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Smart sensor system to trigger irrigation

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Abstract – : The expansion of technology and new innovations extend its influence even in the farming .Usage of sensors and efficient networking in agriculture fields eases work of farmers .Specializing it to the irrigation we are thereby proposing a smart sensor system which can trigger irrigation by sensing the moisture levels in the field . The whole system primarily consists of two parts 1. the set of sensor nodes and base station. The sensor node gathers soil moisture information using provided core and sensor circuit. Base station gets the information from different sensor nodes also which forms an Adhoc network supported by ZIGBEE protocol. Base station which consists of ARM7 Processor, GSM modem and a 3-phase sensing and motor on/off circuit the GSM modem communicates both sides user mobile to base station and base station to user mobile using SMS(Short Message Service) the soil moisture information to user mobile further which the irrigation can be controlled by user using AT command

Keywords – soil moisture sensor; precision agriculture; arm7.

1. Introduction

Soil moisture measurements provide useful information for agriculture such as soil stability, dam monitoring and construction activities. For this application an array of wireless sensors is required.
An array of wireless sensors forms an adhoc network. Each sensor node involves the circuit for soil moisture sensing which a capacitance based one. The sensor node also includes the alternative power source like solar cells etc.
The base station which consists of ARM7, GSM module and three phase detection circuit and a relay which can be turned on whenever a three phase is available and a command is received by the controller from GSM MODULE which was activated by user through SMS. The proposed paper gives the extension of the extra safety measures for the motor triggering done by using the three phase detection in motor and automatic on and off.

2 FRINGING CAPACITANCE MOISTURE SENSOR

The dielectric constant of materials or mixtures containing water increases markedly with moisture content because the dielectric constant of water (about 80) is 10 to30) times higher than the common materials as stated in [1].Rather than using a well known parallel plate capacitance configuration, a fringing field capacitance is used in order to project the sensing electric field into the surrounding material.

The influence of conductivity on the dielectric constant is much greater at lower frequencies and thus a higher sensor operating frequency (5 to 500 MHz) is desirable. At higher frequencies the contribution of conductivity becomes small but for larger sample sizes, which are needed for soils with large aggregates, inductive effects can cause significant errors, at least with fringing capacitance sensors. To avoid these errors, we have chosen an operating frequency of 10 MHz even though some conductivity effects remain. The following figure .1 from [1] shows the Dependence of Dielectric Constant of a Mixture on Water Content.

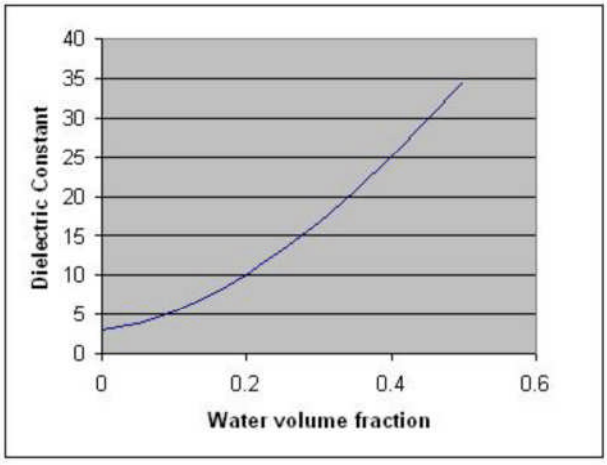

Figure.1 Dependence of Dielectric Constant of a Mixture on Water Content

2.1 FREQUENCY SHIFT OSCILLATOR

Sensor capacitance changes can be conveniently and accurately measured by a frequency shift oscillator. This approach was proposed in an reference[1] paper on frequency shift soil moisture sensors to avoid the adverse effects of the high loss (or high conductivity) of soils on the oscillator circuit, a T-coupling network is desirable, if

not necessary. The below figure-2 from [1] visualizes the frequency shift oscillator circuit with Capacitance T-coupling network along with analog switches SWA and SWB.

2.2 Power management system for sensor node

Power management is the basic necessity to develop a smart sensor node which uses power efficiently. The system architecture, inserting the contribution of power management system that will utilize two batteries. The power management system will manage solar power direction for charging the secondary battery while the primary battery will remain works until at certain level of voltage drops, it will triggered alternate charging-working process for these two batteries. As reviewed from reference [5] the following figure shows the sensor node architecture with optimal power management system.

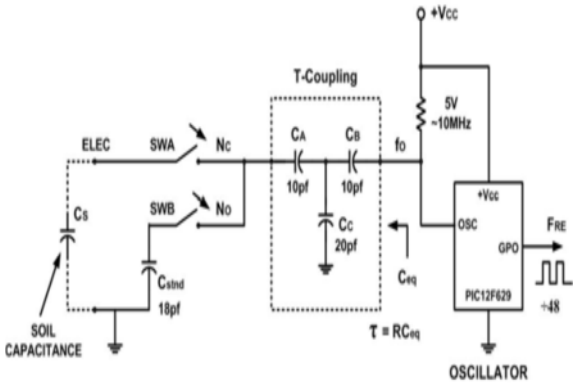

Figure-2 Frequency Shift Oscillator Circuit with Capacitance T-coupling Network

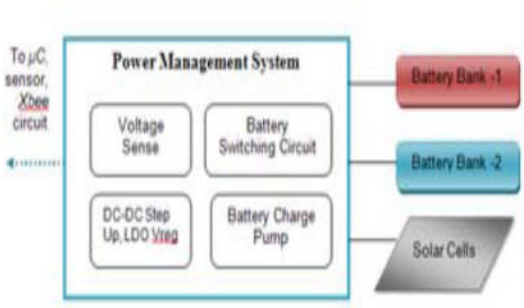

Figure-3 power management system

3. CENTRALIZED BASE STATION

As per the reference [3] the soil moisture sensor sends the sensed data along with the location code over a wireless ZIGBEE network to the base station which passes the data to the Microcontroller where it is analysed and given to the database on the p.c. for further processing Microcontroller also starts the pump as per the feedback received from the farmer via SMS.

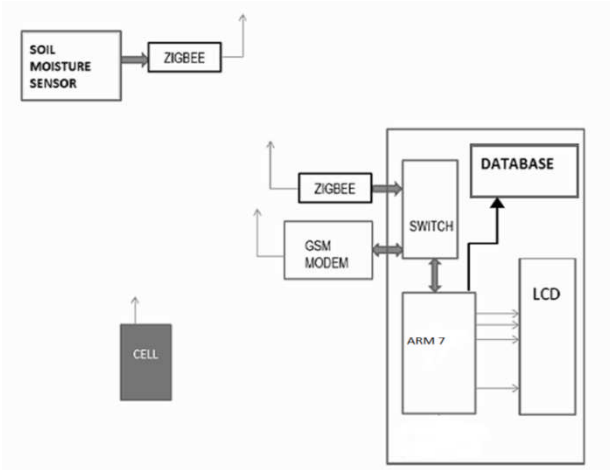

Figure :4 Centralized Base station Block Diagram

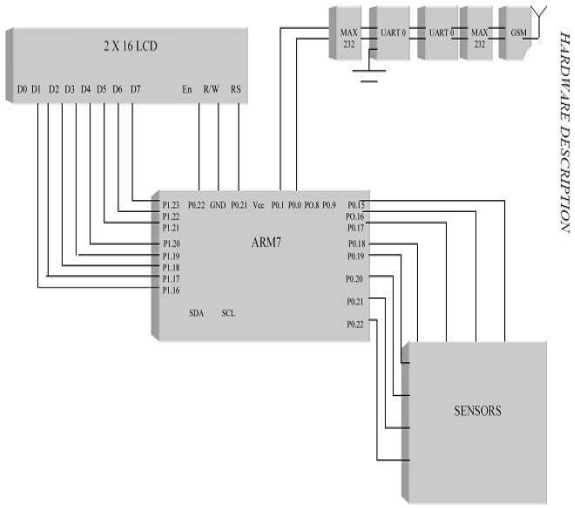

Figure:5 Hardware description of ARM with LCD and GSM module

4. ZIGBEE TECHNOLOGY

ZIGBEE is a new wireless technology guided by the IEEE 802.15.4 Personal Area Networks standard. It is primarily designed for the wide ranging automation applications and to replace the existing non-standard technologies. It currently operates in the 868MHz band at a data rate of 20Kbps in Europe, 914MHz band at 40Kbps in the USA, and the 2.4GHz ISM bands Worldwide at a maximum data-rate of 250Kbps.

Probably the main feature of ZIGBEE is its limited power requirement. ZIGBEE is better for devices where the battery is rarely replaced, as it is designed to optimize slave power requirements, and battery life can be up to 2 years with normal batteries.

ZIGBEE is the only wireless standards-based technology that addresses the unique needs of remote monitoring and control, sensory network applications. 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.

5. GSM MODULE

A GSM modem is a wireless modem that works with a GSM wireless network. Computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. So we can use a GSM modem just like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.GSM is one of the most vital components in our set up since all the communication between the users and centralized unit takes place through this modem. GSM communicates with ARM through I2C bus.

4 AT Commands According to GSM07.05

The GSM 07.05 commands are for performing SMS and CBS related operations. SIM300 II supports both Text and PDU modes.

4.1 Overview of AT Commands According to GSM07.05

Command	Description
AT+CMGD	DELETE SMS MESSAGE
AT+CMGF	SELECT SMS MESSAGE FORMAT
AT+CMGL	LIST SMS MESSAGES FROM PREFERRED STORE
AT+CMGR	READ SMS MESSAGE
AT+CMGS	SEND SMS MESSAGE
AT+CMGW	WRITE SMS MESSAGE TO MEMORY
AT+CMSS	SEND SMS MESSAGE FROM STORAGE
AT+CMGC	SEND SMS COMMAND

6. Temperature and Humidity sensors

The inclusion of the humidity and temperature sensors whose measurements are almost uniform among the field can be added at base station which would give the extra information about the field ,even the power source availability in the base station is unlimited which reduces the effort caused by the wireless sensors. The Temperature and humidity sensors can be directly given to the microprocessor at the base station.

The Therm 200 sensor can be used for the temperature purpose which can avoid the inaccuracy caused by the thermistor based temperature sensor which can also reduce the effort of the microprocessor as it eliminates the complex calculations. It also adds some advantages which can be referred from reference [5].The below figure reviewed from reference shows the therm 200 temperature sensor.

To measure humidity, amount of water molecules dissolved in the air , a smart humidity sensor module SY-HS-220 is opted for the system under design. The humidity sensor is equipped along with signal conditioning stages, as a conditioning signal circuit is to used in order to change the variable capacitance of the sensor into a usable voltage.

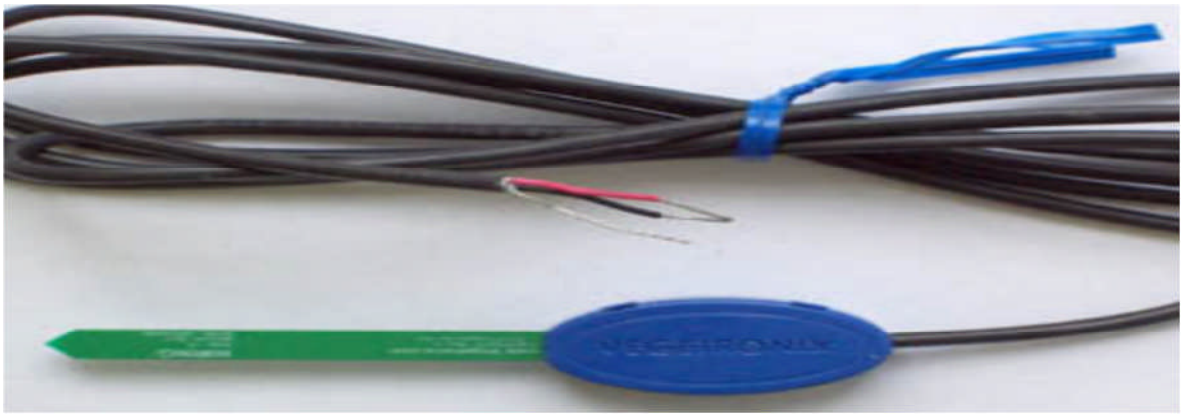

Figure-6 therm 200 temperature sensor

7. THREE PHASE CURRENT DETECTION AND AUTOMATIC MOTOR ON/OFF

Generally the three phase motor is used for the irrigation purpose at least in a countries like india ,so here we should have a note about the safety of the motor before switching it ON automatically . A monitoring circuit here is required for three phase detection and the relay must be made ON only after checking the three phase availability.

As reviewed from the reference [4], whenever the system receives the activation command from the subscriber it checks all the field conditions and gives a detailed feedback to the user and waits for another activation command to start the motor. The motor is controlled by a simple manipulation in the internal structure of the starter. The starter coil is indirectly activated by means of a transistorized relay circuit. Once the motor is started, a constant monitoring on soil moisture and water level is done & once the soil moisture is reached to sufficient level the motor is automatically turned off & a message is send to subscriber that the motor is turned off.

The proposed system consists of two relays which are used to switch on and off the motor to trigger the irrigation. The following figure shows the block diagram of base station which involves the relays for motor on an off.

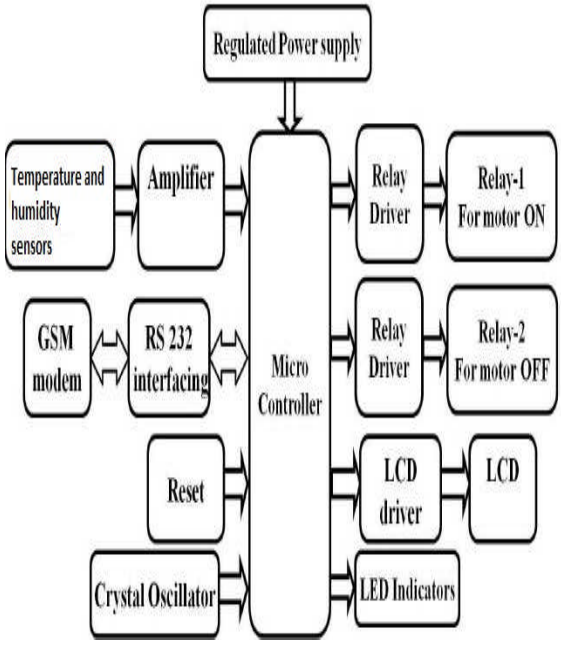

Figure –6 Block diagram of base station showing relays

8. CONCLUSION

The above shown system smart sensor system to trigger irrigation explains the irrigation triggering using the soil moisture ,temperature and humidity measurements from different sensor which use a high performance microprocessor ,as the usage of the high performance processors enhances further extensions. The other enhancements for the system which can be included is an embedded operating system such as ZKOS(ZERO KERNEL OPERATING SYSTEM) and TINY OS for task scheduling and resource allocation which can make a system's scheduling handled more effectively .

Some of the tasks are the microprocessor allocation of A/D and D/A converters etc. Also scheduling the data acquisition from different sensor nodes deployed at different areas of field. Our method can be applied to other fields [6-9].

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