Software Design of Water Supply System for Irrigation

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Water being a limited resource, its efficient use is basic to the survival of the ever-increasing population of the world. In the comprehensive strategy needed for the conservation and development of water resources, several factors are to be kept in view. Water use varies considerably around the world. In Africa, Asia and South America, agriculture is the primary user of underground and surface water. An automated irrigation system that ensures efficient use of available water was designed, i.e., the hardware and software. The software was implemented after the system design using Microsoft Visual Basic 6.0. The software IrrigateSoft2009 is about 10 MB in size and will take about 2 min to set up irrigation activity.

Keywords: Automated irrigation, Drip irrigation, Microcontroller, Visual water tank, Irrigation factor, Software and system analysis

Introduction

The pressure for survival and the need for additional food supplies are causing the rapid expansion of irrigation throughout the world (Michael, 2002). The area of land irrigated in the world is more than 248 million hectares. Nine countries—China, India, the US, Pakistan, Indonesia, Mexico, Iran, Thailand and Uzbekistan—have the largest irrigation areas, amounting to almost 70% of the world total irrigation area (FAO, 2001).

The oceans occupy about 70.8% of the earth's surface and land occupies only 29.2%. About 97.5% of the world water resource is in the oceans and is saline, implying that it may not be good for agricultural purposes (FAO, 2001). Of the remaining 2.5% of the global water resource, about 2% is in ice caps and glaciers, which is generally not available for the requirement of mankind. About half the volume of the groundwater lies in water-bearing formations more than 800 m below ground surface and is not ordinarily available for economical development. The water available for development

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by man is mainly from streams, rivers, freshwater lakes, and about half of the quantity of groundwater which occurs at depths less than 800 m from ground surface (Benami, 1993).

Water being a limited resource, its efficient use is basic to the survival of the ever-increasing population of the world. In the comprehensive strategy needed for the conservation and development of water resources, several factors are to be kept in view. These include the availability of water, its quality, location, distribution and variation in its occurrence (Adedeji and Kola, 2008). The objective of efficient irrigation is to increase agricultural production per unit volume of water per unit of cropped land in a unit of time.

Water is the most valuable asset in agriculture and accurate measurement of water leads to its economic and efficient utilization. Efficient conveyance and proper distribution of water on the farm leads to increase in agricultural productivity (Michael, 2002).

Water for irrigation is normally stored in a reservoir; although a large-scale reservoir system serves many other important purposes like water supply, flood control and low flow augmentation. Reservoir operation problem is how best to use the facilities that are available with less stress, better prediction and improved monitoring method. This brings about the need for a program on how or when to apply irrigation to crops (Adedeji and Kola, 2008).

Human use of water has increased more than 35 folds over the past three centuries. Globally, 3,200 km of fresh water is withdrawn and used annually (FAO, 2001). Of this total, 69% is used for agriculture, 23% for industry and 8% for domestic use. Water use varies considerably around the world. In Africa, Asia and South America, agriculture is the primary user; Asia uses 86% of its water for irrigation. But in most of Europe and North America domestic and industrial requirements of water exceed agricultural needs. Water also contributes in some other areas of farming, apart from domestic uses in dairy farm, poultry farm and other livestock farming (Michael, 2002).

Irrigation management is the key to farm production to meet the worlds need for food products. Given the number and complexity of different hybrid crops that have been produced over these years, to boost food production and the huge influence of the climate change, an efficient use of the available water for agriculture is becoming inevitable (Egharevba, 2002). This can only be achieved through the automation of irrigation methods. The term 'automated' irrigation applies to any irrigation system that is controlled by something other than the direct actions of a person. Typically, it means any irrigation system where irrigation is initiated by a control system using operator settings and measured environmental conditions (Cohen, 1993).

The aim and objective of this study is to design software for an automated irrigation system.

2. Materials and Methods

2.1 Irrigation and Software Design

The complete system design shall be considered for software designs. The design of a drip irrigation system for a particular field/crop(s) requires the following (Bernard, 2006): Water Source: a dependable water source; Software Requirements; Soils: properties such as infiltration rate, moisture holding capacity, texture, structure and bulk density must be known to facilitate the selection of emitters and setting irrigation schedule; Topographic Condition: affects the selection of the main, sub-main and pressure required in the system; and Climatic Records: determines how often irrigation is needed in different seasons of the year (Clement *et al.*, 1997).

2.2 Basic Equation for Drip Irrigation System

Michael (2002) stated that any of the following empirical equations can be used to estimate the loss of head by friction; thus Equation (1) (Blassius equation) estimate the friction coefficient:

$$f = \frac{0.316}{(R_n)^{1/4}} \quad \text{...(1)}$$

where R_n is the Reynolds number.

Equations (2) and (3) (Williams and Hazen equation) are to calculate energy loss by friction in the main and lateral or sub-main respectively.

$$\Delta H = 15.27\left(\frac{Q^{1.852}}{D^{4.871}}\right)L \quad \text{...(2)}$$

$$\Delta H_{Sub} = 5.35\left(\frac{Q^{1.852}}{D^{4.871}}\right)L \quad \text{...(3)}$$

where Q is the total discharge in the pipe (l/s), L is the length of the pipe section (m) and D is the inside diameter of the pipe (cm).

Assuming a turbulent flow in the sub-main, for commonly used emitters, emitter flow and pressure head is expressed by Equation (4),

$$q_1 = c\sqrt{h_1} \quad \text{...(4)}$$

where c is a constant and h_i is the pressure head at i^{th} section.

2.3 Software Design

In designing software, the basic instruction to carry out a task is to determine what the output should be while the second step is to identify the data or input necessary, details that will give the required output (David, 1995).

For the purpose of irrigation, the outputs determined by the software are the time to irrigate and quantity of water to be discharged to the farm for use by the crops. The inputs will include water and environmental conditions. The process of achieving this is complicated. To summarize this, sensors are placed in the field to sense the environmental conditions and send necessary information in the form of signal to micro controllers and then to the computer which uses such information to perform irrigation.

The screen in Plate 1 is designed to create a visual water tank by supplying the tank type rectangular or circular and its dimensions. The program will use this to draw the tank and save it for future use. Plate 1 contains two frames, three textboxes, two option boxes, one picture box and two command buttons. To create a tank, the operator needs to select the tank type, enter tank data and click ok to save the tank details input.

Once the tank has been created and saved, it can be viewed with its properties for the purpose of filling the tank and performing irrigation. Plate 2 was designed with a single picture box to display the tank, a frame to show the tank data and a list box list for selection. Once the tank is selected, its data such as the height, width, etc., is sent to sub-program called draw, which sketch the tank on the picture boxes.

Plate 3 shows the screen where irrigation can be performed. The

Plate 1: Create Tank Screen

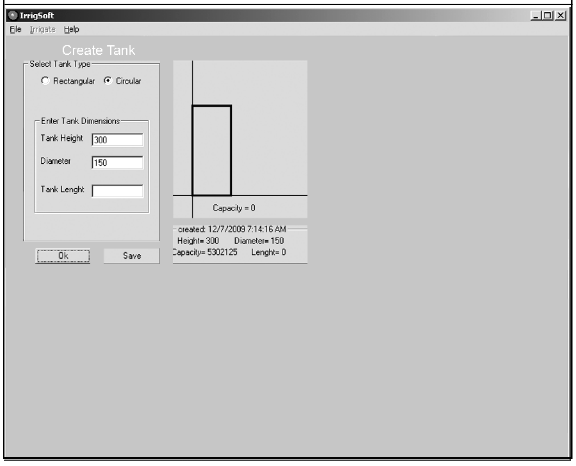


Plate 2: View Tank Screen

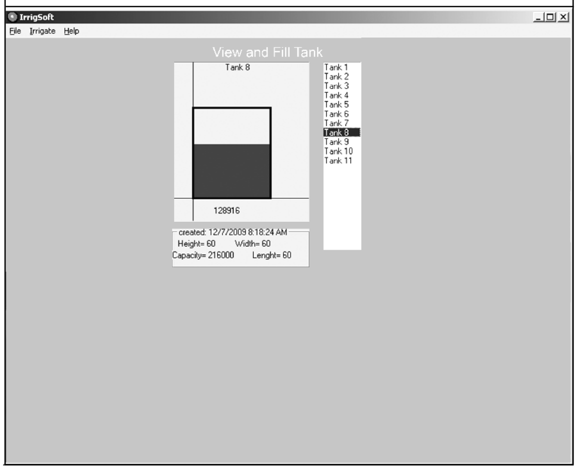
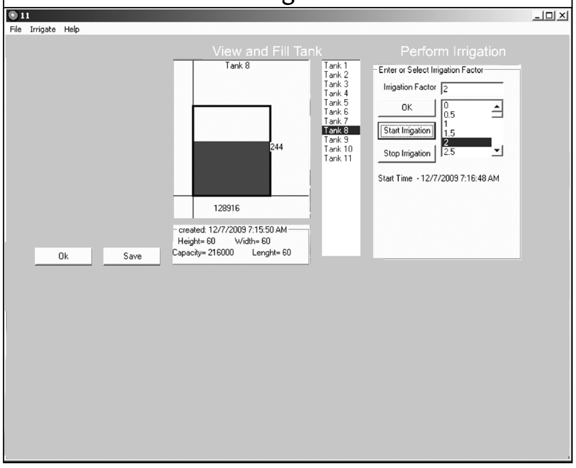


Plate 3: Irrigation Screen



screen simulates how water has been drained for irrigation from the tank. To perform irrigation activities, select a tank that is not empty, enter irrigation factor which depends on the soil and type of crop is irrigated.

Note that when performing irrigation other activities such as creating tank, filling tanks will interfere with the irrigation activities. It is important to note here that there is no particular way of designing or building software for irrigation it only depends on the various parameters under consideration. The system analysis and programer's imagination plays a very important role. Plate 4 shows all the three main modules in this program.

Plate 4: Complete Screen

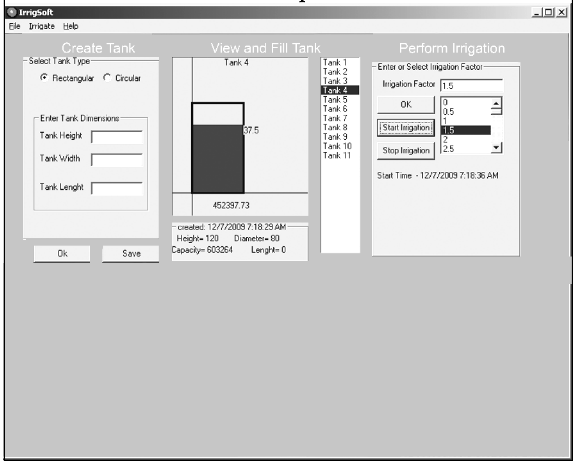
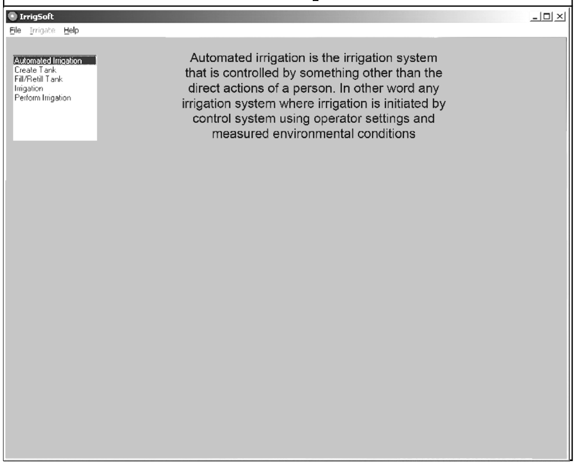


Plate 5: Help Screen



3. Analysis of Results

The package software IrrigateSoft2009, was burned into a CD plate and installed into a computer just like any other application software available in the market. Plates 1-5 are some of the screen shots from the installed software. It will take less than a minute to create, fill a tank and perform or schedule an irrigation activity.

Conclusion

In view of the fact that every profession is moving towards computerization and automation of their system, it has become imperative too, automating the present available irrigation methods (such as drip irrigation). IrrigateSoftware program have been developed successfully, the program was packaged into a folder Irrigation Software and contain one folder (support) and three files (setup.exe, setup.lst and IrrigationSoftware.rar), all less than 10 MB. This software will proffer solution for automated irrigation system. Irrigation activities can be scheduled at any time and require minimal human or physical intervention, and this is made possible by the development of this program.

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