Automated Smart Irrigation Techniques for Sustainable Agriculture

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ABSTRACT

Due to high population the needs of human being are increasing day by day. Simultaneously the food material requirements are also increasing. In order to meet the food demands, it is essential to improve the efficiency of crop production in the scenarios of manpower and water scarcity. The need of hour is to make an efficient utilization of available manpower, water and fertilizers which can lead to cost optimization of the annual crop-production. Fortunately the different technologies and techniques available today can help to achieve the goal of cost optimization and quality control.

This preliminary work focuses on the cost effective automatic smart irrigation system which allows saving water and human efforts with desired quantity and quality of crop-production. The proposed system also incorporates a simple yet lightweight smart phone application which can permit the farmer to execute the irrigation and fertilization schedules. The experimental setup in the farm admeasuring 1 acre of sugarcane crop showed that the water requirement reduced by 56%, manpower expenses for irrigation reduced by 90% while electricity consumption is also reduced by 75 % to that of traditional methods. The proposed system thus leads to a win-win situation for farmers as well as government struggling for water and power supply in our country.

KEYWORDS: Soil moisture water sensor, arduino, GSM module, relay.

1. INTRODUCTION

a) Traditional Irrigation system

Agriculture is one of the major occupations of many people in India. Sugarcane is the major commercial crop in many parts of India [1]. However there are many problems in the areas with enough water as well as areas with scarcity of water [2]. The traditional mechanism used to irrigate the sugarcane field results into more wastage of the water, fertilizers, manpower, electricity etc [3]. Usually, the farmers spend a lot of water, electricity, time and efforts to irrigate their fields [4]. They personally need to visit the field and according to moisture in soil they supply water to farm. They need to switch ON motor and then after irrigating the field they must switch OFF the motor. This whole process is time consuming and farmer can't do any other activities. Moreover, the electricity supply in time is not guaranteed and there are many related problems which are major stumbling blocks in the irrigation process [5]. In a nutshell, traditional irrigation system takes more cost of production along with other side effects leading to conversion into baron land.

b) Drip irrigation

Since its introduction in the 1970's drip Irrigation for sugarcane has increasingly gained popularity. Nowadays drip irrigation is known as the most precise, efficient and practical method of delivering water and nutrients to crops [6]. Drip Irrigation systems water individual plants directly at their root zone, eliminating a lot of fungal issues and wasted water. Drip irrigation system allows you to save time by watering large areas of plants all at once. It allows farmers to increase productivity and reduce the use of resources, resulting in significantly higher rate of incentives (ROI), in terms of quality and quantity, compared with any other irrigation method. Growing sugarcane with drip irrigation contributes to significantly higher yield with higher sucrose content; more number of ratoons from each planting cycle; lower water use [7]; reduced labor costs (simple to operate); saving in fertilizer etc. However, most people will start out with a less expensive, basic drip irrigation system. Drip irrigation systems can help you water tough areas, like slopes where run off and erosion can happen from other watering methods. Drip irrigation can be set to give these areas a slow penetrating soak, or

can be set to deliver water in bursts that can be soaked in before the next burst. Most problems with drip irrigation come from improper installation or not using the right kind of drip irrigation for the site.

c) Proposed Automatic Drip Irrigation System

The proposed automatic drip irrigation system has all sorts of special solutions for drip irrigation problems.

- It has timers that can be set so even if you're away, you can trust that your plants have been watered.

- It has different nozzles that can control water flow so that sugarcane plants can get less water, while plants with higher water needs can get more.
- It has sensors that tell the system if it's raining out so it will not run.

All the problems in traditional drip irrigation system can be avoided using smart irrigation system as its focus is on automation. The farmer can supply the water to field by sitting at home through android phone. According to level of water or fertilizers, the current valve will be switch OFF automatically the next valve will be ON and so on. In such way the water will be supplied to field. At last the motor will be switch OFF automatically based on the level. This all can be operated using smart mobile phone based application. The farmer can do other simultaneous works or activities.

2. DESIGN OF PROPOSED SYSTEM

The proposed system is designed by keeping in mind the low cost devices readily available in the local market. The following hardware units are used for the experimental setup.
Hardware units for Experimental Setup

1. Arduino
Arduino is an open-source platform computing platform based on a simple I/O board and a development environment that implements the processing languages. The Arduino-Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

2. Electromagnetic valve
The solenoid is an electromagnetic part of a valve, comprised of a coil, core tube, core and enclosure. The selection of 2-way, 3-way and 4-way solenoid valves, designed to handle the most demanding fluid control applications. Water enters the valve from the system main line and exerts a force against the center of the valve's diaphragm. A small orifice in the diaphragm allows the water to flow through to the upper chamber between the diaphragm and the bonnet. The water continues to travel on through a port in the bonnet to the solenoid area. The solenoid has a light spring loaded metal piston that, when the valve is closed, covers the inlet port hole. The surface area that the water comes in contact with on top of the diaphragm is greater than the surface area on the bottom of the diaphragm, so the valve stays closed until the water in the upper chamber is released. (Pressure x area = force)

3. GSM Module.
The GSM (Global System for mobile communication) module (mobile) is used for Remote Control (for example Gate Control, Temperature Control etc.). GSM/GPRS module contain to a GSM/GPRS modem assembled together with power supply circuit and communication (like RS-232, USB, etc.) for computer [9]. The MODEM is the soul of such modules. They generate, transmit or decode data from a cellular network, for establishing communication between the cellular network and the computer. These are manufactured for a specific cellular network (GSM/UMTS/CDMA) or specific cellular.

4. Water Timer
Manually pre-set the run time and frequency of watering and the water timer will automatically switch on and off after serving water to your plants through a drip irrigation line .This package include only one Greenage water timer with single outlet used for automatic drip irrigation. Also included the following items : 1) 3/4 to

1/2" size Converter/Reducer 2) 16mm female Compression adapter to connect the timer with your 16mm Drip irrigation polyethylene hose 3) PTFE thread sealing tape to tighten the threaded fittings .-

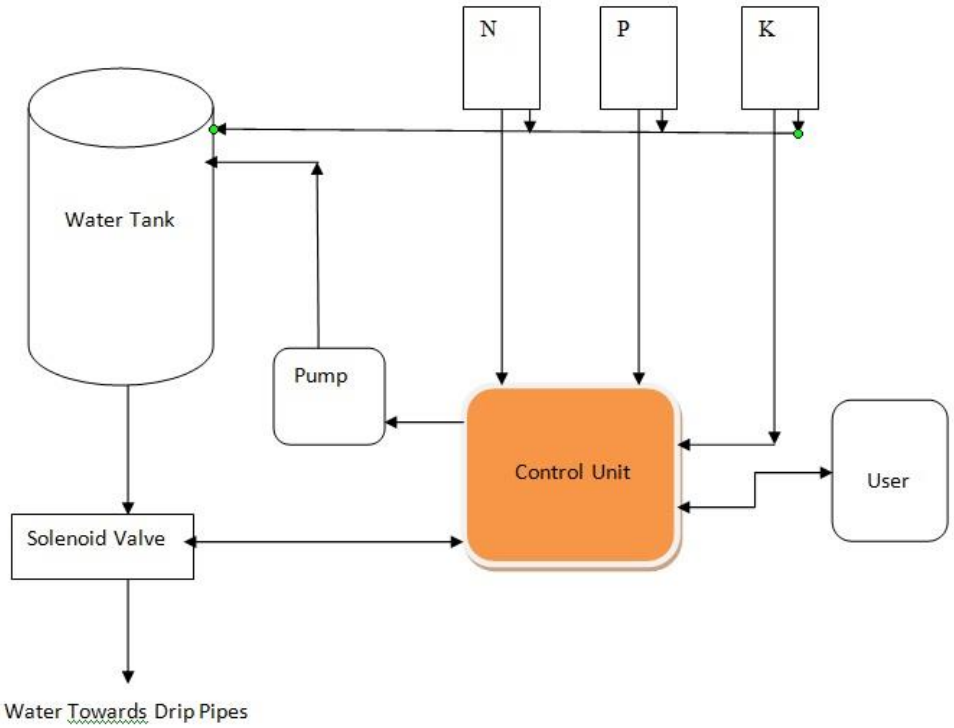

Fig 1: Design of the proposed system

The main menu in the application includes

- Know the level / status of water in the water tank
- Know the level / status Water Soluble fertilizers
- Prepare the schedule of fertilizers
- Add the fertilizers in the water
- Prepare the schedule of water supply
- Switch ON / OFF Water supply

Thus, as suggested in the main menu, user can receive the status of water or fertilizers. Based on the status, user can prepare the schedule of the fertilizers or water for the plants according to the season and temperature. The system is automatic in the sense the schedule of irrigation is fixed in the evening on alternative days except in the rainy season.

The menu in the application is executed with the help of SIM card in the phone and the GSM module in the control unit situated in the farm. The arduino board is programmed carefully to execute all the tasks of the user without any ambiguity.

3. EXPERIMENTAL SETUP

The experimental setup is deployed in the good quality farm land admeasuring 1 acre which is planted with 5000 sugarcane plants of good quality. The experimental setup is as shown in the Fig. 1. The full term of sugarcane crop is assumed to be of 15 months (450 days) as an average case [10]. It is also assumed that the raining period is of 150 days during which watering by means of traditional or drip irrigation system is avoided. The fertilizers are provided by using manpower at the rate of Rs. 50 per bag and total 40 bags are used during full term of the crop.

The user friendly smart phone based application is designed to control the supply of water and water soluble fertilizers. The functions which can be controlled using android based smart phone application are as follows.

1. Decide the quantity of water per turn
2. Decide the quantity of fertilizer to mix in the water tank
3. Schedule of the water supply and fertilizer supply
4. Switch ON / OFF the electric motor to fill the water tank and send the status via SMS

5. Read the water/fertilizer level sensor, and send the status via SMS

4. CONCLUSION AND FUTURE SCOPE

The usage of drip irrigation has showed that the water, electricity and manpower can be reduced considerably. However, due to the manual work involved in the actual farm, the drip irrigation is used by a few farmers only. The smart mobile phone based automatic drip irrigation system can encourage many more farmers to install and use the drip irrigation system for increasing their productivity at lesser expenses. The experimental setup has proved that proposed system can save water, electricity and manpower to a great extent. The cost of one time setup is also affordable and is easy to maintain. More sensors can be added in the system to further automate the irrigation and fertilization based on the moisture and temperature level in the farm.

REFERENCES

[1] International journal of engineering sciences & research technology (IJESRT) survey of smart irrigation system H. N. Kamalaskar* Dr. P. H. Zope, ISSN: 2277-9655

[2] Karan Kanasura, VishalZaveri, Sensor Based Automated Irrigation System With Iot: A Technical Review, Babu Madhav Institute of Technology, UkaTasadia University, Bardoli, and Gujarat, India.

[3] Rafael Muñoz-Carpena and Michael D. Dukes, Automatic Irrigation Based on Soil Moisture for Vegetable Crops, IFAS Extension, 2005.

[4] VeenaDivya K. Member IACSIT1, 2,3,4,5. A real time implementation of a GSM based automated irrigation control system using drip irrigation methology. Department of Instrumentation Technology, R. V. College of Engineering, Bengaluru, Karnata.2013; 4(5). ISSN: 2229-5518 [5] R. Suresh, S. Gopinath, K. Govindaraju, T. Devika, N. Suthanthira Vanitha, GSM based Automated Irrigation Control using Raingun Irrigation System, International Journal of Advanced Research in Computer and Communication Engineering ,Vol. 3, Issue 2, February 2014.

[5] Narayanamoorthy, A., Economic Viability of Drip Irrigation: An Empirical Analysis from Maharashtra, Indian Journal of Agricultural Economics, Vol.52, No.4, October-December, pp.728-739.

[6] INCID, Drip Irrigation in India. Indian National Committee on Irrigation and Drainage, New Delhi, 1994.

[7] Kulkarni, S. A. Looking Beyond Eight Sprinklers. National Conference on Micro-Irrigation. G. B. Pant University of Agriculture and Technology, Pantnagar, India, June 3-5, 2005.

[8] Tahar Boutraa, Abdellah Akhkha, Abdulkhaliq Alshuaibi, Ragheid Atta, “Evaluation of the effectiveness of an automated irrigation system using wheat crops.” Agriculture and Biology.

[9] Jia Wenjun and He Xinlin, “The Study of Influence on Water-Salt Transportation under Saline Drip Irrigation”, ICAE, 27-29 May 2011.

[10] KoushikAnand, C. Jayakumar,MohanaMuthu, and Sridhar Amirneni, “Automatic Drip Irrigation System Using Fuzzy Logic and Mobile Technology,” TIAR, 10-12 July 2015.

[11] Drashti Divani, Pallavi Patil, and Sunil K, “Automated Plant Watering System,” ICCPEIC, 2021 April 2016