Abstract:

Energy is one of the fundamental sources of our life. Saving this energy for the future use has become one of the hot topics to be discussed. Most of the electrical energy is used for the lighting purpose. About 412 billion KWH of electricity is used by residential for lighting. Thus sensor lighting system is a technology developed for the efficient use of energy where it senses the changes in environment through sensors and tries to correct the changes. Sensor lighting acts with the principle that lights are turned on only when natural life is off and if person is present only. Available sensor lighting systems are much costlier. Thus in this technology we use MSP430 and PLC (Power line communication) for the system to be cost effective and for embedded applications with low consumption rate.

Keywords: Power line communication (PLC), MSP430, Infrared sensors.
[1] INTRODUCTION

Saving energy has become one of the hot topics to be discussed now-a-days. As lighting consumes most of the power, energy saving can be easily achieved through smart and effective lighting system. Survey conducted regarding this states that about 20% to 50% of energy is used for lighting in homes and offices. It is surprising that due to insufficient and irresponsible lighting system adopted about 90% of energy is unnecessarily wasted. Most of the engineers are very much involved in finding a alternative to reduce his lighting problem.

Sensor lighting system is one of the alternatives found for the energy saving problem. Sensor lighting system is a intelligent, control system basically designed for effective energy utilization. Sensors sense the environmental changes and try to correct the offset. Generally lights are turned ON if the natural day light is off and there is a person in the room, where the lights are turned off otherwise.

Sensor lighting system or a well-known smart lighting system currently available in commercial market and residential is costly. Thus in this system we make use of MSP430 and PLC to make it cost effective and for usage in lower embedded applications.

Inconvenience of antenna or new wires can be eliminated by power line communication (PLC) which uses power line infrastructure at office, home or other buildings, the outdoor and indoor, for communication and networking. Power line is a extremely noisy and difficult communication medium, characterized by several strong and unpredictable forms of interference. This project overcomes the reliability and interference problems on power line and offers a robust, low cost and superior performance. Low cost and reliable PLC technique gives ubiquitous applications for business and residential. With the application of PLC every electrical outlet can be made as a communication mode.

MSP430 is a microcontroller family of 16bit RISC, produced by texas instruments. It is basically designed for low power embedded application.

- System details
- Hardware details

[2] Sensor lighting systems details:

Block diagram of sensor lighting system is as shown in figure 1.the system sends command to MSP430 microcontroller which controls the lighting model. Using PLC modem the communication between transmitter and receiver takes place with the help of power lines.
i) PLC modem:

Modulation and demodulation of data and processing of data before sending or receiving it from power line communication is done by PLC modem. Modern modulation methods are used to solve problems of interference and noise present in power line communication.

ii) Sensors:

We use 2 kinds of sensors in these lighting systems. They are: PIR sensor and LDR sensor

a. Passive infrared sensor (PIR):

By detecting the motion, the presence of human can we determine by the PIR. When the motion is sensed PIR sensors signal are high and when the motion is not sensed PIR sensor signals are low.

b. Light dependent resistor sensor (LDR):

Light or dark situation is determined by LDR. LDR falls when lights are ON and high resistance in the dark.

iii) RF transceiver:

The RF transmitter and RF receiver is connected to the input of MSP430 and the LDR and PIR sensor are connected to RF transmitter and RF receiver. The data of LDR and PIR sensor is sent to the input of MSP430 through RF transceiver.

IV) Load or Bulb:

When LDR and PIR are high bulb is on and when it is low bulb is off.

V) System:

When MSP430 send the sensor to the systems through power line communication, system is used for load management.

[3] Hardware details:
The RF transmitter is connected with PIR and LDR sensors. The bulb glows only when PIR and LDR sensor signals are to be high. For PIR and LDR sensor signals to be high a person should be present in the room and the natural light should be off. The main circuit diagram is as shown in figure 2.

![Main circuit diagram](image)

**Fig 2. Main circuit diagram**

MSP430 receives sensor data through RF transceiver. Analyzing and processing of data takes place through microcontroller. Depending upon the sensor signal. The light is controlled by MSP430. PLC modem is used to send data through power line communication to the system. Load management is carried out by the system.

**[4] Details about MSP430:**

MSP430 is a mixed signal, Texas instrument microcontroller with 16 bit CPU. MSP430 is used for low power consumption embedded devices where it uses just 1µampere current in the idle mode. MSP430 is capable of wake up times i.e. below 1µsecond, allowing the microcontroller to stay in sleep mode minimizing the current drawn. This device comes in variety of configurations featuring the peripherals like; PWM, watch dog, oscillator, timer brown out search circuitry etc.

MSP430 uses Von-Neuman architecture, where instruction and data are with a single address space. Memory bites are combined little to make 16 bit words. Thus a MSP430 is comparators a 16 bit CPU, RISC, flexible clock system. Pertaining modular memory mapped analog and digital peripherals with modern CPU’s and digital peripherals, MSP430 offers solutions for mixed signal applications. Architecture of MSP430 is as shown in figure 3.

![MSP430 Architecture](image)

**Fig 3. MSP430 Architecture**

**Key features of MSP430:**
• 16bit RISC, CPU enables new applications for a fraction of code size.
• Only 7 addressing modes and 27 Core instructions.
• Core design is of compact size, which reduces the cost and power consumption.
• Von-Neuman architecture with ultra low power extends battery life.
• 250µA/MPS (Million instructions per second) active.
• 0.8µA real time clock mode.
• Supervision for the supply voltage
• 12-bit DAC (Digital analog converter)
• Temperature sensor
• Extensive vector – Interrupt capability.

Limitations:
• It cannot be preferred for a more complex embedded system.
• It does not have an external memory, this limited to on chip memory.

[5] Power line communication:

Power line communication is an emerging communication technology that allows the consumers to send data over existing power cables. For examples one can power it up and at the same time control / retrieve data in off duplex manner. PLC modems are used to have communication in power supply networks with electrical distribution grids as the transmission medium for the transfer of various telecommunication networks.

Telecommunications with the application of electric supply networks has been known in beginning of 20th century.

The first carrier frequency system (CFS) was operated at high voltage networks over 500km using 10W signal transmission power. Such systems are used for medium and low voltage electrical networks realization.

European standard CENENEC EN50065 specifies the standards for communication over the electrical power supply network. Now a days in the modern telecommunication networks PLC as to provide the
much higher data transmission rates (i.e., beyond 2MBPS). Thus PLC is preferred over the other communication technologies.

[6] Benchmark of PLC:

Following table compares the PLC with different technologies depending upon the factors like baud rate, target price and performance.

<table>
<thead>
<tr>
<th>RFISM: Radio frequency in industrial scientific and medical radio band.</th>
<th>BPL: Broad band Power Line</th>
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[7] Serial Communication:

Serial communication receives the information from PLC modem at the rate of 9600 bits/sec. Usually receiving data from embedded microprocessor or to control the system serial communication is used.

In case of serial communication bits of bytes are transferred one after the other in an time sequence on a single wave base. Serial communication has become standard for inter computer communication following figure shows the serial communication connected to PLC modem.

[8] Program Flow:

Different development software is available for the MSP-EXP430G2 launch pad development board. IAR embedded work bench kick start IDE and code composer studio (CCS) IDE are both available in a free limited version CCS is limited to a code size of 16KB. There are many other compilers and integrated development environments (IDEs) available to use with the MSP-EXP430 launch pad including MSPGCC
[9] Experimental results:

The basic operation table of the system is as follows:

\[ \begin{array}{|c|c|c|c|}
\hline
\text{SENT} & \text{INPUTS} & \text{OUTPUTS} & \text{PLC} \\
\hline
1 & \text{HIGH} & \text{HIGH} & \text{ON} & \text{YES} \\
2 & \text{HIGH} & \text{LOW} & \text{OFF} & \text{NO} \\
3 & \text{LOW} & \text{HIGH} & \text{OFF} & \text{NO} \\
4 & \text{LOW} & \text{LOW} & \text{OFF} & \text{NO} \\
\hline
\end{array} \]

The following table shows that:

- If the person is not present PIR sensor is off and natural light is ON LDR sensor is low then bulb is OFF.
- If person is present PIR sensor is ON and natural light is ON LDR sensor is low the bulb is OFF.
- If person is not present PIR sensor is OFF and natural light is OFF LDR sensor is high then the output bulb is OFF.
- If person is present PIR sensor is ON and natural light is OFF LDR sensor is high then the output bulb is ON

10. Conclusion:

Use of ultra low power MSP430 in this system has its own advantages like energy usage, cost and the wastage of energy through over illumination. This system can be easily implemented and scheduled. It helps in day light harvesting, occupancy control through power line communication this system as a automated control of lights i.e., to dim or turn off lights according to environmental changes to take
advantage of demand response incentives and cost savings. Use of PLC modem in the system as a
tother big advantage of better power efficiency and range.

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