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Analysis of Power Consumption and Battery Management Techniques in WSN

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Abstract—The number of wireless sensor network deployments for real life applications has rapidly increased. Still, the energy problem remains one of the major barriers somehow preventing the complete exploitation of this technology. Sensor nodes are typically powered by batteries with a limited lifetime and, even when additional energy can be harvested from the external environment (e.g., through solar cells or piezo-electric mechanisms), it remains a limited resource to be consumed judiciously. Efficient energy management is thus a key requirement for a credible design of a wireless sensor network. All sensors present in wireless sensor network are battery operated devices which have limited battery power. After the deployment of sensor devices it is impossible to replace each and every battery present in the network. So energy conservation must be taken. In this project we proposed an energy efficient dynamic power management technique which can reduce power consumed by each sensor node, by shutting down some components of sensors according to better savings and enhanced life time. To make this power management technique analysis of power consumption of each sensor node must be taken. This survey ensuring that, we can estimate power consumption of wireless sensor network (WSN) in real time.

Index Terms— Battery power, battery management technique, power consumption, power management, sleeping mode, sensor node, WSN

1 Introduction

A sensor network is comprised of a number of low-power devices with sensing and computing capability. In many sensor network systems, the power supply for the network nodes is usually a deplorable power source such as batteries. To increase the lifespan of sensor networks, researchers have designed a number of power management schemes. Many power management schemes take advantage of the energy saving features of sensor network hardware. For example, AT mega128 processor, which is designed for embedded systems.

In one of the working mode of the processor, the processor shuts down all the hardware components except for the memory, a timer and the interrupt handler, hence energy consumption reduces to less than of the active working mode. Power management schemes need to control when a network node should enter a high-power running mode and when to enter a low-power sleep mode. The high-power to low-power transition can usually be done with a set of instructions that shuts down hardware components, and the power management scheme may perform this action when certain conditions hold, e.g., there are no events in the system for a long time. The low-power to high-power transition is, however, a tricky problem because the network node has its CPU halted and is unaware of the external events.

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In many applications, it is desirable to have the network awakened when some events of interest happen. But the network node cannot easily know exactly when events happen. To solve this problem, many power management schemes require that each network node wake up periodically to listen to the radio channel. When an event of interest happens, some nodes (possibly some sentry nodes) detect the event and send power management messages to the network. All the nodes that were in their listening mode and hear the power man

agement messages stay awake – they do not enter sleep mode. By choosing a good wake-up/sleep schedule, the network may save much energy with out compromising the system functionality. The implementation of the wakeup sleep scheduling often involves a timer that wakes up the CPU via an interrupt.

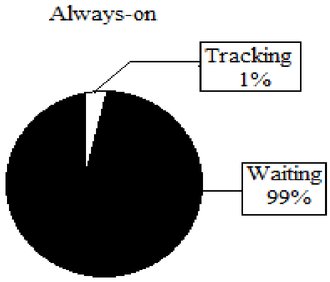

Fig.1 shows analysis of power consumption with always on scheme

As the figure shows, only one per cent of the energy is used in actually tracking targets, the other 99% of the energy is used in waiting for targets to show up. With a rotation based power management, the energy efficiency is much better. Fig. 2 shows the energy distribution.

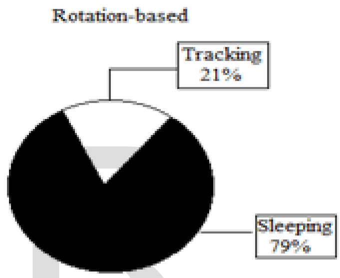

Fig 2. shows analysis of energy distribution with the rotation based scheme

Throughout the network's lifespan, 21% of the energy is used in really tracking targets, and 7% is used in sleep mode. However, 72% of energy is still wasted in a waiting status because the node periodically wakes up to listen to potential wake-up signals, or continuously operates in a low-power stand-by listening of the energy saving should come from eliminating the energy consumed in the waiting status.

2 Power Consumption

As energy consumption determines the lifetime of the Wireless sensor network. Hence it becomes the major issue in Wireless sensor network. Most of sensor nodes use battery power as their energy source. The sensor network can be deployed in hazards conditions so it becomes difficult to change their batteries or provider the energy so there is requirement of developing the networks which efficiently use the battery as energy .The energy consumption depends upon major operations of the sensor nodes which are

- Sensing
- Communication

- Data processing

Most of the power in sensor network will be used during communication. The communication device used in wireless sensor network is zigbee consumes most of the energy to send and receive data.

A Zigbee device consumes 0.035706 W when transferring 24 bytes of data.

- Bits per second = 24 x 8 = 192 bits
- Power per bit = 0.035706/192 = 185.9 μ W/bit

The power consumption of zigbee will also depends on the distance they covered. So the sleeping mode can be implemented in zigbee device will saves most of the energy in wireless sensor network.

3 WSN NODE POWER CONSUMPION

COMPONENTS	VALUE
Zigbee	
Operating voltage	2-3.6V
Receiving data	18.5mA
Transmitting data	33.6mA
Idle	<1 μA
Microcontroller	
Operating voltage	5V
Sleep	8 μA
Sensor	
IR sensor	5.5V
Temperature sensor	5V

Table 1. Power consumption of component

The large amount of energy is consumed during the communication (Transmission and Reception). The various routing protocols are discussed in Therefore the efficient protocols should be used at each layer in order to control energy consumption. Batteries with high power as rechargeable batteries like solar panel can be used in some wireless sensor networks.

Formulas for estimating power consumption:

Energy=Current*Voltage *time

Where current is in Amperes, Voltage is in Volts and Time is in seconds.

Example

$Energy_{Tx} = 20 * 10^{-3}$ A * 3 Volts * 416 *10^{-6} sec / 8 bits
= 3.12 μJ/bit

$Energy_{Rx} = 15 * 10^{-3}$ A * 3 Volts * 416 *10^{-6} sec / 8 bits
= 2.34 μJ/bit

Battery power drain

Batteries used for these experiments are Nickel Metal Hydride rechargeable batteries. It is imperative to use rechargeable batteries, because the experimental plan called for each node to run continuously until the batteries were depleted. Behavior with rechargeable or non- rechargeable batteries is similar. All batteries have a nominal voltage and a nominal charge capacity (C), usually specified as how many Amperes a battery can deliver during one hour.

Consider, for example, a battery with C = 1200 mAh. The battery is capable of delivering the equivalent of 1.2 Amperes (1200 mA) for one hour. The equivalent number of Joules is:

Energy (Joules) = Current * 1hour * 3600 sec / 1 hour * V

Energy = 1200 mA * 1 hour * 3600 sec / 1 hour * 1.2 V
= 5184 Joules

4 PROPOSED SYSTEM

Wireless sensor networks (WSN) are deployed in remote places for the purpose of monitoring a real time data. So each sensor gets the input from the real world and sends the sensed data to the user. Then the user sends power management messages to the zigbee either it will be ON and OFF. But the sensor will be ON at any time to capture the data.

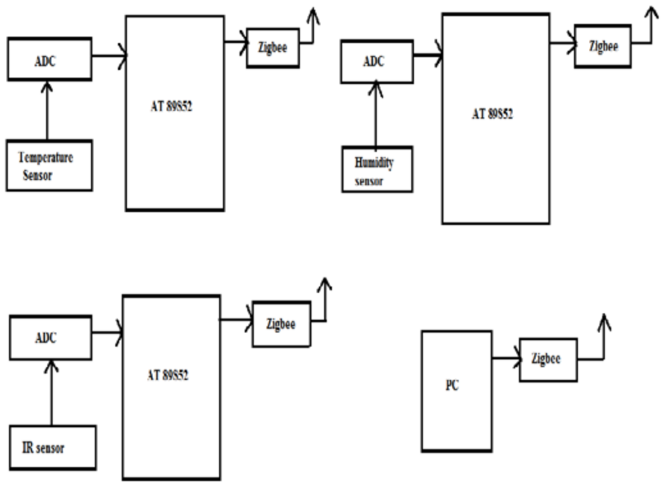

Fig.3 shows block diagram of proposed system

To avoid periodically to send data, the threshold value is set to controller depending on the application. So this mechanism will reduce the power consumption of sensor network and increase the life time of the network.

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4.1 WORKING PRINCIPLE OF PROPOSED SYSTEM

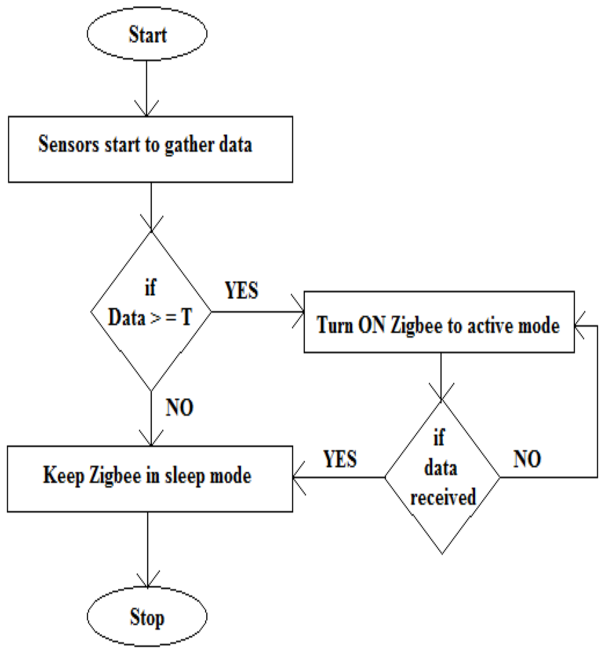

Fig .4 Flow chart of proposed system

5 HARDWARE

5.1 AT89c51 Microcontroler

AT89C51is an 8-bit microcontroller and belongs to Atmel's 8051 family. ATMEL89C51 has 4KB of flash programmable and erasable read only memory (PROM) and 128 bytes of RAM. It can be erased and program to a maximum of 1000 times. In 40 pin A89C51, there are four ports designated as P1,P2, P3 and P0.all these ports are 8-bit bidirectional ports.ie they can be used as both input and output ports. Except P0 which needs external pull- ups. Rest of the ports have internal pull-ups. when 1's are written to these port pins, they are pulled high by the internal pull ups and can be used as inputs. These ports are also bit addressable and so their bits can also be accessed individually.

FEATURE	AT89C51
RAM	128 byte
PROM	4KB
I/O pins	40
I/O ports	4
Serial communication	UART(in-build)
Timer	2
Interrupt	6

Table 2. Features of AT89C5

5.2 Temperature sensor LM-35

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C). The sensor circuitry is sealed and not subject to oxidation. The LM35 may not require that the output voltage be amplified. It has an output voltage that is proportional to the Celsius temperature. The important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self-heating capability.

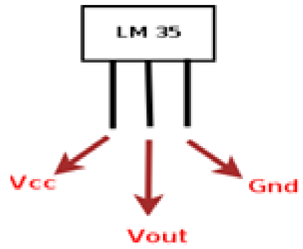

Fig 4. LM35

5.3 IR sensor

Infrared sensor (IR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. All objects with temperature above absolute zero emit heat energy in the form of radiation. Usually this radiation is invisible to the human eye because it radiates at infrared wavelengths, but it can be detected by electronic devices designed for such a purpose. They work entirely by detecting the energy given off by other objects.

5.4 Humidity sensor

HH10D relative humidity sensor module is comprised of a capacitive type humidity sensor, a CMOS capacitor to frequency converter and an EEPROM used to hold the calibration factors. Due to the characteristics of capacitor type humidity sensor, the system can respond to humidity change very quickly. Each sensor is calibrated twice at two different accurate humidity chambers and two unique sensor related coefficients are stored onto the EEPROM on the module.

5.5 RF module Zigbee

XBee and XBee-PRO Modules were engineered to meet ZigBee/IEEE 802.15.4 standards and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of critical data between devices. The modules operate within the ISM 2.4 GHz frequency band and are pin-for-pin compatible with each other.

Here the RF module is used for transmitting and receiving the packets. When the received value from the sensor is above and below the threshold value, it carries out the transmission and reception operations up to that it will in

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sleep mode

6 EXPRIMENTAL RESULT

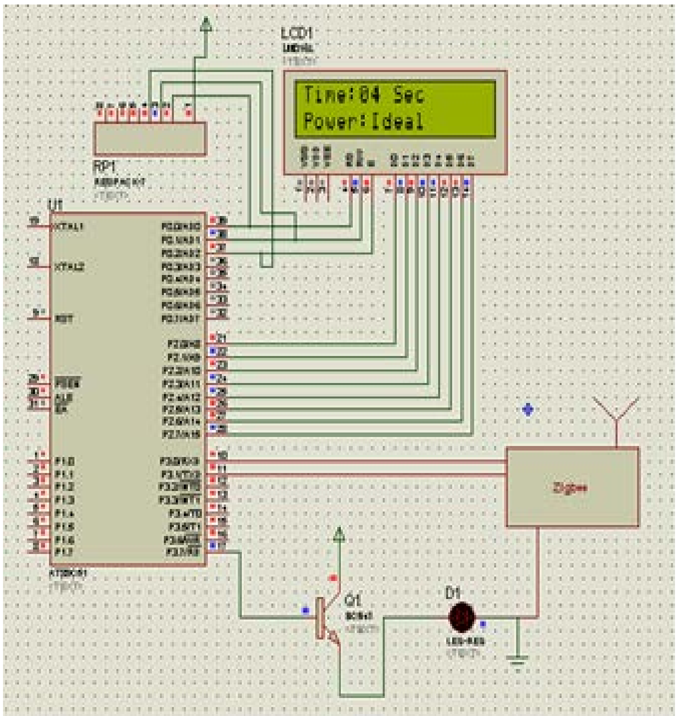

Fig.8 shows simulated result of power consumption

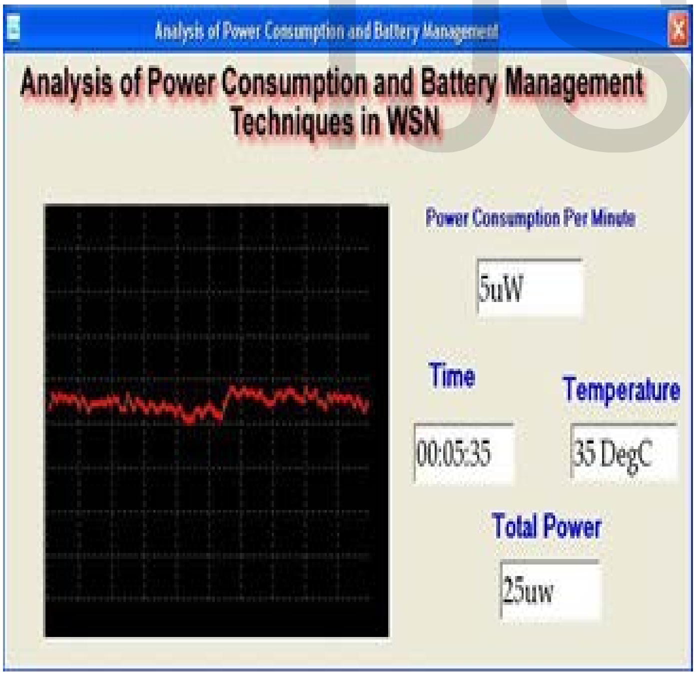

Fig. 9 shows monitoring system for power consumption

The above result shows sleeping mode techniques in wireless sensor network will effectively manage the power consumption.

7 CONCLUSION

Energy sources are very limited in wireless sensor networks. This project is concerned about analysis and implementation of sleeping mode technique to reduce the power consumption of wireless sensor network. The monitoring section continuously monitors the power consumption of each sensor and makes efficient estimation of power consumption of WSN. For monitoring section shows the temperature readings and power consumption of each sensor and time duration of sensor. For implementing this, the programming of ADC and user interfacing with microcontroller is done using Embedded C. Then the Simulation results are obtained using Proteus professional schematic software .Using lesser sensors that are most significant can increase the life time of the network. the energy consumption for wireless sensor networks is analyzed. To estimate the lifetime of sensor node, the energy characteristics of sensor node based on WSN node is measured.

8 FUTURE ENHANCEMENT

This project in future can be enhanced for

1. This project can be expanded to make a collision free network will increase the life time of sensor network.
2. In future a special wireless radio trigger circuit is implemented to minimize the power consumption.
3. Only selected packets will be allowed to send to the monitoring section is also reducing the power consumption.

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