before and during the cropping season and if provided in advance can be helpful in inspiring the farmer to organize and activate their own resources in order to reap benefits. If we provide weather information in advance then it is beneficial to farmer. This thought give us motivation to develop advisory system.

II. Present Theories And Practices

Some of the recent and most relevant works are summarized below:

Bardossy et al., [4] had applied a fuzzy rule-based methodology to the problem of classifying daily atmospheric circulation patterns (CP). Rules are defined corresponding to the geographical location of pressure anomalies. Accordingly the degree of fulfillment of a rule is defined in order to measure the extent to which a pressure map may indeed belong to a CP type. As an output of the analysis, the CP on any given day is assigned to one, and only one, CP type to a varying degree of credibility. The information content of the fuzzy classification as measured by precipitation-related indices is similar to that of existing subjective classifications. The fuzzy rule-based approach thus has potential to be applicable to the classification of GCM produced daily CPs for the purpose of predicting the effect of climate change on space-time precipitation over areas where only a rudimentary classification exists or where none at all exists.

Agboola et al., [5] has investigated the ability of fuzzy rules/logic in modeling rainfall for South Western Nigeria. The developed Fuzzy Logic model is made up of two functional components; the knowledge base and the fuzzy reasoning or decision-making unit. Two operations were performed on the Fuzzy Logic model; the fuzzification operation and defuzzification operation. The model predicted outputs were compared with the actual rainfall data. Simulation results reveal that predicted results are in good agreement with measured data. Prediction Error, Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and the Prediction Accuracy were calculated, and on the basis of the results obtained, it can be suggested that fuzzy methodology is efficiently capable of handling scattered data. The developed fuzzy rule-based model shows flexibility and ability in modeling an ill-defined relationship between input and output variables.

Somia et al. [6] had interested in rainfall events prediction by applying rule-based reasoning and fuzzy logic. Five parameters: relative humidity, total cloud cover, wind direction, temperature and surface pressure are the input variables for our model, each has three membership functions. Among the overall 243 possibilities they had taken one hundred eighteen fuzzy IF–THEN rules and fuzzy reasoning. The output variable which has four membership functions, takes values from zero to one hundred corresponding to the percentage for rainfall events given for every hourly data. They used two skill scores to verify their results, the Brier score and the Friction score. The results were in high agreements with the recorded data for the stations with increasing in output values towards the real time rain events.

III. Soft Computing : Fuzzy Logic

In computer science, soft computing is the use of inexact solutions to computationally hard tasks such as the solution of NP-complete problems, for which there is no known algorithm that can compute an exact solution in polynomial time. Soft computing differs from conventional (hard) computing in that, unlike hard computing, it is tolerant of imprecision, uncertainty, partial truth, and approximation. In effect, the role model for soft computing is the human mind. In general, soft computing includes the methods of FL, neuro-computing, evolutionary computing, probabilistic computing, belief networks, chaotic systems, and parts of learning theory. But we are using fuzzy approach for our system development.

1.1 Fuzzy Logic

FL is a form of multi-valued logic derived from fuzzy set theory to deal with reasoning that is approximate, rather than precise. In contrast to yes/no or 0/1 binary logic (crisp), FL provides a set of membership values inclusively between 0 and 1 to indicate the degree of truth (fuzzy). For the crisp set the characteristic function is assigned a value of 1 or 0 to each value, a value set of a physical property. 1 indicates that corresponding values belong to the set. 0 indicates that corresponding values do not belong to the set. The concept of the crisp set is sufficient for many applications but is not for some applications that require flexibility. In the fuzzy set the characteristic function is assigned a value between 0 and 1, including 0 and 1, to each value. The values between 0 and 1 for corresponding values belong to the set in a certain degree from low, medium, to high. The membership functions may be different in shape and interval. The logic operations such as AND and OR can implemented with the different membership functions to generate a resultant membership function.

In process modeling and control, systems that are ill-defined and with uncertainties can be modeled with a fuzzy inference system employing fuzzy 'If–Then' rules to quantify human knowledge and reasoning processes without employing precise quantitative analyses. The fuzzy inference system should include the following functional blocks:

- a fuzzification interface that transforms the crisp inputs into degrees of match with linguistic values;
- a knowledge base that includes
- a rule base containing a number of fuzzy 'If–Then' rules;
- a database that defines the membership functions of the fuzzy sets used in the fuzzy rules;
- a decision-making unit that performs the inference operations on the rules; and

- a defuzzification interface that transforms the fuzzy results of the inference into a crisp output.

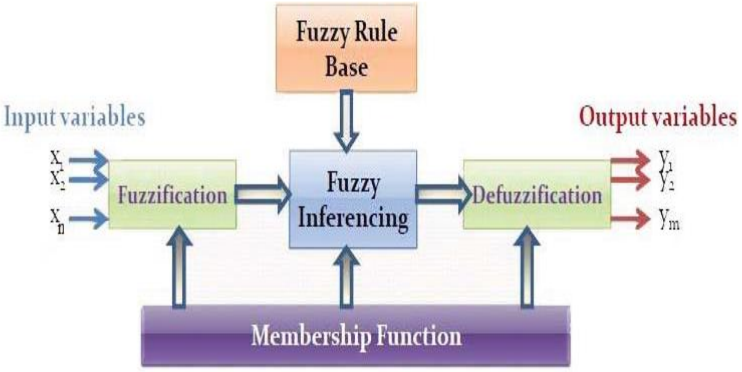
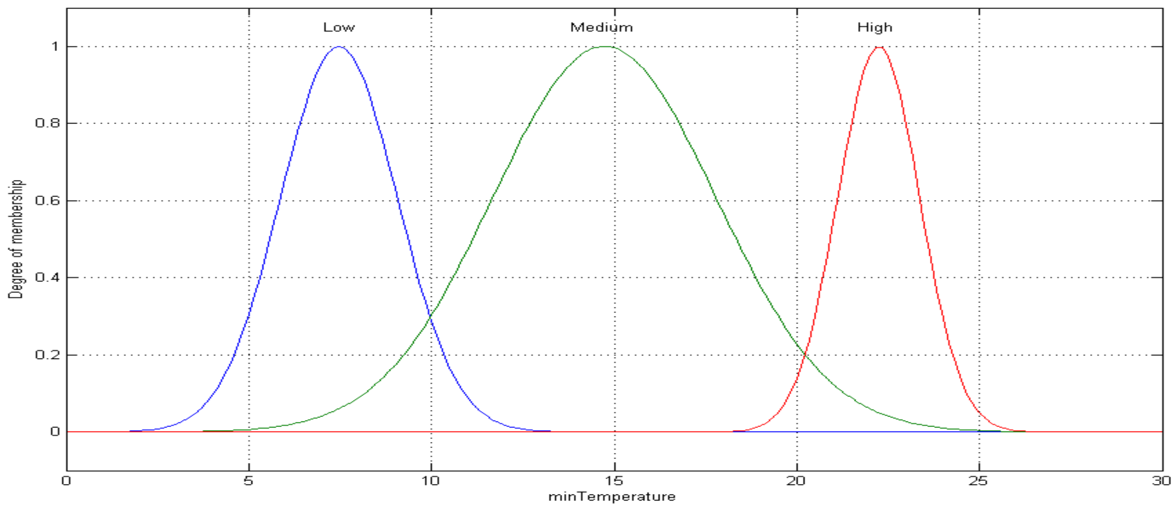
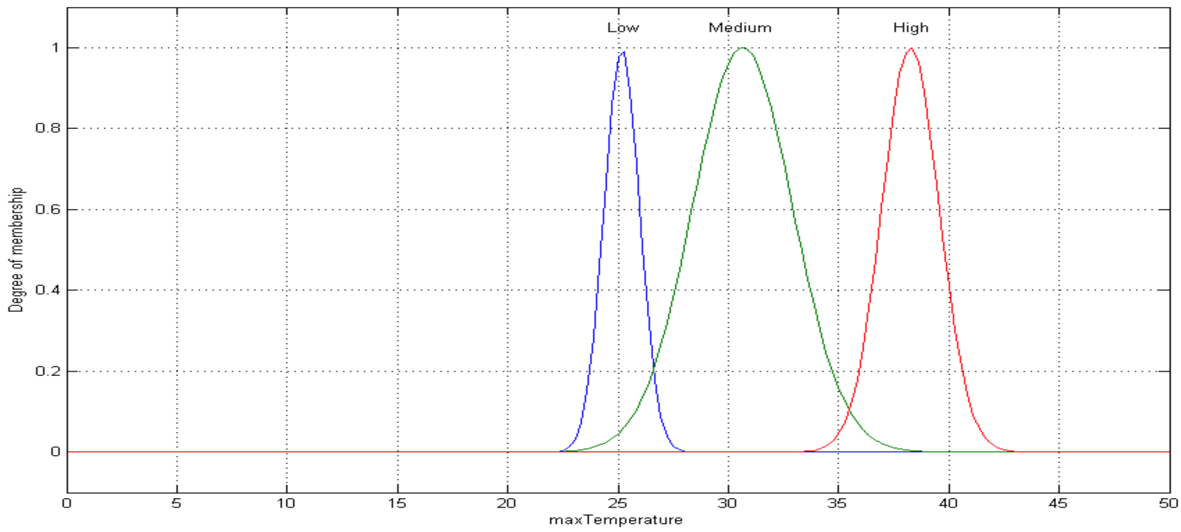


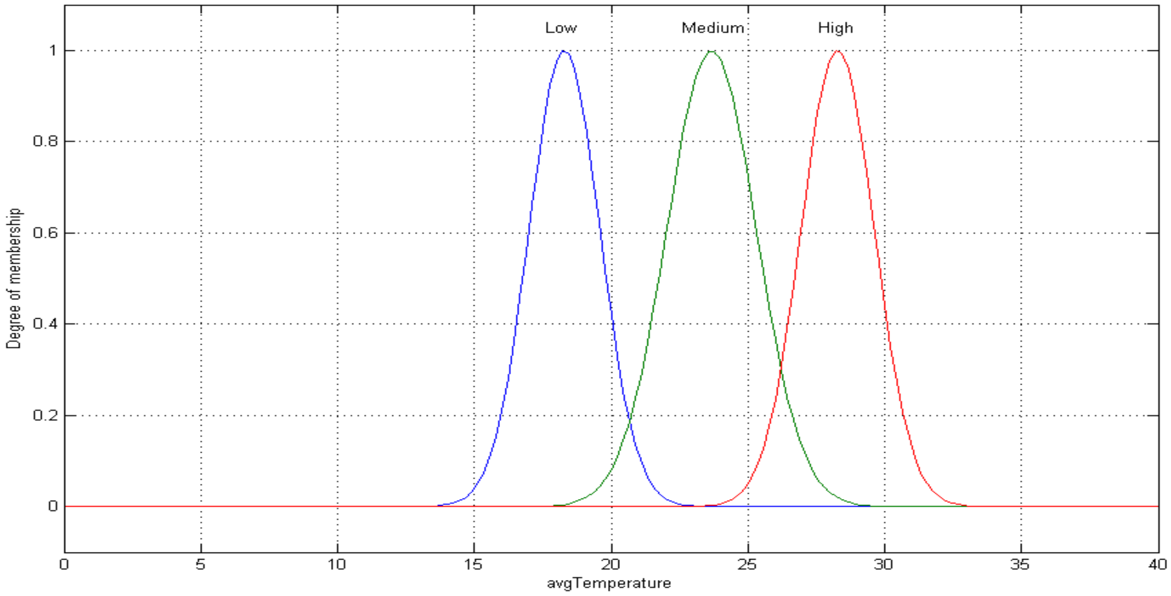
Fig.1. Fuzzy System Element

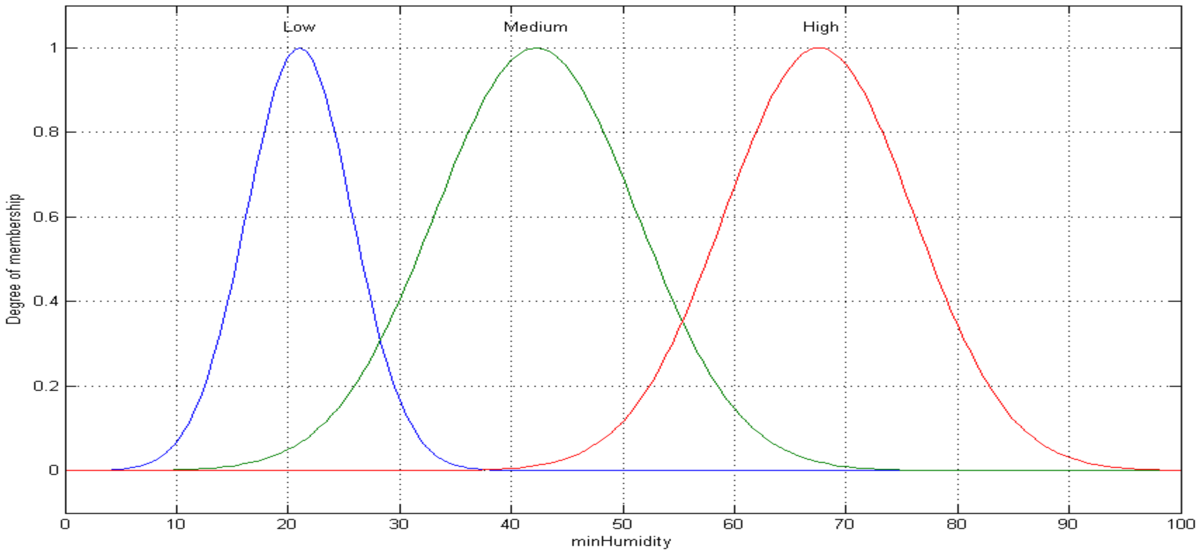
IV. Experimental Result

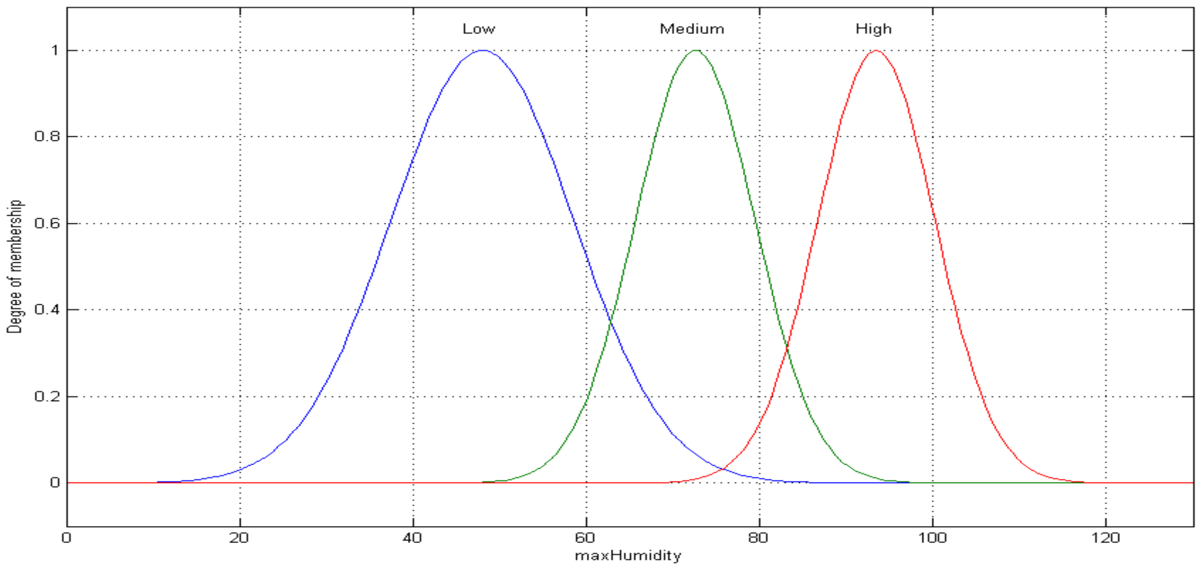
In our work, we have taken the weather data from ICAR-National Research Centre for Grapes of year 2012. Our experimental parameter is Temperature, Humidity and Rainfall. For this parameter we get weather data in minimum, maximum and average format. Then we set the range of low, medium and high for each. Take example of minTemperature, taken observations of low, medium, high and calculate mean and standard deviation. With the help of mean and standard deviation we draw the membership function for it.

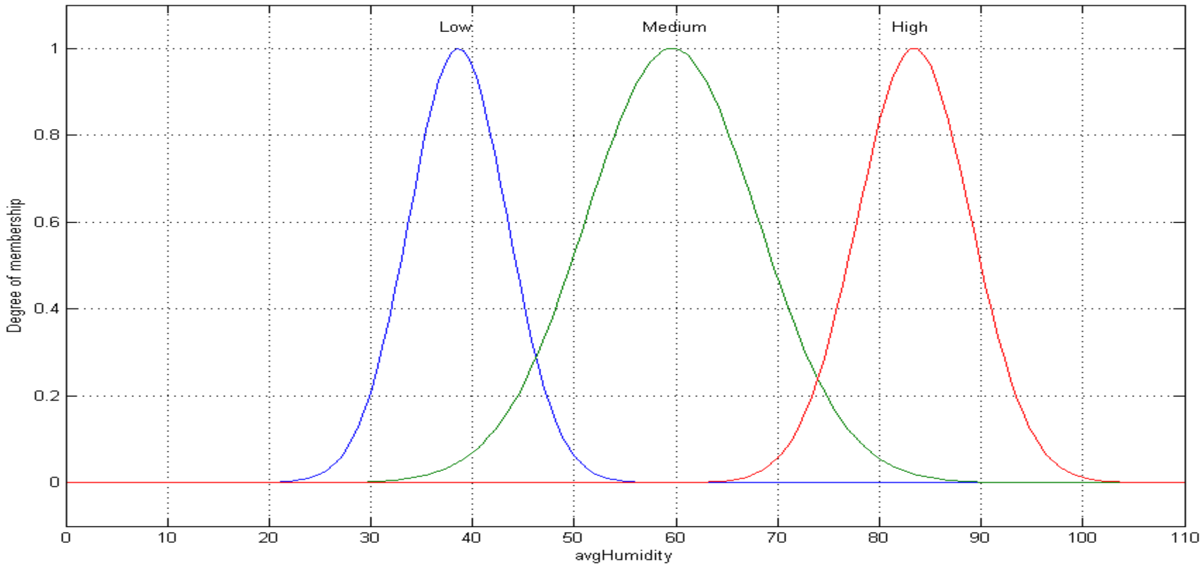





Low
Medium
High
Degree of membership
avgTemperature


Low
Medium
High
Degree of membership
minHumidity


Low
Medium
High
Degree of membership
maxHumidity



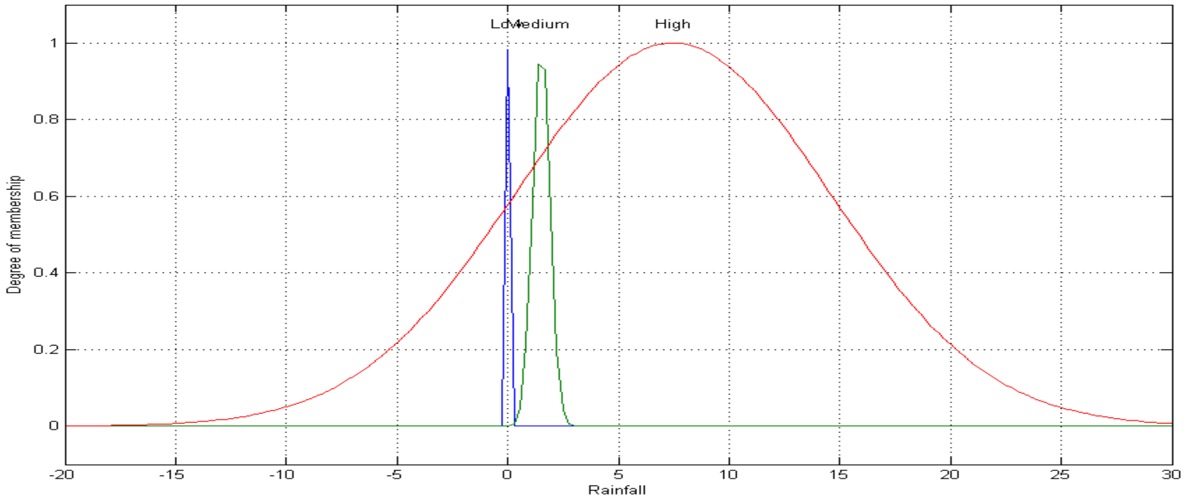


Fig 2 Membership function

At last we calculate the success rate for each parameter as shown in following table

Sr. No.	Parameter	Success Rate for each parameter	Total Success Rate
	minTemperature	100.0000	91.5650
	maxTemperature	42.3488	
	avgTemperature	100.0000	
	minHumidity	100.0000	
	maxHumidity	98.6063	
	avgHumidity	100.0000	
	Rainfall	100.0000	

V. Conclusion

In this paper, we proposed the fuzzy approach for weather advisory system. As we know the weather conditions plays a significant role in a good agricultural harvest. Variable and uncertain weather is a pervasive fact that farmers cope up with. Timely weather advisory information enables the farmers to plan their farm operations in a way that not only minimizes the costs and crop losses but also helps in maximizing the yield gains.

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