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FERTIGATION THROUGH DRIP IRRIGATION USING EMBEDDED SYSTEM

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***Abstract:*--In the field of Agriculture most important things are fertility of soil, nutrition's available in soil, water availability in that area, atmospheric conditions .All these parameters are playing the measure roll regarding the productivity of crop .In this paper we are trying to go through the techniques which will show us how to improve productivity with the minimum use of natural resources like water, and avoid leaching of soil by using fertilizers through drip. This can be used in greenhouse or open environments to efficiently monitor soil moisture and temperature, ambient temperature, and humidity. Wired communications, sensor networks, and other complementary technologies provide the necessary tools to compile and processes physical variables, including temperature, humidity, and soil moisture, pH of soil, fertilizer concentrations. Greenhouse and precision agricultural, in general, demand real-time precise measurement of these parameters in order to avoid unnecessary exposure to unhealthy ambient conditions, assure maximum productivity and provide value-added quality. This paper aims to implement the basic application of automizing the irrigation field by programming the components and building the necessary hardware with ARM7 Processor. This is used to find the exact field condition and maintaining their levels in the soil.**

***Index Terms*--ARM 7, Fertigation, Temperature, Humidity, Soil Moisture**

I. INTRODUCTION

In India 60-70 % economy depends on the agriculture. With the different landforms, different atmospheric conditions, and unplanned use of waters natural resources which causes the shortage of water forces us to think in different way. Best solution to this problem is Drip irrigation system and Sprinkler irrigation. Sprinkler is beneficial for those crops which needs water spray over the ground [1].

With the help of drip irrigation system we can also provide the fertilizers to crop. This process is called as fertigation. Fertigation allows us to apply the nutrients in right amount and uniformly at wetted root where the active roots of plants are present. Fertigation has the potential to ensure that the right combination of water and nutrients is available at the root zone, satisfying the plants total requirement of water and nutrient[2].

An interactive computer program was developed for estimation of irrigation water requirement, required amount of fertilizers, and capacity of fertilizer tank, capacity of drip system, injection duration and injection rates at different levels of Fertigation[3]. Fertigation resulted in saving of 40% fertilizers as compared to the broadcasting method of fertilizer application without affecting the crop yield (23.35 t/ha and 23.56 t/ha, respectively).

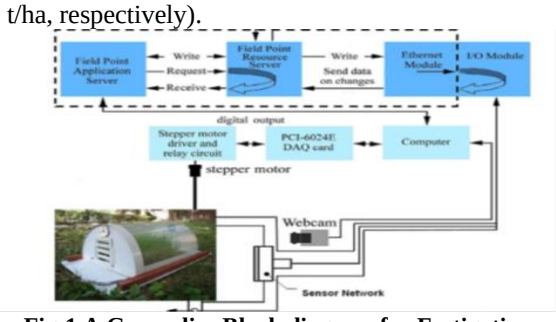


Fig:1 A Generalize Block diagram for Fertigation

Fertilizer application at the level of 100% of recommended dose through fertigation recorded an increase in yield of 25.21% from 23.0 t/ha to 28.8 t/ha, in the year 2000 and 16.5% from 23.56 t/ha to 27.47 t/ha, in the year 2001 as compared to broad-casting method of fertilizer application. [2] The right combination of water and nutrients is the key for high yield and the quality of product. Fertigation saves fertilizer as it permits applying fertilizer in small quantities at a time matching with the plants nutrient need. It is considered eco-friendly as it avoids leaching of fertilizers. Liquid fertilizers are best suited for fertigation. This article suggests a detailed method for using granular fertilizers for fertigation. The methodology also estimates the concentration of nutrients in irrigation water.

A. Methodology For Estimating the parameters

The method used for estimation of different parameters, including amount of fertilizers, frequency of fertigation, water requirement, capacity of drip system, injection rate and injection duration, has been discussed here.

B. Amount of Fertilizer

In order to estimate the fertilizer amount we have to consider following factors

-Depth of the crop rooting system.

-% of soil occupied by the root system under different irrigation systems

-Soil bulk density (Bd)

These parameters calculate weight of soil of a certain area to a depth where the active rooting zone is developed. The amount of nutrient in soil is estimated by considering soil type, depth of roots penetration in soil, rooting habits of the crop

The mass of the soil occupied by the root is

Soil Mass(tons)=(AxDxVxBd)/100 (1)

Where A is area of plantation/irrigated area (m^2), D is root depth(m), V is soil volume occupied by roots(%),Bd is soil bulk density(tons/m^3).From this soil mass value is estimated and from chemical analysis of soil we can get the amount of nutrients available in soil. Therefor amount of fertilizers requirement is calculated as follows

NS(kg/ha)=(NR-SAN+SM)/Ue (2)

Where NS is amount of fertilizer supplied, NR is nutrient required by crop (kg/ha), SAN is soil available nutrient (ka/ha),Ue is nutrient uptake efficiency (fraction).[4]

II. FREQUENCY OF FERTIGATION:

Frequency of Fertilizers injection is depends on optimum growth of plant under fertigation. Implicating the fertigation program the actual water and nutrient requirement with uniform distribution are very important parameters Crop water requirements are the most critical link between irrigation and sound fertigation. Therefor the amount of irrigation water needed over the growing season must be determined by

considering the climatic conditions of the region under consideration. The empirical application of the fertilizer depends on the response of crop to low recovery of fertilizer therefor application frequency is depended on the farmer's experience and on broad recommendation.[4] The frequency depends on irrigation scheduling, soil type, nutrients requirement of crop and the farmer's preference. In any case, it is extremely important that the nutrients applied in any irrigation are not subject to leaching either during that irrigation or during subsequent irrigations.

III. CAPACITY OF FERTILIZER TANK

The stock solution is prepared by dissolving the granular fertilizer in water. The amount of water needed to dissolve the required amount of granular fertilizer depends on its solubility. Depending upon the compatibility of the granular fertilizers, either one stock solution of N-P-K fertilizers or different stock solutions of N, P and K fertilizers were prepared separately. Stock solutions could be prepared for each fertigation or for injection during fertigation over a period of time [5]. The capacity of fertilizer tank was calculated on the basis of frequency of fertigation, area irrigated in one application, application rate and concentration of stock solutions prepared for fertigation.

$$Vt = (RF \times A) / (C \times nf) \quad (3)$$

where Vt is the capacity of fertilizer tank, l; C, concentration of the fertilizers in the stock solution, kg/l; nf , number of fertigations during the crop season and A is the irrigated area, ha.

IV. IRRIGATION WATER REQUIREMENT

Irrigation water requirement was estimated on the basis of evapotranspiration data and crop coefficient as follows.

$$V = Ep \times K p \times Kc \times Cc \times A \times 10\text{-}4 \quad (4)$$

where V is the total irrigation water requirement, l; Vd = (V/N), average daily water requirement, l/day; Kc , crop coefficient; Cc , canopy factor, (Cc = wetted area per plant area = 1.0 for field crops); Kp , pan coefficient (generally it is 0.8); Ep , total pan evaporation during the crop period, mm; and N is the crop duration, days.

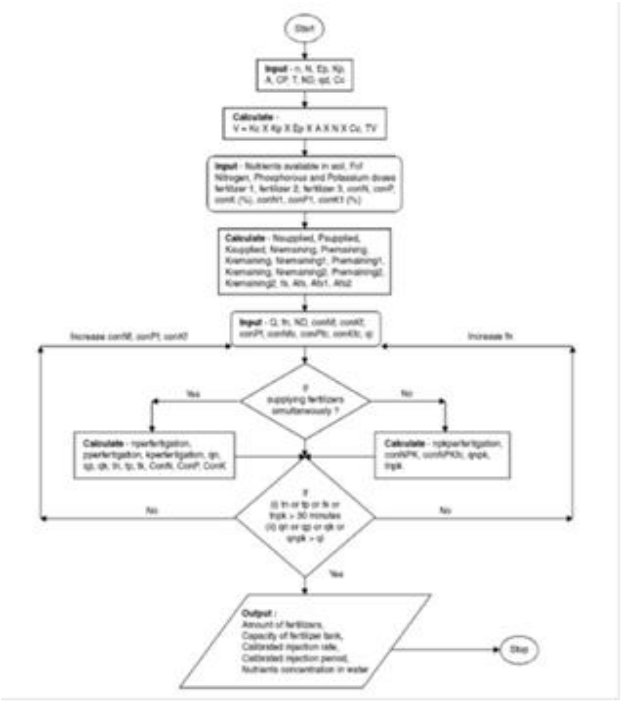
Injection Duration and Rate of Fertilizer Solution:

The fertilizer injection duration depends on the type of soil, nutrient and water requirements of the crop. Maximum injection duration of 45 min to 60 min is generally recommended with enough time for flushing of fertilizer residues from the drip lines before shutting the pump off. Injection rate refers to the volume of fertilizer solution injected during a specific period of time. To inject the fertilizer solution at pre-determined injection rate, the selected fertilizer applicator should be calibrated before starting the fertigation.

After calibration, the duration of injection for different fertilizers may change as it depends on the concentration of the fertilizers in the stock solution and the desired quantity of nutrients to be applied during any fertigation. The discharge through the applicator depends on the duration of Type equation here.irrigation as well as on fertigation. The following equation was used to determine the injection rate of fertilizer injector.

$$Q_I = (RF \times A)/(NF \times C \times T F) \quad (5)$$

where Qi is the injection rate of fertilizer solution, l/h; tf , duration of each fertigation, h. Concentration of Nutrients in Irrigation Water The actual concentration of nutrients needed in irrigation water depends on the fertilizing material and the crop requirement



Flow Chart: 1, Fertilizer Concentration in soil

B) Working Principle

Atomized Fertigation is an interesting application for Real time atomization of agricultural environment. Here in this paper, we are basically concentrating on following applications such as

1. To continuously monitor the soil moisture.
2. To continuously monitor the water level of well and fertilizer tank.
3. To check the temperature, humidity determines the weather condition.
4. To monitor & control the whole system through GSM module.
5. It provides the detail information about the field condition to the user through SMS.
6. Maintain faithful irrigation of the farm field via constant monitoring of pH value or N-P-K concentration of soil and other field parameters.

The system consists of a centralized unit, much like a mobile base station This forms the link between the user and the device. The whole system functions in the form network being connected to the centralized unit as a Node. The centralized unit is connected to many such nodes from/to which it receives or sends the data. The user communicates with the centralized unit through SMS. The centralized unit communicates with the system through SMS which will be received by the GSM with the help of the SMS. The GSM sends this data to ARM7. ARM7 also continuously receives the data from sensors in some form of codes. After processing, this data is displayed on the LCD. The communication between various devices takes place through RS232. Thus in short whenever the system receives the activation command from the subscriber it checks all the field conditions and gives a detailed feedback to the user and waits for another activation command to start the action. This system also monitors the physical parameters like temperature humidity and maintain in application with Green House very well.

C) Methodology Of Implementation Of System

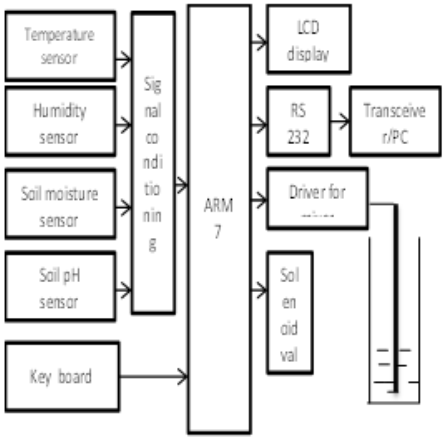


Fig: 2, General Block Diagram

The important parameters to be measured for automation of irrigation system are soil moisture and temperature .RTD like LM35 can be used as a temperature sensor while Tensiometer can be used as the moisture sensor to detect moisture contents of soil. The moisture sensors are buried in the ground at required depth. Once the soil has reached desired moisture level the sensors send a signal to the micro controller to turn off the relays, which control the valves. The signal send by the sensor is boosted up to the required level by corresponding amplifier stages.

A LCD module can be used in the system to monitor current readings of all the sensors and the current status of respective valves. The solenoid valves are controlled by microcontroller though relays. A Chemical injection unit is used to mix required amount of fertilizers, with water, whenever required. Venturi pump is used for equal distribution of mixed fertilizer to the farm. A flow meter is attached for supply of total water required for irrigation. The required readings can be transferred to the Centralized Computer on the receiver side for further analytical studies, through the wireless mode i.e. using RF module connected to the microcontroller unit. Using this technique the data can be transferred to the remote place. So the user can access the data sitting at his Home or Office. While applying the automation on large fields more than one such microcontroller units can be interfaced wirelessly to the Centralized Computer.

The microcontroller unit has in-built timer in it, which operates parallel to sensor system. In case of sensor failure the timer turns off the valves after a threshold level of time, which may prevent the further disaster. The microcontroller unit may warn the pump failure or insufficient amount of water input with the help of flow meter.

In case of monitoring the soil moisture, we know that each crop requires different moisture level we are using a soil moisture sensor which is based on the principle of parallel capacitor. As we know that the voltage across the capacitor is inversely proportional to the dielectric medium. This principle is used to determine the soil moisture by measuring the dielectric constant of soil. This is then informed the centralized unit. The centralized unit will send the message to the device of that particular subscriber. The device waits for a certain amount of default time for which it is programmed. When the user does not respond to the centralized unit in default period the device continues monitoring the field parameters and keep on sending automatically to the centralized unit. The motor is controlled by a simple manipulation in the internal structure of the starter. The starter coil is indirectly activated by means of a transistorized relay circuit once the motor is started, a constant monitoring on soil moisture and water level is done & once the soil moisture is reached to sufficient level the motor is automatically turned off & a massage is send to subscriber that the motor is turned off. Using the database stored in EEPROM of ARM, the corresponding moisture can be known by comparing the stored values and received information from the sensor which ensures faithful irrigation for particular crop.

D) Hardware Description

V. ARM7 MICROCONTROLLER

The ARM Cortex M3 processor is the 32 bit processor for real time applications, specifically developed for high performance and low cost platforms for a broad range of devices including microcontrollers, automotive body systems, industrial control systems and wireless networking and sensors. The processor delivers outstanding computational performance and exceptional system response to events while meeting the challenges of low dynamic and static power constraints.

The processor is highly configurable enabling a wide range of implementations from those requiring memory protection and powerful trace technology to cost sensitive devices requiring minimal area

VI. GLOBAL SYSTEM FOR MOBILE COMMUNICATION (GSM)

A GSM modem is a wireless modem that works with a GSM wireless network. Computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. So we can use a GSM modem just like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. GSM is one of the most vital components in our set up since all the communication between the users and centralized unit takes place through this modem. GSM communicates with ARM through I2C bus. A GSM modem can be an external device or a PC Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. ARM7 is a 32-bit advance featured microprocessor that is a low power consuming processor, which is the foremost requirement of the industry. It has some unique features. GSM is most common mobile technology with easy availability and simple operation. It's less signal deterioration inside buildings has ability to use repeaters. . Talk time is generally higher in GSM phones due to the pulse nature of transmission. The availability of Subscriber Identity Modules allows users to switch networks and handsets at will. GSM covers virtually all parts of the world so international roaming is not a problem. The project can be applicable at any level for different purposes by bringing about minor changes in programming, that is, there is no need to change the basic set up every time. For critical applications that need real-time monitoring, the field condition is transmitted to a base station through radio link. For non-real-time applications the data is logged on an on board memory and down loaded as and when required.

But it has its share of drawbacks too. That is GSM has a fixed maximum cell site range of 35 km, which is imposed by technical limitations.

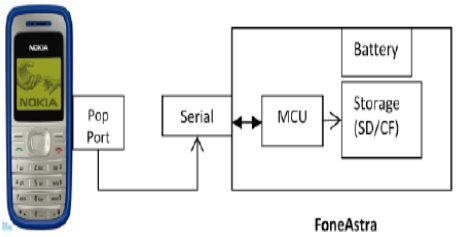


FIG: 3 CONNECTING GSM MODULE TO THE SYSTEM

VII. MAINTAINING PH

The right combination of water and nutrients is the key for high yield and the quality of produce. Fertigation has the potential to ensure that the right combination of water and nutrients is available at the root zone, satisfying the plants total and temporal requirement of these two inputs. Fertigation saves fertilizer as it permits applying fertilizer in small quantities at a time matching with the plants nutrient need. Besides, it is considered eco-friendly as it avoids leaching of fertilizers. Liquid fertilizers are best suited for fertigation.

VIII. RESULTS

The prototype was developed for Fertigation control to show proof of the concept. The scenario for context aware agriculture is as follows:

*Sensors placed over piece of irrigated land will keep on providing weather and soil moisture attributes of each similar zones nearer to each other. The rate of sampling is defined as per soil condition and crop under consideration.

* All conversions from raw samples, aggregation and data storage facilities will be provided by desktop grid nodes.

* Context-aware sensor grid application will be using these converted and aggregated samples for context modelling and interpretation to know about the current situation for irrigation requirements.

* Based on condition, decision will be taken for actuation of respective emitters of drip for misting or for irrigation.

*Based on the pH sensors the action will be taken and it will be maintained by providing Fertilizer with water.

*Temperature and Humidity can be maintained in Green house as per requirement.

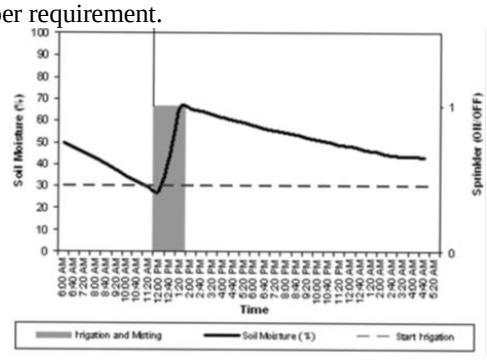


FIG: 4 GRAPH SHOWING SYSTEM BEHAVIOR ON SENSED VALUES OF COOL AND HAZY DAY FOR SOIL MOISTURES.

IX. CONCLUSION

The Microcontroller based atomized drip irrigation system technique proves to be a real time feedback control system which monitors and controls all the activities of drip irrigation system efficiently. Using this system, farmer can save manpower, water to improve production and ultimately profit. The developed irrigation automation system can be proposed to be used in several commercial agricultural productions since it was obtained in low cost and in reliable operation. This application of sensor-based irrigation has showed that each drop of water gives good crop yield, proper and required amount of nutrient for crop which also avoid leaching. Based on the rules and context situations different treatments were performed to properly irrigate the area under consideration. Threshold levels for irrigation and misting were defined based on the plant under consideration Figure 4 presents the graphical representation of climate and soil moisture data of a cool day having hazy sun conditions and system response where drip is actuated at a point when average soil moisture drops down the minimum threshold level to cope up with water stress condition. By providing the proper value of pH and fertilizers and maintaining it in the soil productivity and quality of crop will improve to very high level.

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