Mobile Phone Assisted Irrigation Management System for an Agriculture Field

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Abstract

Irrigation management is one of the major components of agriculture management. It is very important to supply exact amount of water to the agricultural field for obtaining optimum utilization of resources. There is some inefficiency in traditional and existing irrigation management systems. The fact that, water is valuable limited natural resource, so reducing water wastage is a timely action for current situation. This paper presents a suggested solution, its implementation details and result analysis of it. It is titled as Mobile Phone Assisted Irrigation Management System. It is designed to maintain the water level of soil in its optimum level, in order to obtain the maximum yield. So as to give a better solution for agronomist, this system can be controlled in different locations with the use of smart phone. The system is also capable of providing information of the field such as temperature and humidity apart from soil moisture content that enables the user to get a better understanding of the field conditions. Optimum water utilization will increase the performance of irrigation system by reducing the water wastage. Also this system will assure the required quality of the crops which met and will suit the current situation in Sri Lanka as well as the world.

Key words: Field Capacity, Irrigation Management, Mobile, Optimum, Soil Moisture

Introduction

Dabour (2002) has shown that, importance of the irrigation scheduling is that it enables the agronomist to apply the exact amount of water to obtain maximum yield. A critical element is the accurate measurement of soil moisture content of the field and it is maintenance in an optimum way to achieve goals. Wastage of water due to vaporization and leakages is one of the major problems of existing irrigation systems. The traditional irrigation systems do not concern about the different growing stages of the plant and they are not capable of maintaining moisture content in an optimum level.

The goal of an effective scheduling program is to supply the plants with sufficient water while minimizing losses such as deep percolation and runoff. Proper irrigation scheduling requires a sound basis for making irrigation decisions. The level of sophistication for decision making ranges from personal experience to neighbours practices and techniques based on expensive computer-aided instruments that can assess soil, water and atmospheric parameters (Fang *at el*, 2010).

Mobile Phone Assisted Irrigation Management System is an embedded system with remote controlling facility. It is introduced to give a better solution for the irrigation process. Tan (2004) , Veihmeyer and Hendrickson (1993) have shown that, proper irrigation can result in higher consistent yields, better quality, less blossom - end rot and less cracking.

The system is designed to keep the soil moisture content of a particular soil in a given range to keep soil moisture content in optimum way. Tan (2004) and Doorenbos *et al.* (1992) have shown that, for obtaining maximum yield by using limited resources, it is necessary to maintain the soil moisture in its field capacity.

Materials and Method

The system implementation consists of two main components as overall controlling unit and smart phone application (Android) and the basic setup of the system is shown in Figure 1.

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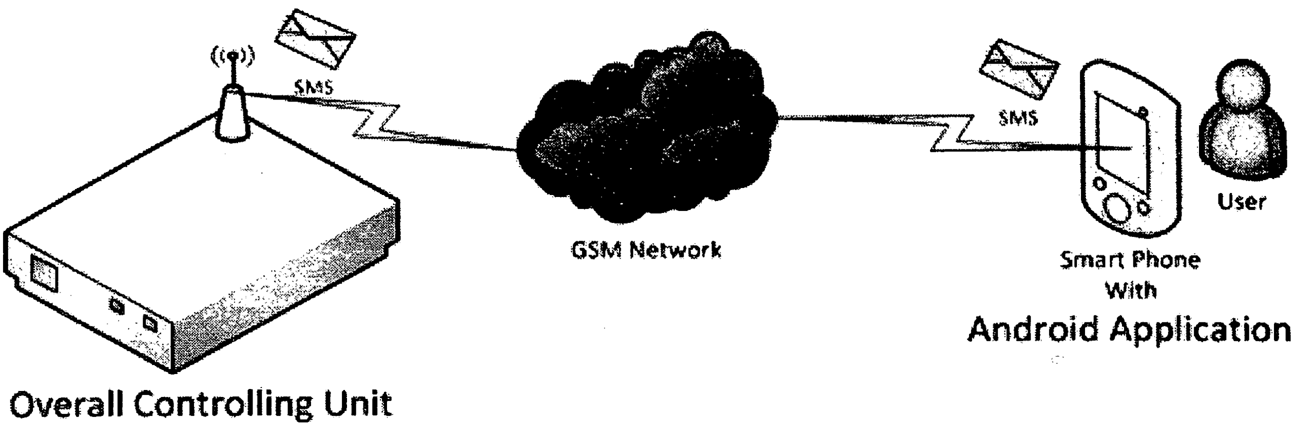

Figure 1. Basic setup of the system.

Overall controlling unit has two options as manual control and automatic control. User can control irrigation period manually using manual control option. Subsequently user needs to instruct the irrigation time period by considering field parameters such as soil moisture, *etc.*

During automatic control, user only needs to enter desired available water levels (upper and lower levels). Then all the controlling will be done by the overall controlling unit. For both operation modes, user can incessantly monitor the available water level of the soil, temperature and humidity of the field via the monitoring section of the mobile application. The diagram of overview of the system is shown in figure 2.

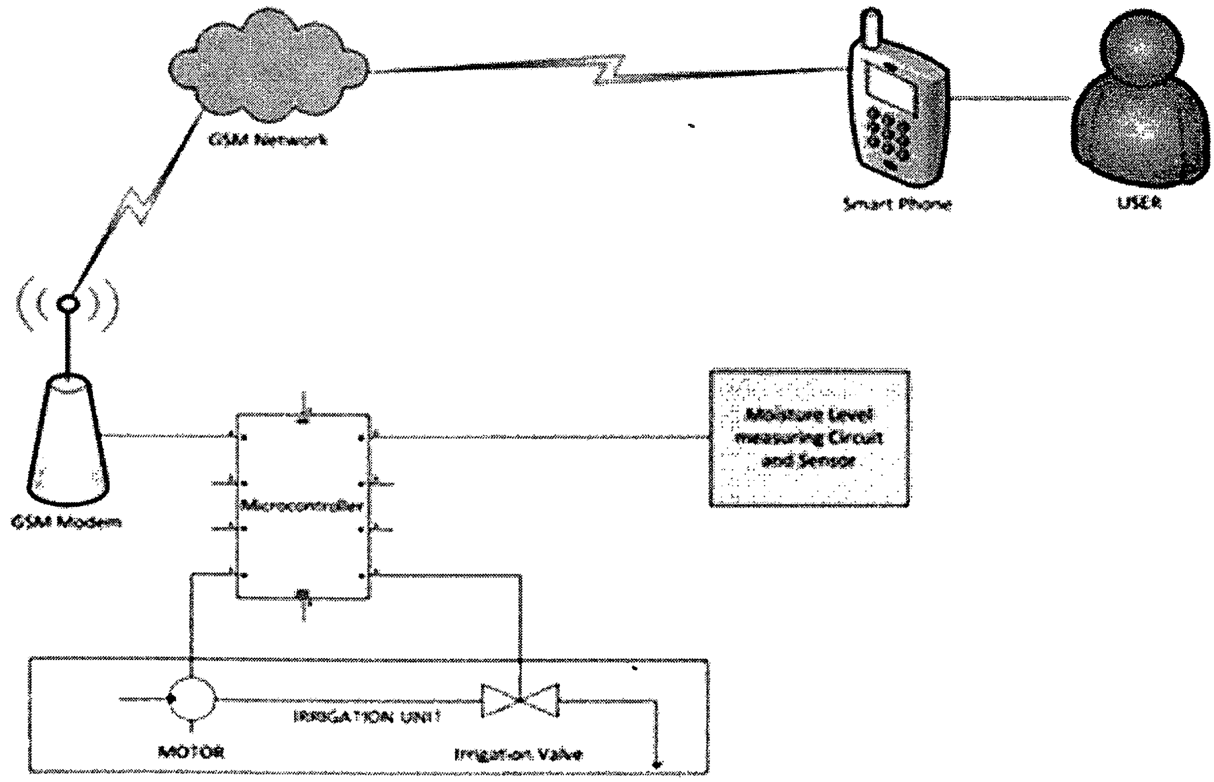

Figure 2. Overview of the system

Overall Controlling Unit:

The overall controlling unit is responsible for controlling of all the subcomponents which are connected to it. Overall controlling unit consists with a GSM modem to achieve communication between controlling unit and the mobile phone. Other than that, the system equipped with four resistive type soil moisture sensors and four DHT11 digital humidity and temperature sensors for measuring purposes. The soil moisture sensor is calibrated according to gravimetric method. Furthermore, the controlling system has a power supply and a relay panel to power up and control the microcontroller based circuits, solenoid valves and water pump. Overview of the overall controlling unit is shown in figure 3.

Smart phone application which is based on Android platform is capable of providing following two features as monitoring and controlling. The android mobile application has ability to check the parameters (soil moisture, humidity and temperature) of the field. Moreover, self developed graphs and the summaries of recorded data of the application can be used to take the irrigation decisions. This option suits to beginners of agriculture. Additionally, skilled people in agriculture sector can use both auto and manual mode for the optimum outcome.

The data transmission between smart phone and the overall controlling units is achieved by short message service (SMS). The algorithms used to send and receive messages from android application are shown in figure 4.

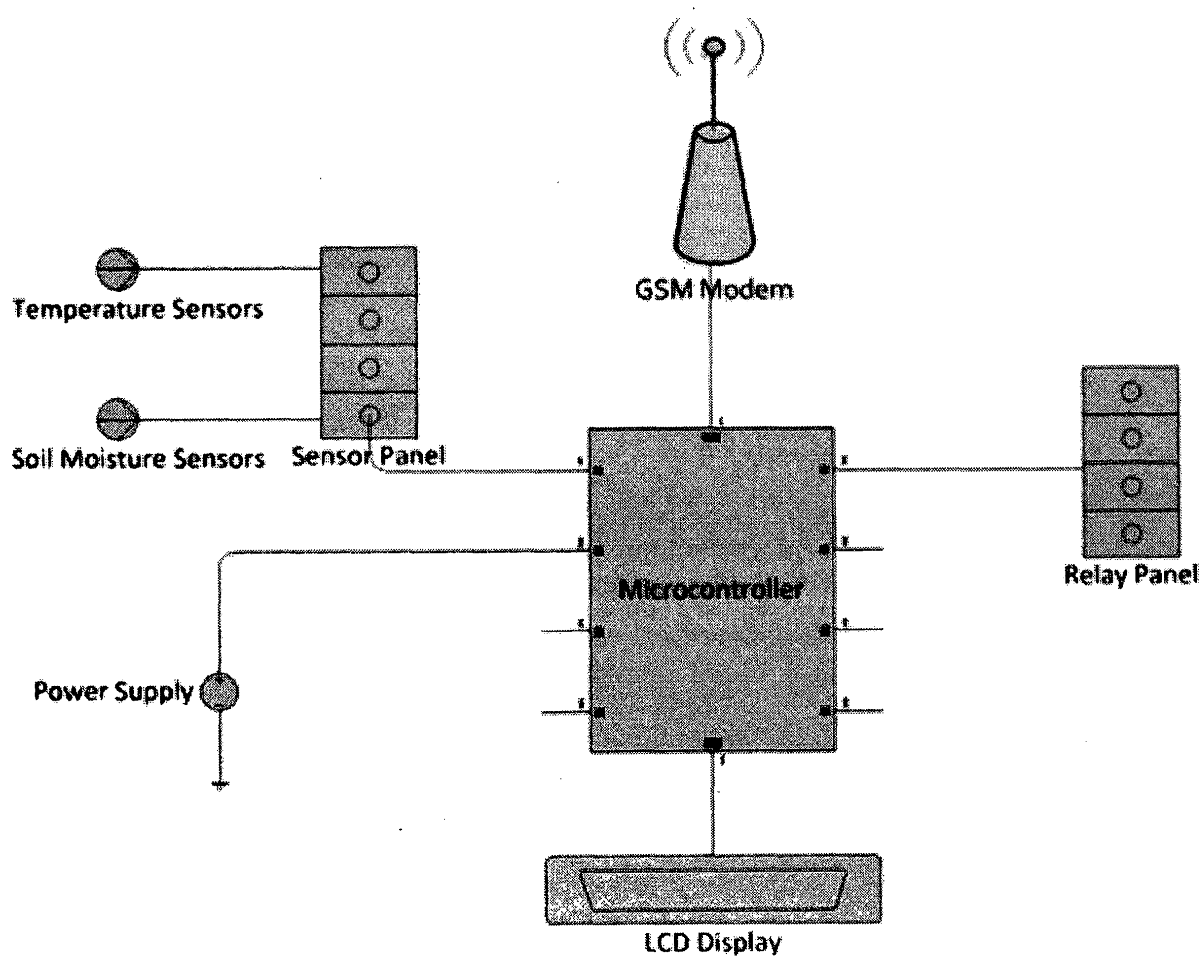

Figure 3. Connection diagram of overall controlling unit.

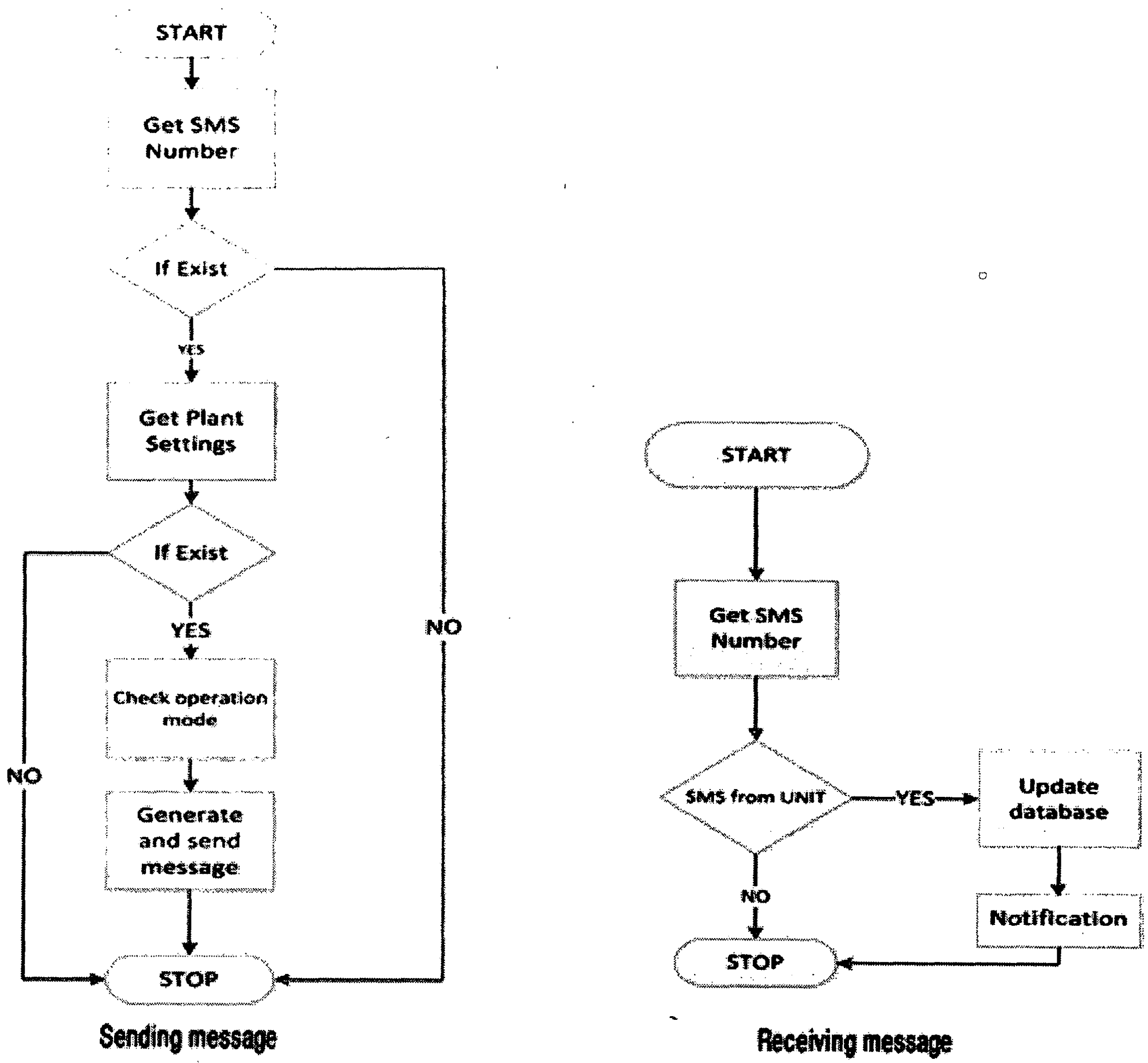

Figure 4. Algorithms for send and receive SMS through Android application

Results and Discussion

The system was tested in a small scale green house at Ambalangoda, Sri Lanka. It is tested continuously for long hours. The system was connected to maintain the soil moisture content between 80%-90% with reference to the field capacity. Furthermore, tensiometers were placed in the field for the accuracy purposes. Measurements were taken for more than 14 days in 6 hour intervals and the results for one week are given in table 1.

Also system was tested for the stability and reliability conditions such as recovery after power failure into its desired condition, SMS reading and sending ability of the overall controlling unit. Other than that, functions and output of the smart phone Android application were tested for number of times with different configuration.

Table 1. Recoded data of field soil moisture with the system for 7 days.

Date	Time	Equipment Reading (%)	Soil Moisture (%)		Tensiometer reading for field capacity (%)	Error Percentage
			System	Tensiometer		
17-Aug	10:00	85	28.1	28.0	84.8	0.2
	16:00	81	26.7	26.7	80.9	0.1
	22:00	89	29.4	29.6	89.7	0.8
	4:00	87	28.7	28.9	87.6	0.7
18-Aug	10:00	84	27.7	27.6	83.6	0.4
	16:00	88	29.0	29.1	88.2	0.2
	22:00	87	28.7	28.8	87.3	0.3
	4:00	86	28.4	29.1	88.2	2.5
19-Aug	10:00	85	28.1	27.9	84.5	0.5
	16:00	82	27.1	26.9	81.5	0.6
	22:00	81	26.7	26.8	81.2	0.3
	4:00	90	29.7	29.7	90.0	0.0
20-Aug	10:00	87	28.7	28.2	85.5	1.8
	16:00	82	27.1	26.7	80.9	1.3
	22:00	80	26.4	26.6	80.6	0.8
	4:00	89	29.4	29.3	88.8	0.2
21-Aug	10:00	87	28.7	28.4	86.1	1.1
	16:00	83	27.4	27.4	83.0	0.0
	22:00	82	27.1	26.3	79.7	2.9
	4:00	81	26.7	26.8	81.2	0.3
22-Aug	10:00	89	29.4	29.2	88.5	0.6
	16:00	85	28.1	28.2	85.5	0.5
	22:00	82	27.1	27.0	81.8	0.2
	4:00	82	27.1	27.1	82.1	0.1
23-Aug	10:00	90	29.7	29.8	90.3	0.3
	16:00	86	28.4	28.6	86.7	0.8
	22:00	85	28.1	27.8	84.2	0.9
	4:00	84	27.7	27.6	83.6	0.4
Average						0.7

According to the table 1, the maximum error percentage was 2.9% and average error percentage was 0.7% between readings taken by the developed system and the tensiometer. Also the system was able to maintain the moisture content between 80%-90% for that particular field in that duration of seven days.

The system can be placed with different configurations for different type of soil and can be used in different locations in Sri Lanka. More than that, the overall controlling unit can be controlled from a mobile phone with correct SMS structure and Android application can be used for smart viewing functions and configurations. In view of the fact that the most people aware of using mobile phones in their day to day activities without favour of their life status, this system offers a user friendly approach for agronomists in both urban and rural areas.

It provides variety of benefits such as fewer workforces to operate and maintain, relieve of portability due to light weight and less initial capital to install the system and remote controlling and monitoring facility. Hence, it guides towards an economical, environmental friendly and user friendly agricultural practice compared to existing conventional irrigation systems.

Thus the Mobile Phone Assisted Irrigation Management System is an ideal solution for irrigation problems in Sri Lanka as well as for developing countries all over the world.

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