A Novel Approach on wireless controlled Drip Irrigation using Fuzzy Controller

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***Abstract*— This paper focus on determining the humidity and temperature of the soil using Raspberry Pi controller. The project designed using MATLAB 10, fuzzy logic and Simulink tools books the temperature and soil moisture sensors are used for detect the water quantity present in agriculture and water level sensor used for detecting water level in tank the level gauge interfaced by electronic circuit worked as signal conditioner circuit the water from tanks controlled by solenoid valve which actuated by relay circuit open and close as the microcontroller output then the water transmitted to roots zone using pipes line for irrigation process . The temperature sensor and humidity sensor will measure both the moisture and temperature in the soil. If the water level is found less, it will be corrected automatically using the relay through Raspberry Pi controller. If any disturbance is found in the field the notification will be sent as message through Global System for Mobile communication (GSM) and the recorded video is sent through mail. And to remove the disturbance manual inspection should be carried out.**

Keywords—component; formatting; style; styling; insert (key words)

I. INTRODUCTION

The population growth and environmental change both are the most challenges for the ministry agriculture and the governments, many researchers developed in this area including, foods production, saving water, and reducing the pollution to protects our environments from the pollutions that produced by the man in through industry and energy production. Universities, research center, institute and the governments through the world they published many articles and paper in the field of irrigation management, irrigation control, solar energy, water safety, environmental management and, yields, vegetables and agriculture production management. With the rapid development of agriculture in China, crop growth required Soil moisture content it's the basic of yields growth, while over soil moisture cause the death of crops', and lot of fertilizer which will cause pollution for water and environmental [2]. The development of the electronics technology support the technical application in the field of agriculture by controlling , monitoring of soil moisture content had made great progress [3] A soil moisture detection system based on ZigBee wireless network, and all the references only stated monitoring soil moisture content and had no control function, set up a small farmland data acquisition platform using ZigBee network, and obtained information of the solar energy, wind and current[4]; achieved a remote monitoring of irrigation system through the distributed WSN and GPRS[5]The farmers manually control the water supply by tabulating the irrigation time of the croups. These process not accurate irrigation amounts of water loosed. For this reason an automatic irrigation system based on sensing technology is required to reduce the cost and to give uniformity in water application across the field [6] A.R.AI-Ali et.al, by usage of the internet the local control or the remote control can moisten their garden grass and trees physically or mechanically. In these recreations outcomes, format presentations were as likely acceptable. The structure can be combined with other home automation systems with slight changes [7].Chandankumarsahu et.al, discussed about, the irrigation field, if the soil humidity is not active to the required level before the motor alert message is guide to recorded mobile phones [8]. Pravina B. Chikankar et.al, in these a normal farmer can choose the crop by attaching the arrangement to his computer and spontaneously screen the irrigation system for the crop with regulatory moisture and temperature [9]. Pandurang H.Tarangeet.al, discussed an embedded Linux board which allows collecting the sensor information from sensor node continuously, store it in a database and providing the web interface to the user 10]. Yunseop (james) kim et.al, the usage of an automated closed-loop irrigation system requires three major components: machine conversion, navigation, and mission planning to support the solid communication protocol. It provided extensive details for the wireless communication interface of sensors from in-field sensor stations and for a programmable logic controller from a control station to the computer at a base station [11]. Joaquín Gutiérrez et.al, used Wireless sensor units (WSUs) and a wireless information unit (WIU), linked by radio transceivers that allowed the transfer of soil moisture and temperature data, implementing a WSN that uses Zigbee technology.

The WIU has also has a GPRS module to transmit the data to a web server via the public mobile network [12]. Jyotsna Raut and V. B. Shere, Used wireless sensor networks in automation for irrigation, this system provides a low-cost wireless solution for an in-field WSN and remote control of precision irrigation. Data mining algorithms used enhances automatic intelligence for WSN based drip irrigation system [13]. ZhaoLiqiang et.al, has said that application monitors the whole farm from remote location using IOT (Internet of Things). Energy saving algorithm is used in node to save energy. Tree based protocol is used for data collection from node to base station. System having two nodes sensor node which collect all environmental and soil parameters value soil moisture, temperature, air, humidity, light, etc. and second node consist of cam to capture images and monitor crops [14]. Robert W. Coateset et.al, using a Wireless sensor network with valve control unit is developed with actuator hardware and software. Irrigation is control by actuator. Web application is used for manual control and schedule irrigation timing. Water meter indicate the requirement of water. Node unit contain soil moisture sensor and actuator. Two way communications take place from actuator to node and base station [15]. Renua Chuimurkar and Vijay Bagadi, the usage of mobile technology provide essential security to our homes and for other control applications. This system uses webcam but IR filter was removed in order to have night vision. It can also find the number of persons located with the help of the Infrared sensor [16]. Rashid Hussain and J Sahgal, explained about different techniques to measure soil fertility in order to check the productivity of crop Information about the fertility of soil and secondly moisture contenet of soil [17]. S.Muhammad Umair and R. Usman, introduced Artificial Neural Network (ANN) based intelligent control system for effective irrigation scheduling. The proposed ANN based controller is prototyped using MATLAB. The input parameters like air temperature, soil moisture, radiations and humidity are modelled. The amount of water needed for irrigation is estimated and then associated results are simulated [18]. Francisco G. Montoya et.al, developed an android application which was implemented using the latest technologies in order to facilitate simple and easy management and monitoring of an agricultural system, greenhouse or golf course, among other functions. The system can simultaneously operate with several installations, which allows the manager or farmer to control the plantations through a better decision-making process [19]. Xiaoxue yang, Urban irrigation system is designed towards the intelligences and precision of irrigation, which is based on zigbee wireless technology combining with the socket internet programming mathematically modelling and digital control of terminal methods [20].

Wireless networks technology used in many field of data collection and dad acquisition system because it is reliable data transfer and law cost and energy consumer, by using mat lab or any electronics software simulator, flexible network can de designed. To save the water and controlling irrigation process the wireless and fuzzy logic control system can be used for this process the technology used in many applications that involve monitoring of real-time data. In order to optimize the yield and the use of the available resources, wireless sensor networks can play a relevant role because of their ability of providing real-time data collected by spatially distributed sensors.

II. IRRIGATION SYSTEM

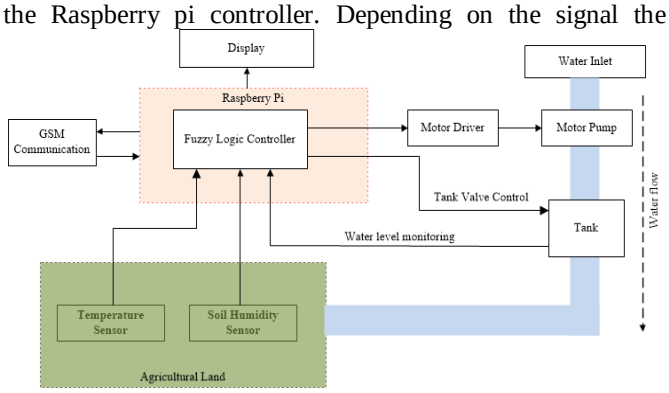
Irrigation is the manual application of delivering water for growing crops. Irrigation process is pumping the water from water source to the crops according to the crops need, irrigation system before depending on the farmers expert and manual observation of the crops, with the growth of the technology they are many techniques of irrigation, open channel close channel Surface irrigation, Localized irrigation, Drip irrigation and Sprinkler irrigation. In this paper drip irrigation with irrigation sensor network is used. Two general types of controllers are used to control irrigation systems: Open control loop systems and closed control loop systems. Open control loop systems apply a preset action, such as is done with simple irrigation timers. Closed control loops receive feedback from sensors, make decisions and apply the results of these decisions to the irrigation system, our circuit diagrams consist of Raspberry pi for controlling the pumps , tanks and solenoid valves , sensor to read temp and another for humidity's. The controlling process monitored with LCD and computer interfaced with the irrigation networks the controller controls valves by sending signal to through the driver to relay circuit witch turn ON or OF the valves or motors according to the fuzzy logic programs. This type of irrigation allows the irrigate at the right time, saving water and improves crop performances.

III. PROPOSED SYSTEM

The proposed system has three sensor unit, in which temperature sensor, humidity sensor. They were used to obtain the soil moisture level, if the moisture level is low, then the water motor is made on by turning the relay on, and if the soil moisture is normal means, the relay is turned off to off the motor. In this entire process, all the activities of the irrigation system is notified to the user as text message by sending an SMS, with the parameters like humidity value, temperature value, Motor status. The humidity sensors senses, measures and reports the relative humidity in the air. It therefore measures both moisture and air temperature. This can vary with environmental conditions. The sensor is designed to adjust to slowly changing conditions that would happen normally as the day progresses and the environmental conditions change, but responds by toggling its output when sudden changes occur, such as when there is motion.

Humidity sensor is placed in the soil to measure the soil wet status. If the soil is wet the value is given to the comparator circuit. In comparator circuit, we set the

predefined value using the trim pot, and read the humidity value and compare the two values, if the soil is wet the comparator will give high signal otherwise low signal to the Raspberry pi controller. Depending on the signal the



controller will give signal to the relay driver circuit to switch ON and OFF the water pump. The controller will send the status of the motor (motor on & motor off). The controller will activate the alarm to intimate that the humidity value is low.

Fig. 1. Block Diagram of the Proposed system.

And the temperature sensor is used to sense the weather condition. The temperature sensor value is given to the comparator circuit. In comparator circuit we set the predefined value using the trim pot and read the temperature value and compare the two values, if the temperature value is high the comparator will give high signal otherwise low signal to the Raspberry pi controller. When the controller reads high signal, it sends the message to the predefined number using GSM modem. The controller will activate the alarm to intimate that the temperature value is high MAX 232 is used to communicate between GSM and Raspberry Pi controller.

In our project we have obtained, a normal farmer can connect this setup to his computer or mobile phones and select the crop type and accordingly he can automatically monitor the irrigation system for the crops along with controlling humidity and temperature in his field. From this it is concluded that we have succeeded in using the technology of "Raspberry pi controller" for an automatic irrigation process using wireless sensor network.

A. Fuzzy Logic System

A fuzzy set is an extension of a crisp set. In crisp sets there is only full membership or no membership while fuzzy sets allow partial memberships. Membership Function (M.F) is a curve that tells where each point of the input is mapped to a membership value between 0 and 1. Different membership functions are used in fuzzy like, triangular, trapezoidal, Gaussian curves, polynomial curves, and sigmoid functions. A simple block diagram of fuzzy logic System is shown in Figure

From the figure it can be seen that the Fuzzy logic system have four components, which are Fuzzification Interface (Fuzzifier), Decision making unit (inference engine), Rule Base, and Defuzzification Interface (defuzzifier). Linguistic rules given by experts are easily extracted in numeric form which is present in Rule Base. When the rules have been set, fuzzifier maps the inputs into fuzzy memberships. Input values are taken by Fuzzifier to activate defined rules by linguistic variables and determine relationship with each fuzzy set with the help of membership functions. Input and output fuzzy set is defined by inference engine, it also define level of satisfaction of antecedent for each and every rule. Fuzzy operator is used to represent results if more than one clause for antecedent is given. All the results are aggregates in to a single fuzzy set. One of the most important aspects of FIS is that Fuzzy rules are fired in parallel way but order how the rules are fired does not affect output. Defuzzifier converts fuzzy output into crisp number. Different practices are used for defuzzification like the mean of maxima, centroid, maximum and height defuzzifier but the most known common technique is the centroid. Numeric Data and linguistic knowledge all together can be controlled by Fuzzy systems.

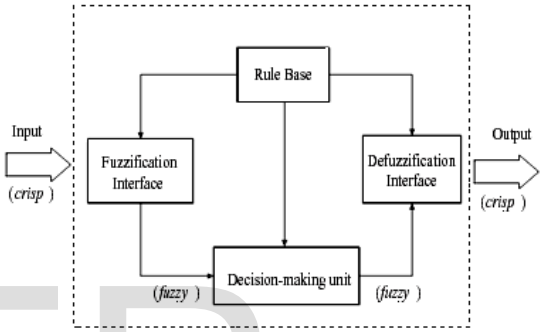


Fig. 2. Block Diagram of the Fuzzy Logic system.

In fuzzy control there are two main types of control rules:

Mamdani System: Expert knowledge is basically collected by this method. This method allows us to explain knowledge in more spontaneous and lively manner. Moreover, Mamdani-type (FIS) gave a detail and significant computational saddle.

Takagi- Sugeno: This method is used by professionals mostly in control problems and in non linear system. In this method membership functions can be customize so data can be best modelized by the fuzzy system.

Binary sets take fixed and exact value whereas fuzzy deals with approximation reasoning and its true value range from 0 to 1. The Fuzzy logic is designed to manage the partial truth. Fuzzy have good performance as compare to PID controllers, used for multi inputs and multi-outputs and also it is easy to handle.

B. Fuzzy Controller for Irrigation System

Following points should be considered to make sure suitable design and process of a water distribution system:

Field Contained Moisture

Temperature of Surroundings and Humidity

Another parameter could be Type of Crop and its Water usage which differs for every crop as shown in section 4. The fuzzy controller designed in this research is best

suitable for standard grass but it can be used for other crops according to their watering needs with respect to standard grass.

With The different temperature and moisture level the water requirements (intake) vary accordingly. Timely and appropriate amount of supply of water should be guaranteed to carry the growth of the crop in a proper way.

In agriculture field temperature and humidity sensors are deployed and Sensor nodes sent data to FIS. In order to design FIS, a choice should be made to select input sensors and output actuators. In this research temperature and Humidity sensors with following membership functions are considered. Moreover actuators are required to be attached with sprinkler and operate according to the output of fuzzy controller. Temperature M.F consist of five portions (cold, cool, normal, warm and hot) while Humidity crisp consist of three(Dry, Moist, Wet).These M.Fs works together to give accurate output.

After Tuning limit ranges for each membership function it will help to find possible solution for specific crops based on requirements of plants, knowledge and working experience. Adjusting these values to make outputs more adequate and comprehensive according to the requirements of the crops. Following table is showing a summary of 15 fuzzy logic rules for this project.

TABLE I. FUZZY RULES SUMMARY

	Cold	Cool	Normal	Warm	Hot
Wet	Short	Short	Short	Short	Short
Moist	Short	Medium	Medium	Medium	Medium
Dry	Long	Long	Long	Long	Long

IV. DESIGN OF CONTROLLER

In order to design the Fuzzy Logic Controller there are four steps required as follow.

- Identification of Control Surfaces
- Behavior of Control Surfaces
- Fuzzy Inference System and Decision Making
- Defuzzification

A. *Identification of Control Surfaces*

Linguistic variables are recognized and membership values for each variable are calculated in this step. The input and output variables are shown in figures 3-6.

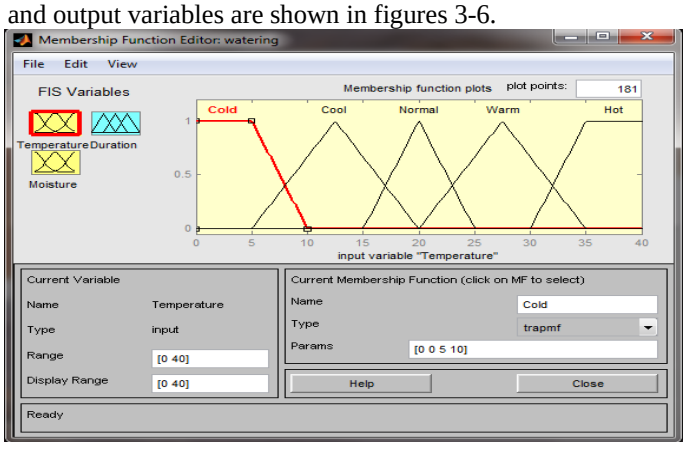


Fig. 3. Membership Graph for Temperature Input.

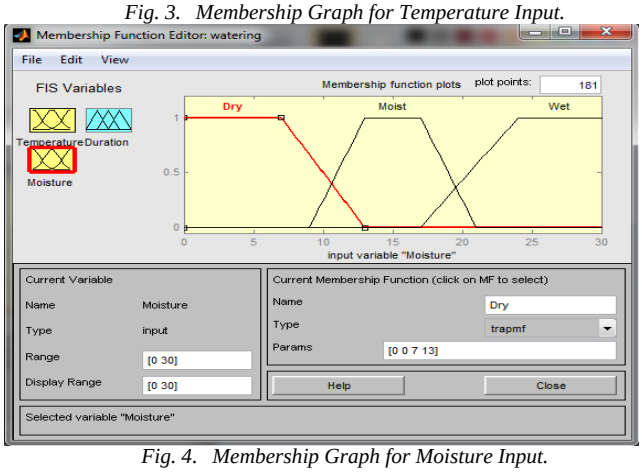


Fig. 4. Membership Graph for Moisture Input.

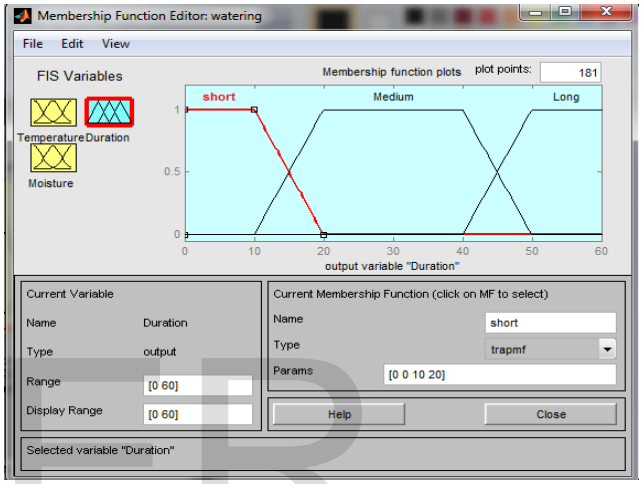
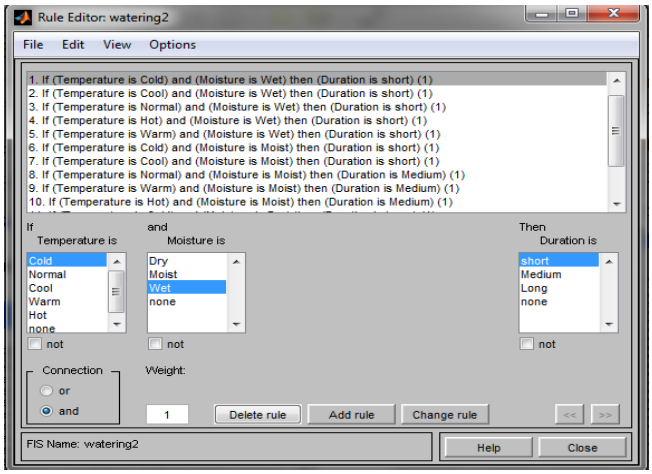


Fig. 5. Membership Graph for Output

B. *Behavior of Control Surfaces*

In this step fuzzy rules are constructed for different inputs to perform different actions. Fuzzy inputs associate with fuzzy output by fuzzy rules. The rule viewer is shown in Fig 6. which are derived from table 1.

Fig. 6. Fuzzy Defined Rules for Water Distribution



C. *Fuzzy Inference System and Decision Making*

The FIS consists of fuzzy rules which are derived by information of experts or from input-output learning of system. Rules mimics‟ human reasoning .Mamdani method is generally used in fuzzy inference technique. Fuzzy inference system used rules to generate fuzzy outputs, in this system there are 2 inputs against each input there is fuzzy linguistic variables as shown in Figure 7.

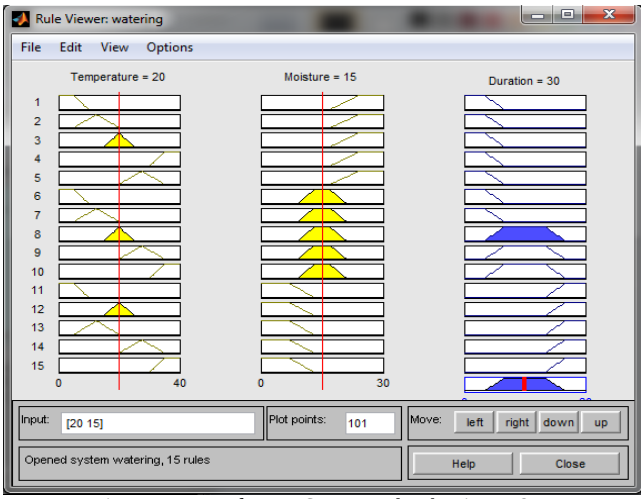


Fig. 7. Fuzzy Inference System and Rule Viewer Output

D. *Fuzzy Inference System and Decision Making*

Defuzzification is a process of conversion from a fuzzy set to a crisp number. For crisp input value, there are fuzzy membership for input variables, and each variable cause different fuzzy outputs cells that will used to activate or to be fired. Output will change into crisp value from this procedure of defuzzification. Defuzzification can be done by different methods but most common technique is centroid method.

V. CONCLUSION

An automatic irrigation system using Raspberry Pi controller was developed and tested. By using this method of irrigation the water is used to the maximum extent and wastage of water is reduced. This system can be adjusted to a variety of specific crop requires minimum maintenance. It can be reckon that in future the precision agriculture projects may have a significant popularity.

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