Evapotranpiration Model Using AI Controller for automatic Irrigation system

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Abstract – Rapid population growth necessitates continued increases in the use of cropland and water resource. Water management is the major issue in many cropping systems in semiarid and aried areas. Distributed filed sensor based automatic irrigation system offers a potential solution to specific area irrigation management that allows while saving water that maximize their productivity. And it is difficult to irrigate large areas of lands. most of the techniques are implemented for saving and water resources those all are fixed rate hardware controller. This paper proposed the sensors based ANN automatic irrigation controller. It saves the lot of energy and water resources, maximize the productivity, decreased the manual effort. The proposed Artificial Neural Network (ANN) based controller is prototyped using MATLAB. The system gets the input parameters as temperature, soil humidity, air humidity, radiation according to these parameters based on ecological conditions and type of crop, stage of growth based on these values it calculates the amount water required for the crop is estimated using evapotranspiration model. Finally associated results are produced.

Keywords: ANN based controller, evapotranspiration model, GPS, Zigbee, Irrigation System

1. I. INTRODUCTION

In human development, agriculture plays a vital role. Different countries of the world, irrigation also a vital component of the crop production. By using irrigation project to control the water flow through the monitoring optimum level of soil moisture [2].

Earlier days, complete research has focused on the practical problems like how much irrigation water was needed for specific crops grown in the area. Relatively little was done to relate the actual evapotranspiration to the climatic conditions so that knowledge gained in one area could be transferred reliably from one climatic zone to another [7]. To design an irrigation system requires estimation of water and power. National Agriculture Research institutions, they determine the amount of water consumed by various agricultural crops. A lot of research has done on soil water plant relations and determination of evapotranspiration from agricultural crops [8].

Irrigation process having two types of controllers. Like Fixed rate hardware controllers and variable rate hardware controllers [3,4,5].

Fixed rate controllers:

The existing alternative irrigation systems are in the stage of selecting irrigation area manually via human operation to achieve a selected area of irrigation, time consuming, response speed is slow. The current irrigation devices need to determine the actual moisture content of the different regions of the crop root zone to determine which area/when needs irrigation. Frequently, accuracy of the control has missed. The critical period of crop water requirement resulting in under production of existing devices. It designed based on following rules.

- It takes input and computes an output for the system accordingly.
- It doesn’t have any feedback to determine whether the correct output has achieved or not.

The above information is based on the fixed rate controller no measures are taken to check weather correct amount of water has supplied or not. The advantage is cost of the devices are very less. The disadvantage is cannot obtain the perfect solution to irrigation problems.

Variable rate Hardware controller (Closed Loop):

It supports predefined controller and developing feedback from the controlled object or system. It entails a few parameters to check weather the total amount of water needed for irrigation or not. We can collect the dynamic data in time and update the database every time. For terminal can live display stored data across the sensors, which is located in the farmland and send farmland water content data, farmland climate data, irrigation drainage data for total control system regularly. To update the database timely, the controllers call the instantaneous data from terminal to know the actual situation.

Different parameters play a vital role to take optimal decision. Some parameters are fixed in the whole process. Like the type of soil, type of plants, leaf coverage, stage of growth etc. Based on the type of crops and local climate data to simulate the crop physical process [1, 6]. Crop situations are

predicted based on the water requirements, water supply reduced under irrigation. Reducing the water is based on the various crop production functions.

Some important parameters for irrigation process:

- Type and Status of growth
- Leaf coverage
- Type of soil
- Water resources

The input parameters of the system are:

- Humidity of soil
- Temperature
- Radiation
- Wind speed
- Humidity of air
- Amount of salt in the ground

The output parameters are:

• Opening/closing the valves for water and/or fertilizer, and adjusting their amounts in combination;

• Turning energy systems on/off (lights, heating, ventilation);

• Opening/closing walls and roofs of hothouses.

II. EXISITNG SYSTEM

In "Engineering Quality Control of Solar-powered Intelligent Water-saving Irrigation" author proposed [3] power saving automatic irrigation system this is suitable for power saving. They are not concentrating on Ecological Conditions for calculating the soil moisture, Ecological conditions plays a major role in irrigation, here they are mainly focused on solar system if don't consider ecological conditions it is difficult to operate winter sessions and we can't save more water recourses.

In "A Water-saving Irrigation System Based on Fuzzy Control Technology and Wireless Sensor Network" they implemented [5] the irrigation System Using Network and collecting the data using sensors, and based on those sensor values it will operate and they are not calculating the Required Soil moisture it is mainly focused on how to utilize network concepts in irrigation and this paper is not concentrating how to utilize water and power resources based on required soil moisture etc.

In "Wireless Sensor Network Based Remote Irrigation Control System and Automation Using DTMF Code" is mainly concentrating on [4] How we manage in dry areas or in case of inadequate rainfall irrigation becomes difficult. They focused on how handle remotely for farmer safety only for managing existing water resources.In this paper they are not calculating parameters like ecological conditions, soil moisture and managing water resources etc.

III. PROPOSED SYSTEM

In this proposed system, to improve the production using an automatic irrigation system using an artificial neural network controller and a GPS system. By using this technique automates the large area of land in agriculture.

Irrigation system having several input parameters, but some parameters are fixed in the process and some parameters (like physical parameters) are varied based on time and production. Some fixed parameters in the process are, Type of soil, plants, and growth. Physical parameters vary based on time and production i.e., temperature, humidity of air, humidity of soil, radiation. The complete irrigation system depends on physical parameters; it calculates the actual soil moisture in the crop yield.

Temperature: It defines as continuing signal. It varies from day and night. But sharp changes in desert places.

- Sine wave with amplitude of 5^{o}c.
- A constant bias of 30^{o}c.

It generates a wave, maximum can reach 35^{o}c and minimum can reach 15^{o}c.

Humidity of air: It designed as sine wave with amplitude of 10% and BIAS of 60% constant.

Radiation: The proposed system modeled as maximum radiation at the earth's surface.

Required soil moisture: By using the above parameters to calculate the actual soil moisture in the ground. Agricultural research centers maintain a database like amount of water and humidity required for crops in the natural conditions for higher production. To get required soil moisture by comparing the desired and actual soil moisture. Soil moisture is calculated based on the below formula.

$$\text{Eto} = \frac{0.408\Delta(Rn - G) + \frac{\gamma 900}{T+273} u2(es - ea)}{\Delta + \gamma(1 + 0.34u2)\ 2a}$$

$$\Delta = \frac{4098\text{eo}(T)}{(T + 273.3)}$$

$$e^{0}(T) = 0.6108 exp\left(\frac{17.27T}{T + 273.3}\right)$$

$$\gamma = \frac{CpP}{\varepsilon\ \lambda}.10^{-3} = 0.001628\,.P/\lambda$$

ET0 = Reference evapotranspiration [mm day-1],
Rn = Net radiation at the crop surface [MJ m-2 day1],
G = Soil heat flux density [MJ m-2 day-1],
T = Mean daily air temperature at 2 m height [°C],
U2 = Wind speed at 2 m height [m s 1],
es = Saturation vapor pressure[kPa],
ea = Actual vapor pressure [kPa],
es-ea = eo
(T)= Saturation vapor pressure deficit [kPa],
D = Slope vapor pressure curve [kPa °C-1],
g = Psychometric constant [kPa °C 1].
P = Atmospheric pressure [kPa],
z = Elevation above sea level [m],
e°(T) = Saturation vap our pressure at the air temperature T
λ= Latent heat of vaporization, 2.45 [MJ kg-1],
Cp = Specific heat at constant pressure, 1.013 10-3 [MJ kg-1
ε= Ratio molecular weight of water vapor/dry air = 0.622

Proposed System Software Architecture:

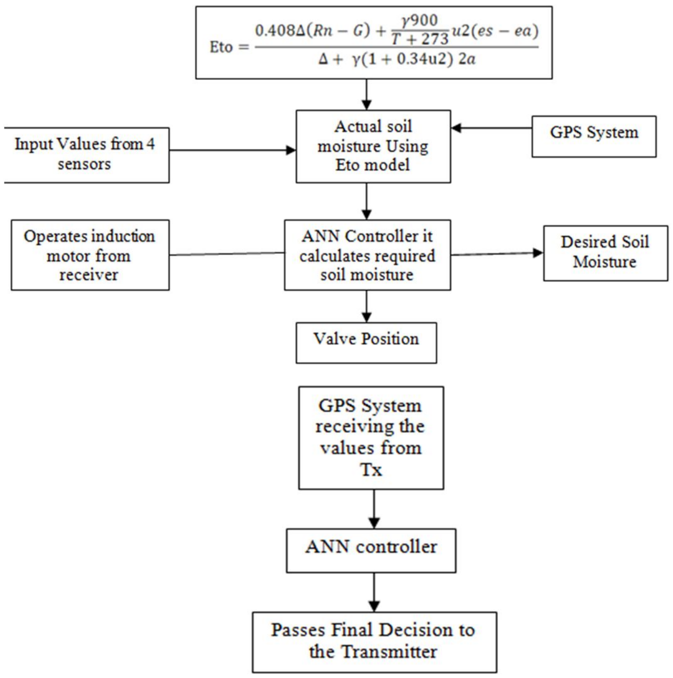

Fig1 proposed system software architecture

Sensors

Sensors are used to collect the soil moisture, temperature, humidity of air, humidity of soil, radiation etc. These values are forwarded to the micro controller. Using Sensors we are collecting the soil moisture, temperature, air humidity, soil humidity, Radiation after collecting this values we are passing this values to micro controller.

MC

Micro controller receives the parameters of the sensor and it automatically calculates the required soil moisture using Et formula and these are passed to LCD system and GPS system.

GPS & Zigbee

GPS system receives value from the controller. Then it forwarded to receiver controller. Receiver controller decides final decision based on the received values.

Application

The complete application depends on the wireless communication like GPS. And it Operates Application according to Receiver Decision.

ANN controller

Using ANN Controller WE Minimize the Error rate value and We get The accurate value of Eto Model.

Receiver

When the receiver receives final values from the transmitter, it compares the received values like soil moisture. If the received soil moisture is low it sends message to transmitter system.

Transmitter:

Function Of Transmitter is It takes The values From Sensors and it calculates the actual and Required soil moisture values and it forwards to the receiver using GPS systems. According to receive Message it controls the function of the application.

Proposed System Hardware Architecture:

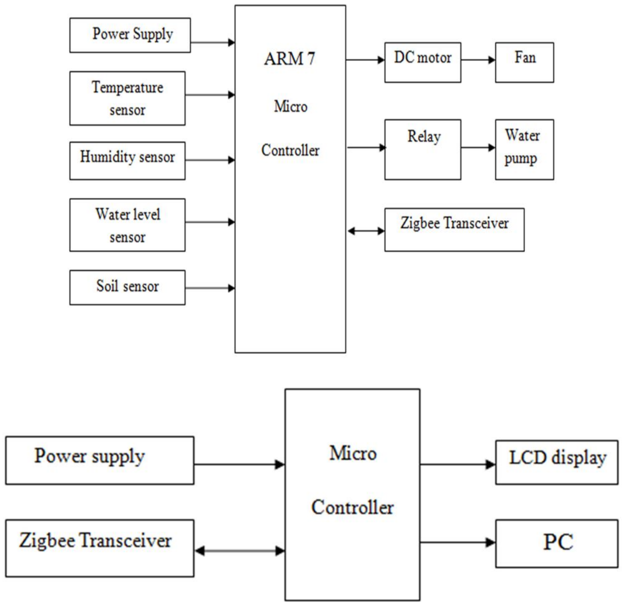

Fig2. Hardware architecture for automatic irrigation system

IV. Experimental Results

The proposed technique has implemented using MATLAB and Embedded System the results as shown below.

By using four Sensors we are taking four input parameter values those are

- Temperature
- Soil Humidity
- Air Humidity,
- Radiation

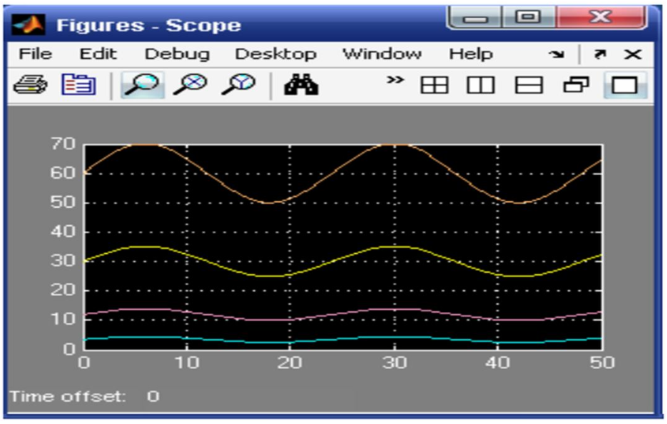

Fig3 four input sensor values

Four input Sensor values shown in graphical Representation in four different colors in the MAT lab (Appendix A, figure 1).

This graph shows the input values taken from sensors in signal values

- X-shows the time period.
- Y-shows the variation of sensor values time to time.

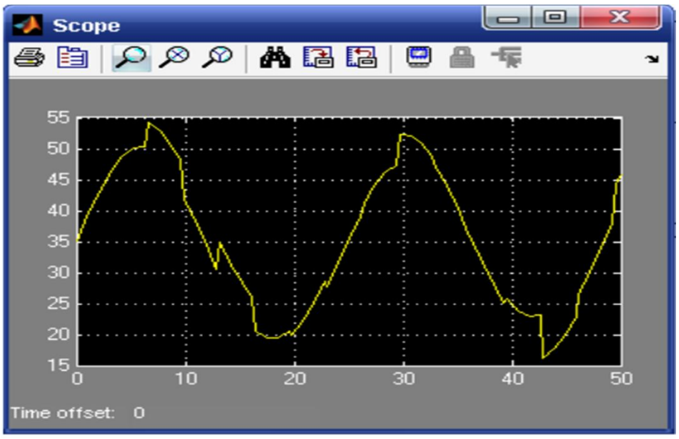

Fig 5 Actual soil moisture value

Actual soil Moisture values are calculated from Those four input values Using Eto Equation (shown in Appendix A figure 2). Eto model equation represents the Combined Function of Four input values. The desired soil moisture we collect the database from the agricultural research center.

This values is generated by comparing The Actual Soil moisture With the desired soil moisture value after comparing two values to get the result as Yellow signal, This signal shows Required Soil moisture Value (shown in Appendix A, figure3).

- Yellow signal-Required Soil moisture
- Light Red signal-Actual Soil moisture
- Green-Valve output.

Fig4 Comparison with Required soil moisture

figure 3 shows, the comparison with the Required soil moisture value With actual soil moisture value. The actual soil moisture calculated from the four input sensor values according to current ecological conditions. This Comparison produces Result as a Green signal, this signal shows the variation between actual and required soil moisture value. Based on this value we operate the Proposed system Functions.

This little bit variation Reduces the lot of power, water and energy recourses compared to the existing irrigation system. The actual soil moisture tracks the required soil moisture without any oscillations.

Embedded system output screens

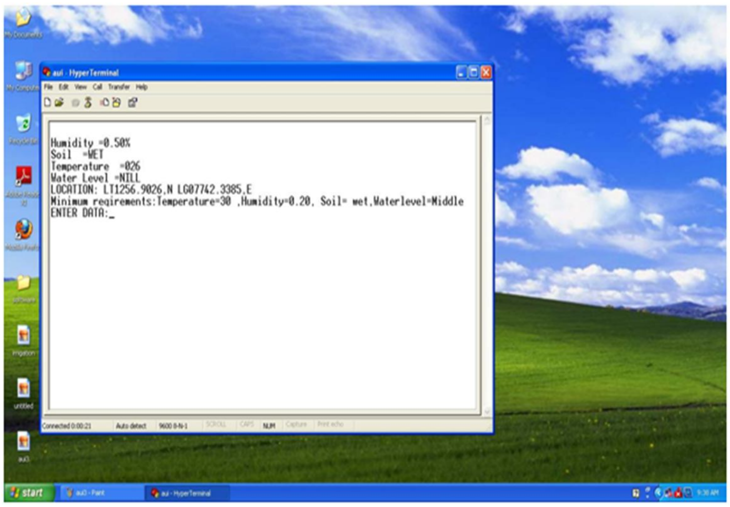

Fig 6 Hyper Terminal getting values from hardware

Showing that Hyper terminal getting values of sensors using receiver with Zigbee protocol above figure showing the values of Humidity is 50%,Soil is Wet and Temperature and Water level and GPS Location values. And Minimum Standard values for irrigation system Based on slandered values we can take the decision either automatically or manually.

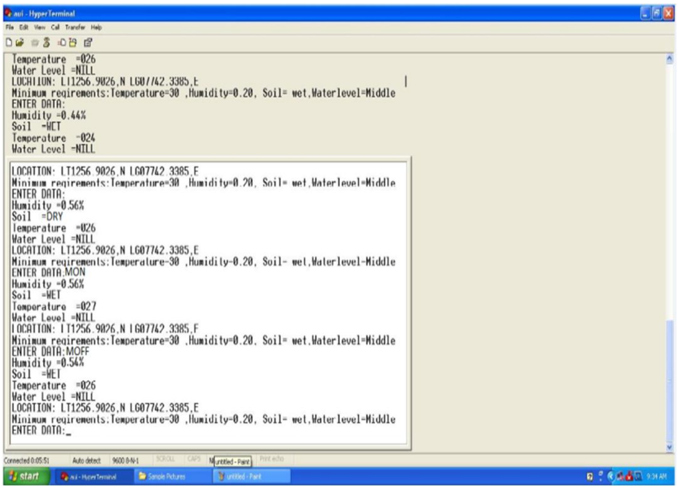

Fig 7 User Taking decision manually according to sensor values

Above figure showing that sensor values and according to those values by comparing the standard values user taking the decisions either automatically switch on the motor when soil goes to dry or manually by passing the commands "MON" for switch on the motor and "MOFF" for switch of the motor.

IV. CONCLUSIONS AND FUTURE DIRECTIONS

In This paper, sensors, wireless networks and ANN controllers are introduced to design automatic power and water saving irrigation System. This proposed System compared Existing System; it's shown that fixed rate hardware devices are failing because of its limitations. Proposed System is implemented better and more efficient than Existing System, Proposed System changes their decision and output according to the ecological condition, By using ANN concept we are getting accurate results while calculating Required soil moisture from the input parameters. Using This ANN Based controller We control the large area of irrigation lands By saving lot of Energy and Water Resourses. And We are showing those results in simulation graph, by comparing Existing and proposed System Consuming resources.

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