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Modern Techniques for Electric Power Preservation and Conservation

Essam I. Saber

Abstract

In recent decades and several years ago, many engineers and specialists have been trying to design electrical and electronic systems that are less power consuming to achieve two important elements of competition: First, the continuity provision of electrical energy to avoid energy problems and the availability of their sources and the Second to achieve the lowest cost of any electronic or electrical system / device. In general, the continuity provision and saving the electric energy is one of the foundations or engineering principles adopted, but required and applied all over the world.

Nowadays, there are many methods and techniques used to preserve the maximum amount of electric energy in all systems designs. One of these methods is to design systems which operate with low values of operating voltage, or draw lower values of current to reach low power consumption and, finally, as a powerful influence to reduce the overall power consumed inside the electronic circuit, equipment or system. For achieving that target, designers are currently designing the embedded systems that rely on integrated circuits (ICs.) and modern microcontrollers (µCs.), which are characterized by their low power consumption while performing the same functions as desired efficiently. The microcontroller has become the heart / brain of a lot of electronic circuits with the smallest size, less electric power-consuming and powerful features on which many modern electronic systems depend.

In this research, we discuss and present a very important issue for engineers and designers of monitoring networks / systems as one of vital electronic systems used in both of environmental monitoring and nuclear power plants (NPPs). This issue was the providing the electric power and how to obtain the lowest value of consumed electricity to operate the monitoring system or network. In this sense, we will demonstrate some of latest modern techniques of power management for preserving and conserving electric power that we used for the environmental / radiological monitoring system.

Keywords

Embedded Systems, Nuclear Power Plants (NPPs), Microcontrollers (µCs.), Power over Ethernet (PoE), Solar Energy, Rechargeable Batteries, Power Sources Superseding, Network node. Wireless Monitoring Networks, Nodes Scheduling.

Introduction

When talking about environmental or radiological monitoring networks (Figure-1), we mean these networks that facilitate the study of fundamental processes and the development of hazard response systems. They have many technologies or concepts to deploy many (may be thousands) small sensor devices fixed on the network nodes to sense and measure the environmental phenomena or industrial factors. The primary function of the node will be to monitor the environmental physical quantities (or radiation parameters) and send them to the base station [1]. The brain of each node is the microcontroller (µC) which processes readings from its own sensors.

Over the last decade, many sensor networks, wired or wireless for monitoring systems have been extensively developed and studied for numerous diverse applications. Sensor networks are environmental centric with nodes embedded within the environment (may be harsh environment of NPPs) in a ad hoc fashion. Currently in the wired networks domain, the main problem is the complexity of data and power cabling. The longest cables present a higher level of complexity and consume more power as power loss. These problems have increasable effects on the overall efficiency or performance of monitoring networks especially when increasing the number of network nodes or sensors. On the other side in wireless domain there are many common problems. Wireless nodes are not tethered or connected to a fixed power source and use internal batteries for power. So, energy conservation / preservation is a major issue or problem for wireless sensors nets.

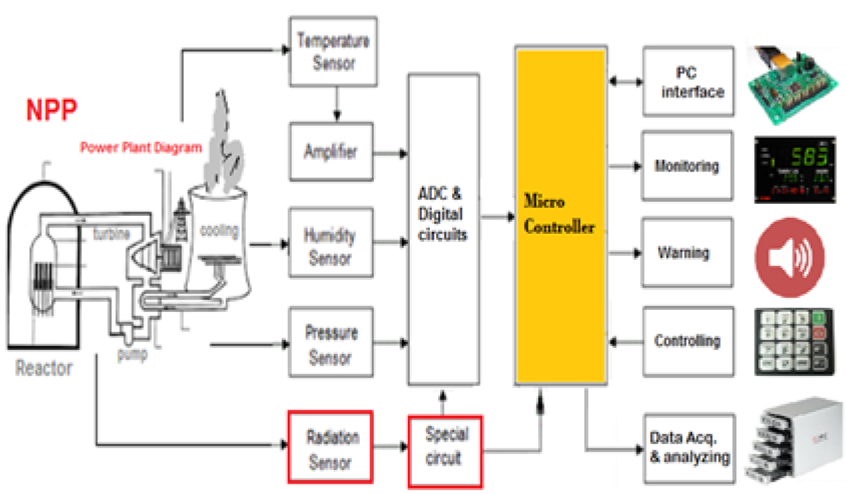


Figure-1: The sensor monitoring system block diagram

By considering all these above issues, in this research we have designed a sensor network node that overcomes some of the previous mentioned drawbacks that related to the electric power of the wired and wireless monitoring networks. Furthermore, we explained the method and the implementation of the practical steps to establish and configure those new and modern techniques of power conservation and preservation to deliver safe and continuous electric power for the desired monitoring system.

1. Power Management Techniques

This section deals with a set of objectives and new power management techniques that are kept track off or pursued to achieve power conservation of the desired environmental / radiological monitoring network. At the same time a series of practical experiments were presented through three main directions; The first was to obtain sources of electric energy from various alternative sources, and then to clarify a programmed electronic circuit for superseding of work between those sources. These alternative sources were the power over Ethernet technique, Solar energy, and the last was the rechargeable batteries. The second direction was looking for modern methods or techniques to decrease the electricity consumption via power saving modes (sleep modes) of the microcontroller. Whilst the third direction was about the techniques used to follow up / check the states of the proper operation to ensure the integrity of power sources. So that the practical work aimed to maintain the following objectives;

1.1. First Objective: Providing alternative and diversified sources of power to supply electrical power to the network points (nodes) and their parts without interruption;

This goal was achieved through the following set of concepts:
- Reliance on battery power as an alternative / reserve energy source.
- Integrating smart units of solar energy as another alternative source of electric power supply.
- The use of network data transmission lines (Ethernet data cables) as alternative routes for electricity feeding in the case of main power supply failures or power outage.
- Quick and automatic superseding between all electric power sources to ensure continuity of electric current without interruption.

1.2. Second Objective: Work on reducing the power consumption, Wattage, all over the network as a whole;

This concept was achieved through a number of technical procedures as follows:
- The design of the sensor node breadboard or the "bare-bone" board.
- Reducing the electric power consumed by the microcontroller by working in cases of Power Saving (Sleep or Power down) modes.
- Distribution of the monitoring functions / operation (timely) between the nodes to save energy consumed (Nodes Scheduling).

1.3. Third Objective: Follow up / check the states of the proper operation of electric energy sources and power values;

This objective is to monitor the power (voltage and current) levels / values required to ensure the integrity of power supply and continuity of work through the following techniques;
Hot spot test points, to measure the voltages and current values from different regions / points of the node electronic circuit.
Built-In Self-Test techniques, to automatically detect or predict any deviations in power values.

Now after we introduced a brief background about our ideas or concepts we go to illustrate the practical stage or part in this paper. It is a group of practical experiments to implement the previous (three) objectives through the network nodes design used to achieve the electric power conservation / preservation for the desired monitoring network.

2. Practical Work: Electric Power Preservation and Management

2.1. Alternative Electric Power Sources

2.1.1. LiPo Battery as Alternative Power Supply

An important thought in the design of the monitoring network was the delivering of electric energy to all parts of the network and related nodes from several alternative sources. It is common and rolling, to rely on electric energy from rechargeable batteries as an alternative source for any electrical system. Two of the most popular types of rechargeable batteries used for such cases worldwide are lithium-ion polymer batteries (abbreviated; LiPo, LIP, Li-poly, lithium-poly and others) and the nickel metal hydride battery (abbreviated as NiMH or Ni–MH). These two batteries types are shown in Figure-2 (a);

Figure-2 (a): Rechargeable Battery

A LiPo battery is a rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid one [2]. This electrolyte is formed from high conductivity semisolid (gel) polymers. These batteries provide a higher specific energy than other types and are being used in applications where weight or size is a critical feature – like Laptop, tablet, cellular phones, toys or radio-controlled air craft. In NiMH battery type, the chemical reaction at the positive electrode is similar to that of the nickel–cadmium cell (NiCd), with both using nickel oxide hydroxide, NiO (OH). Li-ion and NiMH batteries can actually hold a similar amount of power, but the lithium-ion cells can be charged and discharged more rapidly . Also the NiMH has the higher charge capacities than LiPo batteries.

Figure-2 (b): Battery Charger

The microcontroller we used to form the desired monitoring network node was the AVR 8-bit and it is working on a voltage range of 1.8: 5.5 v. So the selection was a LiPo 3.7 volt/300mAh rechargeable battery and it is suitable for power needs, as an alternative source. The other selection was a NiMH 5volt/1500 mAh.

In addition to that, a modern electronic circuit (module) was also used to charge either of those batteries and is characterized by its small size and variety of functions. This tiny / smart module (Figure-2.(b)) is perfect for charging single cell 3.7V 300 mAh or higher (1 Amp. maximum charging current at input voltage 4.5-5.5V.). Based around the charger IC, TP4056, and battery protection IC, DW01 [2], this module or unit offers a full charge current, 1 Amp., then cut off when finished. Furthermore when the battery voltage drops below 2.4V the protection IC will switch the load off to protect the cell from running at too low of a voltage - and also protection against over-voltage and reverse polarity connection.

As shown in figure-3, the NiMH / LiPo battery is connected to B+ and B- leads of the charger module where the charging power source is connected to the Mini –USB socket of the module. Figure-4 illustrates the desired network node, breadboard, while operating and powering via the 5.0 V. NiMH battery or 3.7 V. LiPo battery.

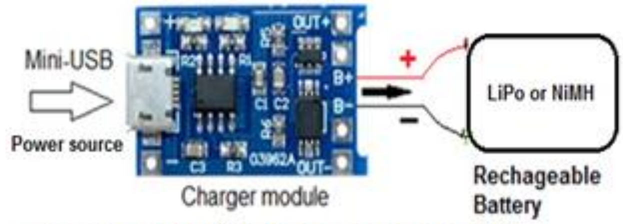


Figure-3: TP4056 Module for Charging

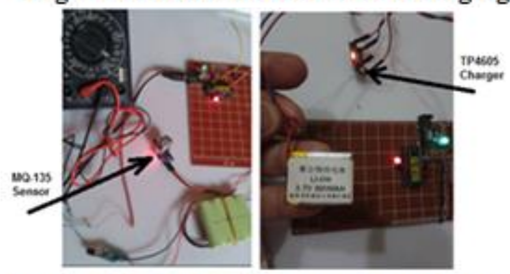


Figure-4: (a) NiMH Battery (b) LiPo Battery

2.1.2. Smart Solar Cell as Alternative Power Supply

Nowadays, with increasing concern of global warming and the depletion of fossil fuel reserves, many are looking at sustainable energy solutions to preserve the earth for the future generations. Other than hydro power, vibration and photovoltaic (solar energy) holds the most potential to meet our energy needs / demands. Solar energy is the viable source of renewable energy over the last two-three decades. It is now used in variety of fields such as industries and domestic purpose. Alone, solar energy is capable of

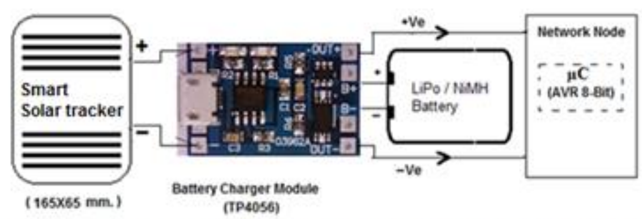


Figure-5: (a): Powering the Network Node via Solar Panel

supplying large amounts of power but its presence is highly unpredictable as it can be here one moment and gone in another.

The common inherent drawback of photovoltaic systems is their intermittent natures that make them unreliable [3], [4]. Solar energy is present throughout the day but its levels vary due to sun intensity and unpredictable shadows cast by dust, clouds, birds, trees, etc. So that solar energy system generally is designed to collect maximum power from sun and to convert it into electrical power.

When an energy source is unavailable or insufficient in meeting the load demands, another energy source can compensate for the difference by combining these intermittent sources. In our case we exploit the solar energy to power the network nodes as another or second alternative power source. Moreover by connecting the solar source (panel) to the battery charger, we obtained a reliable (combining two intermittent sources) electric power source for the network and its nodes. As shown in figure-5 (a), by connecting the solar panel to the TP4056 module, the battery could be charged.

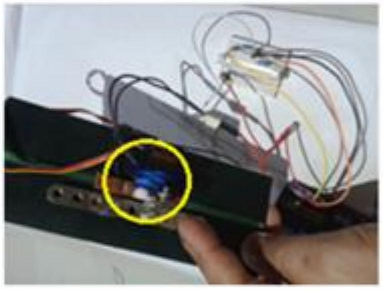


Figure-5: Solar Energy Tracker

(c): The Servo motor mounting

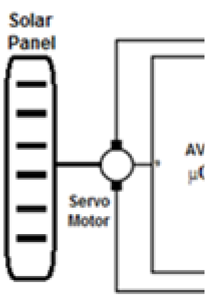


Figure-5: Solar

(b): Circuit

Figure-6: Testing the Smart Solar Energy Tracker

In this experiment we designed a smart system for solar energy tracker, as shown in Figure-5 (b),(c). This solar panel can move toward the sun light (or the source of light) to harvest maximum solar power via a smart solar tracker system by using the AVR µC, two LDR cells (Light Dependent Resistor), and a servomotor. In this smart system by measuring the solar energy which comes through the two LDRs, the microcontroller can determine the direction of the sun light and then produce the appropriate signals to the servo motor.

Figure-6 illustrates the implementation of the smart solar tracker system to measure the electric value (voltage) getting from it by using a digital AVOmeter.

2.1.3. Power over Ethernet (PoE) as Alternative Power Mean

Today, Ethernet is the backbone for network connectivity for either of home or office environments. The growing popularity of Ethernet as the best connectivity medium for networks has to do with the fact that Ethernet networking equipments are easy to install, administrate and maintain at a very competitive effort and cost. Ethernet is also becoming increasingly popular for factory automation, industrial and other wide networking applications. On other side the new evolving technology, **Power over Ethernet or PoE** [5] provides a system to safely transfer electrical power (AC and DC) along with the data bus to remote devices over standard data cables in an Ethernet network. By this way it is possible to power many devices such as phones, routers, switches, access points, cameras, etc. The use of PoE also decreases the AC/DC connections as a path for surges into the equipment. In a wired network (wireline network) with a lot of remote nodes, PoE based switches or routers eliminate the need for large numbers of AC power supplies or the installation of new AC outlets at the remote nodes.

This new technique (Figure-7) provides and simplifies advanced technology deployment such as IP telephony, wireless nodes, IP switches, and IP surveillance cameras by installing the connection and powering (power plus data) the network endpoints over a single Ethernet cable. With no need to install separate power supplies or additional electric power adaptors for devices, PoE extends more benefits and advantages of the advanced communication technology quickly and at lower cost [5], [6].

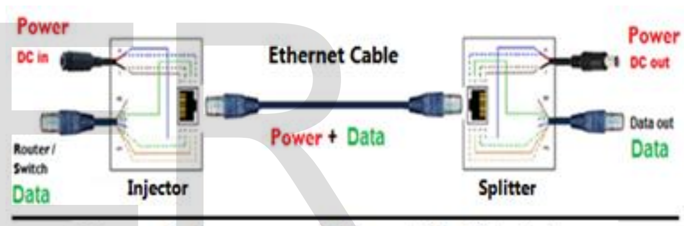


Figure-7: Power over Ethernet (PoE) technique

2.1.3.1. How is PoE Working?

The technology Power over Ethernet or PoE describes a modern system to safely transfer and deliver electrical power, along with data, to remote devices (Powered Devices PD's) over the common standard Ethernet data cables in a network. As a constraint, power is remotely supplied for distances less than 100 meters. IEEE 802.3af, IEEE 802.3at and IEEE 802.3bt standards specify PoE technology in two different methodologies or configurations, End-Span or Mid-Span. So that Power-Supplying Equipment (PSE) can provide power and Powered Devices (PD's) can accept power via either of the two PoE methodologies, they are:

- ***Mid-Span technology*** **-** As shown in figure-8 (a); power is added to the non-data wire pairs of the Ethernet cable 4, 5, 7, and 8 from a patch-panel style hub.
- ***End-Span technology*** **-** As shown in figure-8 (b); Power originates from a powered port on an Ethernet switch itself and is super-imposed on data transmission wire pairs of the Ethernet cable 1, 2, 3, and 6.

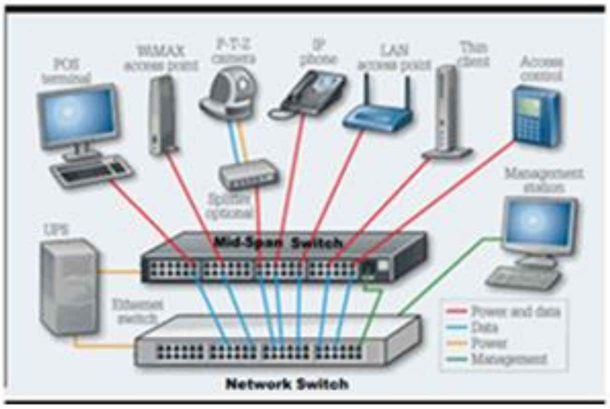


Figure-8 (a): Mid-Span PoE Technology

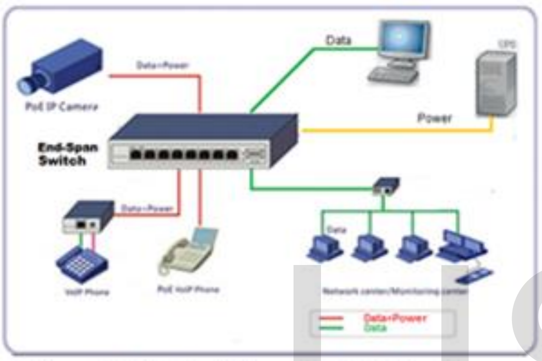


Figure-8 (b): End-Span PoE Technology

To take advantage of PoE with these devices, engineer or a network administrator may use a PoE Injector and splitter, which impose and separate the power lines on / from the data lines in the cable. As shown in figure-9, just by using the PoE Injector, PoE Splitter and the Ethernet cable the electric power could be provided for any device anywhere without adjacent / fixed power supply.

2.1.3.2. Powering a sensor node by PoE as Alternative Power Mean

Nowadays PoE has a lot of great advantages and due to these advantages we had used the Ethernet data cables as alternative routes for electrical feeding in the case of main power supply or power cables failures. For that, using PoE was a great solution to ensure the continuity provision of electrical energy and continuing work of the desired monitoring network. The following experiment is showing how to use the magnificent PoE technique to supply electric power as an additional power source or alternative electric current mean to feed a sensor network node.

As shown in figure-9, the node was powered by a 6 DC-volt battery via an Ethernet cable (UTP- CAT-6 Ethernet cable at 30 Meter length) and operated well.

2.1.4. Automatic Superseding between Electric Power Supplies

Due to the presence of several electrical sources we supplied to the network (DC voltage adaptor, battery and solar cell), it was necessary to establish a special control system to interchange (supersede) these sources quickly and automatically in case of deterioration of the state of power derived from one of these sources. It is also very important that there should be no breakage or interruption of the electrical current that feeds the network and its related nodes to keep the normal operation and reliability of the monitoring system.

In the design of the monitoring network nodes additional capability, for the AVR microcontroller to test or check the voltage values coming from these power sources and alternatives, is added. After that the microcontroller decides the integrity of these sources and selects the best of them to provide the power to the nodes and disconnect the failed or ineffective one.

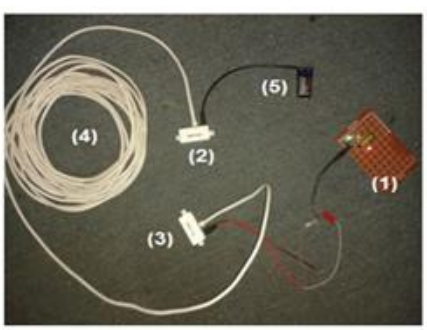
As shown in figure-10, there are two 5V. DC batteries, battery-1 (B1) is the main supply connected the AVR µC while the second battery-2 (B2) is reserved or backup supply. Via a special software code, the microcontroller detects / senses the voltage level of B1. When the B1 voltage value was dropped under critical programmed value (3.2V.), a control signal is produced via Pin7 and sent to the transistor base which in sequence amplifies that signal and turns on the relay. After the Relay is activated, it connects the battery B2 to the positive line to power the µC and the node still working without any interruption in electric power. Moreover, L1 and L2 are green LEDs (Light Emit Diodes) to denote the states of Batteries B1 and B2 whilst L3 is a warning led. L3 flashes (and audio alarm) in case of B1 low voltage and sends a warning light to the operator informing that the B1 was superseded with B2 due to fail / malfunction in Battery-1.

After uploading the software code, the concept of fast and automatic interchange or superseding between power supplies (batteries) is manipulated and executed by the support of the microcontroller and a few electronic parts. By this technique we can depend on the network node and obtain a high level of power continuity and a reliable performance of the desired environmental / radiological monitoring network / system.

2.2. Reducing Electric Power Consumption

2.2.1. The Design of the Sensor Node Breadboard ("Bare-Bone" Board)

The first milestone to reduce the electric power or energy in any system or device is the design of this system itself especially which depends on battery operated power. This aimed design may have a number of directions to achieve the targeted energy or power minimizing such as;



(1) Sensor Node Breadboard,
(2) PoE Injector,
(3) PoE Splitter,
(4) UTP-Cat6 Ethernet cable,
(5) 6V. DC battery

Figure-9: Powering a Sensor Node via PoE

First; Using the suitable components which consume low power to get longer battery life. Second; Low power consumption decreases the cost since smaller battery supplies cost less [7]. Third; By low complexity in the system / circuits design, designers obtain less routing and

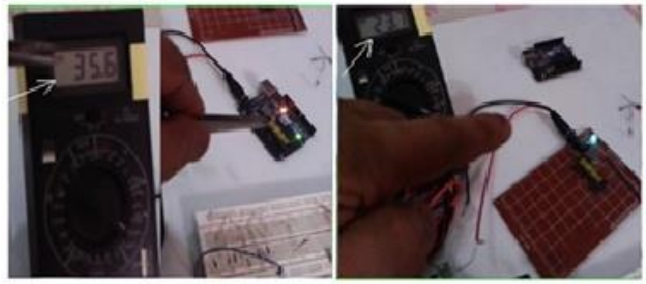


Figure-11: Current Withdrawn in Original Board and Breadboard

lower heat generated and consequently no need for extra protection circuits. For that reasons a simple and functions related devices are more power conservation and cost less.

As an example, in nuclear power plants the number of used sensors is enormous and may be extent up to 10000 sensors in one field, so when think about the consumption of electric energy, it is a very important topic. If we consider one sensor (as an example the MQ-135 electronic

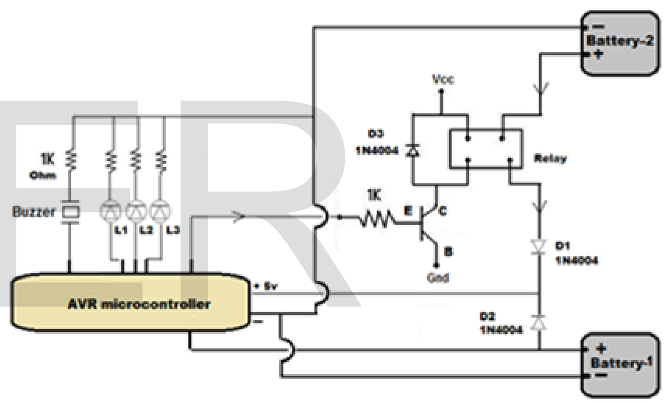


Figure-10: Power Supplies Superseding System – Circuit Diagram

semiconductor sensor) consumes operating voltage 5V and operating current 150 mA, hence the consumed power is 750 mWatt. Then the total power consumed for 10000 sensors is:

Total current=150X10000=1500000 mA=1500Amp. (1)

Total wattage=750X10000=7500000 mW=7500Watt (2)

This value should not be neglected and should be considered when saving energy for the proposed network components. One of the major ways to reduce electric consumption is the design of the bare-bone board or breadboard. That designed (handmade) node breadboard is surpassed (than the original readymade AVR board) by:

1- Containing the most functions related and important components only (less components).
2- No USB connection, where the operation does not need this circuit or port.
3- Omitting the 3.3 voltage regulator and protection circuits. We have an external DC. 5 Volt.

4- Using just two LEDs for normal operation and power states, and saving more unneeded LEDs for unwanted functions (while programming).
5- Using of SD memory card to save the sensors readings to minimize the power consumption.
6- At last, each of these previous characteristics leads to less power consumption and conserving electric energy and consequently the impressive features of the handmade breadboard.

As shown in figure-11, a comparison in the withdrawn electric current value (in amperes) in either of two boards; the original board (35.6 Amp.) and our designed breadboard (23.7 Amp.).

2.2.2. Reducing the Electric Power Consumed by Microcontroller

To obtain electric power saving or conservation there are two techniques or policies. They are Dynamic Power Management (DPM) and Dynamic Voltage Scaling (DVS). DPM conserves power by shutting down parts of the network sensor node which are not currently used or active

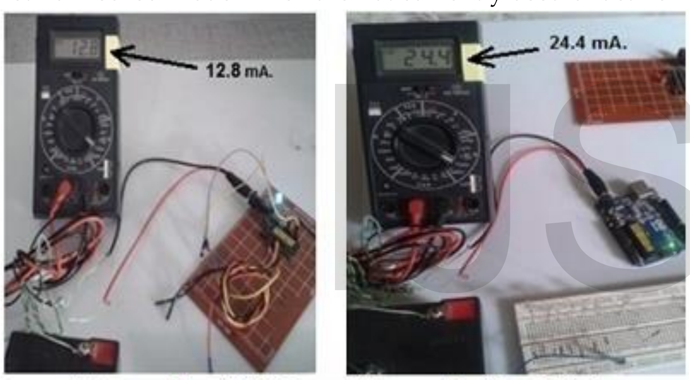


Figure- 13 : Withdrawn Current in Sleep Mode

(such as standby and sleep sensor operational modes) [8]. A DVS scheme varies the power levels within the sensor node depending on the non-deterministic workload. By varying the wattage along with the frequency (frequency of data transmission via the network), it is possible to obtain quadratic reduction in power consumption.

Also, the AVR microcontroller had a lot of capabilities and facilities to save the consumed electric power by working in special power saving modes. The standard rates of consumed power for these modes are;

Active (Normal) operation, AVR consumes 20:25 mA. or 100% electric power.

Idle Mode, AVR consumes 15 mA. or 75% electric power.

Standby Mode, AVR consumes 1.62 mA. or 8.1% electric power.

Sleep Mode, AVR consumes 0.36 mA. or 1.8% electric power.

For AVR 8-bit μC, there are five different sleep modes in order of power saving:

//SLEEP_MODE_IDLE – this is the lowest power saving mode (75%)
//SLEEP_MODE_ADC
//SLEEP_MODE_PWR_SAVE
//SLEEP_MODE_STANDBY (8.1%)
//SLEEP_MODE_PWR_DOWN – this is the highest power saving mode (1.8%)

To save electric energy as much as possible, we used (software code) the SLEEP_MODE_PWR_DOWN, to get

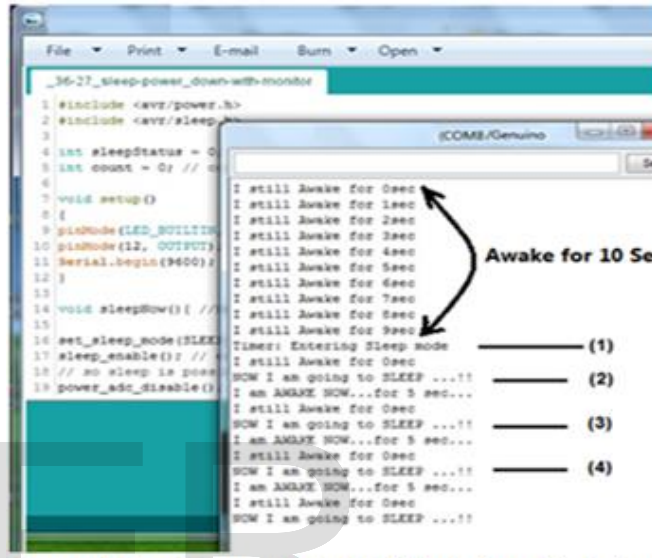


Figure 14 : Network Node Scheduling Technique

greatest reduction in power consumed. In the next experiment, two boards, breadboard and original, are evaluated in different modes as follows;

First; running a program to turn on 7 LEDs, the required task from the microcontroller was to turn on 7 LEDs simultaneously and measuring the withdrawn current (Figure-12).

Second; running a SLEEP_MODE _PWR_DOWN, there was not any task to do because the microcontroller was forced to go in sleep mode to save maximum amount of power by minimizing the withdrawn current (Figure-13).

Obviously, from figures 11, 12 and13, there were some important results which are useful in our proposed network node design; these are:
1- The desired node breadboard draws less current than the original one.
2- The selected sleep mode saves a notable amount of consumed current. So, this mode had a dramatic effect of maximum energy saving, along the day.
3- Number of sensors (loads) connected or controlled by the node will affect the total current withdrawn by node, the total power consumption and life time of the Battery. So it is a very important step in the design to calculate the total current drawn by sensors or detectors that would be

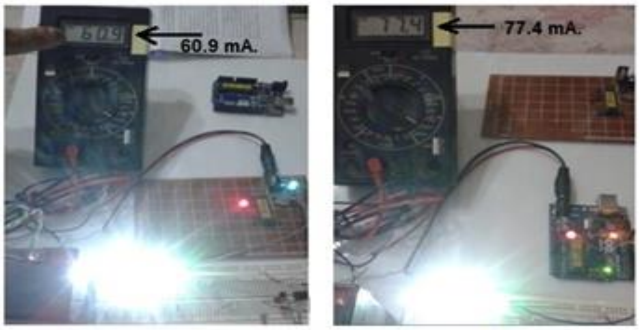


Figure-12: Withdrawn current for 7 LEDs

connected to the node to provide a reliable power supply or battery to be assure of the excellent performance with uninterruptable power.

2.2.3 Nodes Scheduling

The scheduling techniques generally select a group of nodes in each epoch, and the selected nodes work in active mode to provide the required services, while other nodes are kept in sleep mode in order to reduce energy consumption since the sleep mode consumes only a small fraction of energy compared to the active mode [9], [10]. The node scheduling is a good technique to get power reduction, energy-efficient node and maximizing the total profit during the network lifetime. However, the node scheduling problem in the service-oriented sensors networks is not only to select a set of nodes to provide the required services during each epoch but also to choose the service each active node should provide [11].

Moreover such node scheduling based approaches may leave some of the monitored area unattended when a node fails and other nodes are not woken up to replace it right away. In the desired monitoring network, by coding the scheduling process (sleep & Wake up modes) of the nodes we get a schedule approach. As shown in figure-14; the microcontroller entered the sleep mode to save the consumed current and it was asleep after 10 sec. in active mode as shown in figure-14 - (1). When a critical sensor reading or threshold value is detected, the microcontroller wake up and continues to perform its required programmed functions (figure-14-(2)). This “awake” mode was for 5 sec. and once again it go in sleep mode (figure-14-(3)). This procedures or modes are repeated more and more according to the software program code. Notably this frequent sleep and awake mode could be periodic as a schedule for node operation which had positive influent on the power consumption of the network.

2.3. Following up the States of the Proper Operation to Ensure the Integrity of Power Supply

2.3.1. Hot Spot Test Points

The designed monitoring network node includes a lot of functions and varieties of electronic components or elements beside the AVR microcontroller. The functions and tasks of the nodes are different and variance due to the measured / monitored environmental or radiological media.

Engineers and designers look forward to easy and quick method to test and check the electronic systems / circuits. In spite of these varieties of node functions and engineers’ designs, there is a new technique to provide them with an ease / quick way for on-board testing and measurements.

This technique is to fix (solder) a pin header (2, 3, 4,...unlimited) of hardwired pins on the hotspot points of the circuit board as shown in figure-15. These hotspot points / pins have voltage or current values which are well known for the designer and can be measured and tested any time. While the design of the network node we fixed some pins at identified or specified locations on the breadboard as flags or milestones. By this way technicians do not need to desolder the electronic elements or the printed circuit board from the system, node or device to test. These test pins save time and effort for repairing and maintenance processes and consequently the maintenance cost.

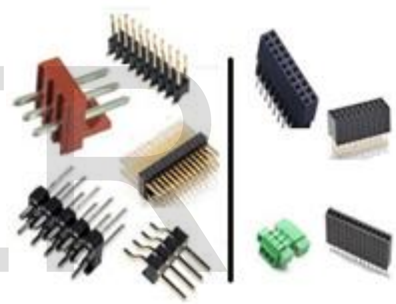


Figure-15: (a) Pin Headers

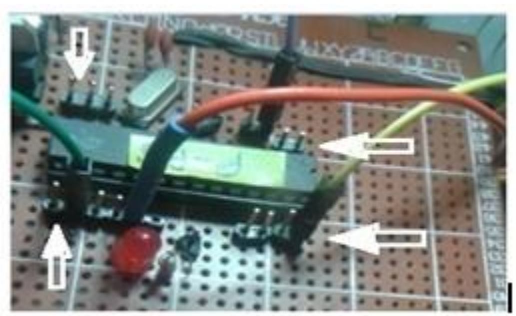


Figure-15: (b) Pin Headers of the Breadboard

2.3.2. System Self Checking

Self check techniques are used to automatically detect / predict any deviations in power (voltage / current) values or levels. It is a mechanism that permits a machine to test or check itself without intervention or supervision from operators, administrators. New testing ((intelligent) techniques are needed for the next generation of electronic circuits / equipment and a great deal of emphasis is being placed on the development of these techniques. Some of them now becoming popular include Built-In Self-Test (BIST firmware program), design for testability (DFT), and automatic test vector generation (ATVG) [12]. Nowadays engineers design BIST to meet necessary requirements in systems design such as:

- High system reliability & stability levels.
- Lower repair cycle times for maintenance.
- Limited technician accessibility.
- Cost of testing and diagnosis processes.
- Prediction and early warning of faults and malfunction.

It is common that a BIST is built on a test function (functions) inside the device or system itself. So that BIST is used extensively for at-speed testing of circuits. On the other side as disadvantage, BIST needs more silicon area (IC) to design testing hardware. As a result it is clear that the design and implementation of that BIST need additional hardware parts / components to the network node and thus increasing the complexity and cost of the proposed system or network. This is why we postpone the BIST to another stage in the future when manufacturing the desired monitoring network. But we just wanted to hint at the idea of the possibility to create a part of the microcontroller program to do the self-test function of the system as a whole.

Conclusion

In this paper, we discussed and presented a very important issue for engineers and designers of monitoring networks and systems (or any electronic system). This issue was the providing the electric power of the proposed system and how to obtain the lowest value of consumed electricity to operate this proposed monitoring system or network at stable and reliable condition.
In this sense, a series of practical experiments were presented through three directions;
The first was to obtain sources of energy from various alternative sources, and then to clarify a programmed electronic circuit for superseding of work between those sources. These alternative sources were the rechargeable batteries, the solar energy and the last was power over Ethernet technique. The most modern techniques was PoE which thrifts a lot of cables, complexity and cost to designers, engineers and network supervisors. The second direction was looking for modern methods and techniques to decrease the electricity consumption by first; the simple design of prototype breadboard of the monitoring node. The second was using power saving (sleep modes) of the AVR microcontroller. At last the third method was via the node scheduling. Whilst the third direction was about the techniques used to follow up the states of the proper operation to ensure the integrity of power sources. Finally, we had implemented the practical steps to establish and configure those new and modern techniques of power conservation and preservation to deliver safe and continuous electric power for the desired monitoring system.

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