DESIGN OF EMBEDDED SYSTEMS FOR THE AUTOMATION OF DRIP IRRIGATION

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ABSTRACT

In this paper, the Design of Embedded system for the Automation of Drip irrigation is presented. Drip irrigation was named in Israel in 1959. The green house based modern agriculture industries are the recent requirement in every part of agriculture in India. In this technology, the humidity and temperature of plants are precisely monitored and controlled. Water is very precious to all the humans and as well as to the plants, trees. The major amount of fresh water is utilized by the agricultural industry for irrigation. By using drip irrigation the water will be maintained at the constant level i.e the water will reach the roots by going drop by drop. This is very important because this can only ensure the survival of the plants. Water can be applied at a single point on the land surface through devices called emitters or as a line source from either closely spaced emitters or tubes with continuous or equally spaced openings that discharge water a drop at a time. If the field is irrigated heavily with water, there are chances that the plant may die because of excessive irrigation. The water could also wash them away during irrigation if very strong force of water is released at the same time. On the other hand, if there is insufficient water, then also there are chances that the plants may die due to lack of water. So, it is very important for the farmer to maintain the content on the field. In this paper the design of a Microcontroller based drip irrigation mechanism is proposed, which is a real time feedback control system for monitoring and controlling all the activities of drip irrigation system more efficiently. Irrigation system controls valves by using automated controller to turn ON & OFF. This allows the farmer to apply the right amount of water at the right time, regardless of the availability of the labor to turn valves or motor ON & OFF. This reduces runoff over watering saturated soils avoid irrigating at the wrong time of the day. It improves crop performances and help in time saving in all the aspects.
Keywords: Drip Irrigation, LM3S5T36 Microcontroller, Wireless Sensor Nodes, Soil Moisture Sensor.

1. INTRODUCTION

It has been ten years since drip irrigation was introduced in California to be used on commercial agricultural crops. The initial work was started in an avocado orchard in San Diego County, and from this small five-acre experimental orchard the acreage has increased tremendously. Many crops are under test with drip irrigation. Equipment used in drip irrigation systems is very important. There are many pieces of equipment required. They include plastic hose or pipe, spaghetti hose, emitters, pressure regulators, pressure gauges, valves, fertilizer tanks, filters — both sand and screen, time clocks, tensiometers, evaporative pans, meters, and fertilizer injectors. One of the most important items in the hardware for drip irrigation systems is the filter. An automated management of green house brings about precise control needed to provide the most proper condition of plant growth. The five most important parameters to consider when creating drip irrigation are humidity, temperature, ground water, carbon dioxide, light intensity [6].

In this paper an advance microcontroller LM3S5T36 which is 32-bit ARM® Cortex™-M3 with features of 32kb single flash memory, 12kb RAM and three 32 bit timers and two 10 bit analog to digital converter is used. A timer for the automation of drip irrigation is set, which works accordingly to the sensors and combining all this features the flow of water in fields will be automatically controlled rather than manually. It also contains the temperature and moisture sensor.

Sensors are installed in the root zone at the undisturbed soil. The soil moisture sensor is a sensor connected to an irrigation system controller that measures soil moisture content in the active root zone. Soil moisture sensor can reduce irrigation application by 50%. Water saving have been measured between 5% to 88% over typical timer -base irrigation system. Sensors are placed at least 5 ft from the downspouts for avoiding the high moisture areas. Tensiometer can be used as the moisture sensor to detect moisture contents of soil. The sensor will not be damaged by temperatures as low as -40°C (-40°F); it is safe to leave the sensor in the ground year-round for permanent installation. These 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. RTD like PT 100 can be used as the temperature sensor. [7]

1.1 Why to Use Drip Irrigation?
- It's easy to install and simple to use
- Fertilize the plants directly through drip system
- Save 20 - 80% of water and fertilizer bills
- Control weed growth by watering only where it need
- Each plant can be watered individually
- Protect the property from erosion
- Reduce snail population
- Have healthier, faster-growing plants

2. LITERATURE SURVEY

2.1 Design of Micro controller Based Drip Irrigation System
The key elements that should be considered while designing a mechanical model: -.

a) **Flow**: -You can measure the output of your water supply with a one or five gallon bucket and a stopwatch. Time how long it takes to fill the bucket and use that number to calculate how much water is available per hour. Gallons per minute x 60=number of gallons per hour.

b) **Pressure** (The force pushing the flow): - Most products operate best between 20 and 40 pounds of pressure. Normal household pressure is 40-50 pounds.

c) **Water Supply & Quality**: **-** City and well water are easy to filter for drip irrigation systems. Pond, ditch and some well water have special filtering needs. The quality and source of water will dictate the type of filter necessary for your system. .

d) **Soil Type and Root Structure**: - The soil type will dictate how a regular drip of water on one spot will spread. Sandy soil requires closer emitter spacing as water percolates vertically at a fast rate and slower horizontally. With a clay soil water tends to spread horizontally, giving a wide distribution pattern. Emitters can be spaced further apart with clay type soil. A loamy type soil will produce a more even percolation dispersion of water. Deep-rooted plants can handle a wider spacing of emitters, while shallow rooted plants are most efficiently watered slowly (low gph emitters) with emitters spaced close together.

e) **Timing**: - Watering in a regular scheduled cycle is essential. On clay soil or hillsides, short cycles repeated frequently work best to prevent runoff, erosion and wasted water. In sandy soils, slow watering using low output emitters is recommended. Timers help prevent the too-dry/too-wet cycles that stress plants and retard their growth. They also allow for watering at optimum times such as early morning or late evening.

f) **Watering Needs**: - Plants with different water needs may require their own watering circuits. For example, orchards that get watered weekly need a different circuit than a garden that gets watered daily. Plants that are drought tolerant will need to be watered differently than plants requiring a lot of water.

The below is the block diagram for the automation of the drip irrigation. From figure 1 it can see that the soil moisture sensor sends the signal to the microcontroller here in this there is an inbuilt timer and LCD is used to display the readings. From microcontroller it sends to the water pump and from their it goes to the irrigation lines.
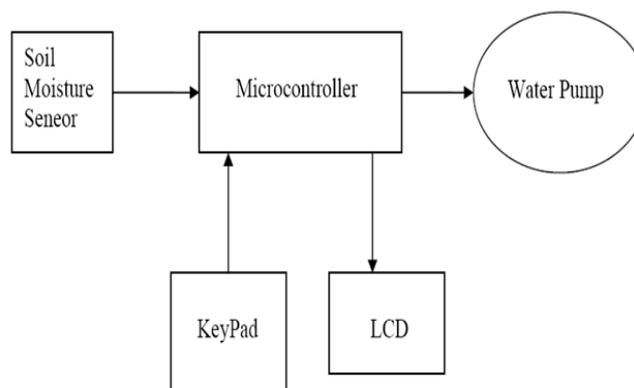

Figure 1: Block diagram

2.2 Concept of Modern Irrigation System

The conventional irrigation methods like overhead sprinklers, flood type feeding systems usually wet the lower leaves and stem of the plants. The entire soil surface is saturated and often stays wet long after irrigation is completed. Such condition promotes infections by leaf mold fungi. The flood type methods consume large amount of water and the area between crop rows remains dry and receives moisture only from incidental rainfall. Water is supplied frequently, often daily to maintain favorable soil moisture condition and prevent moisture stress in the plant with proper use of water resources.

Figure 2: Drip Irrigation

Drip irrigation requires about half of the water needed by sprinkler or surface irrigation. Lower operating pressures and flow rates result in reduced energy costs. A higher degree of water control is attainable. Plants can be supplied with more precise amounts of water. Disease and insect damage is reduced because plant foliage stays dry. Operating cost is usually reduced. Federations may continue during the irrigation process because rows between plants remain dry. Fertilizers can be applied through this type of system. This can result in a reduction of fertilizer and fertilizer costs. When compared with overhead sprinkler systems, drip irrigation leads to less soil and wind erosion. Drip irrigation can be applied under a wide range of field conditions. A typical Drip irrigation assembly is shown in figure (2) below.

Drip irrigation is popular because it can increase yields and decrease both water requirements and labor.
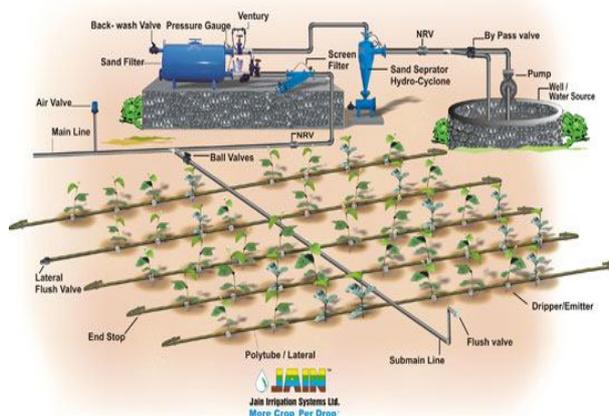

Figure 3: Typical Drip Irrigation

2.3 Components of Microcontroller Drip Irrigation

The components of micro controller based drip irrigation system [1] are as follows: -

       I)   Pump
       II)   Water Filter
       III)   Flow Meter
       IV)   Control Valve
       V)   Chemical Injection Unit
       VI)   Drip lines with Emitters
       VII)   Moisture and Temperature Sensors.
       VIII)   Micro controller Unit (The brain of the system).
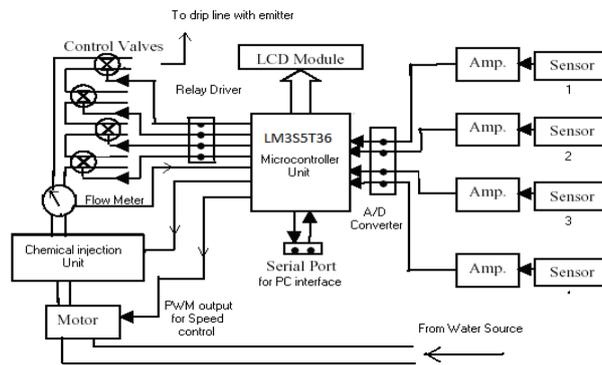
The micro controller unit is now explained in detail: -

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Figure4: Controller Unit

The important parameters to be measured for automation of irrigation system are soil moisture and temperature. The entire field is first divided in to small sections such that each section should contain one moisture sensor and a temperature sensor. RTD like PT100 can be used as a temperature sensor while Tensiometer can be used as the moisture sensor to detect moisture contents of soil. These 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 automated control system consists of moisture sensors, temperature sensors, Signal conditioning circuit, Digital to analog converter, LCD Module, Relay driver, solenoid control valves, etc. The unit is expressed in Figure above.

The signal send by the sensor is boosted up to the required level by corresponding amplifier stages. Then the amplified signal is fed to A/D converters of desired resolution to obtain digital form of sensed input for microcontroller use.
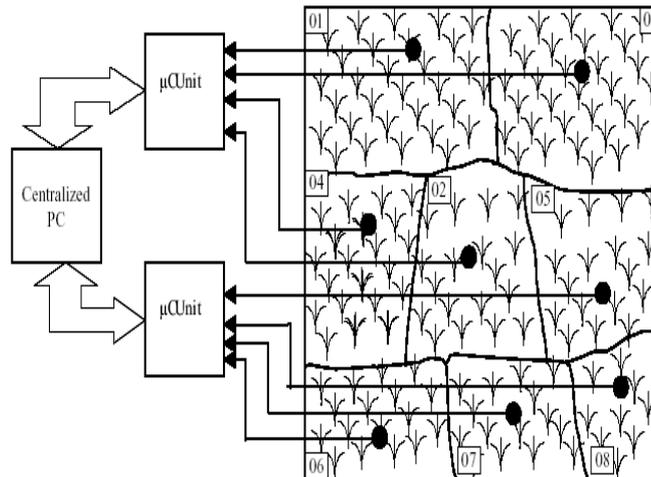

Figure5: Application to field

A 16X1 line 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, pesticides, and nutrients with water, whenever required. Varying speed of pump motor can control pressure of water. It can be obtained with the help of PWM output of microcontroller unit. A flow meter is attached for analysis of total water consumed. The required readings can be transferred to the Centralized Computer for further analytical studies, through the serial port present on microcontroller unit. While applying the automation on large fields more than one such microcontroller units can be interfaced 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 water input with the help of flow meter.

3. GENERAL ARCHITECTURE OF A WIRELESS SENSOR NODE

The general architecture of a wireless sensor node is presented in Fig. 6. As seen from the figure, commonly, a wireless sensor node is composed of four major components which are namely, the sensing unit, the processing unit, the power unit and finally the wireless transceiver unit. The sensing unit converts such measured physical quantities as humidity, pressure, temperature, fuel tank level, flow rate, position, velocity, acceleration, chemical concentration, etc. into a

voltage signal and thereafter digitizes it to produce digital output for processing. The processing unit with a microcontroller controls all of the functions of the sensor node and manages the communication protocols to carry out specific tasks
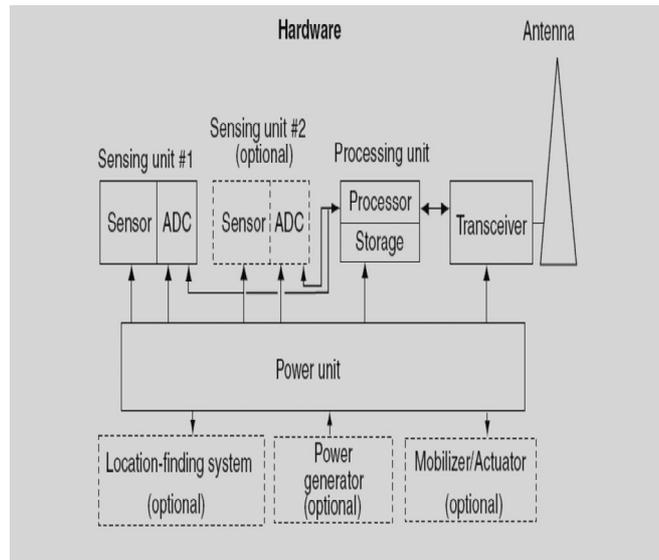

Figure 6: General architecture of WSN

4. CONCLUSION

The Microcontroller based drip irrigation system proves to be a real time feedback control system which monitors and controls all the activities of drip irrigation system efficiently. The present system is a model to modernize the agriculture industries at a mass scale with optimum expenditure. They can provide irrigation to larger areas of plants with less water consumption and lower pressure. Using this system, one can save manpower, water to improve production and ultimately profit.

REFERENCES

[1] Microcontroller based drip irrigation, technical paper on Drip Irrigation www.engineers .com April 30, 2010
[2] Stellaris LM3S5T36 Microcontroller Data Sheets, Texas Instruments Publication(January 15, 2011)
[3] WIRELESS SENSOR NETWORKSAGRICULTURE: FOR POTATO FARMING, Kshitij Shinghal et. al. / International Journal of Engineering Science and Technology Vol. 2(8), 2010, 3955-3963
[4] Maximize drip irrigation benefits by automating By Inge Bisconer, Toro Micro-Irrigation (march 12,2008)
[5] "Controlling water use effiency with Irrigation Automation: cases from drip and center pivot Irrigation of Corn and Soybean" Steven R. Evett, , R. Troy Peters, , and Terry A. Howell Southern Conservation Systems Conference, Amarillo TX, June 26-28, 2006 57
[6] "Irrigating basics" published in American nurseryman, December 1, 2007
[7] "Design and simulation of an automated system for green house using lab view ", American Eurasian J. Agric. & Environ. Sci., 3(2): 279-284, 2008.
[8] Intelligent Humidity Sensor for - Wireless Sensor Network AgriculturalApplication. International Journal of Wireless & Mobile Networks (Ijwmn) (Vol. 3, No. 1, February 2011) Doi: 10.5121/Ijwmn.2011.3111 118
[9] Program for resource efficient communities, university of floridia, 2008