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Architecture for Automated Irrigation System

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Abstract: Agriculture sector provides food as well as large employment. Impact of agriculture development as traditional framing is unable to increase the crop yield. In our country , the growth of population is around 2% per year. Thus food production should increase about 2.6% per year to provide an effcient food intake. The use of water resources to be optimally connected and beneficially utilized with appropriate priorities of use. Therefore the real values of soil moisture, air humidity, temperature and water level in the soil are wirelessly transmitted using wireless technology and same is monitored for optimum production of crop production.

Keywords*: Wireless Network, Soil Water Sensor, Agricultural.*

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I. INTRODUCTION:

Water is the most vital input in agriculture. The population explosion has put tremendous pressure on the natural resources, such as land and water. About more than 70% of water utilization worldwide and 90% of water utilization in the developing countries are for agriculture. Exploitation of ground water and deterioration of water quality has further aggravated the problem of water scarcity.

The revised national water policy, which formulated in 2002 has also taken cognigence of the necessity of proper irrigation water management in the following words. "Irrigation Planning either in an individual project or in a basin as whole should take into account the irrgigability of land, cost effective irrigation options possible from all available sources of water and appropriate irrigation techniques for optimizing water use efficiency. Irrigation being the largest consumer of fresh water, the aim should be to get optional productivity per unit of water. Scientific water management, farm practices and micro irrigation should be adopted wherever possible." Hence along with micro irrigation methods deployment of an automated irrigation system based on microcontrollers and wireless communication system is thought to be the urgent need of the day.

Lack of rains and scarcity of land water also results in decrement in quantity of water on earth. Extraction of water at regular intervals from earth is reducing the water level as a result of which the zones of un-irrigated land are gradually increasing. There is an urgent need to create strategies based on science and technology for sustainable use of water, including technical, agronomic, managerial, and institutional improvements [1].

II. LITERATURE REVIEW:

There are many systems to achieve water savings in various crops, from basic ones to more technologically advanced ones. For instance, in one system plant water status was monitored and irrigation scheduled based on canopy temperature distribution of the plant, which was acquired with thermal imaging [2]. In addition, other systems have been developed to schedule irrigation of crops and optimize water use by means of a crop water stress index (CWSI) [3]. This index was later calculated using measurements of infrared temperatures, ambient air temperatures, and atmospheric vapor pressure deficit values to determine when to irrigate using drip irrigation [5]. Irrigation systems can also be automated through information on water content of soil, using dielectric moisture sensors to control actuators and save water, instead of a predetermined irrigation schedule at a particular time of the day and with a specific duration [6]. Other authors have reported the use of remote contol temperature to automate cotton crop irrigation using infrared thermometers. Through a timed temperature threshold, automatic irrigation was triggered once observed temperatures exceeded the threshold for certain time accumulated per day. Automatic irrigation scheduling consistently has shown to be valuable in optimizing cotton yields and water use efficiency with respect to manual irrigation based on direct soil water measurements [7]. An alternative parameter to determine crop irrigation needs is estimating plant evapotranspiration (ET). ET is affected by weather parameters, including solar radiation, temperature, relative humidity, wind speed, and crop factors, such as stage of growth, variety and plant density, management elements, soil properties, pest, and disease control [8]. Systems based on ET have been developed that allow water savings of up to 42% on time-based irrigation schedule [9]. An electromagnetic sensor to measure soil moisture was the basis for developing an irrigation system at a savings of 53% of water compared with irrigation by sprinklers in an area of 1000 m^2 of pasture [10]. A reduction in water use under scheduled systems also have been achieved, using soil sensor and an evaporimeter, which allowed for the adjustment of irrigation to the daily fluctuations in weather or volumetric substrate moisture content [11]. A system developed for malting barley cultivations in large areas of land allowed for the optimizing of irrigation through decision support software and its integration with an infield wireless sensor network (WSN) driving an irrigation machine converted to make sprinkler nozzles controllable[12]. A data acquisition system was deployed for monitoring crop conditions by means of soil moisture and soil, air, and canopy temperature measurement in cropped fields. Data were downloaded using a handheld computer connected via a serial port for analysis and storage [13]. The development of WSNs based on microcontrollers and communication technologies can improve the current methods of monitoring to support the response appropriately

in real time for a wide range of applications [14], considering the requirements of the deployed area, such as terrestrial, underground, underwater, multimedia, and mobile [15]. In addition, sensor networks have been used in health care purposes for monitoring, alerting, assistance, and actuating with security and privacy to support real-time data transmission [16]. In industrial environments, WSNs have been installed to provide real-time data acquisition for inventory management, to equipment monitoring for control with appropriate actions, reducing human errors and preventing manufacturing downtime [17,18]. Various commercial WSNs exist, ranging from limited and low-resolution devices with sensors and embedded processors to complete and expensive acquisition systems that support diverse sensors and include several communication features [19]. There are also algorithms to maximize the network coverage ratio with a predefined balance the energy consumption in the whole WSN [20], to reduce both the transmission and the computational loads at the node level [21], and to estimate online the optimal sampling frequencies for sensors.

III. SOIL-PLANT-WATER RELATION

In irrigation engineering, it is essential to have an understanding of the relationships between soil, soil water, and plants. With, this knowledge, it is possible to make to some rational decisions concerning the timings and amount of irrigation water applications, selection and design of irrigation methods and other aspects of irrigation water management applied to various climatic, soil and cropping regions of reinfed and irrigated lands.

Soil Moisture - The water below the water table is known as ground water and above the water table is known as soil moisture.

Soil moisture zone above the water table consists of (i) capillary zone, (ii) intermediate zone and (iii) soil zone or root zone. Availability of water in the soil is in the form of (i) Hygroscopic water (ii) Capillary water and (iii) Gravitational water. Hygroscopic water being present in the form of loose chemical bonds with soil particals and hence not available to the plants. Capillary water present in the pore spaces of soil molecules by surface tension against gravitational action and hence can be extracted by plants by capillarity. Gravitational water is in excess of hygroscopic and capillary water which will move out of the soil if favorable drainage is available.

The Hygroscopic water and the capillary water together forms the Field capacity which is very important factor in irrigation, because it is the field capacity moisture which is useful in plant nourishment and will ultimately depends upon the soil properties, organic matter content in the soil and soil temperature. Total hundred percent field capacity moisture is not available for plant nourishment. The moisture which is available from this field capacity moisture is known as Available Moisture which is the difference between field capacity moisture content and permanent wilting point, i.e., the moisture content below which plant can no longer extract sufficient water for its growth and wilts up. Out of the total available moisture only 75% to 80% water can be most easily extracted by plants and is the readily available moisture. The water required through irrigation to bring the soil moisture content of a given soil to its field capacity is called its field moisture deficiency or soil moisture deficiency. To meet out this deficiency application of irrigation water after certain fixed interval of time as per the crop requirement is known as irrigation frequency.

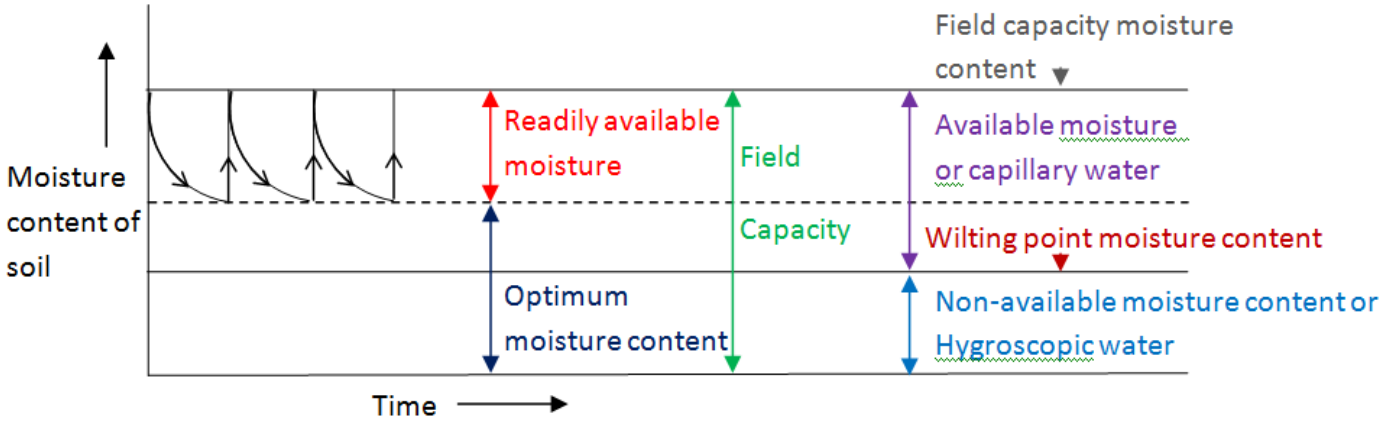

Figure 1: Depth and frequency of irrigation on the basis of soil moisture regime concept

Figure 1 shows the depth of irrigation water required after a certain period, i.e., its efficiency. Soil moisture is not allowed to be depleted upto witting point, as it would result in considerable fall in crop yield. The optimum level upto which the soil moisture may be allowed to be depleted in the root zone without fall in crop yields, has to be worked out for every crop and soil, by experimentation. The irrigation water should be supplied as soon as the moisture falls upto the optimum level (fixing irrigation frequency) and its quantity should be just sufficient to bring the moisture content to this field capacity thus fixing water depth. Water will be utilised by the plants after the fresh irrigation dose is given, and soil moisture will start falling. It will again be recouped by a fresh dose of irrigation, as soon as the soil moisture reaches optimum level.

IV. METHODOLOGY:

In this paper, the development of the deployment of an automated irrigation system based on microcontrollers and wireless communication at experimental scale within rural areas is presented. The aim of the implementation was to demonstrate that the automatic irrigation can be used to reduce water use. The implementation is a photovoltaic powered automated irrigation system that consists of a distributed wireless network of soil moisture and temperature sensors deployed in plant root zones. Each sensor node involved a soil-moisture probe, a temperature probe, a microcontroller for data acquisition, and a radio transceiver; the sensor measurements are transmitted to a microcontroller-based receiver. This gateway permits the automated activation of irrigation when the threshold values of soil moisture and temperature are reached. Communication between the sensor nodes and the data receiver is via the Zigbee protocol [21], [22] under the IEEE 802.15.4WPAN. This receiver unit also has a duplex communication link based on a cellular-Internet interface, using general packet radio service (GPRS) protocol, which is a packet-oriented mobile data service used in 2G and 3G cellular global system for mobile communications (GSM). The Internet connection allows the data inspection in real time on a website, where the soil-moisture and temperature levels are graphically displayed through an application interface and stored in a database server. This access also enables direct programming of scheduled irrigation schemes and trigger values in the receiver according the crop growth and season management. Because of its energy autonomy and low cost, the system has potential use for organic crops, which are mainly located in geographically isolated areas where the energy grid is far away.

The readings from the sensors which are in analog form are sent to the microcontroller through ADC. The microcontroller will send the data to the server. The server will compare the data with the threshold values from the database. The database has the upper and lower threshold values per crop stored in the database. If the values from the sensor is less than or equal to the threshold values, then the microcontroller will trigger the pump to water the field. The moisture level in the soil will be monitored after a time interval of 4 minutes. If the values from the sensors are matched or are above the threshold values then the microcontroller will trigger the pump to stop watering the crops. And the moisture level in the soil will again be monitored and compared after a time interval of 1 hour. Once the server request the microcontroller for watering the crops, the microcontroller will first check the water level in the well. If sufficient water is available in the well then the microcontroller will trigger the pump to water the crops else the microcontroller will return notification which will be sent to the user via server.

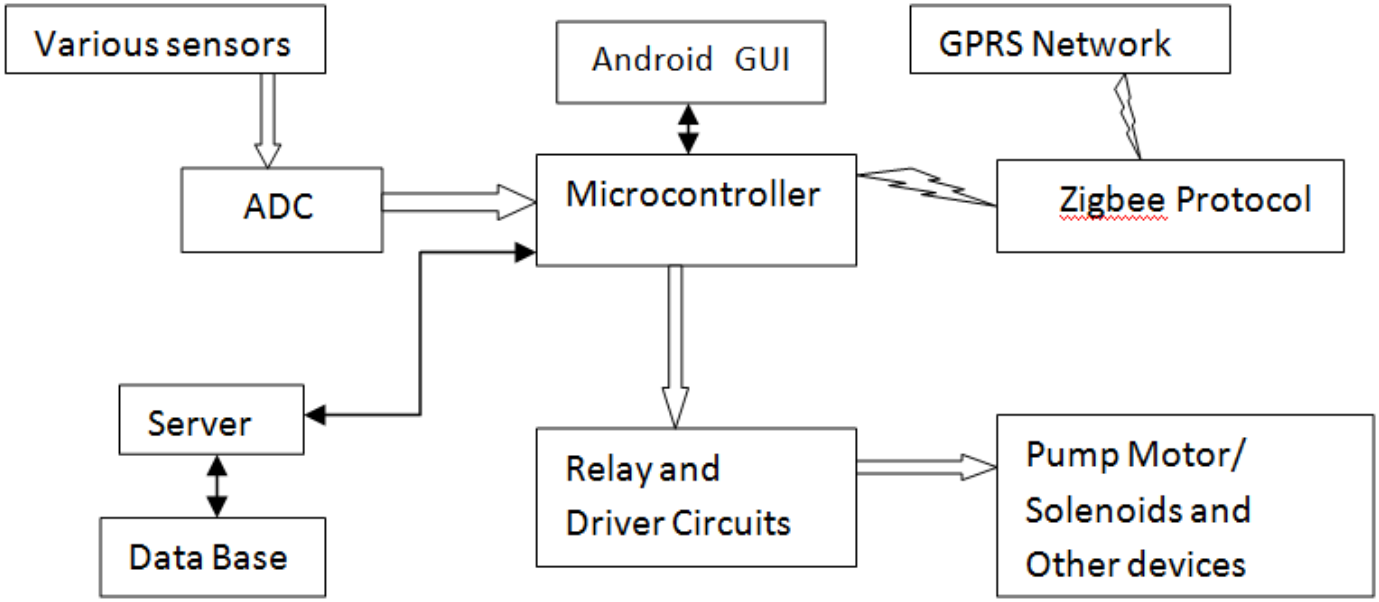

Fig 2: System Architecture for Automated Irrigation System

V. CONCLUSION:

The automated irrigation system implemented was found to be feasible and cost effective for optimizing water resources for agricultural production. This irrigation system allows cultivation in places with water scarcity thereby improving sustainability. The irrigation system can be adjusted to a variety of specific crop needs and requires minimum maintenance. The modular configuration of the automated irrigation system allows it to be scaled up for larger greenhouses or open fields. In addition, other applications such as temperature monitoring in compost production can be easily implemented. The Internet controlled duplex communication system provides a powerful decision making device concept for adaptation to several cultivation scenarios. Furthermore, the Internet link allows the supervision through mobile telecommunication devices, such as a smartphone. Besides the monetary savings in water use, the importance of the preservation of this natural resource justify the use of this kind of irrigation systems.

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