International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 11, November-2014

Efficient Method for Controlling Electric Power by Automated Monitoring System using FPGA

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***Abstract* – Power is considered to be as major concern in today's technology. Several research works are carried in order to minimize the usage of electric power. In this paper, an efficient automated power saving system was designed using Spartan-6 FPGA for minimizing the power wastage in educational institutions. Mostly, the students forget to switch off the electrical appliances, when they leaving out of classroom. The power wastage can be completely eliminated by using this Automated Power Saving System. The system is developed by VHDL and it is implemented using Wipro Mission10x UTLP Board.**

***Keywords*—DC Motor, Electricity wastage, FPGA, Light Dependent Resistor (LDR), Passive electric Infrared (PIR) sensor, Temperature sensor.**

I. INTRODUCTION

In the present scenario, the power generation is not enough to produce the sufficient electricity to satisfy the needs of people due to increasing demand. So it is necessary to utilize the power usage in proper manner. In the present system, PIC microcontroller, Passive Infrared (PIR) Sensor, Light Dependent Resistor (LDR), Temperature Sensor are used to find the motion of human being, light intensity, room temperature level and finally, it switched ON or OFF the electrical appliances automatically. In the proposed system, the design is based on Spartan-6 FPGA and considers the class timetable. The main objective of using FPGA is, here the process is parallel but in case of PIC microcontroller it is sequential. So the performance of execution is much faster in this FPGA and also it is more suitable of real time applications. Most of the cases such as library hour, laboratory hour and break hour students might not be available in class room, so there is no need of power. Frequently students forgot to switch OFF the fans and lights while they leaving out of their classroom during those break hours, so there will be wastage of power. The system automatically switch ON and OFF the fans and lights for the situations such as working days and the presence of students in classroom, not enough sufficient light and room temperature at predefined level.

II. METHODOLOGY

Initially timetable is set as primary in this system. Time table of class for all days are written in VHDL and fed into the Spartan-6 FPGA. There is possible to select the timetable as per our requirement using keyboard and it will display in Character 16x2 LCD. A real time clock will be displayed in 7segment for checking whether the time table operates for proper time. Then the PIR sensor continuously senses the temperature level at particular area and produces the output and fed into FPGA. When students entering into the monitored area, the temperature level measured by PIR will vary and PIR sensor output made high. In accordance with class timetable and PIR output (high) then LDR sensor checks the room lightening, if the light is insufficient, the LDR acts as a resistor with high resistance (in Mega Ohms), so the output low. The FPGA detects low output and switch ON the light. LM35 sensor senses the room temperature and produces the output. It will produce 10mV/°C. The temperature sensor output fed into FPGA using ADC and the speed of the Fan varies according to the temperature level.

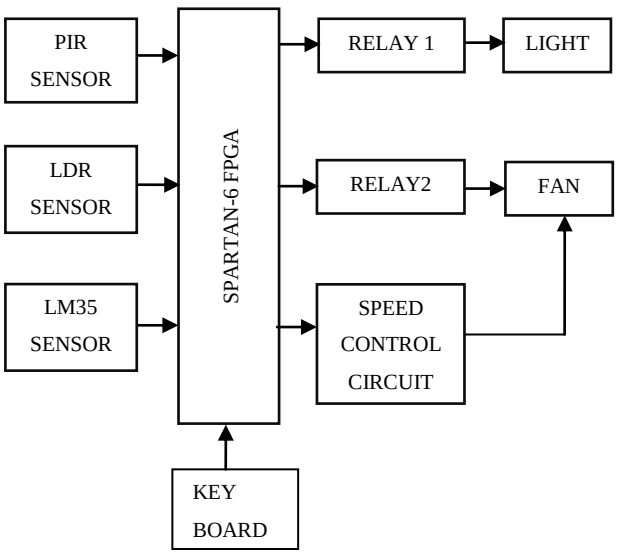

Figure.1.Functional Block Diagram

When the students leaving from the classroom the PIR output made as low. If the output is low for particular delay, then the system will switching OFF the fans and lights. As per the timetable and sensors output the operation will be performed continuously. So that wastage of power can be reduced.

III. HARDWARE DESCRIPTION

A. Spartan-6 FPGA

Unified Learning Kit is based on Texas Instruments OMAP3530 application processor & Spartan-6 FPGA. The Spartan-6 family provides leading system integration capabilities with the lowest total cost for high-volume applications. The thirteen-member family delivers expanded densities ranging from 3,840 to 147,443 logic cells, with half the power consumption of previous Spartan families, and faster, more comprehensive connectivity. Spartan-6 FPGAs are the programmable silicon foundation for Targeted Design Platforms that deliver integrated software and hardware components that enable designers to focus on innovation as soon as their development cycle begins.

SUPPORTING APPLIANCES : The Spartan-6 FPGA supports interfaces such as Ethernet, FPGA HDR2 20-pin Header, Keypad connector(4X4), FPGA Expansion connector, Mictor connector, ADC, DAC, LED, UART Transceiver, 7 segment LED, 16x2 Char LCD, Oscillators (10 & 100Mhz), DDR2 SDRAM, PROM, Dip Switches.

Figure.2.Unified Learning Kit

B. Essentials of PIR

Normally IR sensors can be classified into two categories. They are passive IR and active IR. The active IR sensors emit some energy and determine if any changes occurred. If changes occurred, it's output high. The passive IR sensor, just senses the heat level at particular area and produce output. It does not emit any energy. If any human cross that area, some sudden variation will occur in output. The PIR needs 5v dc supply. The output level is high (approximately 5v) when the PIR continuously senses the human. Otherwise output is low (approximately 0v).

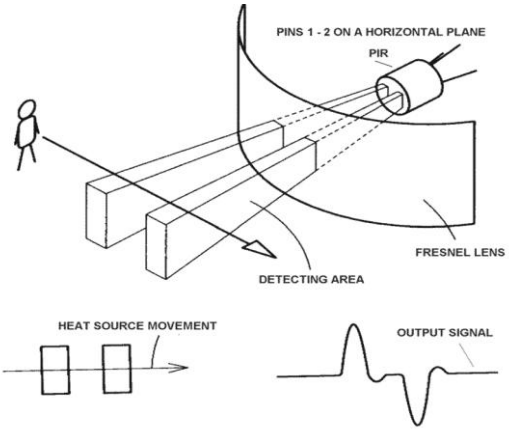

Figure.3.Operation of PIR Sensor

The sensor can detect a human being by temperature of a human body. Human normally have skin temperature of about 93 degrees F, radiate infrared energy with a wavelength between 9 to 10 micrometers. The Passive Infrared (PIR) sensor will detect a human within a detection range of 10m from the sensor. This is an average value, as the actual detection range is between 5m to 12m.The sensor has a horizontal 110° vertical 60° field of view. When an intruder walks into the detector's field of vision it will detect the person but it will not react to a person standing in idle condition in the monitored area. Because a moving person exhibits a sudden change, but in the case of motionless body emitted only slower changes.

C. Applicable LDR

A LDR is a component that uses a photoconductor between two contacts. A Light Dependent Resistor (LDR) is a round semiconductor device, has a resistance which varies according to the amount of light falling on its surface. Normally the resistance of an LDR is very high, sometimes as very high as 1000000 ohms and is called the dark resistance but when they are illuminated with light, resistance drop dramatically to 50 ohms. Light dependent resistors are used to re-charge a light during different changes in the light, or they are made to switching ON and OFF a light during certain changes in intensity of lights. The light dependent resistors (LDR) are used to sense the changes in the light intensity of the classroom.

D. LM35 Temperature Sensor

The LM35 is a Temperature sensor that can be used to measure temperature of the classroom which gives an electrical output proportional to the temperature (^{o}C). The scale factor is .01V/^{o}C. The LM35 does not require any external calibration or trimming to provide typical accuracies

of ± 1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. It consumes 60 micro amps and possesses a low self-heating capability.

IV. DESIGN FLOW

First the Time table of a class is fed to the FPGA. When a person is entering into the classroom the PIR sensor detect the output as high else the output as low. The working model is shown in fig.4

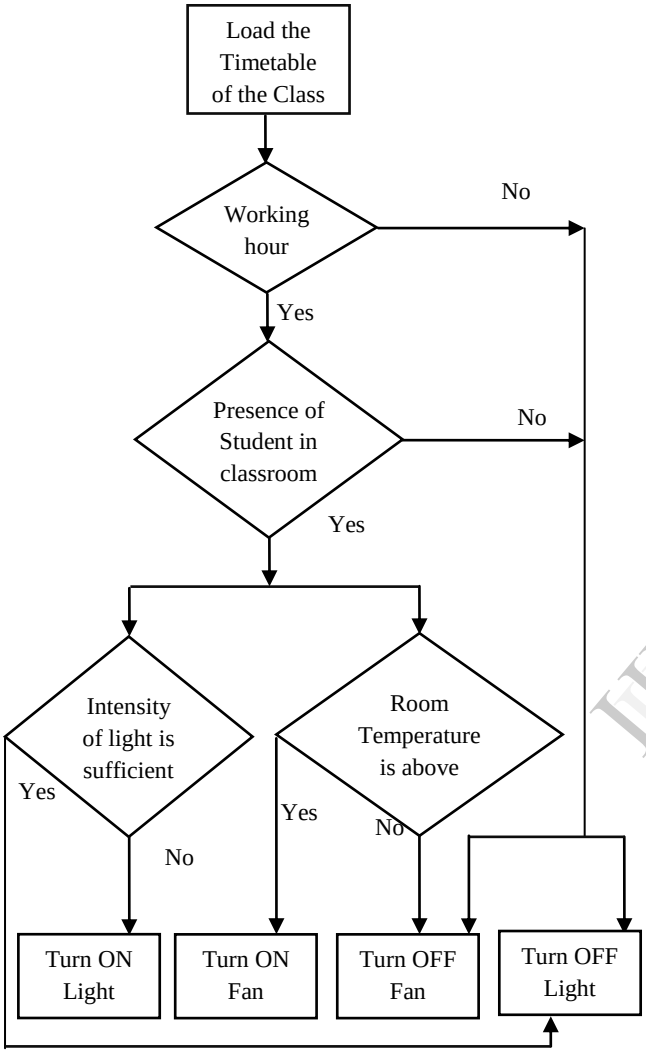

Figure.4.Flowchart for Proposed Model

When the PIR output as high then the flows goes to check the intensity of the light and room temperature, if intensity of the light is sufficient then the flows goes to switch OFF the light otherwise flows goes to switch ON the light and if room temperature is above certain range then the flows goes to switch ON the fan else it goes to switch OFF the fan. When PIR sensor output as low then the flows goes to switch OFF fan and light.

V. SIMULATION RESULTS

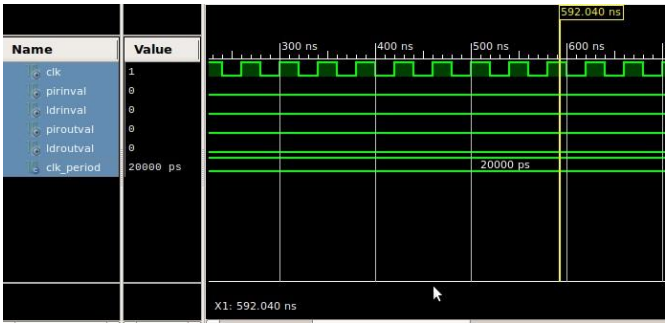

Figure.5.Simulation result for pir & ldr OFF mode

The PIR is responsible to turn ON/OFF the fan, based on presence of humans and LDR is responsible to turn ON/OFF the light's based on intensity of light. Figure.5 shows simulation result when PIR and LDR's inputs are off state, as a result of that all our electrical appliances should be off condition.

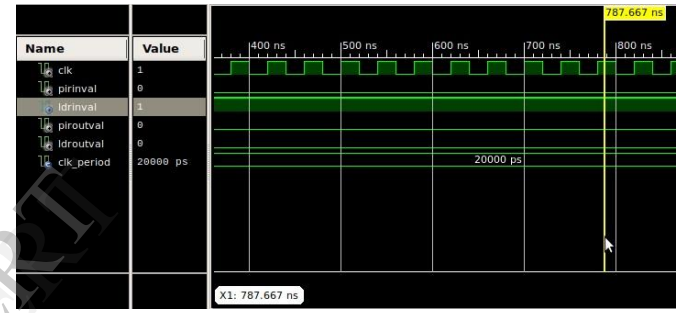

Figure.6. Simulation result for pir OFF & ldr ON mode

Figure.6 shows simulation result when PIR OFF state and even though LDR's ON state, indicates prensence of students in classroom is false irrespective of other changes the result of that all our electrical appliances should in OFF condition.

Figure.7 shows simulation result when PIR ON state and LDR's OFF state, indicates prensence of students in classroom is true as a result corresponding fan will turn on and intensity of light is sufficient so that all lights will be remains turn off condition.

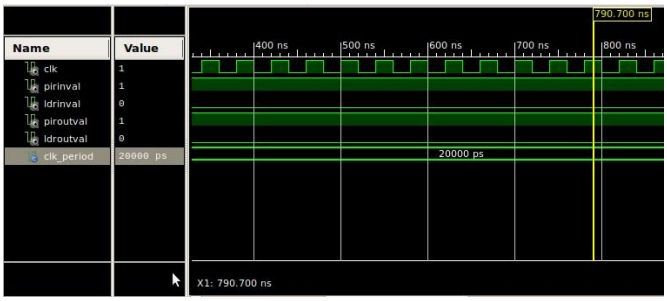

Figure.7. Simulation result for pir ON & ldr OFF mode

Figure.8. Simulation result for pir ON & ldr ON mode

Figure.8 shows simulation result PIR and LDR's both are in ON state, indicates prensence of students in classroom is true as a result corresponding fan will turn on and intensity of light is not sufficient so lights will be turned ON.

VI. CONCLUSION AND FUTURE WORK

With the proposed system, the system can reduce the wastage of electricity in a single classroom. In future the system can be implemented for the whole institution and also in wireless manner. If this system is implemented to all the class rooms in the college then huge amount of Power can be saved as represented in TABLE I.

TABLE I

Implementation of the Proposed System	No. of Fan	No. of Light	Total Power Saved/Hour
Single classroom	4	4	1000 watts

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