

Shamba Web Based System (SWBS) Implementation on Sensor Design in Irrigation Control Monitoring System

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Abstract: *The specific target of this research is to develop a system based on Web Technology (WT) and Solar Technology (ST) for monitoring and controlling a remote farm in Tanzania. A Web Based System (WBS) developed for monitoring and controlling at least one field station in a farm with infield sensor network which gather information and transmit to the browser interface. The system allow user to control and monitor tasks such as ability to set a new or delete station ,ability to control level of automation for each irrigation cycle, ability to view and set cycles for each station ,access to weather station and access to field data integrated with infield distributed sensor network . In this situation the web interface provides an excellent platform from which to develop the system which more pervasive as a means of dynamic system which contain a database records of the field information (such as coverage area, soil type ,weather information, irrigation cycles, plant type ,location and staff information), control entire systems based on infield parameters result. No special software or client are required, just a web browser on a computer with help of web relay. Due to the scarce of electricity in Tanzania A solar based system was also integrated to keep constant power infield so as to ensure the effectiveness in watering the plant by placing the solar water sprinkler infield .The whole system equipment's used were planned to be powered by the solar energy. With the phenomenal growth of the Internet in the last decade, the use of a web browser interface has not only become the standard for viewing pages on the World Wide Web but has become more pervasive as a means of collecting input or providing the output status of control systems. In this situation the web interface provides an excellent platform from which to develop the system. The portability of this technology means that the system could be controlled from anywhere in the world (if required).This project will describes how Web Technology enhancement in water management and instrumentation of a wireless sensor network, and software for real-time in-field sensing and control of a site-specific precision linear-move irrigation system.*

Keywords: SWBS, WWW, Sensor, Database, Zig bee.

1. Introduction

Agriculture is the major economic activity in Tanzania. The economy of Tanzania depends largely on agriculture. The agricultural sector continues to lead the economic growth, in spite of the recent emergence of new high-growth sectors of mining and tourism, and it continues to have the highest impact on the levels of employment and poverty. Small-scale subsistence farmers comprise more than 90% of the farming population, with medium and large-scale farmers accounting for the other 10% [5]. After the liberalization of the economy in last two decades, increasing food production and traditional and non-traditional exports created greater demand of water for irrigation. As it has been known that water resources are getting dried all over the world, water restrictions have been in place in most places for several years now to try to limit water consumption. Common methods of water distribution can be enhanced or replaced by using recent technological advances, using it will improve the efficiency of water distribution, automate the process of irrigation management, provide an easy to use programming and reporting interface, and provide a scalable, versatile base from which to expand or modify if needed. One of the main drawbacks with the old fashioned auto timer irrigation system is that they do not cater for changing environmental conditions. Soil Moisture, Temperature, wind, rainfall and other elements can dramatically affect the amount of water needed to sustain a plants health. Another aspect of regular irrigation systems that could be improved is its user interface some time as there were many alternatives on the market to

choose from. Eventually a microcontroller was chosen for the heart of the system. .

2. Significance of Study

One of the main drawback with the old fashioned auto timer system is that they do not cater for changing environment conditions .Temperature ,soil moisture ,humidity ,wind ,rain and other elements can dramatically affect the amount of water needed to sustain a plants health. If these elements were monitored and used to influence the water cycles the water used should be more effective.

Another aspect of regular irrigation system that could be improved is its user interface .Not only can be difficult to program and setup ,they often do not have the flexibility or scalability to do exactly what the user would like. With the phenomenal growth of the internet in the last decade ,the use of a web browser interface has not only become the standard for viewing pages on the World Wide Web but has become more pervasive as a mean of collecting user input or providing the output/status of control system .In this situation the web interface provides an excellent platform from which to develop the system. The portability of this technology means that the system could be controlled and monitored from anywhere in the world. Common method of water distribution can be enhanced or replaced by using recent technological advances .Hope to use it in order to improve the efficient of water distribution ,to automate the process of irrigation

management ,to provide an easy to use web interface and to provide a scalable ,versatile base from which to expand or modify.

3. Schematic Diagram

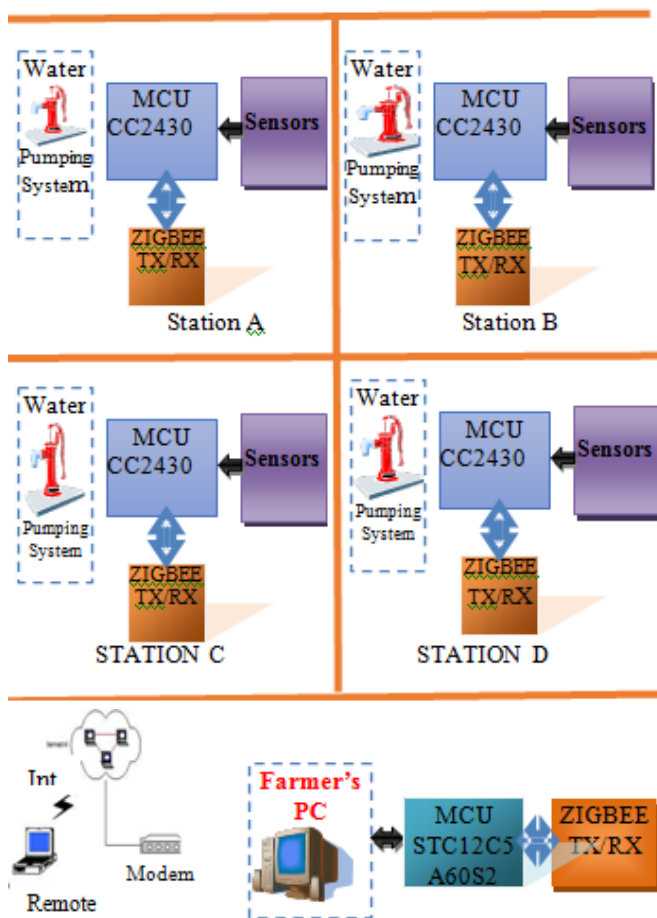


Figure 1: Block diagram of irrigation monitor & control using distributed Wireless Sensor network

The main objective of this research is to design an integrated system which will tackle part of the problem by trying to improve the efficiency of water use in irrigation systems. A system remotely take control to the field of irrigation using the modern technology of World Wide Web integrated with the Zig bee wireless technology and microcontroller the heart of the system .In particular there is a need for the system and methods in which a distal computer ,remote from the user's location ,monitors the operation of the irrigation system ,to assist an irrigation user in attaining more efficient irrigation of the irrigated

3.1 The Microcontroller

As used herein a "microcontroller" means heart of the system, indicate a physical device that controls operation of the infield sensor integrated with wireless transmission protocol and water application devices to an irrigation schedule. It was known found from initial groundwork that a microcontroller based system was a desirable option. The main criteria in deciding on what to use were size, performance, features and price. With the use a serial interface in between the microcontroller and a PC for uploading of programs and retrieving data logged on the

controller for reporting purposes. The PC was to perform all of the user input as well as gathering, processing and displaying the data. As well as performing these tasks locally, it should also be able to via a web page, to enable remote access of the system.

We consider using the 80C51 family which is STC12C5201AD. Many derivative microcontrollers have since been developed that are based on--and compatible with--the 8051. Thus, the ability to program an 8051 is an important skill for anyone who plans to develop products that will take advantage of microcontrollers. STC12C5201AD is a single -chip microcontroller based on high performance IT architecture 80C51 CPU which is produced by STC MCU Limited [6].

3.2 Zig bee Technology

The past several years have witnessed a rapid growth of wireless networking. However, up to now wireless networking has been mainly focused on high-speed communications, and relatively long range applications such as the IEEE 802.11 Wireless Local Area Network (WLAN) standards. The first well known standard focusing on Low-Rate Wireless Personal Area Networks (LR-WPAN) was Bluetooth .However, up till now there hasn't been a wireless network standard that meets the unique needs of sensors and control devices. Sensors and controls don't need high bandwidth but they do need low latency and very low energy consumption for long battery lives and for large device arrays. Although Zig Bee's underlying radio communication technology isn't revolutionary, the zig bee play a role as transmission device which carry information of all the sensor from the infield to the receiving end ready to be stored on the computer[3].

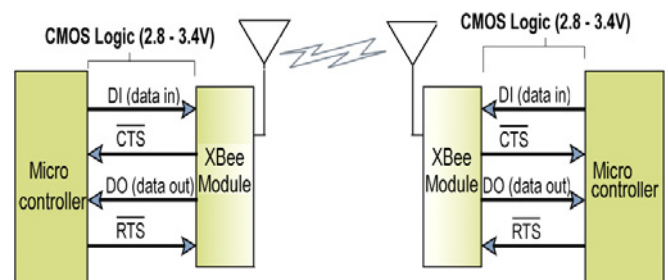


Figure 2: System Data Flow

3.3 Sensor Network

A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. For example temperature sensor, humidity sensor, water level sensor etc, the figure below show how the information were able to be monitored by a designed C# software

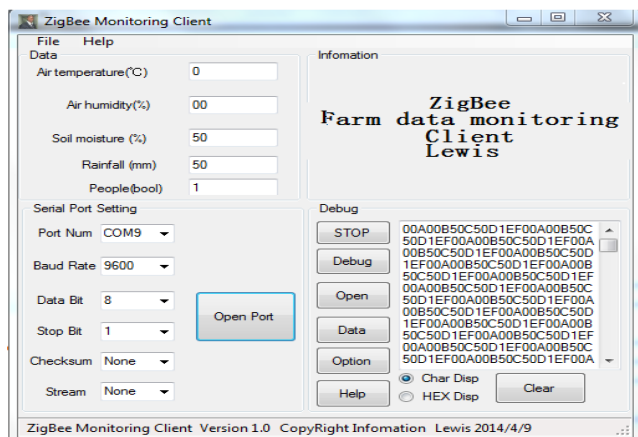


Figure 3: sensor data collection

3.3.1 Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^{\circ}\text{C}$ at room temperature and $\pm 3/4^{\circ}\text{C}$ over a full -55 to $+150^{\circ}\text{C}$ temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only $60\text{ }\mu\text{A}$ from its supply, it has very low self-heating, less than 0.1°C in still air.

The temperature sensor LM35 is used to measure the temperature around the field. In case of events like fire in the field, this sensor will detect and respond to very high temperature. The system's response is to send an SMS alert to the farmer. The farmer will quickly call emergency service an act on time.

3.3.2 Humidity Sensor

A humidity sensor senses relative humidity. This means that it measures both soil temperature and moisture. Relative humidity, expressed as a percent, is the ratio of actual moisture in the soil to the highest amount of moisture soil at that temperature can hold. The warmer the soil is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature.

The most common type of humidity sensor uses what is called "capacitive measurement." This system relies on electrical capacitance, or the ability of two nearby electrical conductors to create an electrical field between them. The sensor itself is composed of two metal plates with a non-conductive polymer film between them. The film collects moisture from the air, and the moisture causes minute changes in the voltage between the two plates. The changes in voltage are converted into digital readings showing the amount of moisture in the air.

3.3.3 Soil Moisture Sensor

A predefined moisture threshold is used as a reference to control the water pumping if needed. If the water level is less than a predefined value then our sensor will detect this and will inform the system to pump the water. On the other hand if it exceeds the threshold value and the water pump is ON then our system will switch OFF the water pump. This will allow efficient usage of water. Soil moisture levels can be expressed in terms of soil water content. **Soil water content:** Most commonly expressed as percent water by weight, percent water by volume or inches of water per foot of soil. Other units such as inches of water per inch of soil also are used^[10].

4. Browser Interface

Before designing the web interface system, I needed to work out which controls would need to be accessible from the web page/s. Finally I come up with the following basic functions which are:

- Access to station data.
- Ability to view and set cycles for each station.
- Ability to add or delete stations.
- Ability to control level of automation for each cycle.
- Access to weather data.
- Ability to set a new user who will be in charge of the data entry and station management.
- Ability to view crop information

WampServer is a development platform on Windows allowing a system to create dynamic web applications with Apache2, PHP and MySQL

These requirements were then used to form the web pages, sourced in html code, php language and java script using a web page design program. They include:

- An index or home page from which there are hyperlinks to all other pages
- A station setup page where the user can enter information about a new station
- A cycle programming page for entry of each station's cycle parameters with
- A current weather data web page.

5. System Database

A System comprises of database which is a collection of information that is organized so that it can easily be accessed, managed, and updated. In one view, databases can be classified according to types of content mostly in my database is full-text and numeric. The data are typically organized to model relevant aspects of reality in a way that supports processes requiring this information. , In my thesis I have design a database which contain information such as station information, weather information, irrigation cycles field, crop data information, infield staff information, user credential .Typically, a database administrator provides users the capabilities of controlling read/write access, specifying report generation, and analyzing usage^[14].

5.1 Entity Relation Model

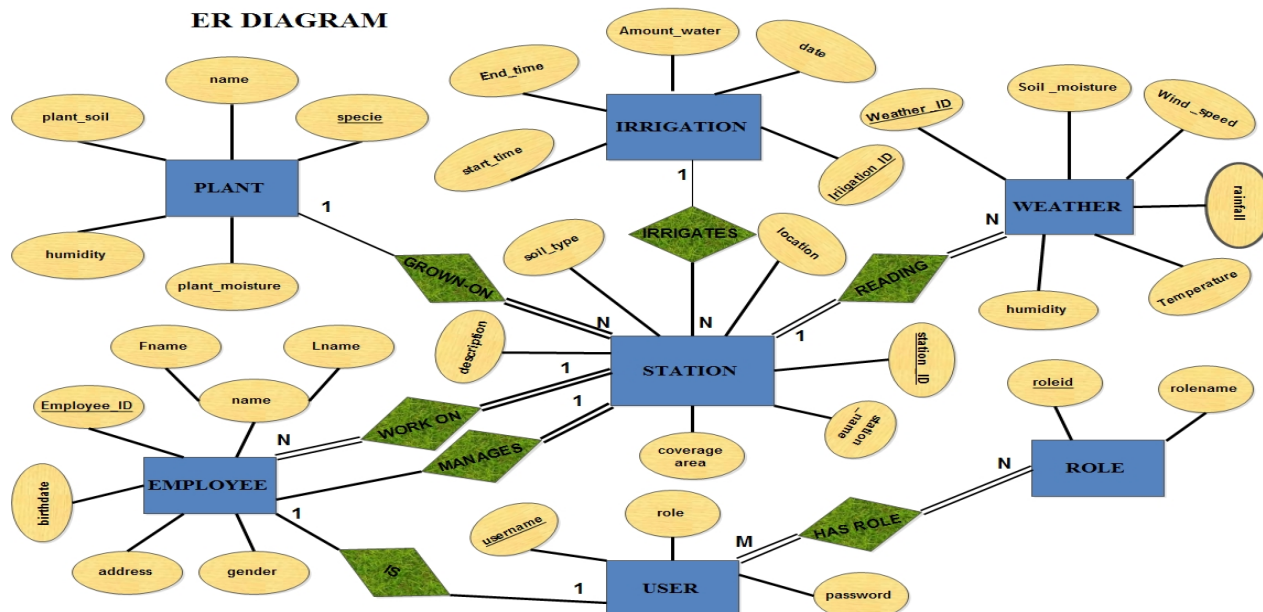


Figure 4: ER Diagram

An *Entity-relationship model* (ERM) is an abstract and conceptual representation of data. ER modelling is a DB modelling method, used to produce a type of *conceptual schema* of a system. Diagrams created by this process are called *ER diagrams*. Sequence: *Conceptual data model* (i.e. ER) is, at a later stage (called *logical design*), mapped to a *logical data model*, (e.g. *relational model*); this is mapped to a physical model in *physical design*. ER Model used to interpret, specify & document requirements for DBs irrespective of DBMS being used^[13]. In my thesis I have design a system which has a relation (shown with blue colour rectangular shape on the ER Diagram) such as

- **READING** –show a relation between station &weather
- **GROWN_ON**- show a relation between station & Plant
- **IRRIGATES_ON**- show a relation between station &Irrigation
- **IS** –show the relation between user and employee
- **HAS-ROLE**- show the relation between user and role
- **MANAGES** show the relation between employee and station
- **WORK -FOR** show the relation between station and employee

6.2 Mapping Er Model to Logical Schema

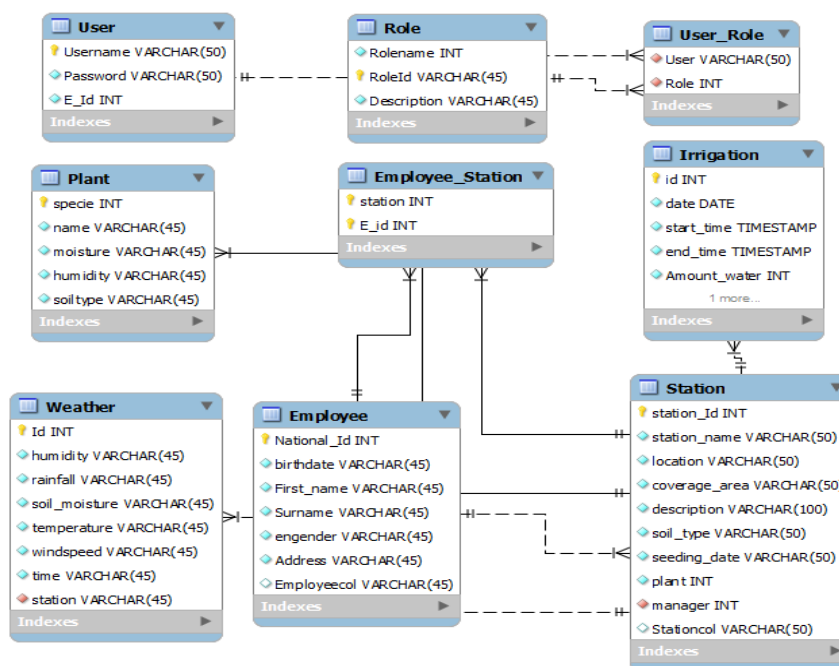


Figure 5: Logical Schema

Here in this logical schema is where the relation attributes are Shown such as station, plant, irrigation etc highlighted.

6. Result and Analysis

System was implemented and will be able to view and monitor the field in real time ,at this stage system is able to view the result of the features comprises in the completion of system database. Mysql database was opted to be the best platform for database design ,I have been working to create a database which will result the system completion after integrated with the hardware part where by the field information such as sensor result will be connected to the database and web based system display the information. Below are the snap shot of the system.

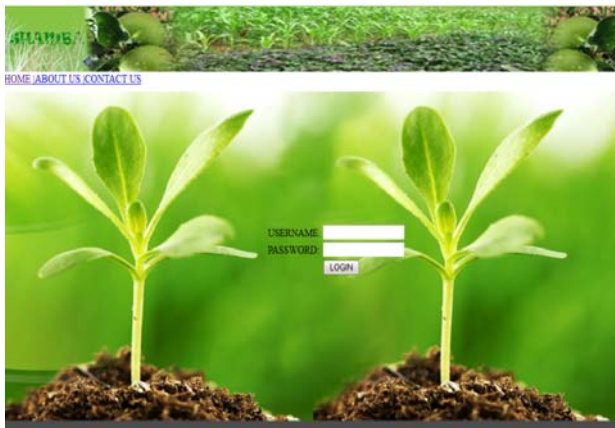


Figure 6: Home page of the system

This below snap shot trying to show the station information the way it was setup and ability to control the station by view its weather information, crop.



Figure 7: Station Information

Each station has its own weather information to be displayed.

DATE	TIME	TEMPERATURE (DEGREE CELCIUS)	HUMIDITY (mm-Hg)	RAINFALL (mm)	MOISTURE (ml/kg)	WIND (M/S)
Thu Jan 23rd, 2014	06:05 AM	32	20	25	3	20
Fri Feb 2nd, 2014	12:50 AM	3	30	50	42	24
Sun Mar 02nd, 2014	09:50 AM	3	31	23	34	35
Sat Mar 07th, 2014	12:00 AM	7	32	52	13	29
Sat Mar 08th, 2014	12:00 AM	3	28	00	3	20

Figure 8: Weather Station Information

In this below snap shot is where the irrigation cycle is viewing by considering the schedule of irrigation.

DATE	START TIME	END TIME	AMOUNT OF WATER (GALLONS)
Thu Jan 23rd, 2014	12:00 AM	12:00 AM	100
Sun Mar 02nd, 2014	08:35 AM	09:15 AM	100
Mon Mar 03rd, 2014	07:07 PM	08:03 PM	200

Figure 9: Irrigation cycle Information

Here below is the plant information of a particular station.

name	specie	Seeding Date	harvesting date
Sunflower	helianthus annuus	Fri Jan 03rd, 2014	Sat Jan 07th, 2014
Kidney Bean	phaseolus vulgaris	Mon Jan 20th, 2014	Tue Apr 15th, 2014
Maize	zea maysa	Mon Sep 09th, 2013	Sun Mar 09th, 2014

Figure 10: Plant information



Figure 11: Test on bench

7. Conclusion

What managed to be done in the process of design and implementation the system is that by combining the web based technology and weather sensing equipment placed on the field, more efficient water delivery can be made possible. This can be achieved while maintaining simplicity, ease of use and ease of implementation. The use of a browser interface meant it was relatively easy to work with from both the user point of view and the programmer's point of view. The station setup on the web browser was successful implemented as well as staff management. The initial cycle setup time is significantly less than the first attempt at setting up a cycle on most manual irrigation controllers. The lack of a hardware interface means that it isn't an expensive part that can be damaged and need replacing (although you will need a computer to modify details). I found that the programmed and actual cycle times differed when a station was setup to make use of sensor based cycle time adjustments. The use of Zig bee technology integrated with infield sensor network allows the flexibility in the system from the farmer point of view. Web based system is important feature in our design which is playing major rule in providing the information accessibility about the status of the field and will be helpful for the farmer to receive notifications of the events occurring in the field and also about environmental changes near the field like cyclone, fire in the field and flood. For real-time in-field sensing and control of a site-specific precision linear-move irrigation system. Field conditions were site-specifically monitored by several in-field sensor stations distributed across the field based on a soil property map, and periodically sampled and wirelessly transmitted to a base station using Zig bee technology [7].

8. Future Scope

It's my recommendation that this model of web irrigation control system for medium to large areas of land with a many number of zones. This is due to the price and time involved in setup of the system. The system hasn't been tested with more than 4 stations instead has been tested on test bench for a four station, but with a bit more development in the pump control / cycle scheduling areas it seems the application will become more feasible as the number of stations increases. For many stations system limit but this could be increased by adding another relay board or making a new one with perhaps many relays and/or relays with different voltage levels for applications in other areas. At the moment the web interface needs more refinement with more user controls. Functions that need work are:

- Pump control needs to be included on the web interface.(future plan implementation)
- Scheduling of cycles needs more development with more sophisticated user
- Entry options available such as a calendar type graphical input.
- Ability to represent the site graphical showing zone boundaries, sensor locations and sprinkler locations.
- Each station's own web page including the ability to view station status and view information such as total hours in use and more.

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