IOT based smart agriculture management system for grapes

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Abstract - Grapes are a wonderful subtropical fruit contains full of pulp, vibrant color and having a huge health benefits. It has huge Phytochemicals content which reduces the growth of chronic diseases. An attempt was made to fulfill the requirement of the world with best superiority of Indian grapes. In this study, Sangli district scored top grape producing regions in Maharashtra. Grape exports to Asia and European countries. In the proposed study, attention has been given on increasing production as well as tonnages of export of superior grapes with the help of efficient and effective use of technology, so that it can play an important role in feeding the world with Indian grapes according to consumer's demand worldwide.

Key Words: Agriculture, sensors, Neural Network, Back Propagation, Prediction, Internet of Things.

1. INTRODUCTION

Grape is one of the world's most consumed fruit crops. India ranks ninth in grape production. Grapes are one of the most important crops in India. They usually grow in subtropical areas of India. The grape planting area is 111.1 thousand hector, and the total output in India is 123.49 thousand tons. 60% of the total area of Maharashtra is used for grape growing. 30% of the total area of Mulberry is under grape cultivation. They can be used in different forms, such as raisins, jams, jellies, juices, wines and other beverages. Due to its great potential in improving the human immune system, its needs are increasing all over the world. Grapes are various health benefits which will helpful to avoid cancer, eye problem, other health conditions [1].

Although the Green Revolution has achieved remarkable success and achieved self-sufficiency in food production, people are increasingly concerned about maintaining the pace of agricultural growth and providing food for a large number of our country's population. Lack of yield breakthroughs, deteriorating soil health, depletion of groundwater, reduced operating holdings, and labor shortages are the main reasons for the slow growth of agriculture. Recently, global climate change and climate variability have further exacerbated these constraints. However, due to the large agricultural population, over-stressed natural resources and poor response capacity, countries such as India are particularly vulnerable. The adverse impact of inter annual environment inconsistency is already evident. Inadequate rainfall in 2016-17 resulted in a significant reduction in good quality grape production. Floods caused by heavy rainfall, hurricanes, heat waves, cold waves, frosts, and hailstorms each year have a severe impact on crop yields in one or another part of the country. The impact of climate change in the future on agriculture is very serious and worrying. It is time for the country to wake up and meet these challenges to avoid national disasters.

There are many other factors that greatly affect productivity of grapes. These factors include the attack of insects and pests. Insects and pests can be controlled by spraying the grapes with appropriate insecticides. Second, when the grapes are in ripe stage, wild animals and birds are attacked, theft may also occur [2, 3].

Therefore, in order to solve all these problems, it is necessary to develop an integrated system which considers all factors that affect the productivity of crop each stage. Therefore, we propose to develop a system that is also useful in monitoring field data as an on-site operation to provide flexibility in control [2].

The Internet of Things is a network of physical devices that embed electronics, software, sensors, and connections to enable objects to connect and exchange data. It is expected to combine data from on-site sensors, weather data to generate operational insights for agricultural sector, weather data used to predict climate changes using artificial neural network[4]and give notification of pesticide control accordingly to take precaution for their crop, thereby increasing yield, quality, quantity, and resource utilization.

2. METHODOLOGY OF IMPLEMENTATION

2.1 DESIGN CONSIDERATION

System is broadly divided into three sub-systems namely,

1) Control unit.

The function of the control unit is to monitor the on-site environmental conditions and make decisions related to irrigation and fencing accordingly.

2) Prediction unit.

The function of the predictive model is to predict the next rainfall and wind conditions and alert the farmers accordingly.

3) Sensor unit.

The job of the sensor unit is to sense present atmospheric data.

2.2 BLOCK DIAGRAM

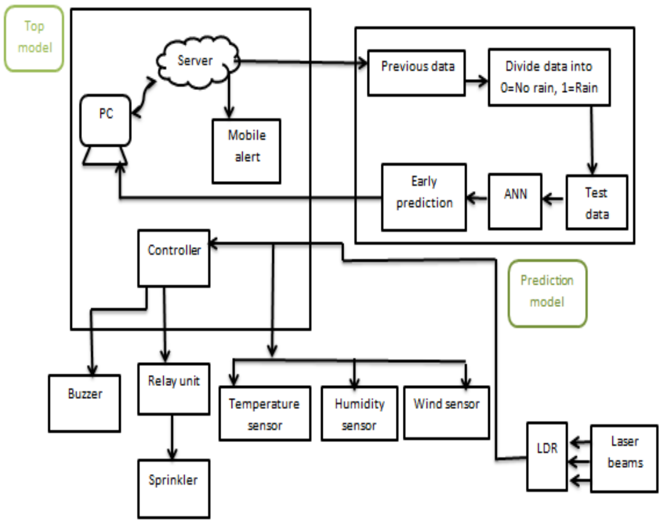

Fig. 1 Block diagram

In this proposed system, we use KG003 as a soil moisture sensor, DHT22 as a temperature and humidity sensor, cup anemometer wind speed sensor. We use Laser beam as a transmitter and LDR as receiver in fencing system. These sensors continuously monitor on field data. If content of moisture level below the certain level then motor then there will be requirement of water for crop then motor is on otherwise off. We use a laser beam as a transmitter and an LDR as a receiver. When there will be any motion in between transmitter and receiver then buzzer starts ringing which alerts farmer. We can use climate, humidity, and wind speed data to check climate change predictions and provide farmers with grape pest control accordingly.

A. Control unit

Arduino is a collection of three things. There are Hardware prototype platform, Arduino language and IDE & libraries. The Arduino board is a microcontroller, not a complete computer. They do not run the full operating system; they just write code and execute it when their firmware is interpreted.

Arduino offers real time functionality; arduino is suitable for analog connectivity. Arduino board has fourteen digital and six analog pins. Arduino provides iterative task functionality in which there are repetitive instructions. The Arduino is better suited for plug-and-play applications because it runs on the firmware and executes the program code directly and iteratively.

Figure.2.A. Arduino Uno

B. Sensor unit

This section gives details of various sensors. Various sensors are interfaced with arduino to capture real time metrological data to generate control signals to take necessary decisions.

Following are the several sensors used in this model:

1] KG003 soil moisture sensor:

The soil moisture sensor has two probes which can be inserted into soil. Sensor KG003 works on the principle of flow of current. Current passes through probes. Moisture soil has less resistance and hence passes more current whereas dry moisture has more resistance and hence passes less current. Thus according to resistance we can calculate moisture content of soil.

Specification:

- Operating voltage: - three and three tenths v to five v.
- By adjusting digital potentiometer we have to adjust sensitivity.
- Digital and analog output modes.
- Analog interface can be used for precise output.
- Provides power indicator LED.
- Provides digital switching indicator LED.

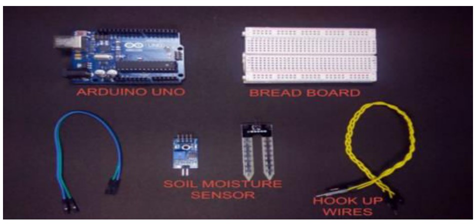

Figure.2.B. Soil moisture sensor

2] DHT22 temperature and humidity sensor:

The DHT22 temperature and humidity sensor is used. The amount of dew content in air defined as humidity. Relative humidity can be calculated by using temperature. Change in temperature can change relative humidity. Rise indews in the air results in reduction in temperature which in turn raises relative humidity.

Specifications:

- Three-five volt power and I/O.
- Two and five tenths mA max conversion current
- Good for zero to hundred % humidity readings with two-five % accuracy
- Good for -forty to eighty degree Celsius temperature readings five tenths degree Celsius accuracy.
- No more than five tenths Hz sampling rate.

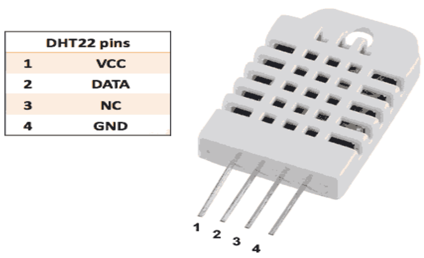

Figure.2.C. DHT22 sensor

3] Cup anemometer wind speed sensor:

In this sensor three cups are connected to reed switch through shaft with magnet positioned at bottom. Exposed to magnetic field metal reeds are joined together which completes electrical circuit. Each time when electrical circuit completes an electrical impulse will be sent to a digital processor which can be used to calculate wind speed reading.

Specifications:

- Wind speed range: zero to seventy m/s
- Accuracy: one meter/s
- Testing range: five tenths m/s to fifty m/s
- Output voltage: four tenths v to two v

Figure.2.D. Wind speed sensor.

4] Laser beam pointer and LDR:

A combination of Laser beam and LDR is used for fencing system. Here Laser beam and LDR continuously faces each other. When there is no interrupt, laser beam light continuously fall on LDR and keep the LED and buzzer ON. When any animal /human interrupts the light, resistance of LDR increases and activates LED and Buzzer.

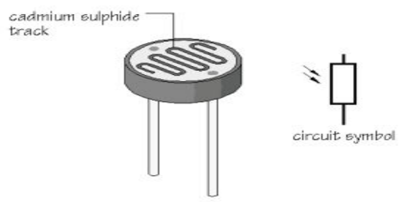

Figure.2.D. Laser beam pointer, LDR

3. PREDICTION MODEL

In order to predict the rain fall by means of temperature, humidity and wind speed, a feed-forward neural network based prediction model has established. Following are the details of this model

- Collection of previous data.

For training the neural network real time r data of temperature, humidity, wind-speed and rainfall during September to December period particularly targeting Sangli/Kolhapur area is collected from

- Import Input and Target data.

The collected data is separated into following:

Input data

Temperature

Humidity

Wind speed

- Target data

Zero =No Rainfall, One =Rainfall.

➢ Test data

Temperature, humidity, wind speed.

- Create network by using newff function.

Following are the details of Feed-Forward Neural Network:

No of input layer: one (two nodes)

No of hidden layers: one (ten nodes)

No of Output Layer: one (one node)

- Training of network.

1. Training of the network is done using backpropagation algorithm.
2. Following are the training parameters:

Gradient coefficient: 0.0029

No of Epochs: 10000

MSE: 0.03

3. We use trainlm as a training function.

Trainlm is a network training function that updates the weight and bias values according to the Levenberg-Marquardt optimization.

The fastest back propagation algorithm in the toolbox is trainlm and it is highly suggested as the first choice supervision algorithm, even if it requires more memory than other algorithms.

• Network test:

Once the network is properly trained, it will conduct real-time data testing of the network and the collected data to check the accuracy of the forecast.

Various weather conditions and pesticide control:

In Grapes cultivation the role of Rain and Pesticide is key point. Depending on the rainfall prediction, a SMS alert will be given to the farmer and recommendation for particular pesticide will also be given to the farmer. The table.1 gives the same details.

WEATHER CONDITION	SUGGESTIONS ON PESTICIDE CONTROL
NO RAIN	NO PESTICIDE CONTROL
RAIN	PESTICIDE CONTROL:-BLACK ROT-CARBENDIZZAM 1GM+MANCOZED 2GM PER LITER KEVDA/DOWNY-(METALAXYL+MANCOZEB) 5GM PER LITER

Table.1

Web application:

Finally a web server on which we can display the data of predicted weather conditions and according to give pesticide control data. Reading of URL using .NET where we have to save predicted data of weather and pesticide control according to predicted climate conditions. And by using php we can read the text file where we can save data of predicted whether conditions and given pesticide control which can display on web server.

Results and discussion:

This system involve hardware model which is used to measure actual data such as temperature, humidity, wind speed, soil moistness. Along with this a prediction model is established to predict the rainfall according to on temperature and humidity as an input data. For more accurate results wind-speed also is taken as other input and another prediction network is developed to predict rainfall data.

Followings are snapshots of simulated results:

Output and observation:

Figure.3displays the result of sensors output on Docklight simulation tool, in which temperature data is in degree Celsius, humidity data is in percentage, and wind speed data is in meter per second.

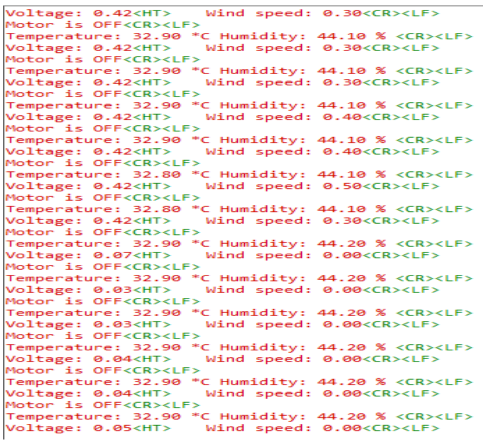

Figure.3. sensor output window

Editor window:

The figure.4 indicates the editor window where we can execute the neural network program. Here R1 is input vector, T1 is target vector, and t is test data. Y indicates the predicted output.

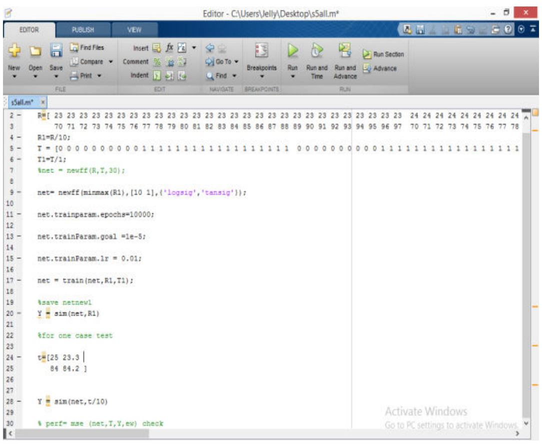

Figure.4. editor window

Neural network training

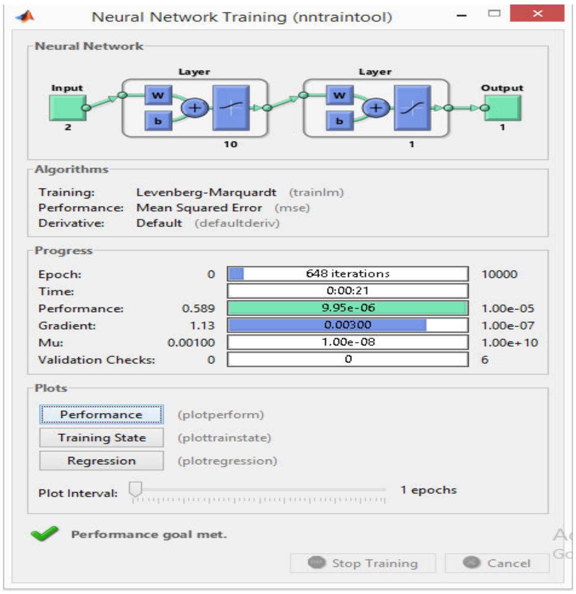

Figure.5. training window

Performance plot

- Check performance plot

  1. The mean-square error is as small as possible.
  2. No vital over fitting has happened (where the finest validation performance arises).

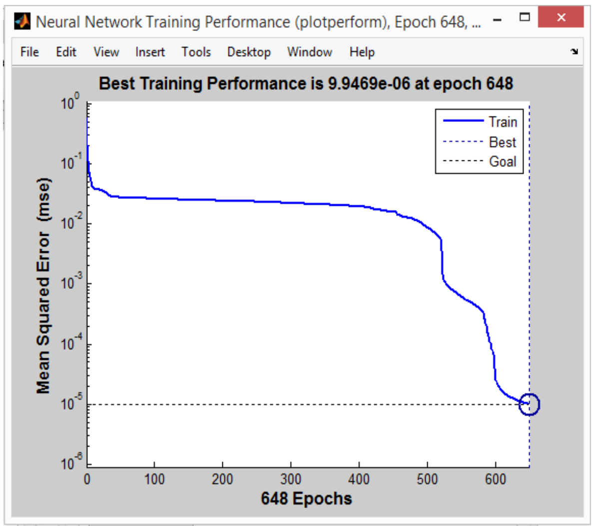

Figure.6. performance plot

TRAINING STATE

Figure 7 shows the change in the gradient coefficient with respect to the number of epochs. The final value of the gradient coefficient at epochs number 648 is 0.002996, which is approximately equal to zero. Least the value of gradient coefficient better will be training and testing of networks. From figure it can be seen that gradient values goes on decreasing with increasing in number of epochs.

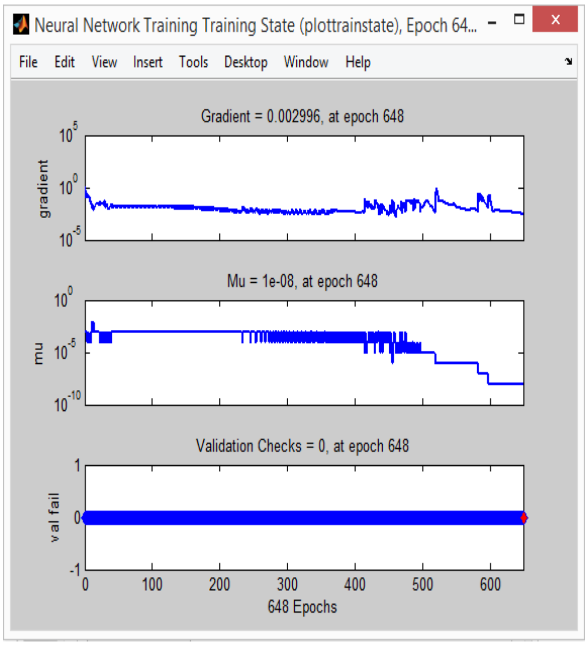

Figure.7. training state

Regression plot:

If even more accurate outcomes were required then,

1. Hidden neurons can be increased.
2. Training vectors can be increased.
3. If more information available then increase number of input values.
4. Try for different training algorithm

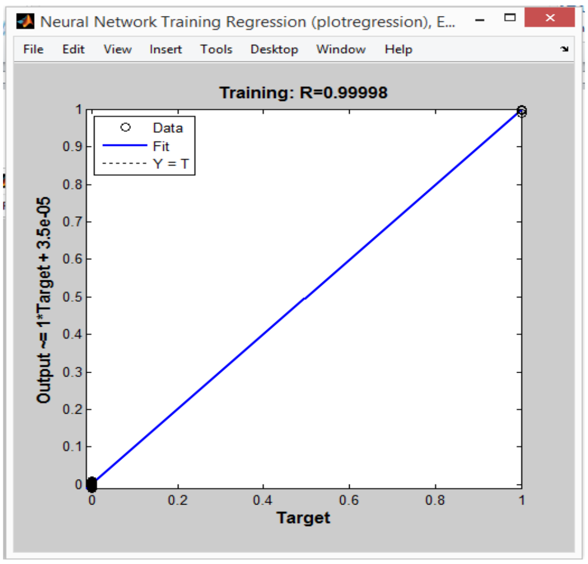

Figure.8. regression plot

Command window output:

Figure.9 shows the predicted output from trained neural network. There are two conditions 0 for no rain and 1 for rain.

0	1
	(23-24)TEMPERATURE (80-86) HUMIDITY. (23-24)TEMPERATURE (90-97) HUMIDITY. (25-27)TEMPERATURE (90-97) HUMIDITY. (25-27)TEMPERATURE (70-79) HUMIDITY.
NO RAIN	RAIN
NO PESTICIDE CONTROL	PESTICIDE CONTROL:-BLACK ROT-CARBENDIZZAM 1GM+MANCOZED 2GM PER LITER. KEVDA/DOWNY-(METALAXYL+MANCOZEB) 5GM PER LITER

Table.2

From highlighted portion of the command window we observed that in first condition there will be no rain. And in second condition there will be chance rain.

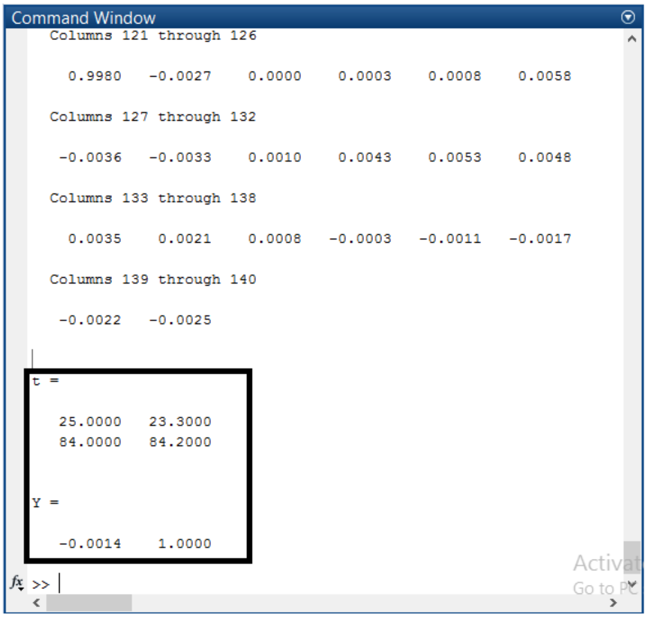

Figure.9.A

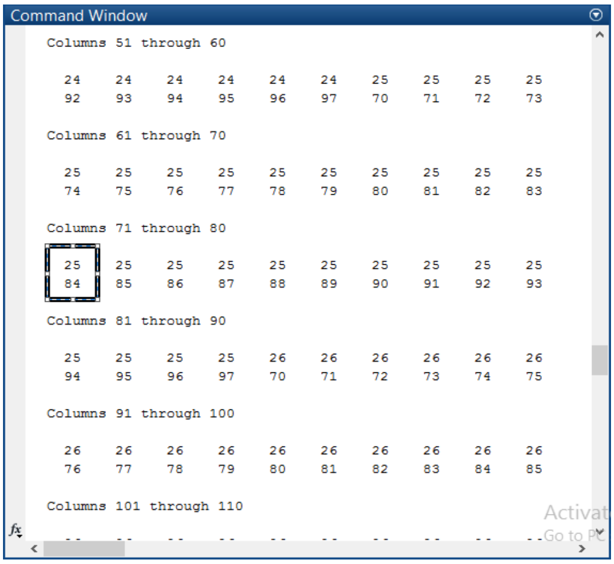

Figure.9.B

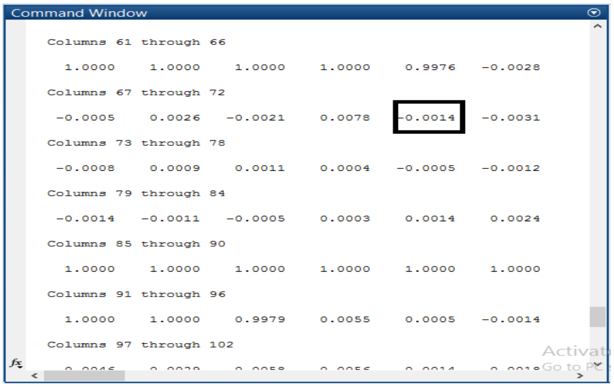

Figure.9.C

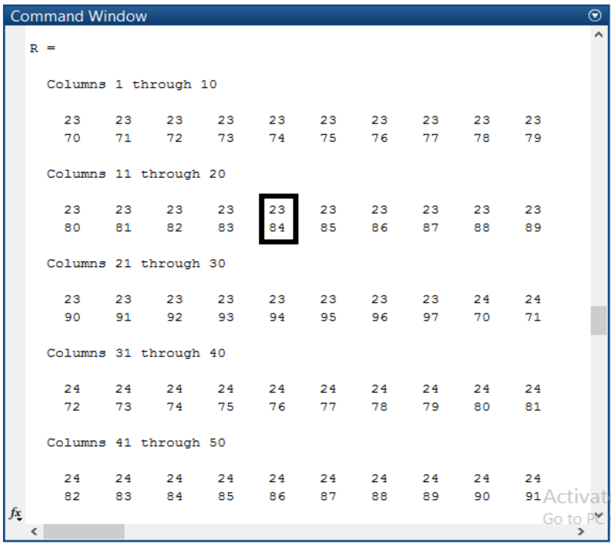

Figure.9.D

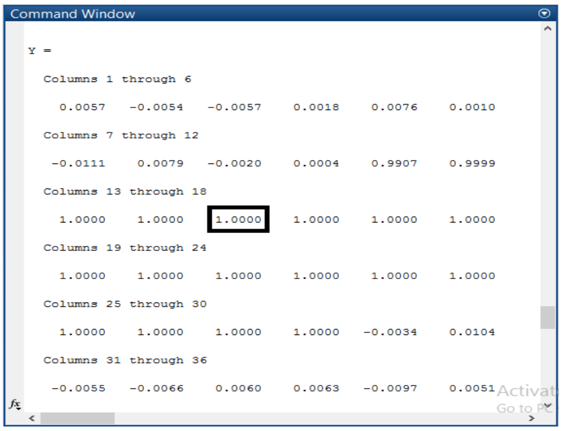

Figure.9.E

Testing with real time data:

SR NO.	TEMPERATURE	HUMIDITY	ACTUAL RAINFALL	PREDICTION 0= NO RAIN, 1=RAIN
1	24.7	84	26.92%	0.9959
2	24.3	88	37.08%	0.9976
3	24.4	64	0	0.0011
4	24.7	58	0	0.0043
5	23.7	74	7.1%	0.9999
6	23.8	58	0	0.0000

Table.3

4. CONCLUSION AND FUTURE WORK

In this paper, neural network based intelligent technology for the agricultural sector has proposed. Weather monitoring and forecasting, farm fencing are the key features of the said system. Smart weather stations provide real-time information of the rainfall based on temperature, humidity, wind speed, and soil moisture data. Smart irrigation systems reduce the use of water. Due to smart agricultural technology, farmers can increase crop productivity, increase product quality, reduce product waste, and offer protective protection systems once crops are in the harvest stage.

The future job is to store data from smart weather stations, which is useful for analyzing and accurately predicting climate change. Guidelines for crop water requirement may also be future work.

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