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Soil Electrical Energy by Wireless Environment Monitoring System

Yamini Y. Tembhurne[1], Dr. Hari Kumar Naidu[2], Partik Ghutke[3]
[1, 2,3]*Mtech of IPS, RTMNU*

Abstract: We are planning to design a wireless environment monitoring system using renewable and cost-efficient soil energy. The D-size (55.8 cm3) soil energy cell with carbon and zinc electrodes can produce electricity depending on the water contents and microbial reactions in the soil. The RC circuit model of a soil cell is to be proposed for understanding the electrical characteristics of the cell. The wireless sensing system, including temperature and air moisture sensors, a custom low-power capacitive sensor readout silicon chip, a microcontroller, and a ZigBee transmitter, is to be demonstrated for long-term environmental monitoring solely by the fabricated D-size soil cell. The capacitive sensor readout chip is to be fabricated in a 0.18-µm CMOS process. The total power consumption of the wireless temperature and air moisture monitoring system in the sleep mode and the active wireless data communication operations, should be within the acceptable values. The new technology can enable remote field environment monitoring with less labour-intensive work and battery replacement.
Keywords: ZigBee, soil cell, wireless, RC circuit, CMOS, D-size

I. INTRODUCTION

Soil is the most spatially complex stratum on Earth, containing minerals and many organisms, such as bacteria, fungi, algae, protozoa, nematodes, and earthworms. The organic matter in subsurface environments and aquatic sediments represents a large potential source of energy. Some bacteria in the soil are known to generate electricity (exo-electrogens) without the provision of an exogenous media [6].The soil energy can be an alternative energy source to remedy the environment and energy endeavours. Through biochemical reactions from the activities of the microorganisms, the energy in the soil can be released as electricity and heat. Recently, the chemical-to-electricity conversion processes from bacteria are utilized to establish microbial fuel cells [10].The electrical properties of the soil are affected by the type of soil, density, operating frequency, water content, and soluble salts and minerals. The equivalent circuit provides insights for optimizing the MFC design and enhancing the output power. The emerging technology of wireless sensor networks (WSNs) provides real time controls and communication with the physical world to reduce the risk of food shortages and casualties from disasters. To be widely deployed, wireless sensor nodes reliable energy source for their long-term operations. Wiring a power-source to sensors not only costs a vast amount of labor and resources but also leads to potential contamination produced by the batteries.. To demonstrate the potential applications of the soil cells, we will design and fabricate a wireless temperature and air moisture sensing system on a printed circuit board (PCB).The capacitive humidity sensor readout IC will be employed to convert the humidity-caused capacitance deviations to frequency deviations. The readout IC will include a regulated RC oscillator and a DC-DC voltage boosting charge pump circuitry. The data from the wireless sensors is sent to the microcontroller for data processing. The final readings will be sent to the ZigBee module for transmission to the smart phone as an output. Thus the overall system will include the DC-DC converter, low power microcontroller, air humidity sensor, custom capacitive humidity sensor readout IC, and a ZigBee transceiver with embedded temperature sensor [1].

II. RESEARCH ANAYLISIS

Farmland relies more on environmental factors, and to increase the capacity of the soil to produce more crops, the sustainable environmental monitoring system is required. Our aim is to develop low power environmental monitoring system which can be used in energy constrained remote areas. Therefore, there is an urgent demand to develop a sustainable power source that can supply sufficient power to wireless sensors in remote locations while requiring less maintenance and low costs.

A. To design sustainable environment monitoring system
B. To develop a system with low maintenance cost
C. To use Soil Energy for environment monitoring using wireless sensor system
D. To develop a Microbial fuel cell foe converting chemical energy into electrical energy
E. To implement temperature sensor and air-moisture humidity sensor using microcontroller

F. To read the data of microcontroller using Silicon chip
G. To transmit the readings by using wireless medium ZigBee transceiver
H. To send the data to the smart phone

III. IMPLEMENTATION

A. Transmitter Section

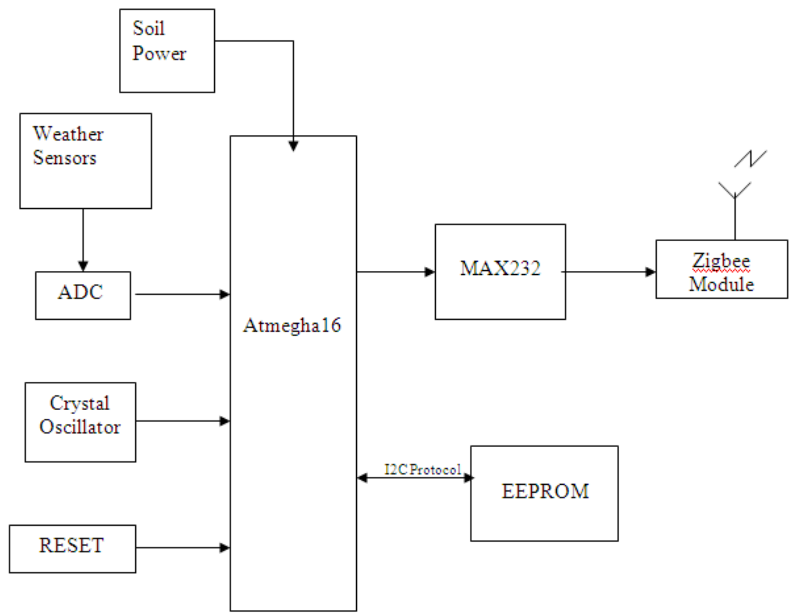

Figure 1.Transmitter Section of the Wireless Monitoring System

B. Receiver Section

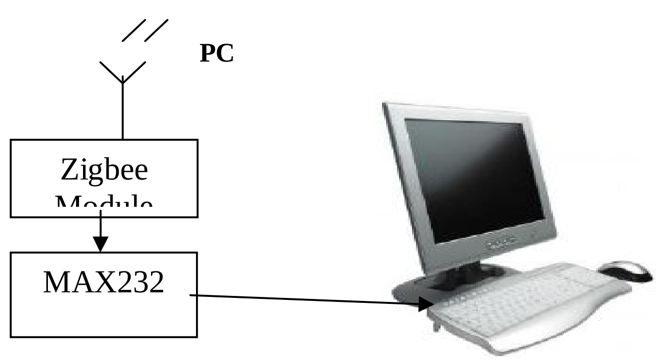

Fig 2.Receiver Section of the Wireless Monitoring System

In view of all this things, the design of wireless parameter progress helps in an industry to monitor the parameter in real time with the use of zigbee, is an easy installation platform, cost effective method for the low bit rate transmission, so with the help of the ready zigbee platform by using the embedded language we interface the module with the pc by the help of visual basic we monitor the parameters in the system. The second part of the project is to make the electronic circuit. There are two circuits one for the transmitter section and another for the receiver section. The connections are made between the components as per the Electronic circuit for Transmitter section. ZigBee is used in applications that require a low data rate, long battery life, and secure networking.

ZigBee has a defined rate of 250 kbit/s, best suited for periodic or intermittent data or a single signal transmission from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that requires short-range wireless transfer of data at relatively low rates. The technology defined by the ZigBee specification is intended to be simpler and less expensive.

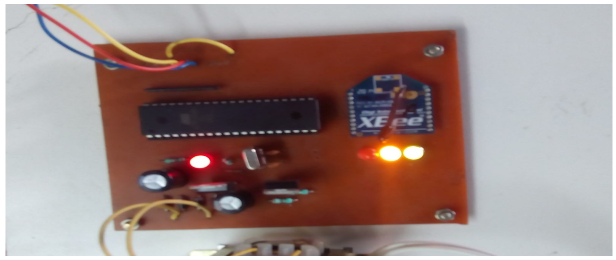

Fig 3: Electronic circuit for Transmitter section

The ZIGBEE interface is another part of the transmitter section. The pin 3 (data in) of ZIGBEE module is connected to the USART transmission (TX-25) pin of port C in PIC. This wireless transmission follows USART protocols and is according to IEEE 802.15.4. ZIGBEE is a transceiver, in the transmitter section it is used as the transmitter. The receiver address of this ZIGBEE module is set as the address of the ZIGBEE module in the main server, so that data is send to this receiver only. It is a low power, low cost wireless mesh networking standard and it uses the ISM band for its transmission. The Controller requires oscillator for clock generation, for this a crystal oscillator 16 MHZ is connected between pin 13 & 14. Parasitic capacitor of 33pf is used to increase the stability of the oscillator. In pin 1 of the PIC a switch is connected for resetting the registers. Pin 1 is the master clear. During normal operation its value is high, when the switch is pressed all the registers of the PIC is cleared. The supply to the PIC (5V) is given by the supply circuitry. The supply is given to pin 11of the PIC. The supply to ZIGBEE module (3.3V) is given by LM317, which is given to pin 1 of ZIGBEE.

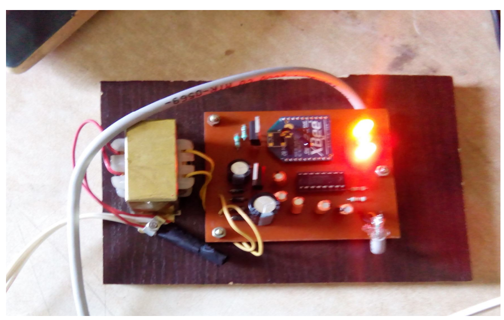

Fig 4:Electronic Circuit for Receiver Section

IV. PC INTERFACING CIRCUIT

In the receiver section the ZIGBEE module can be used as receiver. This module receives the data send by the transmitters. The supply to the ZIGBEE module (3.3V) is given by the supply circuitry in fig with LM317. To interface with the computer we have to convert the TTL logic into RS232 logic, for this purpose we use the IC MAX232. MAX232 is a dual driver/receiver that includes a capacitive voltage generator. The drivers (T_1 & T_2), also called transmitters, convert the TTL/CMOS logic input level into RS232 level. The transmitter (pin 10-T2 in) take input from ZIGBEE's data out pin (pin 2 of ZIGBEE) and send the output to RS232's receiver at pin 7 (T2 out) of MAX232. We use four capacitors, two for doubling the voltage and other two for inverting the voltage. The capacitors are connected between pin 1 and pin 3, pin 4 and pin5, pin 2 and VCC, and pin 6 and GND. The transmitter output (T2 out) from MAX232 (RS232 logic) is connected to pin 2 (receive data) of RS232 port. Thus the data received are given to PC. The pin 5 of RS232 port is connected to ground.

V. CONCLUSIONS

Compared to other renewable energies, such as solar and tidal energy, soil energy is easily accessible, insensitive to environment changes, and does not require expensive infrastructure. The system can be further utilized for remote field experiments and environment monitoring in energy-constrained areas to avoid frequent battery replacement. To improve the output power of a soil cell, cultured bacteria and prepared soil substrate can be used. The new technology can enable promising applications in environmental monitoring and green electronics.

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